BOOK 3
DETAILED SPECIFICATIONS
PART 3 OF 3

STATE / LAKE LOOP ELEVATED STATION

CDOT PROJECT ID: D-1-209
SPECIFICATION NO.: 1269715

CITY OF CHICAGO

BRANDON JOHNSON
MAYOR

Prepared by
Department of Transportation (CDOT)
Contracts Section

THOMAS CARNEY
Acting Commissioner of Department of Transportation
2 N. LaSalle Street, Suite 1110
Chicago, Illinois 60602-2570

DANIEL BURKE, P.E., S.E.
Managing Deputy Commissioner – Division of Engineering

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AILEEN VELAZQUEZ
CHIEF PROCUREMENT OFFICER

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All Signatures To Be Sworn To Before A Notary Public

Any contract entered into as a result of this bid process is governed by the terms and conditions set forth in Book 1 "Terms and Conditions for Construction" for CDOT FTA, as amended and incorporated as if fully set forth here by this reference; and by Book 2, Book 3 (if applicable), plans, drawings, exhibits, and attachments as appropriate.

SECTION 31 15 00

STRUCTURAL SHORING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 01 Specification sections, apply to this section.

1.02 SUMMARY

A. General: This section specifies requirements for temporary shoring (earth retention system excluded) of buildings and facility structures, existing and/or proposed bridge and rapid transit structures, and any other construction and structure during demolition and construction operations, which require temporary support for stability and/or serviceability. The work under this section must include all labor, material, tools, and equipment required to design, provide, install, maintain, monitor, and remove temporary support in a safe and controlled manner to facilitate removal, relocation, repair, additional new structure and related work as shown on the drawings, specified herein and directly by the Authority.

B. Review these documents for coordination with additional requirements and information that apply to work under this section.

C. Related Sections:

1. Section 02 16 10 – Monitoring Adjacent Structures During Construction Activity
2. Section 02 41 19 – Selective Structure Demolition
3. Section 03 20 10 – Concrete Reinforcement Epoxy Coated

   a. Concrete reinforcement for structural shoring needs not be epoxy coated, unless the structure shoring is anticipated to be in service carrying vehicle or track loading for more than a one-year period for bridge or track structures.

4. Section 03 30 00 – Cast-In-Place Concrete
5. Section 05 10 30 – Structural Steel
6. Section 31 20 00 – Earth Moving
7. Section 31 50 00 – Excavation Support and Protection

1.03 REFERENCES

A. General:

1. CTA Infrastructure Design Criteria Manual (IDCM) Chapter 7, Structural. Unless otherwise noted, all references included in this Section must be current one published at the time of contract solicitation.

2. In addition to the references specified herein, all material specific design references specified in the Drawings must be used for the shoring structure design.

3. Material used for the shoring structures must comply with these Specifications as referenced in 1.02 C, Related Sections.

B. Building and Facility Structures:

1. American Society of Civil Engineers (ASCE 37) “Design Loads on Structures During Construction”.
2. American Institute of Steel Construction (AISC) Design Guide 10 Erection of Low-Rise Structural Steel Buildings, Section 3.3

C. Bridge Structures:

1. AASHTO Guide Design Specification for Bridge Temporary Work

D. Track Structures:

1. American Railway Engineering and Maintenance of Way Association (AREMA) “Manual for Railway Engineering”.

1.04 DEFINITIONS

A. The Contractor’s Engineer is defined as be a licensed Structural Engineer in the State of Illinois and experienced in the design of the type of shoring to be designed.

B. When the term “Design” is used in this Specification section, it must be understood as the Contractor’s Design.

C. When the term “sealed” is used in this Specification section, it must be understood as sealed structural calculations, drawings, or letters by the Contractor’s Engineer.

1.05 SHORING DESIGN REQUIREMENTS

A. General:

1. Design drawings and calculation must be prepared by the Contractor’s Engineer based on the requirements listed in this Section.
2. The Design and details must be prepared in accordance to the Contractor’s staging for construction, as detailed in the contract documents. Staging must incorporate any Designer of Record (DoR) requirements listed in the “Suggested Staging/Shoring” drawings of the contract documents.
3. The Design must ensure the stability and integrity of the structure during construction and/or demolition and removal.
4. The shoring system shall be able to maintain lateral stability under any jacking operation.
5. The Design must not damage or otherwise lessen the quality or life of any portion of the structure that is to remain.
6. The Design must consider potential risks to the proposed shoring system including, but not limit to, underground utilities, adjacent structures, traffic, construction equipment impacts etc.
7. Contractor’s Engineer must determine the adequacy of existing structure at time of shoring installation to resist the concentrated force imposed through jacking device. Design must include details to distribute concentrated forces.

B. Building and Facility Structures

1. For temporary shoring used during construction or repair of building and facility structures that are not open to public. Design loads must comply with American Society of Civil Engineers (ASCE 37) “Design Loads on Structures During Construction”, with the

following modifications and clarifications:

- a. Section 1.2, the use of Ultimate Strength Design (USD) is not allowed.
- b. Section 1.4, the use of other authoritative documents is not allowed, unless otherwise approved by the Authority.
- c. Section 2.4 does not apply. Sections 1.03 C and D of this specification apply to bridge and track structures.
- d. Table 4-4, very light duty and light duty working load are not permitted to use. The minimum working load must be 30 psf, unless medium duty or heavy duty are required based on the specific construction.
- e. Chapter 5 – Lateral Earth Pressure does not apply to this Specification.
- f. Section 6.2, the minimum wind pressure of 20 psf must apply.
- g. Section 6.5 does not apply to this Specification.
- h. When loads are determined with ASCE 37, material capacity overstress is not allowed.
- i. For temporary shoring required for steel building and facility structures erection, an additional stability load must be included per AISC Design Guide 10 Section 3.3.

2. For temporary shoring used during construction or repair of building and facility structures that are open to public, design methodologies and design loads in the Contract Documents must be used for the shoring structure design. Connection between the permanent structures and temporary shoring structures must have positive connection with mechanical fasteners.

C. Bridge Structures:

1. For temporary shoring used during construction or repair of bridge structures when bridge is not open to public vehicle traffic, or partially closed and the temporary shoring structure is not used to public support vehicle traffic. Design Loads must comply with AASHTO Guide Design Specification for Bridge Temporary Work Section 1 and 2, with the following modifications and clarifications:

- a. Section 2.0, the drawings and calculations must be stamped and signed by the Contractor’s Engineer.
- b. Section 2.1.2.2 Salvaged Steel ASTM A6 is not allowed. At a minimum, ASTM A36 must be provided for temporary shoring structures.
- c. Section 2.2.3, Construction live load must be a minimum of 30 psf in addition to the equipment weight and the 75 plf line load.
- d. Section 2.2.5.1, the entire section can be eliminated and replaced with “the minimum wind pressure on shoring system is 20 psf”.

2. For temporary shoring used during construction or repair of bridge structures when bridge is open to vehicle traffic and the temporary shoring structure is used to support vehicle traffic. design methodologies and design loads shown in the Contract Documents must be used for the shoring structure design.

D. Track Structures:

1. For temporary shoring used during construction or repair of track structures when track structures are not open to rapid transit traffic, or partially closed and the temporary shoring structure is not used to support rapid transit traffic. Shoring design must comply with AREMA Manual for Railway Engineer Chapter 8 Part 28 Section 28.6, with the following modifications and clarifications:

- a. Article 28.6.2 c, Construction live load must be a minimum of 30 psf in addition to the equipment weight and the 75 plf line load.

2. For temporary shoring used during construction or repair of track structures when track structures are open to rapid transit traffic, and the temporary shoring structure is used to carry rapid transit traffic. Shoring structures must be designed per AREMA Manual for Railway Engineer Chapter 8 and Chapter 15 as permanent structures.

   a. Design speed of trains must be full speed, unless otherwise allowed in writing by the Authority.
   b. Steel elements in the temporary shoring structures anticipated to be in service for less than a one year period do not need to consider fatigue. However, fatigue detail categories E', E, or D must not be used.
   c. Connection between the permanent structures and temporary shoring structures must have positive connection with mechanical fasteners. Use of frictional forces to transmit forces from steel shoring system to ground bearing pads is not permitted.

E. Additional Requirements for Track and Track Structure Profile Adjustments:

1. Where existing track and structure profile is to be adjusted as part of the construction, the shoring Design and staging plans must be developed to adhere to project specific jacking limits as noted in the Contract Documents. Shoring system must allow for elevation adjustments between short train intervals to change and/or maintain track profile as required per the Contract Documents.
2. Final profile adjustments must be based on information from the Contractor's survey and done as per the Section 02 16 10, Monitoring Adjacent Structures During Construction Activity.
3. 1/4 inch jacking limit is permitted without special modifications to connections of the existing or new structure, relative to:

   a. Parallel to tracks, from bent to bent
   b. Perpendicular to tracks from stringer to stringer (left running rail to right running rail)

4. Relative jacking limit greater than 1/4 inch: Contractor's Engineer must submit engineered plan demonstrating affected connections have sufficient rotational capacity to resist relative jacking amounts in excess of 1/4 inch.
5. Contractor must review existing track conditions to determine existence of any shims and incorporate into jacking plan.
6. Contractor's Engineer must determine the adequacy of existing structure at time of shoring installation to resist the concentrated forces imposed through jacking device. Design shall include details to distribute concentrated forces.

F. Shoring Design Calculations:

1. Design calculations shall be provided for all elements and their connections of the shoring system.
2. All controlling dimensions shall be field verified prior to fabrication.

3. The design calculations shall demonstrate that a clear, straightforward load path exists.

G. Shoring Design Drawings:

1. The suggested shoring scheme shown on the Contract Drawings are conceptual and provide criteria and/or requirements. The Contractor's Engineer must prepare all shoring design drawings. The drawings must incorporate the Contractor's phasing/staging and procedure for execution of shoring. Diagrams from product data are not an acceptable alternative to engineered drawings. At a minimum, the shoring design drawings are to include the following:

a. Provide a layout showing locations for all shoring as required by the demolition and new construction work for the project.

b. Provide a layout for all phases.

c. All layout drawings to include locations of underground utilities. Concurrence on design must be received from agencies representing underground utilities prior to final design.

d. All layout drawings to include locations of excavations. Concurrence on design must be received from the Contractor's Engineer in responsible charge for stability of the excavation, prior to final design.

e. Indicate all field-verified dimensions and conditions that affect the shoring operations.

f. The Design must show plans, elevations, and details, including connections, with adequate clarity to demonstrate how the design will adequately resist and transfer all loads into the ground.

g. All points of jacking must be detailed.

h. Detailed plan on how the structure is jacked and how the jacks are not used to support live load of trains.

H. Monitoring:

1. The Contractor must a monitoring plan for shoring per the requirements of Section 02 16 10, Monitoring Adjacent Structures During Construction Activity, for requirements.

1.06 SUBMITTALS

A. Submit the following under provisions of Division 01 Section, Submittal Requirements:

B. Contractor's structural staging/phasing/demolition drawing plans, sealed structural shoring Design drawings and calculations. Drawings and calculations are to be submitted for review at 30%, 60% and 100%, following the guidance in the Authority's Infrastructure Design Criteria Manual (IDCM) Chapter 7, for review. Connection design is not to be delegated to the fabrication shop.

C. Shop drawings must be based on and consistent with Design. Fabrication must not commence until final acceptance is obtained. The Authority's acceptance of the shop drawings must in no way relieve the Contractor of responsibility for constructability, fabrication and fit-up in the field.

D. Submit site specific Process Plan that contains:

1. Detailed construction sequences showing all steps in the shoring erection and removal.

2. Detailed sequences showing all steps in engaging and disengaging the shoring structures.

3. Provide hold points for construction verification, as per 1.07A and 3.01 B.

4. All other requirements per General Division 1 of the Specifications.

E. Product data sheets for jacking devices.

F. Product data for any proprietary devices used proposed as part of shoring.

G. Letter from Contractor's Engineer. as per 1.07 A and 3.01 B.

1.07 QUALITY ASSURANCE

A. The Contractor's Engineer must review all shop drawings and verify all dimensions and procedures. Partial submittals will be returned without review.

B. Confirmed or surveyed field dimensions must be included in drawings prior to fabrication.

C. For shoring structures specified in Section 1.04 D 2, the Contractor's Engineer must be experienced in the design of similar shoring for CTA Track Structure Shoring.

1.08 INSPECTION

A. Contractor's Engineer responsible for design of shoring must review field installations prior to transfer to transfer of load. Written confirmation that the shoring was installed per the design must be submitted to Authority for record. The Authority reserves the right to provide additional comments that must be addressed prior to load transfer.

B. Prior to disengaging the shoring structure, it is the Contractor's responsibility to provide inspection and testing reports for all permanent structures per the specific material Specifications and ensure the permanent structure is complete in either the final condition or intermediate stage condition. The contractor is also to notify CTA at least one week prior to disengaging the shoring to allow for CTA or its designee to review the permanent structure and verify that it is in compliance with the design documents, if CTA so chooses.

PART 2 – PRODUCTS

2.01 GENERAL

A. All materials and fabricated items must be furnished by an established and reputable manufacturer or supplier.

B. Refer to CTA IDCM Chapter 7 for acceptable materials, their sizes, and strength.

C. Hydraulic jacks, if used, must be equipped with check valves and shut-off valves to isolate individual rams. The system must be equipped with hydraulic pressure gauges to monitor line pressures. The system must also be equipped with a locking mechanism. The rated capacity of a jack must be a minimum of 50% greater than the calculated jacking force.

PART 3 – EXECUTION

3.01 PREPARATION

A. Prior to fabrication, the Contractor's Engineer who designed the shoring system must review and approve all shop drawings for the shoring structure, with concurrence from the Authority.

B. Contractor's Engineer must review the field installation of the Design prior to load transfer at each stage/phase of the Contractor's plan. The Contractor's Engineer must write a sealed letter for submittal to Authority certifying that the shoring installation was erected in accordance with the Design Drawings and meets its approval. This letter must be received for record by the Authority prior to transferring load to shoring.

C. The Contractor must establish and locate all lines and levels and be responsible for correct locations of all shoring.

D. The Contractor must verify the location of utilities or structures affected by shoring. Any disturbance or damage to existing structures or other property, caused by the Contractor's operations must be repaired by the Contractor in a manner satisfactory to the property Owner, at no additional cost to the Chicago Transit Authority.

E. The Contractor must verify the support base of sufficient soil capacity for the proposed shoring.

F. Connections to existing rapid transit traffic supporting columns, stringers, and cross girders must be mechanically fastened with high strength F3125 structural bolts and must incorporate existing rivet holes if possible. The recommended rivet removal procedure to be followed is provided in Specification 02 41 19 – Selective Structure Demolition. Alternate methods may be submitted for review.

3.02 STEEL FABRICATION

A. Structural steel used to carry rapid transit traffic or vehicle traffic must be fabricated in accordance with Sections 505, 506, and 1006 Steel Structures, of the IDOT Standard Specification including the current Supplemental Specifications for these Sections and applicable IDOT Guide Bridge Special Provisions. For structural steel used to carry rapid transit traffic, fabrication must also be in accordance with Part 3, Fabrication, Chapter 15 of the AREMA Manual. Where differences occur in the provisions of the IDOT Standard Specification and the AREMA Manual, the more stringent requirement must be followed, as determined by the Authority.

3.03 ASSEMBLY AND ERECTION

A. Structural steel used to carry rapid transit traffic or vehicle traffic must be assembled and erected in accordance with Sections, 506, and 1006 Steel Structures, of the IDOT Standard Specification including the current Supplemental Specifications for these Sections and applicable ID OT Guide Bridge Special Provisions. For structural steel used to carry rapid transit traffic, assembly and erection must also be in accordance with Part 4, Erection, Chapter 15 of the AREMA Manual. Where differences occur in the provisions of the IDOT Standard Specification and the AREMA Manual, the more stringent requirement must be followed, as determined by the Authority. Field welds other than those shown on the drawings are prohibited unless specifically authorized by the Authority.

B. Piles and sheet piles must be installed with vibratory hammers.

C. The sequence of work must follow that outlined in the Drawings. Any deviations must be made only with the prior approval of the Authority.

3.04 HYDRAULIC JACKS

A. Live loads of rapid transit traffic, vehicle traffic, or similar equipment must not be supported hydraulically.

B. When changing structure profile less than or equal to ¼”, live loads may be allowed to pass over the structure while it is supported by the hydraulic jacking system only when the jacking system is mechanically blocked with the locking mechanism.

C. When changing structure profile more than ¼”, jacking under live track will not be permitted. This work will be permitted with a track closure and flagger protection if the contractor’s site specific process plan for the proposed work is acceptable to the Authority.

3.05 PROTECTION

A. The Contractor must be responsible for protecting and maintaining any existing shoring of the elevated structure and platform which is affected by his shoring operations and to prevent his own shoring from disturbance by traffic and construction. When shoring structures are located on the roadway or in an active construction area with heavy equipment and may be subjected to vehicle collision, shoring structures must be designed to withstand vehicle collision force specified in CTA IDCM Chapter 7 Section 7.3.15, or IDOT standard F shape barriers can be installed to redirect errant vehicles.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of STRUCTURAL SHORING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of STRUCTURAL SHORING shall be included in the contract lump sum price as shown in the Schedule of Prices for STRUCTURAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Structural Work: 030000

END OF SECTION

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work under this section shall include all labor, materials, tools, equipment and incidentals required as necessary. This section includes but is not limited to the following:

1. Preparing and grading subgrades.
2. Excavating and backfilling of foundations and footings, column foundations, piers, and other structures.
3. Soil and grading for planters, trees, shrubs, and landscaping.
4. Removal and disposal of unsuitable soil or subgrade materials. Removal and stockpiling of material suitable for backfilling.
5. Providing, installing and compaction of fill and backfill materials.
6. Any other earthwork as shown on the drawings or required for installation of the new or temporary work.

1.03 RELATED WORK

A. Related work specified elsewhere includes:

1. Section 02 41 19 – Selective Demolition

2. Section 31 23 13 – Subgrade Preparation

3. Section 31 23 19 – Dewatering Excavations

4. Section 31 23 23 – Granular Backfill, CA-6

5. Section 32 11 16 – Sub-base

6. Section 32 13 13 – Concrete Pavement

1.04 REFERENCES

A. Definitions

1. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal or stockpiling materials removed.
2. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Commissioner. Unauthorized excavation, as well as remedial work directed by the Commissioner, shall be at the Contractor’s expense.

   a. Fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Commissioner. Unauthorized excavation may also be filled with compacted granular fill as approved by the Commissioner.

3. Unsuitable materials: Material which cannot be left in place for structural support of subsequent construction as determined by the Commissioner or material contaminated with fuel oil, lead, arsenic or any other regulated substances.
4. Additional Excavation: When excavation has reached required subgrade elevations, notify the Commissioner, who will make an inspection of conditions. If the Commissioner determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by the Commissioner.
5. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subballast, drainage fill, or topsoil materials.
6. Structure: Buildings, stations, relay houses, roadway lighting, tracks, equipment, signs, foundations, piers, footings, slabs, curbs, or other man-made stationary features occurring above or below ground surface.

1.05 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Except as modified herein, the work shall be performed in accordance with the applicable portions of the IDOT SSRBC.

1. Except as modified herein, the work shall conform to the applicable portions of Section 502 of the IDOT SSRBC.
2. Excavation of unsuitable material shall conform to Section 202 of the IDOT SSRBC and Section 026100.10 of these Specifications.
3. The installation of porous granular backfill shall conform to Section 209 of the IDOT SSRBC.

C. Testing and Inspection Service: Contractor will employ and pay for a qualified independent geotechnical testing and inspection laboratory to perform soil testing and inspection service during earthwork operations as required by the Commissioner.

D. Follow all applicable regulations, codes and ordinances when removing, transporting and disposing of contaminated subgrade materials and as specified in Section 026100.10 of these Specifications.

1.06 SUBMITTALS

A. Submit each item in this Article according to the conditions of the contract and Division 01 Specification Sections, for approval, unless otherwise indicated:

B. Test Reports: As required by the Commissioner, submit the following reports directly to the Authority from the testing services, with copy to the Contractor:

1. Verification of suitability and bearing capacity of subgrade material at all foundations, in accordance with specified requirements.
2. Field reports; Including daily observations, in-place soil density tests and gradation analysis reports.
3. Test reports of unsuitable and contaminated soil or subgrade material.

C. Procedures, certificates, permits, transport and land fill manifests, etc. for removal and disposal of contaminated soil or subgrade materials.

D. Submit to the Commissioner diagrams and load data for equipment to be used on-site.

E. Test and Inspection program describing the required test to be carried out during removal, placement and compaction of soil. The program shall describe monitoring and oversight activities by the contractor's quality staff to ensure compliance with all requirements specified in contract documents and approved submittals. Advance notice of compaction efforts must be given to the Commissioner.

1.07 PROJECT CONDITIONS

A. Site Information:

1. Soil conditions are assumed to meet the design criteria implied by the details indicated on the drawings.
2. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

B. Existing Utilities: Locate existing underground CTA, public, and private utilities, including cables, in areas of excavation work. If utilities and cable are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

1. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, inform the Commissioner immediately. Cooperate with the Commissioner and utility companies in resolving conflicts, maintaining existing facilities, relocating existing facilities, providing access for facility relocation by others, and in keeping respective services and facilities in operation. Repair any damaged utilities to satisfaction of utility owner. Coordination by the Contractor will not be paid for separately but is included in the cost of the contract.
2. Do not interrupt existing or temporary utilities serving facilities occupied by others, except when permitted in writing by the Commissioner and then only after acceptable temporary utility services have been provided. Provide minimum of 48-hour notice

   to the Commissioner, and receive written notice to proceed before interrupting any utility.

C. Use of Explosives: Use of explosives is not permitted.

D. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

1. Operate warning lights as recommended by authorities having jurisdiction.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
3. Protect pedestrian traffic from excavations. Provide barricades and temporary concrete barriers as necessary and approved. Re-route traffic from traffic areas to be excavated.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

A. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SW, SP, and SM.

B. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT. Unsuitable materials shall be classified as material which cannot be left in place for structural support of subsequent construction as determined by the Commissioner or material that is contaminated.

C. Aggregate Base Course shall be type “A” in accordance with Section 301 of the IDOT SSRBC.

D. Subbase Material: To be used under paved areas shall be naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, and natural or crushed sand, gradation CA-6 in accordance with IDOT Section 1004 of the IDOT SSRBC.

E. Backfill and Fill Materials: Satisfactory soil materials free of expansive clay, rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, wood, glass, metals, organic material, vegetation, concrete, bituminous pavement, masonry and other deleterious matter from on-site excavation, or CA-6 as per applicable portions of the IDOT SSRBC 2012, Section 1004. In addition, the material shall have a standard dry density of not less than 90 pounds per cubic foot when tested in accordance with AASHTO T99 and shall not possess an organic content greater than 10% when tested in accordance with AASHTO T194.

F. Granular fill or backfill shall be crushed coarse aggregate having a CA-6 gradation conforming to applicable portions of the IDOT SSRBC, Section 1004.

G. Porous granular backfill shall have a CA-18 gradation conforming to Section 1004 of the IDOT SSRBC.

H. Bedding Material: Bedding material shall be coarse aggregate having CA-11 gradation conforming to Section 1004.01 of the IDOT SSRBC. This material shall be used in all pipe trenches.

I. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, ASTM D448, coarse aggregate grading size 57, with 100 percent passing a 1-1/2 inch sieve and not more than 5 percent passing a No. 8 sieve.

J. Filtering Material: Evenly graded mixture of natural or crushed gravel or crushed stone and natural sand, with 100 percent passing a 1-1/2 inch sieve and 0 to 5 percent passing a No. 50 sieve.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

L. The use of chats, wet bottom boiler slag or slag sand shall not be allowed for fill.

M. Bearing soil or subbase for the installation of concrete foundation work shall be of 2500 psf bearing capacity minimum or as indicated in the geotechnical report, whichever is the greater value.

PART 3 - EXECUTION

3.01 PREPARATION

A. Protect structures, wayside equipment, stations, elevated structures, roadway lighting, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, crushing, and other hazards created by earthwork operations. Protect landscaping as necessary.

B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. Determine the location of any underground utilities or other items or structures that may be close to the proposed excavations. Utility lines are to be flagged before beginning the work.

D. Contractor is responsible to have the limits and elevations for their excavations properly surveyed by a licensed surveyor, and clearly marked at the site.

E. Any disturbance or damage to existing structures, utilities, or other property, caused by the Contractor’s operation shall be repaired by the Contractor in a manner satisfactory to the Commissioner and at no additional cost to the Commissioner.

F. Existing pavements, alleys, curbs and sidewalks shall be saw-cut prior to removal.

G. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil bearing water runoff or airborne dust to adjacent properties.

3.02 STABILITY OF EXCAVATIONS

A. General: Comply with local codes, ordinances, and requirements of agencies having jurisdiction to maintain stable excavations.

B. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfiling.

C. Shoring and Bracing: Provide materials for shoring and bracing per related work requirements specified elsewhere in contract documents, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Install as required to support excavation. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses. Removal of any temporary earth retention structure shall coincide with placement of backfill and be performed in such a manner as to ensure stability of all adjacent structures.

3.03 DE-WATERING – REFER TO SECTION 312319 DEWATERING EXCAVATIONS

3.04 EXCAVATION

A. Excavate as necessary to the extent required per the Drawings. Remove all unsuitable materials and dispose of all materials not suited for backfill including debris, rubble, abandoned structures, existing foundations and footings, stone bases, stone piers, abandoned utility structures and pipe, pavements, curbs and gutters, tiebacks, deadmen, fill and landscaping not to be reused. All unsuitable materials to be disposed of legally off site in accordance with Section 026100.10.

B. Excavate unsuitable soil or materials where indicated, under new structure, or as otherwise required. Excavate to solid bearing. Remove and dispose of properly all excavated unsuitable soil or other materials.

C. Excavations adjacent to existing utilities, ductbanks, roadways, equipment, structures, foundations and other objects which are to remain shall be performed in such a way as to insure the stability of the existing conditions.

D. All excavations shall be secured with temporary barriers.

E. Do not over excavate unless required to obtain solid bearing or remove unsuitable materials and only with Commissioner’s approval.

3.05 EXCAVATION FOR STRUCTURES

A. Any excavation on site shall include an evaluation by a licensed structural engineer in the State of Illinois to determine adequacy of the existing track structure load transfer (vertical and lateral) into surrounding soil. In the event that formwork, shoring, or other temporary works are required, it shall be documented for submission with elevations and dimensions shown within a tolerance of plus or minus 0.10 feet, and extending a sufficient distance from footings and foundations to permit placing and removal of formwork, installation services, and other construction and for inspections.

B. Excavations for footings, piers and foundations: Do not disturb bottom of excavation, Excavate by hand to final grade just prior to placement of concrete reinforcement.

3.06 EXCAVATION FOR PAVEMENTS, WALKS AND SLABS

A. Excavate surface under slabs to comply with cross-sections, elevations and grades as indicated. Excavate as required to a solid, clean subgrade free of debris.

3.07 APPROVAL OF SUBGRADE

A. Notify the Commissioner when excavations have reached required subgrade as shown on the Contract Drawings. The prepared subgrade shall be inspected and accepted prior to the placement of foundations or slabs.

B. Shape the subgrade to a fine surface conforming to the indicated cross section, and compact the top 12 inches to a minimum 95 percent of the maximum dry density of the subgrade material as determined by ASTM D 1557. Cut down all high spots, fill depressions, and recompact until the surface is smooth and satisfactorily compacted.

C. In areas designated for grading and finishing, rake or machine-grade the areas to remove stones over two inches and other unsatisfactory material; fill depressions, and finish the surface within the indicated tolerances.

D. Compaction testing shall be in accordance with Section 205.06 of the SSRBC and submitted to the Commissioner.

E. If the subgrade fails to meet the Contract compaction requirements, the unsuitable subgrade material, the Contractor shall remove such materials to the required width and depth and replace it with Course Aggregate CA-6 according to IDOT SSRBC 1004 or as directed by the Commissioner.

F. Unsuitable soil may be soil of insufficient bearing strength or soil that is loose mixed with debris. Bearing capacity to be determined by an independent testing agent. Contractor to arrange for and pay for testing as part of the contract lump sum price.

G. Insufficient bearing soil can be corrected by deeper or wider excavation or additional excavation and compacted approved fill. Additional excavation work, compacted fill or additional concrete work required and approved by the Commissioner will be paid according to the contract provisions for changes in the work. Additional excavation must be approved in writing by the Commissioner.

H. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activity, as directed by the Commissioner.

3.08 UNAUTHORIZED, EXCESSIVE OR EXTENDED EXCAVATION

A. Fill unauthorized, excessive or extended excavation under foundations or footings by extending indicated bottom elevation of concrete foundation or footing to excavation bottom, without altering required top elevation; or fill with compacted granular fill, as approved by the Commissioner.

3.09 COLD WEATHER PROTECTION

A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.

3.10 UNSUITABLE EXCAVATION

A. All unsuitable excavated material and excess material not used for backfill or subgrade shall be disposed of at a landfill approved by the Commissioner. The Contractor shall provide written authorization to the Commissioner for the use of that location.

3.11 GRANULAR FILL AND BACKFILL

A. Granular fill or backfill shall be placed in accordance with Article 207 of the IDOT SSRBC.

B. Granular fill CA-6 shall be used for filling unauthorized, excessive or extended excavations from the bottom of the excavation to the proposed bottom elevation. Granular fill shall be installed and compacted in layers of maximum depth of 6” per compacted layer.

C. Granular backfill CA-6 shall be used for backfilling above the bottom of footing elevation after use of all suitable backfill material.

D. Before granular backfill material is deposited under and around foundations, it shall contain the proper amount of moisture required for compaction as determined by the Commissioner for the material and compaction methods used. Moisture shall be added to the material during compaction to maintain the optimum moisture content +/- 3% as determined by ASTM D1557.

E. Granular fill or backfill CA-6 shall be placed in maximum lifts of six (6) inches and compacted immediately after placing to 95% maximum relative density as determined by ASTM D1557. The granular material shall be placed in the full width of the excavation with equipment as approved by the Commissioner and in such a manner which will not cause segregation and which will require minimum blading or manipulation.

F. Compaction tests shall be made at the direction of the Commissioner in accordance with Section 205.06 of the SSRBC.

G. Granular fill or backfill CA-6 shall be used as backfill beneath all areas of new and existing streets, asphalt, sidewalks, curbs or other pavements.

3.12 BACKFILL

A. General: Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.

1. In All Excavations: General backfill and fills, use satisfactory excavated or borrow material.
2. Under walks and pavements, use compacted granular fill only.
3. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall foundations and that are carried below bottom of such foundations or that pass under wall foundations. Place concrete to level of bottom of adjacent foundation.

B. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Acceptance of construction below finish grade including, where applicable, perimeter insulation.

2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
3. Removal of concrete formwork.
4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure of utilities, or leave in place if required.
5. Removal of trash and debris from excavation.
6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
7. Removal of temporary sheet piling and cribbing shall coincide with the placement of backfill and be performed in such a way as to insure the stability of all adjacent shoring and structures.

3.13 PLACEMENT AND COMPACTION OF BACKFILL

A. Place fill materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

C. Backfilling shall proceed immediately after concrete placement where applicable, but not prior to seven days after concrete placement or as approved by the Commissioner.

D. Place backfill and fill materials evenly adjacent to structures, piping, or conduit to required elevations. Prevent wedging action of backfill against structures or displacement of piping or conduit by carrying material uniformly around structure, piping, or conduit to approximately same elevation in each lift.

E. Control fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by the Commissioner if soil density tests indicate inadequate compaction.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D1557:

    a. Under structures, track, building slabs and steps, and pavements, compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
    b. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.

        1) Moisture Control: Where subgrade must be moisture conditioned before compaction, uniformly apply water to surface of subgrade material. Apply water to maintain optimum moisture content +/- 3%.

            a) Remove and replace, or scarify and air dry, fill material that is too wet to permit compaction to specified density.

3.14 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape and compact to required density prior to further construction at no additional cost to the Commissioner.

D. Settling: Where settling is measurable or observable at excavated areas after initial compaction efforts, remove surface, add backfill material, compact and replace surface. Restore appearance, quality and condition of surface or finish to match adjacent work to the satisfaction of the Commissioner.

3.15 PAVEMENT SUBBASE COURSE

A. General: Subbase course consists of placing subbase material, in layers of specified thickness, over subgrade surface to support a pavement base course. Refer to other Division 32 sections for paving specifications.

B. Grade Control: During construction, maintain lines and grades including crown and crossslope of subbase course.

C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least 12-inch width of shoulder simultaneous with the compaction and rolling of each layer of subbase course.

D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations. When a compacted subbase course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.16 FIELD QUALITY CONTROL

A. All material, fill, and backfilling operations shall be subjected to testing at the Commissioner’s discretion by a qualified testing agency retained and paid for by the Contractor and approved by the Commissioner.

B. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

1. Perform field density tests in accordance with ASTM D1557

    a. Field density tests may also be performed by the nuclear method in accordance with ASTM D2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1557. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gages in accordance with ASTM D6938.
    b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Commissioner.

2. Footing Subgrade: For each strata of soil on which footings will be placed, perform at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on visual comparison of each subgrade with related tested strata when acceptable to Commissioner.
3. Paved Area Subgrade: Perform at least one field density test of subgrade for every 2,000 sq. ft. of paved area of building slab, but in no case fewer than three tests. In each compacted fill layer, perform one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case fewer than three tests.
4. Foundation Wall Backfill: Perform at least two field density tests at locations and elevations as directed.
5. If in opinion of Commissioner, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained.
6. Subgrade and Subballast: Perform a minimum of five (5) in-place field density tests per lift for every 15,000 sq. ft. but in no case fewer than three tests or as directed by the Commissioner.

3.17 DISPOSAL OF EXCESS AND WASTE MATERIALS

A. Removal from the Commissioner’s Property: Remove waste and excess materials, including unacceptable or excess excavated material, trash, and debris, and dispose of it legally off Commissioner’s property.

B. The Contractor shall furnish the Commissioner with information on the manner and location of disposal as well as evidence of their authority to use the location.

3.18 REMOVAL AND DISPOSAL OF UNSUITABLE MATERIAL

A. Material contaminated with fuel oil, lead or any other regulated substance must be excavated, removed and disposed of properly as hazardous waste at landfills approved by the Commissioner. All local, state, federal, OSHA, USEPA, and any other applicable regulations must be adhered to for the handling, transport, and disposal of such material. This contaminated material may be encountered during excavations, or may be otherwise identified by the Commissioner.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of EARTH MOVING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of EARTH MOVING shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 31 20 00

SECTION 31 23 10

EXCAVATION, TRENCHING AND BACKFILLING (UTILITIES)

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This specification includes the requirements for excavation, bedding, backfilling and compaction, of utility trenches for watermain, sewer mains, gas mains, electric & telecommunication conduits and associated appurtenances.

1.03 RELATED SECTIONS

A. Section 01 55 26 – Traffic Control.

B. Section 31 20 00 – Earth Moving.

C. Section 31 23 19 – Dewatering Excavations.

1.04 REFERENCES

A. CDOT Regulations for Openings, Construction and Repair in the Public Way (CDOT Specifications), January 2014.

B. IDOT Standard Specifications for Road and Bridge Construction (SSRBC), latest edition.

C. IDOT Supplemental Specifications and Recurring Special Provisions (SSRSP), latest edition.

D. ASTM D1557 - Laboratory Compaction Characteristics of Soil, latest edition.

E. Department of Labor, Occupational Safety and Health Administration 29 CFR Part 1926, Occupational Safety and Health Standards – Excavations; Final Rule (OSHA), latest edition.

1.05 DEFINITIONS

A. Soil types are defined as follows.

1. Trench Excavation. Excavation of soil for the purpose of installing utilities and their appurtenances, and for the restoration of surface features. The excavated material maybe classified as either clay or sandy soil, a mixture of each, and may contain varying mounts of loam, silt, gravel, organic material, or rock fragments less then one (1) cu yd in volume. Trench excavation excludes all material defined as Rock Excavation and Unsuitable Soil.
2. Rock Excavation. Excavation of naturally occurring deposits of limestone, sandstone, shale or other indigenous rock occurring as bedrock, rock ledges, outcroppings, or boulders, one (1) cu yd or larger in volume necessitating removal by the use of systematic drilling, expansive jacks, or backhoe mounted pneumatic hole punchers or rock breakers.
3. Unsuitable Soil Materials. This soil material includes varying amounts of material classified as slag, cinders, trash, debris and rubble; organic or contaminated soil and material; asphalt and concrete pavements (including aggregate sub-base); sidewalks and curbs; concrete slabs concrete or masonry foundations; metal beams, bracing, and sheet piling; or similar matter.

1.06 SUBMITTALS

Note: Any utility excavations greater than 12 feet must be submitted to the Office of Underground Communication before a building permit can be issued.

A. Submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples must be submitted in accordance with Book 1 – Terms and Conditions for Construction, latest edition, issued by the City of Chicago, Department of Procurement Services.

B. Provide to the Commissioner copies of all contractual agreements, permits and / or licenses for proposed disposal sites for all material and waste removed from the job site. C. Excavation Support Systems:

- a. Prepare and submit a written schedule and procedure, along with detailed drawings, of the proposed excavations and excavation support systems.
- b. Include installation procedures; method of concrete placement; excavation sequence; interface details; protection measures for existing structures and facilities; instrumentation and monitoring procedures to check performance, sequence, and method of removal; and contingency plans for excessive wall or foundation movements.
- c. The program must take into account that excavations cannot extend beyond the right-of-way into adjacent properties above or below grade, unless otherwise indicated. Where Contractor requires the installation of part of excavation protection system on private property, the Contractor will be solely responsible for securing permission from adjacent property owners to access and install such temporary and permanent systems.
  - 1) Any such permission from adjacent property owners must be in writing, and the owner's signature, granting such permission, must be witnessed and properly notarized. Certified copies of all such permissions must be submitted to the Commissioner for record purposes.

D. Shop Drawings: Submit Shop Drawings and specifications for support systems, lagging, and internal bracing. Include the following:

- a. Specific description of field quality control measures.
- b. Details of interface with permanent structures.
- c. Details of bracing struts and wales, if used, and the proposed installation procedures, including method and sequence of preloading.
- d. Details of required preloading systems, pre-stressing systems, load measuring facilities, systematic schedule of preloading and pre-stressing operations, and sequence of construction.
- e. Method and details for securing lagging in support system openings.
- f. Proposed method of providing for utility penetrations.
- g. Assembly and erection details of members and connections for the system.

E. Plating of Excavations: When requested submit design calculations stamped by a Structural Engineer Licensed in the State of Illinois as proof of the structural integrity of the plating provided.

F. Calculations: Submit appropriate design calculations to support Shop Drawings. Include maximum theoretical deflections of supporting members. Include calculations indicating the expected magnitude of vertical and lateral movement.

G. Professional Engineer's Certification: The excavation support systems program, Shop Drawings, calculations, and test reports must be prepared, sealed, and signed by a professional structural engineer currently registered in the State of Illinois.

H. The Contractor, before starting work, must submit to the Commissioner for approval, a layout of his construction procedures and the equipment to be used in maintaining the trees in place without damage.

I. Provide for CLSM (Flowable Fill) backfill quality control (QC) and quality assurance (QA) in accordance with the IDOT SSRSP, Check Sheet #31 “Quality Control Quality Assurance of Concrete Mixes”.

PART 2 - PRODUCTS

2.01 GENERAL

A. Pipe bedding and trench backfill material must conform to the requirements and gradation specified in Section 1003, Fine Aggregates (FA), or Section 1004, Coarse Aggregates (CA), of the SSRBC.

B. Coarse Aggregate (CA) material classified, as Chert or Novaculite Gravels, or Slag from any source, are not permitted for use as bedding or backfill material.

C. Fine Aggregate (FA) material classified as Silica Sand, Slag Sand from any source, or Construction Debris Sand, are not permitted for use as bedding or backfill material.

D. All material must be dry and free of organic matter, clay, garbage, paper, wood or similar material, boulders or large particles of frozen material.

E.

2.02 PIPE BEDDING

A. Pipe Bedding for Water Main Construction Coarse aggregate (CA) material classified as mechanically crushed gravel, mechanically crushed stone, mechanically crushed limestone, or mechanically crushed recycled concrete conforming to IDOT gradation CA-16 for water mains 16 inches in diameter or smaller, CA-11 for water mains larger then 16 inches in diameter, unless otherwise authorized by the Commissioner. Material must be washed, angular, have uniform properties, and non-corrosive. Material must have a pH range between 7.5 and 10.

B. Pipe Bedding for Sewer Main Construction Coarse aggregate (CA) material classified, as crushed gravel, crushed stone or crushed concrete must conform to gradation CA-11, unless directed otherwise by the Commissioner. Material must have a pH range between 7.5 and 10.

2.03 BACKFILL MATERIAL

A. Backfill Material for Water Main Construction

1. Coarse aggregate (CA) material classified as mechanically crushed gravel, mechanically crushed stone, mechanically crushed limestone, or mechanically crushed concrete conforming to IDOT gradation CA-16 unless authorized otherwise. Material must be washed, angular, have uniform properties, and non-corrosive. Material must have a pH range between 7.5 and 10.

B. Backfill for Sewer Construction

1. Fine aggregate (FA) material classified as sand, crushed concrete sand or stone sand must conform to gradation FA 6 unless directed otherwise by the Commissioner.

C. Controlled Low Strength Material, CLSM (Flowable Fill Material)

1. Materials for Flowable Fill must meet requirements of IDOT SSRBC Sections 593 and 1019 for Controlled Low Strength Material, CLSM.

   a. Flowable fill material placed adjacent to water mains must be of a non-fly ash type mix design, mix # 2.

2.04 GEOTEXTILE FABRIC

A. Geotextile fabric must be Fabric for Silt Filter Fence and must conform to the requirements of Section 1080.02 in the SSRBC.

2.05 AGGREGATE FOR STABILIZATION OF TRENCH BOTTOMS

A. When required aggregate used to stabilize trench bottoms must have an aggregate such that the majority of the material passes a 1½ to 2½-inch sieve, with no more than 10% of the material passing the No. 16 sieve. The quality of the aggregate must meet requirements established for aggregate bedding.

PART 3 - EXECUTION

3.01 WORK AREA PREPARATION

A. Existing Work Area Condition

1. All information on subsurface exploration available to the Commissioner, if any, will be made available to the Contractor for examination. However, Commissioner in no way takes responsibility for, the interpretation, accuracy, or thoroughness of the information. It will be the responsibility of the Contractor to make such subsurface explorations as deemed necessary, to supplement information provided by the Commissioner, at no additional cost to the Commissioner.
2. Prior to excavating, thoroughly investigate the limits of the proposed trench to ascertain the existence and location of any underground structures, existing utilities or other items that might interfere with the pipe installation. Notify the Commissioner of any obstructions that will prevent the installation of the pipe or appurtenances as indicated on the Drawings. Contractor shall call DIGGER at 312744-7000 prior to excavation activities to have all existing utilities marked in the field.

B. Clearing Work Area

1. Before starting trench excavation, all obstructions, which must be removed or relocated, must be cleared. Pavement, curbs, walks, trees, shrubs, utility poles, and other structures, which are to be preserved, must be properly braced and protected. Unless otherwise shown or directed by the Commissioner, all trees and large shrubs must be preserved with minimal damage inflicted on the root structure. When required, small trees and shrubs may be removed and replaced with equivalent specimens if approved in advance by the Commissioner.

C. Segregation and Disposal of Soil Material

1. Surplus excavated material and excavated material unsuitable for backfilling, final grading, and landscaping, must be transported off of the Site and disposed of in disposal areas obtained by the Contractor and approved by the Commissioner.
2. Excavated material must not be stockpiled along the route of the work unless authorized beforehand by the Commissioner.

D. Pavement Removal

1. The Contractor must saw cut all concrete and asphalt pavements to their full depth prior to breaking and removing the pavement. On pavements consisting of an asphalt overlay on a concrete base, the Commissioner reserves the right to order the removal of up to 6 additional inches beyond the edge of the concrete base. This additional asphalt removal must be removed to a neat saw cut edge and will be considered incidental to the Work.
2. Utilizing drop weight equipment for the purpose of breaking the pavement is not permitted.

E. Protection or Removal of Existing Trees

1. Comply with CDOT Specifications Chapter 4, “Excavation Pavement Removal” for protection of trees, shrubs, and other improvements.
2. The Contractor is not permitted to remove trees beyond the limits of the trench excavation except as specified in these Specifications, or as shown on the Plans, or as ordered by the Commissioner.
3. The Contractor must arrange his construction operations and use the necessary equipment required, so as not to remove or damage any existing trees due to the Work to be performed under this Contract.
4. To protect the trunks of existing trees from damage, the Contractor must place 2" x 4" boards, six (6) feet long, vertically and about 6 inches apart around all trees located in the parkways along the route of the work. The boards must be held in place by wire looped around the circumference of the tree trunk. After completion of all work, the protective boards and wires must be carefully removed.
5. Any pruning of trees and roots required to permit the operation of the Contractor's equipment must be kept to a minimum, subject to the approval of the Commissioner, and must be done symmetrically by a licensed arborist. The arborist is required to obtain a permit from the City of Chicago, Bureau of Forestry, Plans and Permits Section of the Department of Streets and Sanitation, to trim and spray or in any way affect the general health or structure of trees in the public way. Prior to this approval, the Bureau will conduct an investigation at the sites of the proposed sewer. They will work with the Resident Engineer and the Contractor, and request 48-hour notice prior to starting any tree work.

F. Trench Excavations Over 12-feet Deep

1. Comply with CDOT Specifications Chapter 4, “Excavation Pavement Removal” for trenches over twelve (12) feet deep.

G. Excavating Over or Adjacent to Existing Utilities

1. The Contractor must verify the location of existing utilities in the vicinity of the work before starting construction. The Contractor is responsible for protecting, and repairing utilities damaged by the work under of this contract, at no additional cost to the City. The Contractor must coordinate all work with the owner of the utility.

H. Erosion Control

1. Install geotextile fabric under each storm inlet, catch basin and sewer manhole cover to prohibit dirt, debris and backfill material from entering the sewer system, but to permit drainage. The geotextile fabric is to be maintained until restoration is completed. After restoration is completed, remove the geotextile fabric.

I. Plating of Excavations

1. Unattended excavations in public streets, alleys, driveways, and walkways necessitated by the work must be plated, if the excavation has not been backfilled, or a temporary paved surface has been provided, or specifically authorized otherwise by the Commissioner.
2. Steel Plate(s) must be large enough to safely span the excavation with sufficient overlap beyond the edge of the excavation to provide firm support as appropriate for the type of pavement and soil encountered. Plate(s) must be firmly bedded and secured to the adjacent pavement to prevent rocking or movement, and of adequate thickness

to carry anticipated loads. When plating is left in place during off-work periods, or if the Commissioner feels vehicular or pedestrian safety may be compromised, a bituminous ramp is to be provided at the perimeter of the plate(s) as appropriate to provide a smooth transition between the surface of the plate(s) and the adjacent pavement or walkway.

3. Plating subjected to vehicular traffic must be capable of carrying AASHTO H-20 traffic loading without movement or excessive deflection. The plating must be secured to the adjacent paved surface in such manner so as to prevent rocking or other movement which could expose the excavation. The name of the Contractor must be indicated on both sides of the plating.
4. When steel plates are used and left in place beyond normal working periods, a bituminous ramp must be provided at the perimeter of the plate(s), to provide a smooth transition between the surface of the plate(s) and the adjacent street pavement or walkway, unless authorized otherwise.
5. Plating of excavations is not intended as a substitution for providing traffic control, which must be provided in accordance with Section - 015526 of these specifications.

J. Protection of Existing Water Main from Contamination: Protect existing water mains from contamination by groundwater, dirt, debris, or other foreign material:

1. Prevent groundwater and surface water, dirt, debris, and other foreign material from entering the open pipe.
2. Provide water tight temporary closure of pipe before leaving work site at the end of the work day.
3. Equipment, cables, hoses, supports and all appurtenant equipment placed in the water main must be thoroughly cleaned of dirt and debris, and disinfected with chlorine solution with a chlorine concentration of at least fifty (50) parts per million.
4. Workers entering pipe must wear clean temporary disposable coveralls.
5. Install foot bath and brush and have workers entering the pipe clean footwear with chlorine solution with a chlorine concentration of at least fifty (50) parts per million.

3.02 EXCAVATION PROTECTION

A. General Requirements

1. Excavations must be protected in accordance with applicable rules, laws and regulations of Federal, State and City ordinances applicable to underpinning, shoring of excavations, and other work affecting adjoining property and the safety of worker, but must not be less than the standards and regulations established by OSHA.
2. All excavation, trenching, and sub-grade work shall require a licensed structural engineer to review and provide their seal and signature on calculations that either prove the soil as proposed for excavation and/or trenching is adequate to resist both vertical and lateral forces, or that temporary shoring and bracing systems (whether pre-engineered or site constructed) can resist both vertical and lateral forces.
3. Structural support systems are required for all excavations exceeding five (5) feet in depth. Structural support systems are to be used in all excavations in soils that are determined to be unstable or subject to cave-ins, regardless of the depth of the excavation.

4. Protective systems for any excavation exceeding ten (10) feet in depth must be designed and approved by an Structural Engineer licensed in the state if Illinois.
5. The Contractor must remove and replace, or provide the means to support any surface features when their location posses a hazard to workers in the excavation.
6. Whenever excavations cross the location of an existing underground utility, the Contractor must proceed with caution and use appropriate methods of excavation to avoid damaging the utility. The Contractor is responsible for coordinating all work with the owner of the utility.
7. Ramps, runways or ladders must be provided for ingress and egress by workers from excavations exceeding four (4) feet in depth in accordance with OSHA.
8. Surface or ground water entering excavations must be controlled by the use of appropriate equipment. If the trench interrupts the natural flow of surface water, diversion ditches or dikes must be used.

B. Protection of Adjacent Structures

1. When the stability of adjoining buildings, walls, sidewalks, pavements or other structures are endangered by the excavation operations, structural support systems such as shoring, bracing or underpinning must be used to ensure the stability of the structure.
2. The Contractor is responsible for posting and issuing all notices required to inform adjacent or adjoining property owners or other parties and such notice or notices must be served in sufficient time as not to delay the progress of the Work under this Contract.
3. Excavation requires either of the following:

    a. A Structural Engineer or Professional Engineer licensed in the state of Illinois has determined that the structure is located far enough away from the excavation so as to be unaffected, or
    b. A Structural Engineer licensed in the state of Illinois has designed and approved a structural support system to provide adequate protection to the existing structure.

C. Structural Support Systems Structural support systems may consist of pre-engineered systems such as aluminum hydraulic shoring, trench shields, trench boxes, or systems constructed on the job site such as timber or steel shoring or steel sheet piling.

1. Pre-Engineered System

    a. Pre-engineered structural support systems installed in accordance with the manufacturer’s recommendations do not require certification by a Structural Engineer when trench depth is less than twenty (20) feet. However, the Commissioner, at his sole discretion, may require a manufacturer’s certification indicating the support system is suitable for the intended use and site conditions.
    b. Pre-engineered structural support systems will require analysis and certification by a Structural Engineer licensed in the state of Illinois, when trench depth exceeds twenty (20) feet.

2. Site Constructed Systems

    a. Construct steel sheet piling system in accordance with Division 05 of these Specifications.
    b. Structural support systems built in place and made of timber constructed in accordance with OSHA Standards, do not require certification by a Structural Engineer licensed in the state of Illinois, provided trench depths shown in the OSHA Standard, relative to the soil type at the site, are not exceeded.
    c. If the OSHA Standard is not followed for timber shoring and the depths of trenches exceed those in the tabulated data; or soil conditions have been determined to be substantially different that those given in the OSHA Standard; the design must be performed and certified by a Structural Engineer licensed in the state of Illinois.
    d. A structural support system built in place and consisting of materials other than a timber shoring systems will require design and certification by a Structural Engineer licensed in the state of Illinois.
    e. When close-sheeting is used, it must be driven so as to prevent adjacent soil from entering the trench either below or through such sheeting. Tight-sheeting must be used in that portion of the excavation in or along streets or alleys below the intersection of a 1 to 1 slope line from the nearest face of the excavation to the edge of the pavement.
    f. Sheeting must not be in contact with existing pavement but must bear uniformly against the sides of the excavation.

3. Where structural support systems, such as steel or wood sheeting are used for stabilizing excavations, the width of the trench may be increased as necessary to accommodate installation of the work. When soils in the lower limits of the excavation have been determined to have adequate stability; the Contractor may end the shoring elements above the bottom of the excavation. If soil begins moving into the excavation below the shoring during construction, the Contractor is solely responsible for making corrections to the excavation and for lowering the shoring, at his own expense.
4. When structural support systems are required to be left in place, they must be cut off at the same elevation as the bottom of the water main, unless otherwise directed by the Commissioner. Bracing that is to remain in place must be driven up tight. The right of the Commissioner to request sheeting and bracing to be left in place, is not meant to construe any liability or obligation on behalf of the Commissioner to issue such orders.
5. Structural support systems that are not to be left in place may be removed only when the excavation has been backfilled to such an elevation so as to prevent the collapse of the sides of the excavation. Any voids created by the removal of the structural support system members, must be filled and compacted in an acceptable manner.

3.03 EXCAVATION

A. Trench Excavation (Open Cut)

1. The width of the trenches must provide adequate space for workers to place and join the pipe properly, and must be kept to the minimum practical width. Unless otherwise approved by the Commissioner, the total clear width of the trench at the level of the top of the pipe and at grade must be at the Neat Lines as detailed on the Drawings.
2. The Contractor must excavate a minimum of 6-inches below the bottom of the pipe unless otherwise shown, specified, or directed, so bedding material can be placed in the bottom of the trench and shaped to provide a continuous firm bearing for the pipe barrel. Bell holes must be provided for proper make-up of the joints.

3. The open excavated trench preceding the pipe laying operation and the unfilled trench with pipe in place must be kept to a minimum length causing the least disturbance. The maximum length of open trench must not exceed 300-feet unless otherwise directed by the Commissioner. Comply with Article 4G, CDOT Specifications, for other trench opening length requirements within the public right-of-way.
4. Excavation in Arterial Streets. Comply with Article 4C, CDOT Specifications, for protection requirements when working within arterial streets.
5. Contractor must saw cut existing pavement prior to excavating. Width of saw cut pavement must be such that any sheeting provided for excavation protection is not in contact with the pavement.
6. Where water is encountered in the excavation, the excavation must be dewatered in accordance with Section 312319 – Dewatering Excavation of these specifications.

B. Rock Excavation (open cut)

1. Whenever rock, stone, masonry or other hard, unyielding material is encountered at or above the required trench bottom elevation, remove it to provide a clearance of no less that 8-inches below and on each side of pipes and associated fittings, valves and other appurtenances. Backfill the over excavated area with granular bedding material.
2. Removal of Rock by blasting or by use of a drop hammer is not permitted under this contract.
3. Excavate rock as near as practicable to the outside shape of the work as shown on the Plans. Solid rock, not loosened from the adjacent solid rock, may extend within the neat outside surfaces of these shapes no more than two (2) inches, provided no single projection exceeds one and one-half (1.5) square feet in area at the neat surfaces of the excavation and provided that on any ten (10) foot section of the excavation the total area of such projection at the neat outside surfaces of the section does not exceed twenty (20) percent of the area of the section.
4. The Contractor is required to remove all loose rock and other material from the excavation and in the event that the excavation is enlarged beyond the outside shape of the sewer or sewer structures as shown on the Plans, the Contractor will not be entitled to any payment for the additional Class SI concrete needed to fill the voids caused by such over-breakage.
5. Where rock is encountered, excavate to eight (8) inches below the bottom of the pipe for bedding placement.

C. Trench Excavation (Short Tunnel Construction)

1. In some instances, trees, fire hydrants, sidewalks, and other obstructions may be encountered, the proximity of which may be a hindrance to open cut excavation. In such cases, the Contractor must excavate by means of short tunnels in order to protect such obstructions against damage. Short tunnel work will be considered incidental to the construction and no additional payment will be allowed.

D. Additional Trench Excavation

1. If the soils encountered at the elevations specified are not suitable, or it is determined necessary to go to an additional width and depth, or required to fill designated areas for work done under Section 026100.10 the excavation must be carried to such additional width and/or depth and must fill such excavated areas with approved backfill material as required or directed by the Commissioner.

E. Unauthorized Excavation

1. Wherever the excavation is carried beyond or below the lines and grades shown on the Drawings all such excavated space must be refilled with select fill materials and in such manner as may be directed in order to insure the stability of all affected structures. Beneath all structures, space excavated without authority must be refilled by the Contractor with approved backfill materials and will be considered incidental to the construction and no additional payment will be allowed.

F. Trenching Across or Over Existing Excavations or Utility Trenches

1. In the event that the trench passes over or through a previous excavation, carefully compact and stabilize the bottom of the new trench or excavation to a density equal to or greater than 95% of the maximum dry density as determined by ASTM D1557. Perform this compaction carefully to avoid damaging the existing utility or structure.

G. Special Excavation

1. Remove unsuitable materials to provide two (2) feet minimum horizontal and vertical clearance around water mains or related structures as applicable, unless otherwise directed by the Commissioner.

H. Excavation in Tunnel

1. The tunnel must be excavated and trimmed to such size and shape as will allow the placing of the full section of the pipe as shown on the Plans after all lining is in place.
2. The Contractor must excavate the tunnel and support the surrounding earth so there is no movement of the earth over or adjacent to the work at any time. The Contractor must excavate the tunnel and support the surrounding earth so at no time there is more than 5 feet, measured horizontally, unsupported by bracing as approved by the Commissioner.
3. The Contractor must use extreme care in excavating and trimming to insure that a full section will be placed without materially deviating from the correct lines and grades of the finished structure. In case, due to bad soil conditions, the Contractor requests that the outside outline of the sewer be changed to a minor extent to accommodate his method of construction, such a change will be allowed provided the strength of the structure is not impaired. Any such modification will not alter the price per foot specified to be paid for the completed sewer, whether such minor modification results in a minor addition or subtraction from the theoretical quantity for the section herein specified.
4. If permission is given the Contractor to excavate the tunnel for a specified distance without immediately placing the concrete lining, the proposed method of bracing the tunnel and the extra bracing necessary must be submitted for approval.
5. No additional payment or allowance of any nature will be made for timber cants, steel plates or other forms of tunnel lining used for supporting the earth during construction. All such tunnel lining must be left in place.

3.04 PLACEMENT OF PIPE BEDDING

A. Pipe Bedding

1. Pipe laid in trenches must be bedded in accordance with the details shown on the Drawings. Bedding material must consist of compacted; well-graded crushed stone fill material as shown and as specified, or as directed by the Commissioner.
2. Existing underground structures, tunnels, conduits, and pipes crossing the excavation must be bedded with compacted sand. Bedding material must be placed under and around each existing underground structure, tunnel, conduit, or pipe as required to stabilize the excavation.
3. At each joint, enough depth and width must be provided around the pipe so that joints can be properly made up.

B. Bedding Placement – Vaults and Structures

1. Pipe bedding beneath precast bases, cast-in-place bases and other foundations must be 6-Inches in thickness and thoroughly compacted in place to not less than 95% of the maximum dry density as determined by ASTM D1557.

C. Bedding and Backfill for Short Tunnel

1. Pipes placed in short tunnels must be bedded in sand. The annular space between the pipe and undisturbed earth must be completely filled with compacted sand fill material. Pipelines in short tunnels must be supported to permit the placement of backfill.

3.05 BACKFILLING EXCAVATIONS

A. General

1. All excavations must be backfilled to the original surface of the ground or to such other grades shown on the Drawings or as directed by the Commissioner. For areas to be covered by topsoil, backfill must be left 6-inches below the finished grade or as shown on the Drawings, or directed by the Commissioner. All backfilling must be done as soon as possible after the utility has been installed and inspected, and as soon as mortar for masonry or thrust blocks have sufficiently set, unless directed otherwise by the Commissioner.
2. Crushed stone fill material must be used for trench and structure backfill and other areas as shown, specified, or ordered by the Commissioner.
3. Unsuitable material and material rejected by the Commissioner must immediately be removed from the Site and disposed of by the Contractor at his expense.
4. Construction equipment used to backfill against and over cast-in-place concrete structures must not be permitted to travel over these structures until the designated concrete strength has been obtained, as verified by concrete test cylinders. In special cases where conditions warrant, as determined by the Commissioner, the above restriction may be modified if the concrete has gained sufficient strength, as determined from test cylinders, to satisfy design requirements for the removal of forms and the application of load.

B. Backfill Procedure

1. Crushed stone fill material must be used for backfill where roadways, driveways, sidewalks or other pavements are to be placed on the backfill or where the edge of the trench excavation is 5 feet or less from any county or state highway, any city or village street pavement and in any trenches crossing pavements or sidewalks from a distance

beyond the edge of the pavement or sidewalk equal to the depth of the trench. Crushed stone fill material must be used as backfill in trenches parallel to roadways, driveways or other pavements from the top of the bedding to a depth below the ground surface equal to the distance between the inner face of the trench and the closest edge of the pavement.

2. Where pavements and appurtenances for streets are to be placed over the trenches, the backfill material must be placed in uniform layers not greater than 6-inches in thickness and compacted in place. Each layer must be compacted to or not less than 95% of the maximum dry density as determined by ASTM D1557.
3. All pipe sewers must be surrounded and covered by trench backfill above the granular embedment as soon as they are laid. The trench backfill must be properly compacted and tamped to a depth of at least one foot above the top of the pipe prior to placing the remainder of backfilling.
4. For sewer pipe construction with FA 6 backfill, water jet the backfill to the depth of approximately two-thirds of the depth of cover over the sewer. The distance between jetting holes must not exceed 10 foot along the length and width of the trench, or as directed by the Commissioner. Water jetting of the trench backfill must proceed as soon as practicably, as determined by the Commissioner. The Contractor, in this manner, must place and compact the trench backfill to the level of the sub-grade.
5. Excavated material can be re-used as backfill only if directed or approved by the Commissioner.
6. Trench backfilling work must be done in such a way so as to prevent damage to any pipe, utility, or structure.
7. On monolithic concrete sewers and structures cast-in-place, trench backfill must not be placed until the concrete has attained a compressive strength of 2,000 psi.

C. Backfill under a Supported Water Main

1. Backfill the open trench under the water main and 10 feet beyond the water main sides with approved material up to a level of 1-foot below the invert of the supported water main. The backfill material must be placed in layers of 12-Inches with each layer mechanically compacted to 95% of the maximum dry density as determined by ASTM D1557.
2. Place pipe bedding material from 1-foot below the water main invert to the water main centerline and compact to achieve 95% of the maximum dry density as determined by ASTM D1557.
3. Remove the water main pipe support systems, supporting beams, and pipe support straps; and cut-off and remove soldier piles to a level at least four (4) feet below finished grade.
4. The water main pipe must be inspected for leakage and joint integrity and repaired if necessary, prior to backfilling above the water main.
5. After approval by the Engineer, continue backfilling with approved material. The open trench must be backfilled up to the required sub grade level. The backfill material must be placed in layers of 12-Inches with each layer mechanically compacted to 95% of the maximum dry density as determined by ASTM D1557.

D. Backfilling with Controlled Low Strength Material (CLSM) - Flowable Fill

1. Do not place the mix on frozen ground, in standing water, or during wet weather conditions. Mixing and placing may begin only if the air temperature is 35 °Farenheit minimum and rising. At time of placement, the material temperature must be 40

°Farenheit minimum. Mixing and placing must stop when the air temperature is 40 °Fahrenheit and falling or when the anticipated air temperature will be 35 degrees F or less in the 24-hour period following proposed placement.

2. Place the mix directly from the chute into the space to be filled. Other placement methods may be approved by the Commissioner if the mix design is appropriate.
3. When backfilling against structures, place the mix in layers to prevent damage by lateral pressures. Side slopes must be stepped or serrated to prevent wedging action of the backfill against the structure. Allow each layer to harden prior to placing the next layer.
4. When backfilling pipe trench, distribute the mix evenly on each side of the pipeline to prevent movement.
5. The mix must not be exposed to freezing temperatures or wet weather conditions during the first twenty (24) hours after placement.
6. The mix may be subjected to loading upon approval by the Commissioner, or when a penetration of 39 mm / blow or less has been obtained with the Dynamic Cone Penetrometer test.
7. Backfilling against water main pipe with CLSM is not allowed, unless authorized otherwise by the Commissioner. Contractor must provide a minimum of 6-inches of coarse aggregate backfill material over the water main pipe prior to placing the CLSM material.

3.06 FINISH GRADING

A. Finish grading must be performed in accordance with the completed contour elevations and grades shown and must be made to conform to the existing ground surface. All finished graded surfaces must be left smooth and firm and graded to permit positive drainage.

3.07 TRAFFIC CONTROL

A. The Contractor is responsible for traffic control and the protection of vehicular and pedestrian traffic from the work. For detailed requirements see Section 015526.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of EXCAVATION, TRENCHING, & BACKFILLING (UTILITIES) shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of EXCAVATION, TRENCHING, & BACKFILLING (UTILITIES) shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 31 23 10

SECTION 31 23 13

SUBGRADE PREPARATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies requirements for subgrade preparation. The work under this Section will include furnishing all labor, materials, tools, and equipment required for the preparation of subgrade under roadway pavements, sidewalks and curb and gutters.

B. Except as modified herein, the work must conform to the applicable portions of the Standard Specifications, Sections 212, 301, and 606.

C. Related Sections: Related work specified, measured, and paid for elsewhere includes:
   1. Section 32 11 16: Sub-Base Granular Material, Type B
   2. Section 31 20 00: Earth Moving
   3. Section 32 16 21: Concrete Curbs, Gutters and Walks
   4. Section 32 16 23: Portland Cement Concrete Sidewalk, 5-Inch

1.03 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, Adopted January 1, 2022 or latest edition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

A. Conform to IDOT Standard Specifications for Road and Bridge Construction.

B. Refer to Section 312000 – Earth Moving

4.01 MEASUREMENT

A. The Work of SUBGRADE PREPARATION will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of SUBGRADE PREPARATION will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 31 23 13

SECTION 31 23 19

DEWATERING EXCAVATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes requirements for dewatering excavations when necessary to provide a safe working environment and protect the Work so as to provide a satisfactory installation.

1.03 SUBMITTALS

A. Refer to Book 1 for submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples.

B. Prior to commencing excavation work at the project site, the Contractor must submit to the Commissioner for review and comment a method for removing water which has entered the excavation either from groundwater sources, surface drainage, or other source such as the dewatering of a new or existing water or sewer main. The submittal must include a description of the source of the water, equipment to be used to dewater the excavation, the arrangement of the equipment, time needed to dewater the excavation, method of disposal, and discharge rate of the equipment expressed in gallons per minute. No excavation is to be started until authorization has been given by the Commissioner to proceed with the excavation work.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 PREPARATION

A. Capacity of Facilities

1. Facilities for the removal and disposal of water must be of sufficient capacity to keep the excavation dry under all circumstances.

B. Standby Facilities

1. Adequate standby facilities must be provided to insure that the excavation will be kept dry in the event of power failure or mechanical breakdown.

C. Well Points

1. If well points are used, the Contractor must make provisions for removing and resetting individual well points without taking any part of the dewatering system out of service.

3.02 CONSTRUCTION

A. Dewatering

1. At all times during the excavation period and until completion of the Work and acceptance at final inspection, ample means and equipment must be provided with which to promptly remove and properly dispose of all water entering any excavation including leakage from the existing water main which is to be replaced. All excavations associated with the Work must be kept dry. Water must not be allowed to rise over, or to come in contact with, masonry and concrete until the concrete and mortar has attained a set satisfactory to the Commissioner and, in any event, no sooner than twelve (12) hours after placing the masonry or concrete.

B. Groundwater Levels

1. The Contractor must maintain the groundwater level at least 12-inches below the bottom of the excavation until the work has been completed and the excavation has been backfilled.

C. Water Management

1. Water pumped or drained from the Work must be disposed of in a suitable manner without damage to adjacent property, other Work under construction, street pavement, and parks. Water must not be discharged onto streets without adequate protection at the point of discharge. No water containing settleable solids may be discharged into sewers.
2. All damages caused by dewatering the Work must be the responsibility of the Contractor and must be promptly repaired at the Contractor's expense.
3. Limit dewatering flow rates to current operating capacity of City sewers.

D. Pumping, Bailing and Diversion

1. The Contractor must at all times during construction provide and maintain ample means and devices for the temporary diversion of flow in existing sewers and drains and the prompt removal and proper disposal of all water or sewage entering the tunnels, trenches or other parts of the work, and must keep said excavations as dry as practicable until the structures to be built therein is completed. All water pumped or drained from the work and from existing sewers must be disposed of in a suitable manner without damage to adjacent property, or to sewers, pavements, electrical conduits or other work or property. The Contractor must provide all temporary flumes or pipe lines and pumping equipment required for the proper diversion of sewage and removal of drainage from the work.

2. Whenever the Contractor removes an existing bulkhead, he must install a screen suitable for the purpose of preventing construction debris from floating into the completed portions of the sewer system. As work progresses, Contractor must clean the completed portions of the sewer by removing rails, jacks, lumber, sandbags and all other construction equipment, excess material and debris.
3. The Contractor must place and maintain all temporary dams, flumes, bulkheads or other structures necessary to prevent water from adjacent sections of the sewer system from entering the work under this Contract in such a manner as to injure it, and must completely remove all such temporary structures from the completed portion of the work as rapidly as practicable. The Contractor must not place a dam, flume or bulkhead in any sewer without first obtaining the approval of the Commissioner. The Contractor must ascertain the possibility of sewage backing up into basements and causing damage and he will be held responsible for any such damage.
4. The City does not assume responsibility for providing the Contractor with an outlet for any storm water or sewage which must be disposed of during the construction work under this Contract. Until the acceptance of the work, the Contractor will, if so ordered by the Commissioner, keep the entire work pumped free of water and sewage and before the acceptance of any part of the work. Contractor must clean the entire length of such finished part of the work to the satisfaction of the Commissioner.
5. Water must not be allowed to flow over or stand on the pipe or structure invert in such a manner as to cause scouring of the surface.
6. Route all water pumped from trenches or other excavations to settling basins (five feet by ten feet by two feet deep with three compartments) before entering the City of Chicago sewer system. Discharge from the settling basin must be by gravity to the catch basin.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DEWATERING EXCAVATIONS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of DEWATERING EXCAVATIONS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 31 23 19

SECTION 31 23 23

GRANULAR BACKFILL, CA-6

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies requirements for GRANULAR BACKFILL CA-6. The work under this Section will include furnishing all labor, materials, tools, and equipment required for the installation and compaction of GRANULAR BACKFILL CA-6. B. Related Sections:

1. Section 31 20 00: Earth Moving
2. Section 31 23 10: Excavation, Trenching and Backfilling (Utilities)

1.03 REFERENCES

A. Except as modified herein, the work must conform to the applicable requirements of Section 1004 of the Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, Adopted January 1, 2022, or latest edition.

1.04 SUBMITTALS

A. Submit a representative sample of the CA-6 aggregate to the Commissioner for approval.

PART 2 - PRODUCTS

2.01 GENERAL

A. The material must be crushed coarse aggregate having a CA-6 gradation and conforming to the applicable portions of Section 1004 of the Standard IDOT Specifications.

B. The use of slag or similar metal bearing rocks will not be permitted.

3.01 GRANULAR BACKFILL CA-6

A. GRANULAR BACKFILL CA-6 must be uniform in gradation. Before the material is deposited at foundations, it must contain the amount of moisture required for compaction. The amount of moisture required will be determined by the Commissioner for the material and compaction methods being used. Moisture must be added to the material during compaction only when it is necessary to increase the percentage of moisture to obtain satisfactory compaction.

B. GRANULAR BACKFILL CA-6 must be placed in maximum lifts of six (6) inches and compacted immediately after placing to 98% maximum relative density as determined by AASHTO T99, Method C. The granular material must be placed in the full width of the excavation with equipment as approved by the Commissioner and in such a manner which must not cause segregation, which will require minimum blading or manipulation and which will cause no damage to adjacent or underlying structures.

3.02 TESTING

A. Testing of material is the responsibility of the contractor. The Commissioner has the option to test materials if so desired. The contractor shall use an AASHTO accredited lab for all testing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

The Work of GRANULAR BACKFILL, CA-6 will not be measured for payment.

4.02 PAYMENT

No separate payment will be made for the work covered in this section. Payment for the Work of GRANULAR BACKFILL, CA-6 will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK for all applicable work performed with the CIVIL WORK pay item account and STRUCTURAL WORK for all applicable work performed with the STRUCTURAL WORK pay item account.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

B. STRUCTURAL WORK: 030000

END OF SECTION 31 23 23

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes all labor, materials and equipment for the design and installation of temporary soil retention systems (TSRS) and the implementation of instrumentation and monitoring materials.

B. Related Sections:

1. Section 02 16 10 – Monitoring Adjacent Structures During Construction Activity
2. Section 03 30 00 – Cast-In-Place Concrete
3. Section 05 10 30 – Structural Steel
4. Section 31 15 00 – Structural Shoring
5. Section 31 20 00 – Earthwork for excavating and backfilling and for controlling suface-water runoff and ponding
6. Section 31 23 19 – Dewatering Excavations

1.03 REFERENCE STANDARDS

A. Chicago Transit Authority Adjacent Construction Manual (CTA ACM).

B. ASTM International.

1. All ASTM Standards included in the Specifications referenced in CTA ACM Section 8.

1.04 DESIGN CRITERIA

A. Temporary soil retention system (TSRS) shall conform to the requirements as shown on the Drawings and in all related chapters in the CTA ACM, unless otherwise noted herein and in this Specification.

1. Where DoR provided conditions shown in the Drawings would require any Exceptions, Waivers, and/or Variance Requests per CTA ACM, the Contractor can assume the conditions have been coordinated with CTA and a Variance Request is not required.
2. Contractor shall propose temporary soil retention and shoring systems type with the considerations outlined in CTA ACM Section 4.
3. Section 2.9 for review fees shall not apply.

B. The excavation support shall allow safe and expeditious construction of the permanent structure and shall be designed to carry the loads imposed upon it per CTA ACM Section 5, including earth pressures, vehicular traffic loading, railroad loading, utility loads, loads from adjacent structures (both temporary and permanent), ground water pressure, equipment and construction loads, with minimum movement or settlement of adjacent structures, utilities or tracks.

1. The maximum deflection at top of the excavation support shall follow the deflection criteria as specified in CTA ACM Section 7.9, unless a stricter deflection limit is specified

by CDOT and OUC for adjacent structures, utilities, and etc. Maximum allowable horizontal or vertical movement of rail is 1/4".

2. CDOT and OUC requirements apply to all excavation support used on the Authority's system.

C. The shoring analysis methodologies shall comply with CTA ACM Section 7.

D. Material properties and their allowable stress shall comply with CTA ACM Section 8.

E. The Contractor shall comply with CTA ACM Section 9 for special conditions such as sealed shoring, local stability, etc., as applicable.

F. All existing underground utilities within the excavation limit shall be located per CTA ACM Section 3.6 using Ground-Penetration Radar (GPR) at a minimum before the excavation support design. If potholing is used instead of GPR, Section 1.09 D for utility verification in the field before excavation support installation can be eliminated.

G. If open cut is used in lieu of ERS, refer to CTA ACM for soil investigation and analysis requirements.

1.05 SUBMITTALS

A. Temporary Soil Retention Systems and Excavation Shoring Systems: Submit the following according to Division 01 section, "Submittals", showing the proposed methods of construction, design and details.

B. Product Data: For each type of product.

C. Construction details, material descriptions, performance properties, and dimensions of individual components and profiles for excavation support and protection system.

D. Shop Drawings: For excavation support and protection system and temporary soil retention shoring system, prepared by or under the supervision and stamped by the excavation support design Structural Engineer. Shop Drawings shall comply with requirements in Section 2.3 of CTA ACM.

1. All layout drawings shall include locations of structural shoring system, if applicable. Coordination and concurrence on design must be received from the Contractor's Structural Engineer who is responsible for the structural shoring system design, prior to final design.

E. Structural Calculations: Signed and sealed by the licensed in Illinois Structural Engineer indicating all loadings and conditions and demonstrating that the required design parameters have been met. Structural Calculations shall comply with requirements in Section 2.4 of CTA ACM. The engineer that signs and seals the design calculations shall be the same engineer that signs and seals the shop drawings.

F. Drawings and calculations shall be submitted for review at 30%, 60%, and 100%, following the guidance in the CTA ACM flowchart in Section 2, for review.

G. If applicable, submit concrete mix designs as specified in Section 03 30 00, Cast-In-Place Concrete.

1. Submit soil-cement design mixes, including test data demonstrating that the proposed mixes will meet required strength.
2. Submit quality control/quality assurance plan for soil-mix wall construction. Coordinate with Section 01 43 00, Quality Assurance, and Section 01 45 00 Quality Control, suitable

for demonstrating that the soil-mix walls have been installed to the required depths and dimensions and will have the required strength, continuity and permeability at the time of excavation. Include the means of continuously monitoring the slurry injection process during soil mixing, soil-cement sampling methods and frequency and soil-cement testing methods and frequency.

3. Submit soil-cement testing results to the Authority within three (3) days of tests being performed.

H. Instrumentation and Monitoring Plan:

   1. Instrumentation and Monitoring Plan shall be in accordance with requirements in Specification Section 02 16 10 Monitoring Adjacent Structures During Construction Activity.

I. Site Specific Process Plan shall comply with CTA ACM Section 2.7.

J. In addition to the acceptance of the proposed excavation shoring system by the Authority, the final excavation shoring system approval shall be contingent upon acceptance by any involved utilities, public agencies, or railroads. The Contractor shall prepare and submit for the City of Chicago Office of Underground Coordination (OUC) approval, the proposed excavation and temporary soil retention shoring system. The Contractor shall secure OUC approval prior to start of any fabrication or field work.

K. All qualifications listed in Section 1.06 of this Specification shall be submitted for review.

L. Construction verification letter from Contractor’s Structural Engineer who is responsible for the design of the ERS, as per 3.08 D.

1.06 QUALITY ASSURANCE

A. Contractor’s Structural Engineer Qualifications: Provide a description of their experience in the design of temporary soil retention and shoring systems and their qualifications in regards to Excavation Support Systems; together with references. The Structural Engineer must be approved by the Authority.

B. Contractor’s Surveyor Qualifications: Provide a copy of their current State of Illinois surveyor’s license. Provide a description of their experience and his qualifications; together with references.

C. Contractor’s GPR Surveyor Qualifications: Provide a copy of their GPR certificate. The certificate shall be NGPRU Level II. Provide a description of their experience or previous project identifying underground utilities under railroad ballast.

D. Contractor’s Installer Qualifications: Provide a description of their experience in the installation of temporary soil retention and shoring system. The Installer must have not less than 5 years of experience in installing temporary soil retention systems and must be experienced in installing the same type of system being proposed by the Contractor.

   1. If the soil retention system is a proprietary system, provide a description of the manufacturer’s experience and qualifications. The proprietary system must be successfully utilized in no less than 5 projects similar in scope of the proposed work.

E. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before work begins.

F. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

G. Contractor is responsible for coordinating temporary soil retention and shoring designers.

1.07 CONTRACTOR ALTERNATIVES

A. Where excavation and temporary soil retention support systems and details are shown on the Contract Drawings, the Contractor may propose for review and approval by the Authority alternate systems and details provided such systems meet the design requirements and criteria specified herein and shown on the Contract Drawings and the limitations on shoring types specified herein.

B. Alternate excavation support systems and details shall be submitted for the Authority's approval as specified herein for Contractor-designed excavation shoring systems.

C. Should the Contractor choose to modify the shoring system without the Authority's approval, the Contractor does so at the Contractor's own risk and no claims for additional time or compensation will be allowed as a result of any delays or difficulties suffered.

1.08 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at the Project Site.

1. Review geotechnical report.
2. Review existing utilities and subsurface conditions.
3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
4. Review proposed excavations.
5. Review proposed equipment.
6. Review monitoring of excavation support and protection system.
7. Review coordination with waterproofing, if applicable.
8. Review abandonment or removal of excavation support and protection system including temporary soil retention systems.

1.09 FIELD CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving occupied facilities or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify the Authority no fewer than two (2) days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without the Authority's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. The Authority is not responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection according to the performance requirements.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

D. If it is not practical to use potholing to locate utilities before design, as shown in Section 1.04 F, potholing shall be done before excavation support installation by a qualified surveyor.

PART 2 – PRODUCTS

2.01 MATERIALS

A. General: Provide materials that are either new or in serviceable condition, provided they are sound and free from any strength-impairing defects.

B. All materials shall comply with CTA ACM Section 8.

2.02 INSTRUMENTATION AND MONITORING MATERIALS

A. Instrumentation and Monitoring Materials shall be in accordance with the requirements of Specification Section 02 16 10 Monitoring Adjacent Structures During Construction Activity.

B. If open cut is used in lieu of ERS, refer to CTA ACM for additional monitoring requirements.

PART 3 – EXECUTION

3.01 PREPARATION

A. Implement Instrumentation and Monitoring Program establishing railroad settlement points by the approved monitoring plan.

B. Locate ERS based on survey benchmarks as noted in 1.09 C.

C. Prior to placing and driving steel piles or sheeting, hand dig exploratory trenches in areas where railroad underground installations are known to exist. Existing utilities shall be positively identified by means of potholing. Backfill these trenches immediately after the exploratory work is finished. Perform this work in the presence of the Authority’s representative.

D. Coordinate support of excavation with dewatering as applicable. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

   1. Shore, support, and protect utilities encountered.

E. Install excavation support and protection systems to ensure minimum interference with tracks, roads, streets, walks, stations and other adjacent occupied and used facilities.

   1. Do not close or obstruct right-of-ways, tracks, bus lanes and loading areas, streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

F. Locate excavation support and protection systems clear of permanent construction so that construction and finishing of other work is not impeded.

3.02 TEMPORARY SOIL RETENTION SYSTEMS – GENERAL

A. Perform welding in accordance with the provisions of AWS D1.1.

B. Maintain sheeting, bracing and other temporary protective work in place and functioning until temporary protective work is no longer necessary. Refer to quality assurance requirements specified herein.

C. If, at any time, existing or new construction, tracks, utilities or similar facilities appear to be endangered, support such facilities, subject to the approval of the Authority. Provide additional bracing or shoring if considered necessary by the Authority to safeguard against and prevent movement or settlement.

D. Protect track ballast against contamination. Replace contaminated ballast.

E. Prevent settlement points from being damaged during construction.

3.03 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Accurately align exposed faces of flanges to vary not more than two (2) inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood or precast lagging within flanges of soldier piles as excavation proceeds. Excavation lift before installing laggings must be determined by the Contractor’s Structural Engineer. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

D. The soldier piles shall not damage the existing structures that are required to stay in place.

3.04 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. During construction, cut off sheet piling at the elevation of the top of adjacent tie.

D. The sheet piles shall not damage the existing structures that are required to stay in place.

3.05 TIEBACKS

A. Drill, install, grout, and tension tiebacks. Tieback installation procedures shall be developed by the qualified Structural Engineer responsible for the design of excavation support and protection system.

B. Test load-carrying capacity of each tieback. At a minimum, load testing procedures and acceptance for performance and proof testing shall comply with CTA ACM Section 9.5, unless otherwise developed by the Contractor’s Structural Engineer.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.06 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by the Authority.
2. Install internal bracing if required to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.07 TEMPORARY SOIL RETENTION SYSTEM

A. Fill cavities adjacent to the temporary soil retention system created by driving of sheet or soldier piling with sand.

3.08 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks in accordance with the requirements of Specification Section 02 16 10 Monitoring Adjacent Structures During Construction Activity unless directed and approved otherwise by the Authority during installation of excavation support and temporary soil retention and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify the Authority if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

D. Construction verification shall comply with CTA ACM Section 2.8.

3.09 REMOVAL AND REPAIRS

A. Unless indicated to leave excavation support and protection systems permanently in place, remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
2. Fill voids immediately with approved backfill compacted to density specified in Section 31 20 00, Earth Moving.
3. Repair or replace, as approved by the Authority, adjacent work damaged or displaced by removing excavation support and protection systems.

B. If components of the support system are left in place, cut off at the top and the remaining portion is to be removed as the backfill is being placed.

C. Immediately restore and tamp any ballast disturbed during construction of excavation support systems.

D. Remove any bracing tieback anchors or other support devices that are exposed.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of EXCAVATION SUPPORT AND PROTECTION shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of EXCAVATION SUPPORT AND PROTECTION shall be included in the contract lump sum price as shown in the Schedule of Prices for STRUCTURAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Structural Work: 030000

END OF SECTION

SECTION 31 63 33

DRILLED MICROPILES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification sections, apply to this section.

1.02 SUMMARY

A. This work consists of designing and installing small diameter, high capacity thick-walled pipe piles with or without steel reinforcing bars and filled with cement grout in accordance with this Specification and as shown in the Drawings. Also known as minipiles or pin piles, the micropiles must be used to transfer structural load shown in the Drawings to competent bearing strata.

B. Construction of the micropile shaft consists drilling the outer steel casing to the desired bearing strata, and filling the interior with neat cement grout. Steel reinforcing bars may be installed through the grout column to increase structural capacity.

C. The Contractor must select the micropile type, size, pile top attachment, installation means and methods, estimate the ground-grout bond value and determine the required bond length and final micropile diameter. The Contractor must design and install micropiles that will develop the load capacities indicated on the Drawings. The micropile load capacities must be tested as required and must meet the test acceptance criteria specified herein.

D. Related Sections: The following sections contain requirements that relate to this Section:

1. Section 03 20 10 – Concrete Reinforcement Epoxy Coated
2. Section 03 30 00 – Cast-in-Place Concrete
3. Section 05 10 30 – Structural Steel

1.03 REFERENCES

A. All references included in this Section must be current one published at the time of Contract Solicitation, unless otherwise noted herein.

B. American Society for Testing and Materials (ASTM)

1. ASTM C150 “Standard Specification for Portland Cement”
2. ASTM A615 “Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement”
3. ASTM A722 “Standard Specification for High-Strength Steel Bars for Prestressed Concrete”
4. ASTM C109 “Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50mm] Cube Specimens)”
5. ASTM D1143 “Standard Test Methods for Deep Foundations Under Static Axial Compressive Load”
6. ASTM D3689 “Standard Test Methods for Deep Foundations Under Static Axial Tensile Load”

C. American Petroleum Institute

1. API 5CT Grade N80, Steel Pipe

D. American Association of State Highway and Transportation Officials (AASHTO) Standard Specification 17th Edition, 2005

E. American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications

F. "Bending Strength of Threaded Micropile Connections" by Steven R. Musselman, J.H. Long, N. Carroll, and S. Farr.

G. Illinois Department of Transportation (IDOT) Bridge Manual

H. Illinois Department of Transportation Standard Specification for Road and Bridge Construction, including the current Supplemental Specifications and applicable Guide Bridge Special Provisions.

I. Chicago Building Code (CBC), Division 18 Chapter 13-132, with related code memorandum.

1.04 DEFINITIONS

A. Bond Breaker:

1. A device or special treatment incorporated into a length of a bored-in pile that will allow no load to be transferred to the soil within that length. A bond breaker also provides full lateral support of the pile within the length of the bond breaker.
2. Grout placed in contact with the soil using only gravity pressure will not be considered to constitute a bond breaker.

B. Bond Zone: The pressure grouted or post grouted length of a bored-in pile that provides the pile's axial load capacity.

C. Bored-In Pile: A pile formed by removing materials using non-vibratory and non- displacement methods to create a cased open, cylindrical hole in the ground, which is subsequently filled with grout and steel reinforcing.

D. Duplex Drilling: A method of progressing and cleaning out a hole for installing a bored-in pile in which the outer casing is progressed simultaneously with an inner drill rod string. The casing is cleaned using reverse circulation. Intimate contact between the soil and an outer casing is maintained during drilling.

E. Non-production Pile: Non-production piles are piles that are not incorporated into the substructure, such as test piles, which are abandoned after testing has been completed. Non-production piles must be installed using the same equipment, methods and materials as production piles. Test piles may be used as a production pile if not loaded to failure during the load test.

F. Positive Circulation or Flush: A method of progressing and cleaning out a hole for bored-in piles wherein water is injected into the hole and returns upward along the outside of the drill casing.

G. Post Grouting: A method used to increase pile capacity after the grout column has reached initial set. Grout is pumped at very high pressure (up to 1,000 psi) through a sleeved port pipe (post grout tube), fracturing and expanding the grout column. A positive displacement piston pump with a liquid filled pressure gauge located near the pile head is used to pump the grout, and packers are used to isolate the grout ports.

H. Pressure Grouting: A method used to develop pile capacity wherein pressure is applied continuously to the top of the fluid grout column using a grout pump and is applied continuously as the casing is removed from the bond zone.

I. Production Pile: A pile, which will be incorporated into the structure's foundation.

J. Recirculation: A method of handling drill fluid where the fluid coming back out of the hole is captured in a pan and reused.

K. Reverse Circulation: A method of cleaning the inside of casings. Water is circulated down through the drill rods and returns upward through the inside of the casing to flush the casing clean.

L. Rock Anchor: A double corrosion protected threaded bar conforming to ASTM A722 embedded and grouted into the underlying bedrock to transmit tension loads directly to the bedrock.

M. Tremie Grouting: A method used to place grout in a wet hole. A ½ inch to one inch I.D. grout tube is placed to the bottom of the drill hole. While keeping the tube opening submerged in the grout, grout is pumped into the hole, displacing the drill fluid.

1.05 SUBMITTALS

A. Provide design calculations (structural and geotechnical) and shop drawings signed and sealed by a Structural Engineer licensed in the State of Illinois that include:

1. Pile details including, but not limited to, nominal diameter, length, embedment length size and length of permanent casing, grout strength, reinforcement, pile top attachment, splices in piles, splices in reinforcement, post grout tube, grouting pressures and detail of rock anchors.
2. Layout drawings showing the proposed sequence of pile installation. Coordinate this sequence with the proposed phasing and scheduling.
3. Details of placement, splicing and centering devices for steel reinforcing.
4. Pile load test schedule and acceptance criteria per Part 3 Execution – Pile Load Tests.

B. Provide Process Plan that contains:

1. Details of equipment and procedures for pile installation including, but not limited to, consecutive steps and the approximate time required for each step.
2. Procedures for advancing through soils, timber piles, boulders, and other obstructions. Methods to be used to control and verify pile positions and alignment.
3. Procedures for control and removal of all spoil.
4. Drawings that show that the specified work can be performed under limited headroom conditions and as close to obstructions as site conditions warrant to install the piles at the locations shown on the Plans.
5. Procedures and equipment for placing grout.
6. Details of post-grouting equipment and procedures including the method, procedure and equipment required.
7. Procedures such as temporary casing to maintain an open hole during drilling, and the method to assure that the drilled hole has not collapsed and has the minimum required diameter before grouting. Methods to be used to measure the minimum required diameter.
8. Methods to flush the drilled hole and methods and equipment for measuring volumes of grout placed in each pile.
9. Detailed procedures for pile load tests including, but not limited to, consecutive steps and the approximate time required for each step.

C. Prepare the mix design for the grout and obtain documentation from an independent laboratory certified by the State of Illinois and approved by the Engineer, showing that the mix design conforms to the submitted mix and meets the strength requirements.

D. Provide evidence that the ultimate strength of the threaded joint complies with requirement shown in Part 1 Design Criteria – B by one of the following methods:

1. If the evidence will be provided by testing, testing apparatus setup and procedure must be reviewed and approved by the Engineer.
2. If the evidence will be provided by structural calculations per Part 1 Design Criteria – C, submit signed and sealed calculations done by the Structural Engineer who is responsible for the micropile design for review.

E. Comply with Quality Assurance requirements listed herein and submit written proof of Contractor's and supervisor's qualifications and work experience records for approval by the Engineer.

F. Specifications of material and equipment to be used for the installation of micropiles piles must be submitted to the Engineer for approval. The following items will be submitted, as a minimum:

1. Manufacturer's certification or coupon testing of steel casing.
2. Grout mix design and typical 28-day compressive strength as determined by an independent testing laboratory.
3. Manufacturer's literature for drilling equipment.
4. Manufacturer's literature for any admixtures used in the grout mix, and manufacturer's literature for grout plant.
5. Structural and geotechnical calculations and shop drawings signed and sealed by a qualified Structural Engineer, licensed in the State of Illinois for testing apparatus including, but not limited to, reaction piles, anchor piles, tension rods, load transfer beams, test beam(s) and their connections. Shop drawings shall also include, but not limited to, capacity of the hydraulic jack, type of bearing, load cell, and apparatus for movement measurements, etc.

G. As-built records of the micropile pile installation shall be furnished to the Engineer within twenty (20) days of the completion of the work. The as-built record of a micropile pile shall be contained on a single sheet and will contain the following information as a minimum:

1. Date constructed
2. Location
3. Grout mix used
4. Tested strength of grout
5. Depth drilled
6. Total grout used
7. Size and type of steel casing
8. Grout injection pressure
9. Log of soil/rock drilled
10. Final base and top elevation of outer casing
11. Elevations for all splices
12. Splice types
13. Testing reports for weld splice testing
14. For tension piles, provide mill certs for tension rod and couplers

1.06 QUALITY ASSURANCE

A. The work of this Section is specialized. The Contractor performing this work must be a reputable firm regularly engaged in the design and installation of bored-in piles. The Contractor must have successfully completed at least five projects of similar size and complexity in this type of installation. The Contractor must have experience installing and designing bored piles of high capacity (design capacity of 200 tons per pile in compression and 75 tons in tension or greater), installation of piles through obstructions and using duplex and non-displacement drilling techniques, and load testing experience of similar capacity piles. The Contractor must submit load test results for at least three previous successful micropile load tests from the five projects as required above.

B. The Contractor must identify the design consultant and owner for each referenced project for which this type of work was performed. The Contractor must provide proof to the Engineer of each project for approval no later than 10 days after Notice to Proceed. Such evidence must include the name and location of the project, client name and address, and the name and telephone number of a representative of the consultant and owner for whom the work was performed and who can attest to successful completion of the work.

C. A project summary must be included for each referenced project. The project summary must contain the start date and completion date of the project, total contract amount for the bored in piles and a detailed description of the project, site conditions and subsurface conditions. The project description must include the nature of the project, details of the bored-in pile design, installation techniques, total length of bored-in piles installed, design capacity and load test results, individual length of pile installed, and any other information relevant to demonstrating the Contractor's qualifications.

D. Assign an experienced, full-time supervisor who has been in responsible charge of supervising bored- in pile operations for at least five projects in the last three years. The supervisor must be present at the work site at all times during bored-in pile operations. Provide written verification of the supervisor's experience. The qualifications of the supervisor will be subject to review and approval by the Engineer.

1.07 DESIGN CRITERIA

A. The design of micropiles, including reaction piles for the load testing, shall be based on the reference show in Part 1 – Reference for the following type of structures:

1. Building and Track structures:

   a. Chicago Building Code (CBC), Division 18 Chapter 13-132, with related code memorandum used to determine allowable stresses for micropile structural components.
   b. American Association of State Highway and Transportation Officials (AASHTO) Standard Specification 17th Edition, 2005 used to determine geotechnical capacity, settlement and displacement.
   c. Maximum long term settlement including elastic shortening must not exceed 3/4 inch.
   d. Maximum uplift displacement including elastic elongation must not exceed:

      1) 1/4 inch for Building structures
      2) 1/8 inch for Track structures

2. Bridge structures: Illinois Department of Transportation (IDOT) Bridge Manual

3. For reaction piles for the load testing purposes, the factor of safety of 1.75 may be used, unless otherwise directed by the Structural Engineer or Geotechnical Engineer.

B. The ultimate strength of splices in the pile casing must be capable of withstanding the actual unfactored flexural stress times 2.0, except if the flexural stress is from the vehicle collision force the factor will be 1.0.

C. Design the threaded joint per Part 1 Reference – E.

D. Differential settlement between micropile foundation and other types of foundation in the same structure must not exceed 1/4 inch.

E. Design the micropiles with a 5'-0" unsupported length for future excavation below micropile cap. This need not be considered for the extreme load case with vehicle collision.

PART 2 – PRODUCTS

2.01 CASING

A. Casing shall have physical properties equal to or exceeding API oil field casing Grade N-80, 5CT N80. Physical properties must be determined by coupon tests of random samples. A letter must be provided by the supplier verifying the lot-coupon relationship. Drill tooling and methods should be selected by the Micropile Contractor based on previous experience in the soil and rock conditions presented at the site. The Contractor must have the casing shop flush-joint threaded in predetermined lengths.

B. API 5CT Grade N80 casing shall not be spliced with welded joints.

2.02 CEMENT

A. Must meet the requirements of ACI 318. Cement furnished must be in paper bags or bulk tanker and clearly labeled as to type and manufacturer. A sufficient quantity of cement must be stored at or near the site of the work to ensure that grouting operations will not be delayed by shortage of cement. The use of bulk cement will be permitted provided the Contractor employs methods of handling, transportation and storage that are satisfactory to the Engineer.

2.03 WATER

A. Must be potable or tested for suitability in grout mixes.

2.04 ADMIXTURE

A. Fluidifier/expansion admixture may not be used in the cement grout unless it is approved by the Engineer.

2.05 GROUT

A. A mixture of Portland Cement, admixture and water. Grout must have a strength as specified in the micropile design drawings but not less than 28-day strength of 5,000 psi when tested in accordance with ASTM C109. The grout must consist of a neat cement or sand cement mixture of Type I, II, III or V portland cement conforming to Section 1020 of the IDOT Standard Specifications. Expansive admixture shall not be used except to seal the encapsulations and anchorage covers. Admixtures must be able to control bleed, improve flowability, reduce water content, and retard set may be used if approved by the Engineer. Accelerators and admixtures containing chlorides are not permitted. Contractor must provide molds and make test cubes (1 set of 3 cubes or cylinders per micropile), and have compressive strength tests performed by an approved independent testing laboratory with the results submitted to the Engineer.

2.06 REINFORCEMENT

A. Provide bar reinforcement meeting the requirements of Section 03 20 10 ASTM A615, or continuously threaded in accordance with ASTM A 722.

1. Reinforcement bars do not need to be epoxy coated.

B. Rebar couplers are to be threaded and are to be rated at 1.25 times the yield strength of the rebar being spliced.

2.07 STRUCTURAL STEEL

A. All structural steel must conform to Section 05 10 30, unless otherwise noted in the Plans.

1. Structural steel need not be hot dipped galvanized.

2.08 PIPE JOINTS

A. Shop threaded joint must be designed per Part 2 Design Criteria – C, or tested per Part 1 Submittal – D (1).

B. Welded splice is not permitted.

PART 3 – EXECUTION

3.01 JOB CONDITIONS

A. The Contractor must, throughout the duration of the construction work, coordinate his work and cooperate with authorities and other contractors in order to allow ongoing operations to continue undisturbed throughout the micropile pile program. The Contractor must contain his micropile pile and grout products, drill cuttings, drilling fluid, and dust, from his operations in such fashion as to not interfere with adjacent operations.

3.02 EXAMINATION

A. Verify that site conditions will support drilling equipment required for pile drilling operations, and that equipment meets clearance required to install the piles at the proposed locations.

3.03 PROTECTION

A. Use a drilling method which will not cause damage to all structures and protect structures near the work from damage.

B. During grouting operations, the Contractor must take such precautions as may be necessary to prevent dust, drill cuttings, equipment exhaust, oil, wash water, and grout from defacing or damaging any adjacent structure or equipment. Any accidental unforeseen spillage of grout must be cleared immediately to reduce the possibility of staining existing structures.

C. Protection must include the covering with plastic sheeting or similar material of all structure walls near drilling and grouting operations. The Contractor must furnish such pumps as may be necessary to care for waste water and grout from his operations, and clean up all waste resulting from his operations.

3.04 GENERAL REQUIREMENTS

A. The Contractor must inspect the site to evaluate the conditions affecting the work. No claim for additional costs will be allowed because of lack of knowledge of any existing conditions discernible from observation at the site, adjoining property and available sources of information.

B. The Contractor must fully examine the existing site conditions to ensure that all equipment can operate without removing or relocating existing utilities, structures or structural members, except as shown on the plans or approved by the Engineer.

C. The micropiles shall be designed and installed according to the loads indicated in the Plans. The Contractor is responsible for determining the required embedment as well as the method of grouting inside and outside of the piles to obtain the required capacities. In general, the micropiles shall be designed in accordance with the requirements specified herein and as shown on the Plans.

D. All bored-in piles must be installed using a steel casing.

E. The method of installation must be submitted to the Engineer for review and approval. The Contractor must not begin work prior to receiving approval from the Engineer. Review by the Engineer does not constitute a guarantee of acceptable pile installations. Acceptable installation of piles as shown on the Drawings is the responsibility of the Contractor.

F. Install micropile by non-vibratory and non-displacement methods. The casing shall be advanced using duplex drilling or external flush rotary drilling. Drilling and excavation shall be performed in such a manner to minimize collapse of the hole. Blasting is not permitted.

G. The geotechnical information to be used for developing construction methods for the bored-in piles is shown on the Soil Borings in the Contract Documents.

H. A permanent casing must be provided and extended through all soil layers above bed rock, and extended into the foundation bed rock. The pile shall be drilled and socketed into sound dolomite bedrock, for a length as noted in the drawings and as verified in the calculations as required in the contractor’s submittal.

I. The permanent casing must be fully supported along its length, except where shown otherwise on the Plans and in intimate contact with the soil or encapsulated in grout, which must be in intimate contact with the soil.

J. The minimum bond length for the bored-in piles is shown on the Plans or appropriately designed based on the unfactored design loads indicated on the Plans. The minimum bond length refers to the embedment into the bedrock. Actual embedment will depend on conditions encountered in the field and will be as approved by the Engineer.

K. Post-grouting of the pile shall be performed if required to meet micropile design capacity. Post grouting shall consist of pressure grouting the soil and rock around the pile plus the soil and rock below the tip of the pile. Pressure grouting of the, soil and rock around the pile shall be performed from within the pile. The Contractor's equipment and methods shall permit him to regrout several times if necessary to achieve the required capacity. The annular space between the pipe casing and soil/rock side walls will be completely filled in the finished pile.

3.05 EQUIPMENT

A. Drilling equipment must be rotary pneumatic drilling equipment suitably and adequately powered with sufficient headroom specifications to permit working in the areas where the micropile piles are to be installed.

B. The grout plant must be designed to handle the specified material for this type of work. Only approved equipment must be used.

3.06 CONSTRUCTION METHODS

A. Drilling and Excavation:

1. Align the drill casing at the bored-in pile location.
2. Perform drilling for pile installation by rotating or oscillating the drill casing and applying a static vertical load. Advance the hole using duplex drilling and reverse circulation within the drill casing. Perform drilling and excavation in such a manner as to prevent collapse of the hole. Use of bentonite or polymer slurry is not permitted.
3. If obstructions are encountered during excavation for a pile, progress through them by means of coring, a tri-cone roller bit, or appropriate timber cutting bit. Use of drop type impact hammers and blasting are not permitted. Use of a down-the-hole hammer must be

approved by the Engineer. The vibration level induced by an approved down the-hole hammer must not exceed the ambient vibration level.

4. Control the procedures and operations so as to not cause undermining, disturbance or settlement to the adjacent structures or utilities. If any disturbance occurs, halt operation and modify the equipment and/or procedures so that no further disturbance occurs. Engineer approval of the modified equipment and/or procedures will be required. Repair any disturbance to the satisfaction of the Engineer at no additional cost.
5. Control the procedures and operations so as to prevent the soil at the bottom of the hole from flowing into the hole. Maintain the fluid level inside the hole above the ground water level at all times during installation and cleaning out. Monitor and record the rate of fluid flow used to advance the holes.
6. Waste and spoil must be disposed of in an appropriate manner. Deposition of waste and spoil in local streets, railroad ballast, sewers and/or waterways is not permitted.
7. Do not advance a hole, pressure grout, or post grout near a completed bored-in pile when such actions may have a harmful effect on the completed unit.

B. Reinforcement and Post Grout Tube Placement: Attach the post grout tube, if required, to the steel reinforcement. Place steel reinforcement and a post grout tube to the hole.

C. Grout Placement:

1. Place grout by means of a tremie pipe from the bottom of the pile upward so as to avoid segregation. Maintain the grout level at the top of the pile.
2. Calculate and record the initial volume of grout required filling the hole.
3. Grouting of a pile must be completed on the same day that the pile is drilled.

D. Post Grouting

1. Provide the equipment and materials to perform post grouting. Perform post grouting as required on the reviewed shop drawings or as directed by the Engineer.
2. Perform post grouting after the grout for the bored-in pile has set.
3. The work consists of pumping grout under pressure into a post grout tube cast into the pile. The grout will exit the post grout tube one port at a time, with the port being isolated using a packer system.
4. Record the pressure at which the grout was pumped and the volume pumped through each port.

E. Construction Tolerance:

1. Install the piles so that the center of each bored-in pile does not vary from the plan location by more than three inches. Do not allow the bored-in pile to vary from the vertical or established batter by more than 1/8 inch per foot, as measured aboveground. Any variation caused by unforeseen conditions needs to be approved by the Engineer.
2. Top elevation of micropile shall be plus 1 inch minus 2 inches from vertical elevation indicated on Drawings or where ordered by the Authority.
3. Center of reinforcing steel shall not be more than 3/4 inches from indicated location on Drawings.
4. If the soil at the pile tip is post grouted, monitor the elevation of the pile top during post grouting. Do not permit pile uplift to exceed ¼ inch.

F. Pile Acceptance Criteria:

1. All piles must meet construction tolerance criteria.
2. All piles must be installed in accordance with the dimensions and procedures shown in the approved submittals and specified herein.
3. All piles must meet the acceptance criteria in Part 3 Pile Load Tests.

3.07 UNACCEPTABLE MICROPILES

A. Unacceptable micropiles are piles that are rejected by the Engineer because of damage, failure to advance through obstructions, misallocation, misalignment, or failure to install the pile to the proper bearing stratum. Submit a written plan of action to the Engineer for approval, showing how to correct the problem and prevent its reoccurrence. Repair or augment the pile to the satisfaction of the Engineer to make it acceptable. To mitigate and/or to remedy unaccepted piles, the Contractor may be required to provide additional piles or supplement piles to meet specified requirements at no cost to the Engineer.

3.08 PILE LOAD TESTS

A. The Contractor must perform one micropile load test for each foundation micropile type or as required by the Building Department. These tests are required to verify the adequacy of the micropile system as installed. A separate test pile is not required at each location, rather a pile within the group may be selected for testing and if it successfully passes the load test it may be incorporated into the final pile group. The cost of the load test and the pile for the load test is incidental to the project Contract.

B. The Contractor must submit, for review and acceptance by the Engineer, the proposed micropile load testing procedure. This submittal must be made at least 28 calendar days prior to starting the load testing.

C. The micropile load test program proposed by the Contractor must be in conformance with ASTM D- 1143 Static Load Test Procedure B for all friction piles in compression and the Quick Test Loading Procedure A for rock bearing compression piles; ASTM D-3689 Procedure B - Maintained Test for tension piles, except as modified by the City of Chicago Building Code and herein, and must at a minimum contain the following information:

   1. Type and Accuracy of apparatus for measuring load
   2. Type and Accuracy of apparatus for applying load
   3. Type and Accuracy of apparatus for measuring pile deformation
   4. Type and capacity of the reaction load system
   5. Hydraulic jack calibration report
   6. Micropile Load Test Loading Schedule and Acceptance Criteria

D. The following clarifications shall be used for ASTM D-1143 Quick Test Loading Procedure A:

   1. The Structural Engineer who is responsible for the micropile design must determine the anticipated failure load, but must not be less than 2.0 DL (Design Load).
   2. All load time intervals are 15 minutes.

E. If the capacity of compression piles is only developed by skin friction (or side resistance), it is acceptable to load test these piles in axial tension for easier testing apparatus setup.

F. Acceptance Criteria must contain the following items at a minimum:

   1. For building structures, use the acceptance criteria as shown in the Chicago Building Code (CBC) Pile Deep Foundations Code Memorandum.
   2. For track and bridge structures:

      a. Total vertical movement at top of the pile at the first compression or tension 1.0DL test load does not exceed the maximum allowable movement. The maximum allowable movement must be determined by the Structural Engineer based on structural design requirements but no more than the settlement limits in Design Criteria.
      b. Failure does not occur at the anticipated failure load. Failure is defined as pile

movement exceeding the failure criterion determined using Davisson Method as specified in AASHTO LRFD 7th Edition Figure C10.7.3.8.2-1.

3. If the micropile load test fails to meet the design requirements, the Contractor must determine the cause, and must modify the micropile and/or installation methods and retest the new system as directed by the Engineer.

3.09 GROUT TESTING

A. During construction, grout mix samples selected at random must be taken daily (six samples per day) for testing. The Engineer will control sample selection. The Contractor will be responsible for testing the samples; the cost of testing is deemed to be included in the cost of bored-in piles.

B. The samples must be molded, cured in a properly constructed curing box supplied by the Contractor, and tested in accordance with ASTM C109, and must reach a compressive strength after seven days equal to at least 60 percent of the design strength.

C. If this requirement is not met, the Contractor must modify the proportions of the mix subject to the approval of the Engineer.

D. The Engineer may also require the Contractor to modify the mix design if an excessive amount of grout is lost from a pile hole into voids in the in place materials. Materials must be accurately measured by weight or volume prior to mixing.

E. Each batch of grout must have the same volume and contain the same whole number of sacks of cement, unless a modification is approved by the Engineer. Time of mixing must be not less than three minutes.

F. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding three hours at temperatures below 70 degrees Fahrenheit and for a period not exceeding two hours at higher temperatures.

G. If there is a lapse in pumping of grout, the grout must be recirculated through the pump or through the mixer drum (or agitator) and pump.

H. s of grout will not be permitted.

3.10 CLEAN-UP

A. Upon completion of daily grout operations, excess grout in the hoses, mixer and grout pump must be trapped in a confined section of the construction site and immediately removed off site.

B. The Contractor must clean up all waste resulting from his operations and restore any damage or defaced structures to original condition. The site ground must be cleaned and restored to its original condition.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DRILLED MICROPILES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of DRILLED MICROPILES shall be included in the contract lump sum price as shown in the Schedule of Prices for STRUCTURAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Structural Work: 030000

END OF SECTION

SECTION 31 64 00

DRILLED SHAFTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this section.

B. Except as modified herein, the work shall conform to the applicable portions of the IDOT Standard Specifications, Section 516.

1.02 SUMMARY

A. This section specifies requirements for constructing drilled shafts foundation system. The work under this Section shall include furnishing all labor, material, tools, equipment and incidentals necessary to construct drilled shafts, including the excavation and disposal of all material encountered, both wet and dry, by machine drilling methods to the elevations and diameters as shown on the drawings or as determined by the Authority; the furnishing and installation of steel casings and liners, and the removal or grouting in place of same; the use of bentonite slurry to prevent caving, and the disposal of same; the pumping, bailing, removal and disposal of water and mud from the excavations; the removing of any abandoned utilities, wooden pilings, or other obstructions encountered; assisting the Authority in arriving at the final elevations and bell diameters; the furnishing and placing of concrete, reinforcement and attachment dowel rods in the shaft excavation; and all other related and collateral work necessary to construct the drilled shafts.

B. Related Sections: The following sections contain requirements that relate to this section.

1. Section 02 16 10 – Monitoring Adjacent Structures During Construction Activity
2. Section 03 20 10 – Concrete Reinforcement Epoxy Coated
3. Section 03 30 00 – Cast-in-Place Concrete
4. Section 31 20 00 – Earth Moving

1.03 QUALITY ASSURANCE

A. Drilled shafts shall be installed by a Contractor or Subcontractor who specializes in such work as specified in the IDOT Standard Specifications Section 516.

B. Do not install buckled, distorted, or otherwise damaged casings. Replace casings damaged during construction, casings that are not watertight, or casings that are otherwise not in accordance with the drawings or specifications, at no addition cost to the Authority.

1.04 SUBMITTALS

A. Forty-five (45) days prior to beginning any construction, the Contractor shall submit design calculations for the steel casing and permanent corrugated metal liner to be used and the proposed procedure for the installation of all drilled shafts on the project to the Authority. The calculation and plans shall be signed and sealed by an Illinois licensed Structural Engineer. The Contractor's procedures shall at all times be subject to the Authority's approval. The contractor’s process plan shall at a minimum include the following:

1. Permanent and temporary casing and liner installation methods.
2. Drawing of Permanent and temporary casing and liner and elevations relative to soil strata elevations from soil borings.
3. Concrete pouring methods.
4. Water mitigation plan.

5. Equipment to be used and their load charts.
6. Staging of equipment and materials.
7. Independent testing lab testing procedures determining bearing capacity for both cohesive and granular subgrade soils.
8. Temporary casing grouting and extracting methods.
9. All other requirements as noted in the general requirements
10. A letter from the Contractor’s Inspector, as noted in 3.09, confirming that they agree with construction methods.

B. The Contractor shall submit to the Authority the concrete mix design, reinforcement material and reinforcement shop drawings for the drilled shaft construction.

C. The Contractor shall maintain an excavation log during shaft excavation that includes the following and submit to the Authority:

1. Description and approximate top and bottom elevation of each soil or rock material encountered during shaft excavation.
2. Elevations at which seepage or groundwater flow are encountered, and remarks.
3. Changes in the type of tools used for excavation, if any.

D. The Contractor shall submit test reports from an Authority approved testing service for bearing capacity to the Authority.

E. The Contractor shall submit to the Authority the disposal location and proof of proper authority to dispose of excavated material for the drilled shaft construction.

F. The Contractor shall submit a copy of the gas test log kept during drilled shaft work to the Authority.

G. The Contractor shall submit a drilled shaft report for each drilled shaft to the Authority showing that the construction tolerances as indicated in the IDOT Standard Specifications Section 516 have been met.

1.05 SPECIAL REQUIREMENTS

A. The elevations shown on the Drawings for the bottoms of the drilled shafts are approximate and may be raised or lowered as directed by the Authority to obtain satisfactory bearing pressure. This may require additional reinforcing steel, casings and liners, or it may require cutting of reinforcing steel. No separate payment will be made for this work if the bottoms of the drilled shafts are lowered within 5 feet. Any addition over 5 feet will be considered as an extra to the Contract. Contactor’s field inspector shall retain all boring log documents and refer to the nearby borings to determine the potential soil conditions near the proposed drilled shaft locations. If competent soils that meet the required allowable design bearing pressure specified in the Drawings are encountered during the excavation process above the design elevation and after review of the boring logs to indicate that competent soils exist below the excavated depth, the Contractor shall confirm these findings with the Authority. The Contractor may base the drilled shaft at such elevation under the Approval of the Authority. However, the bottom of drilled shaft shall be no more than one (1) drilled shaft diameter above the design elevation shown on the Plans.

B. The use of explosives will not be permitted for the construction of drilled shafts.

C. In constructing the drilled shafts, the Contractor may encounter boulders, fill, wooden pilings, foundations, abandoned utilities, and other obstructions. No separate payment will be made for removal of any such obstructions and the cost for removing any such obstructions encountered shall be included in the Contract Price if the delay is within 2 hours. Any additional delay over 2 hours will be considered as an extra to the Contract.

D. The Contractor shall be responsible for positively identifying the location and extent of all existing utilities before the start of the excavation.

E. All materials and equipment necessary to perform the work required for successful completion of any drilled shaft work in accordance with these specifications shall be on the job site of this Contract before any work may be started.

F. The Contractor shall monitor settlement of adjacent structures during drilled shaft drilling operations per Specification Section 02 16 10, Monitoring Adjacent Structures During Construction Activity.

G. Where shown on the Drawings, permanent casing shall be provided.

H. Corrugated metal liners shall be provided for all drilled shafts. Corrugated liners may be delivered in any convenient sections with sections connected in accordance with manufacturer's instructions.

I. The Contractor shall inspect the project site for overhead clearance constraints and make appropriate adjustments in the work plan to accommodate any constraints.

PART 2 – PRODUCTS

2.01 CONCRETE

A. Concrete shall conform to Section 03 30 00, Cast-in-Place Concrete.

2.02 REINFORCEMENT BARS

A. Material for the reinforcement bars, Grade 60, shall conform to the requirements of Section 03 20 10, Concrete Reinforcement Epoxy Coated, or as modified herein. Reinforcement bars in the drilled shaft may be plain bars except bars from the drilled shaft to the pedestal shall be epoxy. Vertical reinforcement shall be full length of the drilled shafts as shown on the Drawings. If the bottoms of the drilled shafts are lowered, as directed by the Authority, additional reinforcement bars shall be added. The vertical reinforcement up to and including No. 11 bars may be extended by lapping or spliced with Class A tension splice. The cost of adding additional reinforcement will not be paid for separately if the bottom of the drilled shaft is lowered within 5 feet. Any addition over 5 feet will be considered as an extra to the Contract. In the event of over drill, the bottom of the reinforcement shall be no more than one shaft diameter of the drilled shaft above the bottom of the drilled shaft, but no more than 3 feet in any case.

2.03 TEMPORARY AND PERMANENT STEEL CASINGS

A. Temporary and permanent steel casings shall conform to the requirements of ASTM A 252 Grade 2, produced by electric seam, butt, or spiral welding.

2.04 PERMANENT CORRUGATED METAL LINERS

A. Corrugated metal liners shall conform to the requirements of ASTM A929.

PART 3 – EXECUTION

3.01 GENERAL CONSTRUCTION REQUIREMENTS

A. Each drilled shaft shall be constructed at the location shown on the Drawings or as directed by the Authority. The maximum allowable variation of the center at the top of any drilled shaft from required location shall not be greater than 2 inches. Any deviation greater than herein specified shall be corrected by the Contractor at no additional cost to the Authority.

B. The drilled shafts shall be plumb. Any deviation from the vertical at the bottom of the drilled shaft shall not exceed 1 percent of the drilled shaft length or 3 inches, whichever is the smaller value. Any deviation from the vertical greater than herein specified shall be corrected by the Contractor at no additional cost to the Authority before any reinforcement steel and concrete are placed.

C. No drilled shaft excavation shall be made in embankment material in an uncased condition.

D. The drilled shafts shall be excavated to the lines and limits shown on the Drawings or as directed by the Authority. Any unauthorized excavation made outside the established lines and limits shall be filled with concrete and abandoned at no additional cost to the Authority for either the unauthorized excavation or the concrete.

E. The bottoms of the drilled shafts shall be cut to a level firm surface, cleaned of any soft, loose or extraneous materials and maintained dry for inspection purposes and for the placing of reinforcement steel and concrete. Concrete shall not be placed in any excavation until the bottom has been inspected by an independent approved testing agency approved by the Authority and certified as being satisfactory for carrying the design loads. Testing shall be included in the Contractor’s bid price.

F. Once the excavation has started for any drilled shaft, the work of that drilled shaft shall be carried on continuously, 24 hours a day, including Saturdays, Sundays and Holidays, until the drilled shaft has been completed all at no additional cost to the Authority. If at any time, work on any drilled shaft is not continuous for any reason not approved by the Authority, any and all casings which have been installed in the drilled shaft for any reason shall be left in place and backgrouted immediately at the Contractor's expense.

G. Any drilled shaft found to be deficient and unsuitable shall be repaired or replaced in a manner satisfactory to the Authority at the Contractor's expense.

H. Excavated material shall be considered surplus and shall be removed and disposed of by the Contractor at the Contractor’s expense. The manner and location of disposal shall be determined by the Contractor and shall be subject to the approval of the Authority. The Contractor shall furnish to the Authority satisfactory evidence that he has proper authority for the disposal (See Section 31 20 00 – Earth Moving).

I. Drilled shafts shall be checked for eccentricity by the Contractor at the top and bottom prior to the placement of the reinforcement steel and concrete. Concrete shall not be placed until each excavation has been approved by the Authority or their appointed designee.

3.02 TEMPORARY CASINGS

A. The Contractor shall install a temporary steel casing at each drilled shaft location that extends from ground surface into sufficiently stable soils to prevent caving of soil into the excavation. The casing shall be of ample strength to withstand handling stresses, the pressure of the surrounding soil materials, and shall be water tight. The inside diameter of the steel casing used for this purpose shall be greater than the nominal diameter of the drilled shaft as shown on the drawings, and the wall thickness, diameter and length shall be approved by the Authority.

B. If additional casings are not required to prevent caving, the drilled shafts may be drilled without the use of additional casings. However, after drilling is completed, the Contractor shall install casings for the protection of personnel working in the drilled shafts or for use during the placement of reinforcement steel and concrete, if necessary. Whenever personnel are required to enter the drilled shaft, temporary protective casings shall be used and there shall be adequate provisions for fresh air, light and protection from falling objects and toxic gases. Operation of harmful gas-producing equipment in the drilled shaft shall be prohibited.

C. When casing is to be removed during placement of grout or lean concrete, the lower end of the casing shall be at least 5 feet below the top surface of the concrete to insure that the concrete will have sufficient pressure at the bottom of the casing to prevent any earth from coming in from the sides and mixing with the concrete or reducing the diameter of the drilled shaft and to insure that the concrete will be pressed tightly against the earth.

D. Furthermore, if in the opinion of the Authority, the removal of temporary casings will endanger the excavation or the concrete or existing adjacent structures, or methane or other explosive or noxious gases are encountered, the entire temporary casing, or some portion thereof, shall be left in place. If this is the case, the annular space between the casing and the surrounding soil shall be pressure grouted or filled by a method approved by the Authority.

3.03 PERMANENT CASINGS

A. The Contractor shall install permanent casings where called for on the Drawings. Generally speaking, permanent casings are to be provided by the contractor when near adjacent tracks, properties, sidewalks, streets, utilities, shallow foundations, both temporary and permanent. If permanent casings are not called for on the Drawings, the Contractor shall determine if the proposed drilled shafts require permanent casings by assuming an influence envelope at a 1:1 slope from the top of the first clay layer to the bottom of an existing foundation, utility elevation, or bottom of track ties; if an existing foundation, major utility, or tracks falls within this envelope, the proposed drilled shaft shall be considered adjacent to an existing structure/utilities/track and permanent casings shall be provided. The casing shall extend from ground surface into sufficiently stable soils and be of ample strength to withstand handling and installation and dewatering stresses, the pressure of the surrounding soil materials, and shall be water tight. The liner shall be of ample strength to withstand handling and dewatering stresses, the pressure of the concrete, and shall be watertight.

B. The minimum wall thickness for the permanent casing shall be as required to resist the stresses, as determined by the Contractor, but shall be a minimum of ¼” thick or 0.0075 of the diameter of the drilled shaft, whichever is larger.

C. The wall thickness, diameter and length shall be approved by the Authority.

3.04 CONCRETE REINFORCEMENT

A. Reinforcement shall be installed as shown on the Drawings. The Contractor shall provide suitable supports or spacers for holding and aligning the reinforcement away from the walls of the drilled shaft excavation, so as to keep the reinforcement securely in proper position during concreting operations.

3.05 WATER CONTROL

A. The Contractor shall protect all drilled shaft excavations against surface and rain water and against water which may enter from sides or bottom of the excavation. In the event that quick sand, running material, water-bearing strata, or other materials are encountered which cannot be excluded by means of conventional lagging, lining or casing, the Contractor shall perform such work as necessary to seal off such material in a manner approved by the Authority at no additional cost to Authority.

B. Pumping of water is allowed and shall be limited to a total of approximately 900 gallons. Pumping of the water shall follow the requirements of Section 3.05 (C) and (D). Extreme caution shall be used to prevent an unbalanced water head from causing a “blowout”, bottom heave, or “quick” condition that could disturb the proposed bearing stratum or surrounding soil strata. If the water to be pumped exceeds the stipulated 900 gallons and the standing water elevation is 6 inches above the bottom of the drilled shaft, concrete shall be placed under water using the tremie method. The tremie pipe shall always be kept well below the water/concrete interface during concreting. The tremie pipe and hopper connections shall be watertight and in clean condition to permit free flow of the concrete.

C. When pumping, the Contractor shall provide a settling basin system which is capable of removing approximately 90% of the sediments. All pumping shall flow through the system prior to being disposed of into the sewer systems. The Contractor shall provide and operate all equipment necessary to pump and remove all water that may be encountered in the construction of the drilled shafts. No additional payment will be made for installing and operating the pumping and settling basin systems and equipment.

D. Immediately after the excavation has passed inspection and the installation of the reinforcement steel has been approved by the Authority or their appointed designee, any pumping of water from the excavation shall be stopped. If the flow of water into the excavation has stopped or is slight enough in the opinion of the Authority that no damage will be done to the concrete, the excavation shall be filled with concrete following the method described in concrete placement for dry excavation.

E. If in the opinion of the Authority the flow of water is considerable, the water shall be allowed to flow freely into the excavation. When the water level has ceased to rise, concrete shall be placed in the excavation by use of the tremie method.

F. Where water cannot be removed from drilled shaft excavation and water is permitted to rise in the drilled shaft and concrete is placed under water, the Contractor shall perform either core borings or other accepted method of exploration satisfactory to the Authority to insure that a satisfactory drilled shaft has been constructed. To insure that a satisfactory drilled shaft will be constructed the drilled soil shall be tested immediately upon removal as it approaches the bottom of drilled shaft elevation indicated in the Plans. Tests performed on soil that have been sitting under water for an extended period of time (> 30 min) are not allowed and shall not be deemed valid.

3.06 CONCRETE PLACEMENT FOR DRY EXCAVATION

A. Concrete shall be deposited in accordance with Articles 503.07 and 516.06 (a) of the IDOT Standard Specifications.

3.07 CONCRETE PLACEMENT TREMIE METHOD

A. Tremied concrete shall be placed in accordance with Articles 503.07 and 503.08 of the IDOT Standard Specifications, except as modified herein.

B. The bottom of the tremie shall extend to within a foot of the bottom of the excavation. The tremie shall be withdrawn as the concrete is placed, but the bottom of the tremie shall always be at least 2 feet below the top of the concrete. The method of placing the concrete shall be subject to the approval of the Authority at all times, and the method used shall be one that provides a continuous flow with no segregation of the concrete materials.

C. Wherever tremie concrete is necessary, casing shall not be removed. Once placing of the concrete has started, no pumping of any kind shall be allowed.

3.08 SAFETY

A. In the event that methane or other explosive or noxious gases are encountered, the Contractor shall make suitable tests for gases at each excavation at the start and end of each shift and at such other times as he deems necessary or as the Authority may direct. If the presence of a noxious or explosive gas is indicated, work shall be discontinued immediately, the Authority notified, and work shall not resume at said location until the necessary safety measures have been taken and further tests indicate the absence of any noxious or explosive gas. A log recording the location, date, time and findings of all gas tests shall be maintained by the Contractor and copies in duplicate shall be furnished to the Authority. All such testing shall be done at the Contractor's expense.

B. The Contractor shall provide and operate an approved ventilation system for supplying fresh air and exhausting foul air and gases for the excavations. All safety equipment required by OSHA for the workmen, such as safety harnesses and gas detectors shall be on the job site at all times.

C. Suitable, safe, weather resistant, water and explosive proof electric lamps shall be provided by the Contractor for illumination of the excavation at all times.

D. The Contractor shall provide and operate an approved safety harness and protective temporary steel casings to be used in conjunction with the lowering of personnel into an excavation. A test for gas shall be made prior to lowering any personnel into the excavation. Personnel entering an excavation shall be confined space entry trained and qualified.

E. The Contractor shall provide a safety plan which includes rescue and extraction procedures.

3.09 SAMPLING AND TESTING

A. Contractor's soil testing laboratory shall conduct the following tests and inspections of drilled shaft operations, and interpret tests. Inspection shall take the form of full-time inspection of drilled shaft operations. In addition, review and comment on the construction methods, equipment, and other pertinent construction details as furnished by the Contractor. Determine if temporary liners are required for drilled shaft excavation and soil content in the pumped water from the drilled shaft excavation. Submit daily reports.

1. Review the Contractor's proposed drilled shaft installation methods, sequences, procedures and equipment.
2. On a full-time basis visually inspect the installation of each drilled shaft including visual inspection of the bottom of each drilled shaft.
3. Verify the specified bearing capacity of each drilled shaft with the following tests.

    a. Sampling and Testing: Take undisturbed sample and test utilizing unconfined compression test ASTM D2166, of bearing materials at the drilled shaft bottom for each drilled shaft.

4. Provide direction to Contractor as to specific final bearing elevation at each drilled shaft location and /or necessity for additional shaft excavation.
5. Visually inspect and test samples of water being pumped from drilled shaft as to solids content.
6. Observe, record, and report the Contractor's locational and plumb tolerance measurements, and the final elevations of the bottom and top of the completed drilled shafts.

B. Contractor's Concrete Testing Laboratory: Perform full-time inspection of drilled shaft concrete and reinforcing installation and conduct the following tests and inspections during construction.

1. Inspection of Concrete and Reinforcing Placement: Provide continuous visual inspection of reinforcing site fabrication and installation, and concrete placement including verification of laitance removal at the top of the drilled shafts.
2. Compression Tests: Perform tests for each 50 cu.yd. of concrete, or fraction thereof, but not less than 1 set of cylinders for each drilled shaft. Make 4 standard 6" x 12" cylinders and test in accordance with ASTM C 31 and ASTM C 39. Test 1 cylinder at the age of 7 days and 2 cylinders at the age of 28 days. Keep 1 cylinder in reserve for 56-days test if 28 day test does not meet requirements. Only 1 set of tests shall be made from any one batch of concrete and all 4 cylinders shall be made from the same batch. All cylinders shall be cured in the laboratory. Reports of cylinder tests shall state the location of the pour in the drilled shaft, laboratory or site curing, compression strength, type of fracture, age at testing, concrete supplier, mix specification strength and any other pertinent information, together with a statement as to whether this concrete complies with the specifications.
3. Slump Tests: ASTM C 143. Perform tests for every set of cylinders cast in accordance with Section 3.09 B (2).
4. Air Content Test: ASTM C 173. Perform tests for every set of cylinders cast in accordance with Section 3.09 B (2).

3.10 BELLS

A. Drilled shaft bells are to be excavated to the lines and limits shown on the Drawings or directed by the Authority. Any unauthorized excavation made outside the established lines and limits shall be filled with concrete at no additional cost to the Authority for either the unauthorized excavation or the concrete. The bottom of the bells shall be level and shall be cleaned immediately before concrete is poured. All mud, water, or any other loose material shall be completely removed to the satisfaction of the Authority.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DRILLED SHAFTS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of DRILLED SHAFTS shall be included in the contract lump sum price as shown in the Schedule of Prices for STRUCTURAL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Structural Work: 030000

END OF SECTION

SECTION 32 11 16

SUB-BASE GRANULAR MATERIAL, TYPE B

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies requirements for SUB-BASE GRANULAR MATERIAL, TYPE B. The work under this Section will include furnishing all labor, materials, tools, and equipment required to furnish, place and compact sub-base granular material, Type B on a prepared subgrade.

B. Except as modified herein, the work will conform to the applicable portions of the Standard Specifications (IDOT), Section 311, at locations shown on the Drawings and as directed by the Commissioner. C. Related Sections:

1. Section 31 23 13: Subgrade Preparation.
2. Section 32 16 21: Concrete Curbs, Gutters and Walks.

1.03 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, latest edition.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS:

A. The material must be coarse aggregate having a CA-6 gradation conforming to Article 1004 of the Standard Specifications except as herein modified.

PART 3 - EXECUTION

3.01 SUB-BASE GRANULAR MATERIAL

A. It is understood that a certain amount of sub-base granular material, may be displaced into the existing soil when the material is placed and compacted; however, any such material will not be measured for payment and the cost thereof considered incidental to this item Conform to IDOT Standard Specifications for Road and Bridge Construction.

B. The sub-base granular material must not be placed on a wet subgrade or a subgrade rutted by the Contractors equipment. The Contractor will be required to drain off all rainfall as rapidly as possible and maintain the subgrade in a dry, smooth, and compacted condition until the granular material is placed.

C. The sub-base granular material must be placed and compacted according to Article 311.05 of the Standard Specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of SUB-BASE GRANULAR MATERIAL, TYPE B will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of SUB-BASE GRANULAR MATERIAL, TYPE B will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 32 11 16

SECTION 32 12 16

ASPHALT PAVEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes requirements for Hot Mix Asphalt (HMA) Pavements as required for proposed roadway binder and surface courses proposed with the project improvements.

1.03 RELATED SECTIONS

A. Section 01 55 26 – Traffic Control.

1.04 REFERENCES *

A. CDOT Rules and Regulations for Construction in the Public Way (CDOT Specifications), January 2019.

B. IDOT Standard Specifications for Road and Bridge Construction (SSRBC), latest edition.

*In the event of a conflict between CDOT and IDOT Specifications in this Section, CDOT Specifications shall govern.

1.05 MATERIAL TESTING, INSPECTIONS, AND SUBMITTALS

A. All materials and workmanship are subject to inspections, testing, and approval by the Commissioner.

B. Unless otherwise designated by the Commissioner, all tests must be conducted to current CDOT standards.

C. Provide 100% quality control (QC) independent of said contractor for all field testing in accordance with CDOT and IDOT Standards. The contractor is responsible for notifying CDOT Commissioner no later than 2pm on the day previous to the asphalt placement. All provisions required for tests, samples and inspections are considered incidental to the Work and no additional payment is allowed.

D. Failure of the Contractor to pass required tests and inspections is grounds for rejection of the Work. All rejected Work is subject to removal or other corrective actions as directed by the Commissioner.

1.06 QUALITY ASSURANCE

C. Comply with CDOT Specifications for all work within public right-of-way, IDOT Article 1030.05 for QC/QA, and IDOT Bureau of Local Roads and Streets LR1030-2 – Local Quality Assurance/Quality Management QC/QA. In the event that a conflict exists between this Section and the CDOT Specifications, CDOT Specifications govern. Work, which is not within CDOT jurisdiction, must be coordinated with the agency having jurisdiction to ensure compliance with applicable standards and permit requirements. The Contractor is responsible for forwarding copies of correspondence to the Commissioner for proof of coordination and compliance with CDOT and other agency regulations.

A. Material Tickets

1. Deliver to the Commissioner, at the time of delivery, a weight ticket for all material delivered signed by a Certified Public Weighmaster indicating the net weight or volume and mix or type of material being delivered.

D. LR1030-2

State of Illinois
DEPARTMENT OF TRANSPORTATION Bureau of Local Roads & Streets SPECIAL PROVISION FOR LOCAL QUALITY ASSURANCE/ QUALITY MANAGEMENT QC/QA Effective: January 1, 2022

Replace the first five paragraphs of Article 1030.06 of the Standard Specifications with the following:

“ **1030.06 Quality Management Program.** The Quality Management Program (QMP) will be Quality Control / Quality Assurance (QC/QA) according to the following.”

Delete Article 1030.06(d)(1) of the Standard Specifications.

Revise Article 1030.09(g)(3) of the Standard Specifications to read:

> “ (3) If core testing is the density verification method, the Contractor shall provide personnel and equipment to collect density verification cores for the Engineer. Core locations will be determined by the Engineer following the document “Hot-Mix Asphalt QC/QA Procedure for Determining Random Density Locations” at density verification intervals defined in Article 1030.09(b). After the Engineer identifies a density verification location and prior to opening to traffic, the Contractor shall cut a 4 in. (100 mm) diameter core. With the approval of the Engineer, the cores may be cut at a later time.”

Revise Article 1030.09(h)(2) of the Standard Specifications to read:

> “ (2) After final rolling and prior to paving subsequent lifts, the Engineer will identify the random density verification test locations. Cores or nuclear density gauge testing will be used for density verification. The method used for density verification will be as selected below.

Density Verification Method	
☐	Cores
☒	Nuclear Density Gauge (Correlated when paving ≥ 3,000 tons per mixture)

> Density verification test locations will be determined according to the document “HotMix Asphalt QC/QA Procedure for Determining Random Density Locations”. The density testing interval for paving wider than or equal to 3 ft (1 m) will be 0.5 miles (800 m) for lift thicknesses of 3 in. (75 mm) or less and 0.2 miles (320 m) for lift thicknesses greater than 3 in. (75 mm). The density testing interval for paving less than 3 ft (1 m) wide will be 1 mile (1,600 m). If a day’s paving will be less than the prescribed density testing interval, the length of the day’s paving will be the interval for that day. The density testing interval for mixtures used for patching will be 50 patches with a minimum of one test per mixture per project.
>
> If core testing is the density verification method, the Engineer will witness the Contractor coring, and secure and take possession of all density samples at the density verification locations. The Engineer will test the cores collected by the Contractor for density according to Illinois Modified AASHTO T 166 or AASHTO T 275.
>
> If nuclear density gauge testing is the density verification method, the Engineer will conduct nuclear density gauge tests. The Engineer will follow the density testing procedure detailed in the document “Illinois Modified ASTM D 2950, Standard Test Method for Density of Bituminous Concrete In-Place by Nuclear Method”.
>
> A density verification test will be the result of a single core or the average of the nuclear density tests at one location. The results of each density test must be within acceptable limits. The Engineer will promptly notify the Contractor of observed deficiencies.”

Revise the seventh paragraph and all subsequent paragraphs in Section D. of the document “Hot-Mix Asphalt QC/QA Initial Daily Plant and Random Samples” to read:

> “Mixtures shall be sampled from the truck at the plant by the Contractor following the same procedure used to collect QC mixture samples (Section A). This process will be witnessed by the Engineer who will take custody of the verification sample. Each sample bag with a verification mixture sample will be secured by the Engineer using a locking ID tag. Sample boxes containing the verification mixture sample will be sealed/taped by the Engineer using a security ID label.”

PART 2 - PRODUCTS

2.01 AGGREGATE

A. Aggregate materials must be coarse aggregate consisting of mechanically crushed stone or mechanically crushed concrete, and must meet the requirements of Section 1004 of the SSRBC. Material must have a pH range between 7.5 and 10 and be non-corrosive.

The material shall be according to Section 1004.04 of the Standard Specifications except for the following:

Reclaimed Asphalt Pavement (RAP) may be blended with gravel, crushed gravel, crushed stone, crushed concrete, or crushed sand stone. The RAP materials shall be crushed and screened. Unprocessed RAP grindings will not be permitted. The RAP shall be uniformly graded and shall pass the 1.0 in. (25 mm) screen. When RAP is blended with any of the coarse aggregate listed above, the blending shall be done mechanically with calibrated feeders. The feeders shall have an accuracy of + 2.0 percent of the actual quantity of material delivered. The final blended product shall not contain more than 40 percent by weight RAP.

B. Gradation of aggregates.

1. Aggregate for Sub-Base Course-Type B, Aggregate Base Course, and Temporary Stone Fill must be gradation CA-6.
2. Aggregate for Sub-Base Course-Type A must be gradation CA-6.

2.02 HOT MIX ASPHALT

A. Hot Mix Asphalt (HMA), Reclaimed Asphalt Pavement (RAP) (D-1), and Reclaimed Asphalt Shingles (RAS) (D-1) mix selections are to conform to mixes as described in the latest CDOT and IDOT requirements as noted on the drawings, or as directed by the Commissioner.

B. HMA materials are to conform to Section 406, 1030, and 1031 of the SSRBC.

C. HMA base course must conform to the requirements of Section 355 of the SSRBC.

D. Gradation: The fine aggregate gradation for all HMA shall be FA1, FA 2, FA 20, FA 21 or FA 22. When Reclaimed Asphalt Pavement (RAP) is incorporated in the HMA design, the use of FA 21 Gradation will not be permitted.

2.03 PRIME AND TACK COATS

A. Bituminous material for prime and tack coat must conform to the requirements of Section 1032 of the SSRBC concerning Liquid Asphalt.

1. Prime coat material for application over aggregate base courses must be Grade MC30.
2. Tack coat for application over concrete or bituminous base courses must be Grade SS-1, unless directed otherwise by the Commissioner.
3. Aggregate materials for prime or tack coats for streets open to traffic must be limestone or granite screenings free from dust and conforming to the requirements of Section 1003.03 of the SSRBC. Aggregate materials for tack coat must be gradation FA-1, FA-2 or FA-3.

2.04 REFLECTIVE CRACK CONTROL TREATMENT

A. Reflective crack control materials must conform to the requirements of Section 443 of the SSRBC for System A.

PART 3 - EXECUTION

3.01 GENERAL

A. If the limits of excavation of the trench width and/or the edge of the cut lines are exceeded during excavation, the restoration limits must be extended to include the additional widths.

B. In order to assure a straight-line edge restoration, the Commissioner may extend the width of the pavement removal and restoration to the extent that may be deemed necessary to satisfy the intent of this Section.

C. Plating of Unattended Excavations

1. All unattended openings in streets, alleys, and driveways necessitated by the work under this contract, must be covered with steel plates of adequate thickness to provide protection to both vehicular and/or pedestrian traffic.
2. Steel plate(s) subjected to vehicular traffic must be of a sufficient thickness to support AASHTO HS-20 traffic loadings without movement, and be secured to the pavement surface to prevent rocking or movement which could expose the excavation. When steel plates are to be left in place beyond normal working hours and in areas subjected to pedestrian traffic, a bituminous ramp is to be provided around the perimeter of the plate(s), to provide a smooth transition between surface of the plate(s) and the surrounding pavement, unless directed otherwise by the Commissioner.
3. Plating of openings is not intended as a substitution for providing traffic control, which must be provided in accordance with Section 015526.

3.02 TEMPORARY PAVEMENT

A. Provide temporary pavement where specified and as directed by the Commissioner. Temporary pavements must consist of HMA binder or crushed stone fill, as directed by the Commissioner.

B. In placing and compacting the crushed stone fill, the Contractor must conform to the applicable requirements of Section 351 of the SSRBC, except that the crushed stone surface fill must be compacted to the degree required to maintain the safe passage of vehicular and pedestrian traffic.

C. Maintain the temporary pavement in a passable and safe condition for traffic and surface drainage.

D. Fill sidewalk areas disturbed by construction with compacted crushed stone fill and grade to provide safe passage for pedestrian traffic. The thickness of the compacted crushed stone fill is to be 4-inches, unless otherwise directed by the Commissioner.

E. The Commissioner will be the sole judge as to when compaction densities, required herein, have been obtained.

F. Surface Treatment of Temporary Pavement

1. Apply prime coat to temporary aggregate surface in accordance with the requirements of Section 406.05 of the SSRBC, except as modified herein. Before placing the Bituminous Material Prime Coat, the base must be compacted and cleaned of all dirt and foreign material. The bituminous material for the tack coat must be applied uniformly at the rate of 0.10 to 0.25 gal per sq. yd. The exact rate will be specified by the Commissioner. Bituminous material must not be placed on wet surfaces.
2. Apply ¼-inch thick uniform layer of aggregate screening over the asphalt treated surface.

G. HMA temporary surfacing will be placed only at locations as directed by the Commissioner. Temporary bituminous pavement must not exceed 3-inches in thickness, unless directed otherwise by the Commissioner.

3.03 SURFACE MILLING

A. Where restoration is shown on the Drawings, is specified, or is directed by the Commissioner, the existing pavement surface is to be removed to a sufficient depth to accommodate resurfacing the pavement with HMA Surface Course, HMA Binder Course and/or Leveling Binder Course, as specified in the pavement restoration note on the drawings, or as directed by the Commissioner. All pavement restoration including but not limited to HMA / final bituminous surface course and permanent pavement markings must be completed within seven (7) days of commencing milling operation.

1. When the vertical differential between the milled pavement surface and adjacent pavement exceeds 2¼-inches, a stepped milled wedge longitudinal joint must be provided. Each step is to be a minimum of 9-inches in width for each 1-inch in differential height.

B. The machine used for surface removal must be a self-propelled milling machine capable of planning and cutting the existing surface and depositing the cuttings into a windrow or loading directly into trucks.

C. The machine must be capable of removing, in one pass, a layer of bituminous or portland cement concrete material of at least 6 feet in width.

D. The machine must be capable of accurately and automatically establishing profile grades by referencing from either the existing pavement, or from an independent grade control to provide a milled surface with a tolerance of 3/16-inch in 10 feet when checked with a 10 feet straight edge.

E. Remove the excess material from the surface without permitting dust from the operation to escape into the air.

F. The temperature at which the Work is performed, the nature, the condition of the equipment, and the manner of performing the Work must be such that the milled surface must not be, gouged, shaved, or otherwise damaged by the milling operation.

G. Make sufficient cutting passes so that all irregularities or high spots are eliminated to the satisfaction of the Commissioner.

H. Remove the pavement to the required depth adjacent to structures such as drainage castings and utility covers using machine or hand methods in a manner satisfactory to the Commissioner.

1. Provide a temporary bituminous ramp around utility structures where directed by the Commissioner.

I. The Contractor is responsible for the disposal of all milled materials off of the Site, unless otherwise directed by the Commissioner.

1. After cold milling a traffic lane, the pavement must be swept by a mechanical broom to prevent re-compaction of the cuttings onto the pavement. All loose material must be removed from the roadway to the satisfaction of the Commissioner. Temporary ramps are to be provided at butt joints between milled and existing pavements on both the approach and departure ends.

J. Removed bituminous and Portland cement concrete materials are to be removed from the site and taken to a recycling facility.

3.04 HOT MIX ASPHALT PAVEMENT

A. Sub-base Preparation

1. Construct sub-base in accordance with the requirements of Section 311 of the SSRBC, to match the existing pavement cross-section, to the lines and grades shown on the Drawings, or as established by the Commissioner.

B. Aggregate Base Course

1. Add water to the material during compaction only when it is necessary to increase the percentage of moisture to obtain the required density.

C. Tack and Prime Coats

1. Apply tack coat to all prepared aggregate base course in accordance with the requirements of Section 406.05(b) (2) of the SSRBC, except as modified herein. Before placing the Bituminous Material Tack Coat, the base must be compacted and cleaned of all dirt and foreign material. The bituminous material for the tack coat must be applied uniformly at the rate of 0.10 to 0.25 gal per sq. yd. The exact rate will be specified by the Commissioner. Bituminous material must not be placed on wet surfaces.
2. Apply prime coat to prepared bituminous or concrete base course in accordance with the requirements of Section 406.05(b) (1) of the SSRBC. Before placing the Bituminous Material Prime Coat, the base must be cleaned of all dust, dirt and foreign material. The bituminous material must be applied uniformly at the rate of 0.05 to 0.10 gal per sq. yd. The exact rate will be specified by the Commissioner. Bituminous material must not be placed on wet surfaces.
3. When the road is to be kept open to traffic, the tack or prime coat (except emulsion type) must be placed not less than 1 hour in advance of the placement of HMA and no tack or prime coat may be placed more than 5 days in advance of the placement of HMA.
4. When the road is closed to thru traffic, non-Emulsion type prime may be placed no more than 5 days in advance of the placement of HMA.
5. When directed by the Commissioner, the tack or prime coat must be covered immediately following its application with fine aggregate mechanically spread at a uniform rate of 2 to 4 lbs. per sq. yd.
6. “Fresh Oil” signs must be posted at all ingresses to primed surfaces.

D. Bituminous Wearing Course

1. Construct HMA binder course and HMA surface course as noted in the pavement restoration note on the Drawings, and HMA temporary surfacing as directed by the Commissioner, in accordance with the IDOT requirements of Section 406 of the SSRBC.
2. Unless otherwise directed by the Commissioner, where the existing bituminous thickness over a concrete or brick base is less than the combined proposed level binder and surface course thickness, reduce the thickness of the level binder course. If the reduced thickness of the level binder course is less than ¾-Inch omit the binder course and modify the thickness of the surface course.
3. Surface course and binder course mixtures must be placed on a dry, clean base and when weather conditions are suitable. In the event of a sudden rain, loading additional trucks must immediately stop whether it is from the plant or storage bins. Materials in transit will be permitted to be laid at the Contractor's risk providing the pavement is free of standing water and the proper temperature of the asphaltic mix is maintained. Approval to unload the trucks in transit in no way relaxes the requirements for quality, density or smoothness of the bituminous mixture being placed.
4. A preset grade reference device, i.e. 30 foot skid with electronic grading sensors, traveling on the adjacent pavement must be used for surface course placement.
5. Any foreign material on the existing surface must be removed to the satisfaction of the Commissioner before the surface course is placed.
6. In no case may the speed of the paver exceed 35 - feet per minute or as directed by the Commissioner.
7. "Flow Boys" must be used at all locations where vertical clearance precludes the use of normal dump trucks. The use of "Flow Boys" is considered incidental to the various HMA pay items and no additional payment will be made.
8. The Contractor must protect all sections of newly compacted surface courses from traffic until they have hardened to the satisfaction of the Commissioner.
9. Surface Tests must be made in accordance with applicable portions of 406.11 of the SSRBC. The Contractor must furnish a sixteen foot straight edge for use by the Commissioner. The Contractor will be responsible for straight edging the surface course before the surface course is opened to traffic.
10. The Contractor must furnish the name(s) of the QC manager and Level I Technician assigned to the project at the time of the Preconstruction meeting.

E. REFLECTIVE CRACK CONTROL

1. Reflective crack control treatment must be installed in accordance with requirements of Section 443.06 of the SSRBC. Locations for installing the reflective crack control treatment will be determined by the Commissioner or agency having jurisdiction over the roadway.

3.05 TRAFFIC CONTROL

A. The Contractor is responsible for traffic control and the protection of vehicular and pedestrian traffic from the work. For detailed requirements see Section 015526.

3.06 FIELD QUALITY CONTROL

A. Testing and Inspecting: Contractor must provide an IDOT qualified Hot Mix Asphalt testing agency to perform tests and inspections and to submit reports for Work of this Section.

B. Coring must be conducted using procedures and equipment that will provide undamaged, undistorted cores of a diameter of no less than 3-5/8-Inches. The hole caused by the removal of the cores must be refilled immediately with a bituminous meeting these specifications, compacted and finished to the satisfaction of the Commissioner. The Contactor must transport obtained cores to the plant laboratory for density determination. Determination of bulk specific gravity of cores will be performed using procedures specified in IL 166-86 or, if applicable IL 275-86. No less than 4 or more than 20 cores per day will be required by the Commissioner for the purpose of acceptance and / or compaction with nuclear gage density measurements. The cost of this work will not be paid for separately, but will be considered incidental to the various HMA pay items.

C. Hot Mix Asphalt Tests: Testing of Hot Mix Asphalt must comply with Article 1030.05 of the SSRBC.

1. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ASPHALT PAVEMENT shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of ASPHALT PAVEMENT shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 32 12 16

SECTION 32 12 17

PROTECTIVE COAT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies the requirements for applying a protective treatment to the permanently exposed surfaces of all Portland Cement Concrete placed in this project. The work under this Section must include all labor, materials, tools and equipment required for cleaning the concrete surface to be covered and applying a minimum of two coats of the protective surface treatment.

B. Except as modified herein, the work must be done in accordance with the applicable portions of Section 503.19 of the IDOT Standard Specifications.

C. Related Sections

1. Section 32 16 21: Concrete Curbs, Gutters and Walks.
2. Section 32 16 23: Portland Cement Concrete Sidewalk

1.03 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, Adopted January 1, 2022 or latest edition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of PROTECTIVE COAT will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of PROTECTIVE COAT will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 32 12 17

SECTION 32 13 13

CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes requirements for Portland Cement Concrete Pavement as required for the roadway base courses proposed with the project improvements.

1.03 RELATED SECTIONS

A. Section 01 55 26 – Traffic Control.

1.04 REFERENCES*

A. CDOT Rules and Regulations for Construction in the Public Way (CDOT Specifications), January 2019.

B. IDOT Standard Specifications for Road and Bridge Construction (SSRBC), latest edition.

C. IDOT Supplemental Specifications and Recurring Special Provisions (SSRSP). latest edition.

*In the event of a conflict between CDOT and IDOT Specifications in this Section, CDOT Specifications shall govern.

1.05 MATERIAL TESTING, INSPECTIONS, AND SUBMITTALS

A. All materials and workmanship are subject to inspections, testing, and approval by the Commissioner.

B. Unless otherwise designated by the Commissioner, all tests must be conducted to current CDOT standards.

C. Contractor must provide an independent material testing agency to conduct testing and inspection. All provisions for test, samples and inspections are considered incidentals to the work and no additional payment is allowed.

D. Failure of the Contractor to pass required tests and inspections is grounds for rejection of the Work. All rejected Work is subject to removal or other corrective actions as directed by the Commissioner.

1.06 QUALITY ASSURANCE

A. Conformance with Specifications. Comply with this Section and CDOT Specifications for all work within public right-of-way. In the event that a conflict exists between this Section and the CDOT Specifications, CDOT Specifications govern. Work, which is not within CDOT jurisdiction, must be coordinated with the Commissioner to ensure compliance to all standards and permit requirements.

B. Material Tickets. Deliver to the Commissioner, at the time of delivery, a weight ticket for all material delivered signed by a Certified Public Weigh master indicating the net weight or volume and mix or type of material being delivered.

C. QC/QA. Provide quality control (QC) and quality assurance (QA) in accordance with the IDOT SSRSP Check Sheet #23 “Quality Control / Quality Assurance of Concrete Mixes”.

PART 2 - PRODUCTS

2.01 AGGREGATE

A. Meet requirements of Article 1004 of the Standard Specifications for coarse aggregate with gradation of CA-6.

2.02 PORTLAND CEMENT CONCRETE

A. Meet requirements of Article 1020 of the Standard Specifications for Class PV Concrete.

2.03 DOWEL BARS AND PAVEMENT REINFORCING

A. Meet requirements of Article 1006 of the Standard Specifications.

2.04 JOINT FILLER

A. Meet requirements of Articles 1050 or 1051 of the Standard Specifications.

2.05 PROTECTIVE COAT FOR CONCRETE SURFACES

A. Meet requirements of Article 1023 of the Standard Specifications.

PART 3 - EXECUTION

3.01 GENERAL

A. If the limits of excavation of the trench width and/or the edge of the cut lines are exceeded during excavation, the restoration limits must be extended to include the additional widths.

B. In order to assure a straight-line edge restoration, the Commissioner may extend the width of the pavement removal and restoration to the extent that may be deemed necessary to satisfy the intent of this Section.

C. Notification to CDOT

1. Notify the Commissioner and CDOT for inspection of work requiring CDOT approval by noon on the day prior to commencing additional work. If CDOT inspectors fail to perform the inspection within forty-eight (48) hours after notification, the Contractor may, after approval of the Commissioner, proceed with subsequent work.

D. Plating of Unattended Excavations

1. All unattended openings in streets, alleys, and driveways necessitated by the work under this contract, must be covered with steel plates of adequate thickness to provide protection to both vehicular and pedestrian traffic.
2. Steel plating subjected to vehicular traffic must be of a sufficient thickness to support AASHTO HS-20 traffic loadings. The size of the plating must be large enough to span the opening with sufficient overlap and must be firmly bedded and secured to the pavement surface to prevent rocking or movement. A bituminous ramp is to be provided around the perimeter of the plating as appropriate to provide a smooth transition between surface of the plate(s) and the surrounding pavement or walkway, unless authorized otherwise. The use of steel plating during winter construction must be approved by CDOT and conform to their applicable requirements.
3. The name of the Contractor must be marked on both sides of each plate.
4. Plating of openings is not intended as a substitution for providing traffic control. Traffic control is to be provided in accordance with Section 015526 of these specifications.

3.02 PORTLAND CEMENT CONCRETE PAVEMENT

A. Pavement Base Course

1. Construct sub-base as shown on the Drawings, or as directed by the Commissioner. Work is to be in accordance with Section 311 of the SSRBC.

2. Construct Portland cement Concrete base as shown on the Drawings, or as directed by the Commissioner. Work is to be in accordance with Section 353 of the SSRBC after the sub-base has been placed and compacted. Provide dowel bars and tie bars for connections to the existing concrete pavement in accordance with Chapter 6 of the CDOT Specifications.

3. Limits for restoration for concrete base course are to be the width of the trench neat lines plus one additional foot on each side of the trench unless noted otherwise on the Drawings. If the gutter line or edge of pavement is at a distance of 2-feet or less from

the edge of excavation, the pavement is to be restored from the edge of the trench excavation to the gutter line or edge of pavement.

B. Portland Cement Concrete Pavement (Where Applicable)

1. Construct Portland cement concrete pavement as shown on the Drawings and in accordance with Section 420 of the SSRBC. Provide dowel bars and tie bars for connections to existing concrete pavement, and reinforce Portland cement concrete pavement with pavement fabric in accordance with Chapter 6 of the CDOT Specifications, unless otherwise specified, or directed by the Commissioner.

C. Protective Coat for Concrete Surfaces

1. A Protective Coat must be applied to all concrete surfaces constructed and opened to traffic between October 15th and April 15th. The application of the Protective Coating should be applied in accordance with the requirements of Article 420.18 of the SSRBC.

D. Protection from Extreme Temperatures

1. It is the responsibility of the contractor, at no cost to the City, to provide temperature controlled concrete during hot weather in accordance with SSRBC Article 1020.14(a) and 1020.14(c).
2. It is the responsibility of the contractor to provide temperature controlled concrete during cold weather in accordance with SSRBC Article 1020.14(a) and 1020.14(c).
3. Protect new concrete in accordance with SSRBC Article 1020.13(c) for protection.

3.03 TRAFFIC CONTROL

A. The Contractor is responsible for traffic control and the protection of vehicular and pedestrian traffic from the work. For detailed requirements see Section 015526.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of CONCRETE PAVEMENT shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of CONCRETE PAVEMENT shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 32 13 13

SECTION 32 14 43

UNIT PAVING

PART 1 – MATERIALS

1.1 SUMMARY

A. This section includes all ungrouted and mortarless exterior specialty unit paving system.

1.2 RELATED DOCUMENTS

A. Following sections:

1. Section 31 00 00 Earthwork
2. Section 31 23 33 “Excavating, Backfilling, and Compacting for Utilities.”
3. Section 32 13 00 Portland Cement Concrete Paving

1.3 REFERENCES

A. The American Society of Testing and Materials (ASTM):

1. ASTM D698 - Tests for Moisture-Density Relationship of Soils and Soil-Aggregate Mixtures, Using 5 Lb. Rammer and 12 in. Drop.

B. Illinois Department of Transportation:

1. Standard Specifications for Road and Bridge Construction, January 2022, including all addenda.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract.

B. Product data for the following products:

1. Precast Concrete unit pavers
2. Joint filler for non-permeable paver systems.

C. Samples for initial selection purposes in form of actual units or sections of units showing full range of colors, textures, and patterns available for each type of unit paver indicated. Include similar samples of material for joints and accessories involving color selection.

D. Qualification data for firms and persons specified in "Quality Assurance" Article 1.05 to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, plus other information specified.

E. Shop Drawings: showing detailed paving patterns and proposed cuts within concrete banding modules. Concrete banding shall be designed so that minimum cuts are required for the unit pavers.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has successfully completed unit paver installations similar in material, design and extent to that indicated for Project.

B. Single-Source Responsibility: Obtain each color, type and variety of unit pavers, from a single source with resources to provide products and materials of consistent quality in appearance and physical properties without delaying progress of the work.

C. Field-Constructed Mock-Up: Prior to installation of unit pavers, erect mock-ups for each form and pattern of unit pavers required to verify selections made under sample submittals. Build mock-ups to comply with the following requirements, using materials and same base construction including special features for expansion joints and contiguous work as indicated for final unit of work.

1. Locate mock-ups on site in location and size indicated or, if not indicated, as directed by Owner’s Representative and/or Architect/Engineer.
2. Notify Owner’s Representative and Architect/Engineer one week in advance of the dates and times when mock-ups will be erected.
3. Demonstrate quality of workmanship that will be produced in final unit of work.
4. Retain and maintain mock-ups during construction in undisturbed condition as a standard for judging completed unit of work. Accepted mock-ups in undisturbed condition at time of Substantial Completion may become part of completed unit of work.
5. Paving is to show the proposed color, crevice fill material, surface finish and workmanship. Consult Architect for paver color.
6. Panel size shall be a minimum of 10' -0" wide x 10' -0" long in the presence of the Architect/Engineer prior to the installation of these materials on the site.
7. Do not start paving site work until the Architect has given written approval of all components of the sample panel.
8. This sample panel will be used as a standard of comparison for all site concrete constructed of same materials.

D. Visual Inspection

1. All units shall be sound and free of defects that would interfere with proper placing of the unit or impair the strength or permanence of the construction. Minor cracks incidental to the usual methods of manufacture, or minor chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect unit pavers and aggregate during storage and construction against wetting by rain, snow, or ground water and against soil or contamination from earth and other materials.

1.7 PROJECT CONDITIONS

A. Cold Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations: Protect unit paver work against freezing when atmospheric temperature is 40 deg F (4 deg C) and falling. Heat materials and provide temporary protection of completed portions of unit paver work. Comply with International Masonry All-Weather Council's "Guide Specification for Cold-Weather Masonry Construction."

PART 2 - PRODUCTS

2.1 UNIT PAVING

A. All pavers shall comply with the quality specifications for solid concrete interlocking paving units as set out in ASTM Specifications C 936-01.

B. Concrete pavers shall be A Grade pavers manufactured/supplied by a member of the Brick Institute of America (BIA).

C. Unit Pavers: Provide pavers aligned and sized to match existing conditions.

1. Exposed Aggregate Precast Concrete Paver:
   a. Color and Finish A: match existing
   b. Chamfer: Relieved edge
   c. Size A: Match Existing
2. Concrete pavers have spacer bars on each unit. These insure a minimum joint width between each unit in which the aggregate is placed. Spacer bars help prevent contact of the edges with adjacent pavers and subsequent chipping.

D. Physical Requirements

1. Compressive Strength
   a. At the time of delivery to the work site, the average compressive strength shall not be less that 8,000 psi, with no individual strength less than 7,200 psi as per ASTM Specifications C 936-01.
   b. Testing procedures shall be in accordance with ASTM Specifications C 140.
2. Absorption
   a. The average absorption shall not be greater that five percent (5%) with no individual unit absorption greater that seven percent (7%) as required by ASTM Specification C 936-01.
3. Resistance to Freezing and Thawing
   a. The manufacturer shall satisfy the purchaser either by proven field performance of laboratory freezing and thawing test that the paving units have adequate resistance to freezing and thawing. If a laboratory test is used, when testing in accordance with ASTM Specification C 67-02, Section 8, specimens shall have no breakage and not greater that 1 % loss in dry weight of any individual unit when subjected to 50 cycles of freezing and thawing.

2.2 AGGREGATE MATERIALS

A. Aggregates shall conform to ASTM Specifications C 33 for normal weight concrete aggregate (no expanded shale or lightweight aggregates) except that grading requirements shall not necessarily apply. Engineering fill shall conform to IDOT SSRBC 2016.

B. Jointing indicated on construction documents

1. Color: Match Existing

C. Bedding Layer indicated on construction documents.

D. Drainage Course indicated on construction documents.

E. Base Course indicated on construction documents.

F. Joint in-fill, as recommended by manufacturer for paver pavements. Provide standard color palette for Architect/Engineer review, selection, and approval.

2.3 BITUMINOUS SETTING BED MATERIALS

A. Conform to ASTM D-946-69A.

B. Mix shall be 7% asphalt cement and 93% sand/coarse aggregate

C. Joint and Bedding Layer indicated on construction documents.

D. Primer for Base comply with ASTM D 2028; as recommended by product manufacturer.

E. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or AC-20.

F. Neoprene-Modified Asphalt Adhesive: Adhesive consisting of oxidized asphalt combined with 2% neoprene and 10% long-fibered minerals containing no asbestos.

2.4 GEOTEXTILE FABRIC

A. Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 157 lbf (700 N); ASTM D 4632.
3. Sewn Seam Strength: 142 lbf (630 N); ASTM D 4632.
4. Tear Strength: 56 lbf (250 N); ASTM D 4533.
5. Puncture Strength: 56 lbf (250 N); ASTM D 4833.
6. Apparent Opening Size: No. 70 (0.212-mm) sieve, maximum; ASTM D 4751.
7. Permittivity: 0.5 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

PART 3 - EXECUTION

3.1 SUBGRADE

A. Under this section the Contractor shall perform the final shaping and compaction of earth to provide for the construction of the pavement structure, to conform to the lines, grades and cross-sections shown on the plans.

B. Site grades can be elevated to the design sub grade elevation using clean native earth fill (free of deleterious material). This fill should be placed in lifts not exceeding 6 inches and compacted to a minimum of 90 percent Standard Proctor Density per ASTM D 698. The final sub grade profile should be (1) uniformly compacted to a minimum of 90 percent Standard Proctor Density and (2) proof-rolled using a heavy rubber tired vehicle (such as a loaded tandem) to delineate soft (wet and “spongy”) areas. These areas should be repaired by removing the unstable soil and replacing with clean dry compacted earth fill.

3.2 PLACEMENT OF BASE COURSE

A. Aggregate base course shall consist of a thickness as indicated in drawings and shall be compacted to a minimum of 95 percent Standard Proctor Density.

B. Concrete base course, as indicated on plans. Refer to Section 32 13 13 Portland Cement Concrete Paving.

3.3 BITUMINOUS SETTING BED

A. Apply primer per manufacturer's recommendations to concrete base slab prior to placing setting bed.

B. Install the setting bed directly over a prepared concrete base. Place screed rails to serve as guides for the striking board. The screed rails shall be carefully set to ensure proper setting bed depth and finished paver grade. Place the bituminous material between the parallel screed rails. Position striking board perpendicularly over the screed rails and pull smooth. Repeat several times showering low porous spots with fresh bituminous material to yield a smooth, firm and even setting bed. The bed depth shall be adjusted to ensure the top surface of the placed pavers will be at the required finished grade.

C. Spread bituminous mix at a minimum temperature of 250 degrees-F. Compact and roll setting bed smooth to a depth of ¾", or otherwise indicated on plan. Complete rolling before mix temperature cools to 185 degrees-F.

3.4 INSTALLATION OF PAVERS

A. General

1. Pavers with excessive chips, cracks, voids, discoloration's or other defects shall not be installed. Pavers should be produced with spacer lugs which maintain consistent joint spacing.

B. Patterning

1. As indicated on plans.

C. Edge Restraints

1. Provide edge restraints as indicated.

D. Placement of Pavers

1. Apply neoprene-modified asphalt adhesive to cooled setting bed to uniform thickness of 1.6mm. Setting bed shall be clear of debris. Upon adhesive reaching operable tackiness proceed with the placement of paver units.
2. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood sheets and advance installation.
3. If additional leveling of pavers is necessary, roll pavers prior to infilling joints.
4. Fill joints with in-fill material. Broom in-fill evenly. A second application of the aggregates may be required to completely fill the surface voids.

E. Inspection of Paver Surface

1. Any units, which are structurally damaged during compaction, shall be immediately removed and replaced.
2. Inspection by the owner or consultant shall determine whether and additional aggregate application is required.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to Installer, which ensures unit paver work being without damage or deterioration at time of Substantial Completion.

3.6 CLEAN-UP

1. Sweep clean all paved areas of excess aggregate and dirt.
2. Pick up and remove from the site all surplus materials, equipment and debris resulting from this section of the work. Dispose material off site legally in accordance with Section 31 23 18.13 “Contaminated Soil, General Construction & Demolition Debris Disposal” or Section 01 35 63 “Construction Waste Management”, as applicable.

PART 4 - MEASUREMENT AND PAYMENT

1. MEASUREMENT
    a. The Work of UNIT PAVERS will not be measured for payment.
2. PAYMENT
    a. No separate payment will be made for the work covered in this section. Payment for the Work of UNIT PAVERS will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.
3. PAY ITEM ACCOUNT NUMBER
    a. CIVIL WORK: 020000

END OF SECTION

SECTION 32 16 21

CONCRETE CURBS, GUTTERS & WALKS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes requirements for restoration of Portland Cement Concrete Walkways, ADA Ramps, Curbs and Gutters and Miscellaneous Concrete.

1.03 RELATED SECTIONS

A. Section 03 20 00 – Concrete Reinforcement.

B. Section 03 30 00 – Concrete.

C. Section 32 13 13 – Concrete Pavement.

D. Section 32 17 26 – Tactile/Detectable Warning Surface Tiles.

1.04 REFERENCES

A. CDOT Rules and Regulations for Construction in the Public Way (CDOT Specifications), January 2019.

B. CDOT Appendix B: Rules and Regulations for Construction in the Public Way (ADA Standards), January 2019.

C. IDOT Standard Specifications for Road and Bridge Construction (SSRBC), latest edition.

D. IDOT Supplemental Specifications and Recurring Special Provisions (SSRSP), latest edition.

E. Americans with Disabilities Act (ADA): Title 49 CFR Transportation, Part 37.9 ‘Standards for Accessible Transportation Facilities, Appendix A, Section 4.29.2 Detectable Warnings on Walking Surfaces,’ latest edition.

F. Illinois Administrative Code, Chapter 1, part 400.310 Subchapter B, latest edition.

G. California Code of Regulations (CCR): Title 24, Part 1, Articles 2, 3, and 4 and Part 2, Section 205, Section 1127B.5 and Section 1133B.8.5, latest edition.

1.05 MATERIAL TESTING, INSPECTIONS, AND SUBMITTALS

A. All materials and workmanship are subject to inspections, testing, and approval by the Commissioner.

B. Unless otherwise designated by the Commissioner, all tests must be conducted to current CDOT standards.

C. Refer to Book 1 for submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples.

1. Submit manufacturer’s literature describing products, installation procedures and routine maintenance.
2. Submit two (2) samples minimum 8” square of the Detectable Warning Tiles proposed for use.
3. Submit layout drawings for products specified showing plans of placement including joints, sizes, types and quantity of tiles to be used at each ramp, and an outline of installation materials and procedures.

D. Failure of the Contractor to pass required tests and inspections is grounds for rejection of the Work. All rejected Work is subject to removal or other corrective actions as directed by the Commissioner.

1.06 QUALITY ASSURANCE

A. Installer’s Qualifications: Engage an experienced Installer certified in writing by Detectable Warning Tile manufacturer as qualified for installation, who has successfully completed installation similar in material, design and extent to that indicated for the Project.

B. Detectable Warning Tiles must be guaranteed in writing for a period of five years from date of final completion. The guarantee includes defective work, breakage, deformation and loosening of tiles.

C. Remove and replace concrete which does not satisfy the performance requirements of this specification, which does not conform to grades and profiles shown on the Drawings, contains cracks, spalling or other defects which impairs the strength, safety or appearance of the work, or has been damaged or discolored during construction. Protect the Work from damage until accepted.

D. Meet the requirements of CDOT ADA Standards Appendix B.

E. Meet the requirements of quality control (QC) of Specification 033000 Concrete.

PART 2 - PRODUCTS

2.01 PORTLAND CEMENT CONCRETE

A. Meet requirements of Section 033000 – Concrete.

2.02 PROTECTIVE COAT FOR CONCRETE SURFACES

A. Meet requirements of Section 033000 – Concrete.

2.03 DETECTABLE WARNING TILES

A. Provide detectable warning tiles from manufacturers approved by CDOT in accordance with CDOT Standards and Specifications. These include but are not limited to the following:

1. East Jordan Iron Works
2. Neenah Foundry
3. Pioneer Detectable, LLC
4. Advantage Cast Iron

2.04 JOINT FILLER

A. Meet requirements of Section 033000 – Concrete.

2.05 DOWEL BARS AND PAVEMENT REINFORCING

A. Meet requirements of Section 032000 – Concrete Reinforcement and Embedded Assemblies

PART 3 - EXECUTION

3.01 SIDEWALKS

A. Excavate, prepare and compact subgrade to 95% of maximum laboratory density and in accordance with SSRBC Section 424.

B. Construct Portland cement concrete sidewalk in accordance with Section 424 of the SSRBC. Construct Portland cement concrete sidewalk 5-inches thick in one (1) course where shown on the drawings, or as directed by the Commissioner.

C. Restore to the original conditions areas damaged by the contractor during the removal and/or installation of the new sidewalk. This includes all existing parkway including brick, grass and asphalt, sidewalk, concrete base, and pavement

D. Cross slopes of sidewalks must be a minimum to provide positive drainage to curb and a maximum of 2%.

3.02 ADA RAMPS / DETECTABLE WARNING TILES

A. The Contractor is solely responsible for the construction of the ramps in accordance with the American with Disabilities Act (ADA) and CDOT Appendix B Requirements for Openings, Construction, and Repair in the Public Way (ADA Standards)

B. Detectable Warning Tiles and Anchors must be installed in accordance with manufacturer's recommendations and CDOT requirements.

C. Transportation and Delivery

   1. Deliver Detectable Warning Tiles to worksite in such quantities and at such times to assure continuity of installation. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses or damage.
   2. Store units at worksite to prevent cracking, distorting, and warping, staining or other physical damage and so that markings are visible.
   3. Keep panels under cover and protected until installed.
   4. Deliver anchors in sufficient quantity for the work to be done before the start of construction.

D. Environmental Conditions and Protection: Maintain minimum temperature of forty (40) degrees Fahrenheit in spaces to receive Detectable Warning Tiles for at least forty-eight (48) hours prior to installation, during installation, and for not less than forty-eight (48) hours after installation. Maintain minimum temperature of forty (40) degrees Fahrenheit in storage spaces where tile material will be stored for at least forty-eight (48) hours before beginning installation.

E. Excavate, prepare and compact subgrade to 95% of maximum laboratory density and in accordance with SSRBC Section 424. When directed by the Commissioner, provide 3-Inch sand sub-base under new sidewalks in parkways or when a change in the subgrade elevation occurs.

F. Construct Portland cement concrete sidewalk in accordance with Section 424 of the SSRBC and the City of Chicago Department of Transportation's latest Standard Drawing for Curb Ramps for People with Disabilities. Construct curb ramps and side flares a uniform 8-Inch thick in one (1) course where shown on the drawings, or as directed by the Commissioner.

G. The concrete must be poured and finished, true and smooth to the required dimensions and slope prior to tile placement. Immediately after finishing the concrete, check that the required slope is achieved. Place the tile true and square to the curb edge in accordance with the contract drawings. Tamp or vibrate the Cast-In-Place Tiles into the fresh concrete to ensure that the field level of tile is flush to the adjacent concrete surface. Ensure that the tile field level is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes. The tolerance for elevation differences between tile and adjacent surface is ±1/16". Place the second panel next to the first, leaving no gap. (tiles must be abutted to one another) and press into the wet concrete. Set adjacent panels even and level with each other and with the surrounding concrete.

H. Before the concrete has set, trowel the concrete flat around the tile perimeter to the field level of the tile. Remove any excess concrete, leaving no gap (tiles must be abutted to one another) between the panels. Apply broom finish to the area immediately surrounding the panels

I. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Place a minimum of two (2) suitable weights of 25 lb each on each tile to ensure solid contact of tile underside to the concrete

J. Remove the protective plastic coating and insert one anchor into each of the preformed holes. The anchors must be set flush to the panel surface. Tap the top of each anchor to ensure contact of the concrete with the anchor.

K. During and after the tile installation and the concrete curing stage prevent exertion of external forces upon the tile.

L. Following the curing of the concrete, remove the protective plastic wrap from the tile face. Prevent damage to the tile surface while removing the plastic wrap and /or and concrete residue. Tile surface must be clean prior to final inspection and acceptance.

M. Protect tiles against damage during construction period to comply with tile manufacturer's specification. Tiles damaged prior to placement will not be acceptable for installation and must be replaced at the Contractor's cost.

N. Protect tiles against damage from rolling loads following installation.

O. Clean tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean tile by method specified by tile manufacturer.

3.03 CONCRETE CURB AND COMBINATION CURB AND GUTTER

A. Construct concrete curb and combination concrete curb and gutter as shown on the Drawings, or as directed by the Commissioner. Construction must be in conformance with Section 606 of the SSRBC.

3.04 PROTECTIVE COAT

A. Apply protective coats of linseed oil and petroleum spirits to concrete sidewalks, curbs and gutters constructed between October 15 and April 15. The application of protective coat must conform to the requirements of Article 420.18 of the SSRBC. Provide sand to prevent slipping on walking surfaces open to traffic.

3.05 PROTECTION FROM EXTREME TEMPERATURES

A. It is the responsibility of the contractor, at no additional cost to the City, to provide temperature controlled concrete during hot weather in accordance with SSRBC Article 1020.14(a) and 1020.14(c).

B. It is the responsibility of the contractor, at no additional cost to the City, to provide temperature controlled concrete during cold weather in accordance with SSRBC Article 1020.14(a) and 1020.14(c).

C. Protect new concrete in accordance with CDOT and IDOT Standards.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of CONCRETE CURBS, GUTTERS AND WALKS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of CONCRETE CURBS, GUTTERS AND WALKS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 32 16 21

SECTION 32 16 23

PORTLAND CEMENT CONCRETE SIDEWALK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies requirements for sidewalk. The work under this Section will include furnishing all labor, materials, tools and equipment required to construct PORTLAND CEMENT CONCRETE SIDEWALK, 5-INCH and PORTLAND CEMENT CONCRETE SIDEWALK, 8-INCH, including, but not limited to, all joints, fillers, dowel bars, subgrade preparation, sub-base materials, protective coating and its application and other appurtenant items associated with construction of this item.

B. Except as modified herein, the work must conform to the applicable portions of the Standard Specifications (IDOT), Section 424 and to the applicable portions of the CDOT QC/QA program which is in accordance with Check Sheet 23 of IDOT's Recurring Special Provisions and shall take precedence over all other specifications. C. Related Sections:

1. Section 31 23 13: Subgrade Preparation.
2. Section 32 11 16: Sub-base Granular Material, Type B.
3. Section 32 12 17: Protective Coat.
4. Section 32 16 21: Concrete Curbs, Gutters and Walks.
5. Section 32 17 26: Tactile/Detectable Warning Surface Tiles

1.03 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, Adopted January 1, 2022 or latest edition.
B. Chicago Department of Transportation (CDOT) Rules and Regulations for Construction in the Public Way, Adopted January 2019 or latest edition.
C. Americans with Disabilities Act, as amended
D. U.S, Access Board Public Right-of-Way Accessibility Guidelines (PROWAG)

1.04 SUBMITTALS

A. The Contractor must submit the proposed concrete mix designs for the review and approval of the Commissioner.

PART 2 - PRODUCTS

2.01 PORTLAND CEMENT CONCRETE: SIDEWALK Concrete must conform to the applicable portions of Section 1020 of the Standard Specifications. Concrete must be Class SI Concrete, compressive strength of 3500 psi at 14 days.

2.02 Concrete surface must receive a Brush Finish, as per Article 424.06 of the Standard Specifications.

2.03 Concrete control joints must be spaced between 4 to 6 feet on center, as per Article 424.06 of the Standard Specifications.

2.04 Expansion joint material must be bituminous preformed joint filler conforming to Article 1051.03 of the Standard Specifications.

2.05 Sidewalks replaced on State St must match the existing colors and patters of the State St sidewalk, unless indicated otherwise in the plans or directed by the Commissioner. Colored concrete mixes for these sidewalks, as prepared on a previous project by Ozinga are:

A. Beige - 71-PCC-Z394 BG WR FULL AE with limestone color added
B. Red - 4000 PSI REDGRNT 1974 aggregate with Santa Barbara Brown additive

PART 3 - EXECUTION

3.01 Protective coat must be applied on all sidewalk constructed herein, in accordance with Section 420.21 of the Standard Specifications regardless of time of year.

3.02 Concrete testing for PORTLAND CEMENT CONCRETE SIDEWALK, 5 INCH and PORTLAND CEMENT CONCRETE SIDEWALK, 8-INCH must be completed as specified in the standard CDOT QC/QA program which is covered in IDOT’s Recurring Special Provision Check Sheet 23.

3.03 Compacted Sub-base Granular Material, Type B as specified in Section 321116 must be placed beneath all sidewalks on a prepared subgrade, placed and compacted to a minimum depth of five inches.

3.04 The Contractor must provide expansion joints at forty (40) foot intervals in long runs of sidewalks and wherever sidewalk abuts curbs, paving, structures or elsewhere as shown on the plans. Joint size must be as specified in Article 424.07 of the Standard Specifications (IDOT). Joint type, pattern, and spacing for State St sidewalks must match the existing layout.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of PORTLAND CEMENT CONCRETE SIDEWALK, 5 INCH and PORTLAND CEMENT CONCRETE SIDEWALK, 8-INCH will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of PORTLAND CEMENT CONCRETE SIDEWALK, 5 INCH and PORTLAND CEMENT CONCRETE SIDEWALK, 8-INCH will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 32 16 23

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes requirements for installing temporary and permanent pavement markings.

1.03 RELATED SECTIONS

A. Section 01 55 26 - Traffic Control and Regulations.

1.04 REFERENCES

A. CDOT Rules and Regulations for Construction in the Public Way (CDOT Specifications), January 2019.

B. CDOT Bike Lane Design Guide, latest edition.

C. IDOT Standard Specifications for Road and Bridge Construction (SSRBC), latest edition.

1.05 QUALITY ASSURANCE

A. Conformance with Specifications. Comply with this Section and CDOT Specifications for all work within public right-of-way. In the event that a conflict exists between this Section and the CDOT Specifications, CDOT Specifications govern. Work, which is not within CDOT jurisdiction, must be coordinated with the Commissioner to ensure compliance to all standards and permit requirements.

PART 2 - PRODUCTS

2.01 PAVEMENT MARKINGS

A. Pavement markings on all finished pavements must be the thermoplastic extruded type conforming to the requirements of Section 1095.01 of the SSRBC.

B. Temporary pavement markings must be:

1. Paint or Pavement Marking Tape on milled surfaces, primed surfaces, and binder courses, conforming to Article 1095.02 and 1095.06 of the SSRBC;
2. Pavement marking tape on final surface course, conforming to Article 1095.06 of the SSRBC.

C. Raised reflective pavement markers must conform to the requirements of Section 1096.01 of the SSRBC.

D. Pavement markings for bicycle symbols, bicycle lettering and speed bumps must be pre-cut plastic pavement markings.

E. Curb paint marking must be a yellow color to match Safety Yellow. A draw down must be submitted for approval.

PART 3 - EXECUTION

3.01 GENERAL

A. Notification to CDOT

1. Notify the Commissioner and CDOT for inspection of work requiring CDOT approval forty-eight (48) hours prior to commencing additional work. If CDOT inspectors fail to perform the inspection within forty-eight (48) hours after notification, the Contractor may, after approval of the Commissioner, proceed with subsequent work.

3.02 PAVEMENT MARKINGS

A. Temporary pavement markings are to be provided where existing pavement markings are milled surfaces and on the binder and surface courses. The installation of Temporary Pavement Markings must meet the requirements of Section 703 of the SSRBC, or as directed by the Commissioner.

B. All pavement markings, including thermoplastic lane dividers, etc. removed during construction must be replaced. The installation of Pavement Markings must meet the requirements of Section 780 of the SSRBC, or as directed by the Commissioner.

3.03 TRAFFIC CONTROL

A. The Contractor is responsible for traffic control and the protection of vehicular and pedestrian traffic from the work. For detailed requirements see Section 015526 – Traffic Control.

3.04 RAISED REFLECTIVE PAVEMENT MARKERS

A. All raised reflective pavement markers removed during construction must be replaced. The installation of Raised Reflective Pavement Markers must meet the requirements of Section 781 of the SSRBC, or as directed by the Commissioner.

3.05 PRE-CUT PAVEMENT MARKINGS

A. Installation Requirements:

1. Air Temperature 60o Fahrenheit and rising.
2. Pavement Temperature 70o Fahrenheit and rising.
3. Overnight Temperature 40o Fahrenheit minimum.
4. No rainfall within twenty-four (24) hours preceding placement.
5. Contact cement primer to be allowed to dry before applying marking.
6. Tamp marking three (3) times back and forth for an equivalent of six (6) passes using a tamper cart carrying 200 pounds (lbs.) of weight. Passes are to work any entrapped air from center of marking outward to edges.

3.06 CURB PAINTING

A. Curb painting is to be in accordance with applicable portions of Section 780 of the SSRBC.

1. When directed by the Commissioner the top and face of the curb is to be painted yellow for 15 feet each side of the fire hydrant, except where the 15 foot dimension intersects a crosswalk, driveway or similar feature.
2. Glass beads are NOT required.
3. Painting is to have neat straight edges along back of curb and vertically up the curb face.

3.07 CURB PAINTING REMOVAL

A. Existing curb painting that is not in conformance with the new fire hydrant location is to be removed.

1. The paint is to be removed from the curb by scraping, or mechanical wire brushing.
2. The existing curb markings are to be removed by a method that does not materially damage the surface or texture of the curb surface. Very small particles of tightly adhering existing paint marking may remain in place, if in the opinion of the Commissioner, complete removal of the paint will result in surface damage.
3. Any damage to the curb caused by the paint removal is to be repaired by methods acceptable to the Commissioner.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of PAVEMENT MARKINGS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of PAVEMENT MARKINGS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

TABLE A - STANDARD LETTER & SYMBOL SIZES

Letter or Symbol Type	Large Size – Sq. Ft.	Small Size – Sq. Ft.
“ONLY”	28.8	17.8
Through Arrow	11.5	6.5
Left or Right Arrow	15.6	8.8
Combination Left (Right) and Through Arrow	26.0	14.7
Railroad “R” (6 Ft.)	3.6	-
Railroad “X” (20 Ft.)	54.0	-
Handicap Symbol	4.6	-
Bike Lane Symbol	10.9	-
Bike Lane Arrow Symbol	5.8	-

END OF SECTION 32 17 23

SECTION 32 17 26

TACTILE/DETECTABLE WARNING SURFACE TILES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This work consists of providing all labor, materials, tools, and equipment necessary to install a TACTILE/ DETECTABLE WARNING SURFACE TILES, of the specified type (linear or radial) having a surface color and a truncated dome pattern. Tactile/Detectable Warning Surface System will be installed on all Curb ramps. This work will be done in coordination with PCC Sidewalk, 5-Inch and PCC Sidewalk, 8-inch, where shown on the plans or as directed by the Commissioner. Tactile/ Detectable Warning Surface Systems must be installed across the entire width of the depressed curb, and per the latest CDOT ADA Standard details.

B. RELATED SECTIONS

1. Section 32 16 23: Portland Cement Concrete Sidewalk

1.03 DELIVERY, STORAGE, AND HANDLING

A. Deliver tactile detectible warning surface system materials to the worksite in such quantities and at such times as to assure continuity of installation. Handle and transport material in a position consistent with their shape and design in order to avoid excessive stresses or damage.

B. Store material at worksite to prevent cracking, distorting, warping, staining or other physical damage and so that markings are visible.

C. Keep material under cover and protected until installed.

D. Deliver anchors in sufficient quantity for the work to be done before the start of construction.

1.04 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, latest edition.

B. CDOT Rules and Regulations for Construction in the Public Way (including Appendix B – ADA Standards), latest edition.

C. Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, Part 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES.

D. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR). Title 24, Part 1, Articles 2, 3 and 4 and Part 2, Section 205 definition of “Detectable Warning”. Section 1127B.5 for “Curb Ramps” and Section 1133B.8.5 for “Detectable Warnings at Hazardous Vehicle Areas”.

PART 2 - PRODUCTS

2.01 SUBMITTALS

A. Submit manufacturer’s specifications describing products, installation procedures and routine maintenance procedures.

B. Submit two (2) samples (minimum 8” square) of the tile type proposed for use.

C. Submit copies of manufacturer’s specified maintenance practices for each type of tactile detectable warning system and accessory as required.

2.02 APPROVED MANUFACTURERS

A. See approved detectable warning products in CDOT Rules and Regulations for Construction in the Public Way (Appendix B – ADA Standards), latest edition.

2.03 MATERIALS

A. Polymer Concrete-Replaceable Tile

1. Materials Requirements: Composite Polymer Concrete Detectable Warning tiles shall be manufactured using polymer concrete material. Polymer concrete material shall consist of calcareous and siliceous stone, glass fibers and thermo set polyester resin. The polymer concrete material shall be tested by an independent testing laboratory for chemical resistance and mechanical properties.

2.

Chemical Resistance	ASTM D-543
Simulated Sunlight	ASTM D-1501
Accelerated Service Test	ASTM D-756 Procedure “E” Water
Absorption	ASTM D-570

Material shall be determined to be acceptable if the following criteria are met. For chemical resistance, simulated sunlight, accelerated service test, and water absorption: retention of 75 percent of the control specimen values for load and deflection and no more than 2 percent change in weight. For flammability test, specimen should be self-extinguishing. For fungus resistance test the material should not allow any fungus growth. Smoke density shall be less than 0.5 at 1.5 minutes and less than 15 at 4 minutes. Surface flammability shall be less than 25.

3. Mechanical Properties: The mechanical properties of polymer concrete material shall be tested by an independent testing laboratory. Polymer concrete material shall have the following mechanical properties:

Mechanical Properties	Average Value	Test Method
Compressive Strength	11,430 PSI	ASTM C-170-99 Flexural
Strength	3,330 PSI	ASTM C-580-02
Tensile Strength	1,710 PSI	ASTM C307-99
Shear Strength	11,670 PSI	ASTM D-372-02
Modulus of Elasticity	1,776,400 PSI	ASTM C-580

4. Fabrication

   a. For consistency, detectable warning tiles shall be manufactured using matched die molds under heat and pressure for superior material compaction, controlled chemical curing and uniform dimensions.
   b. Polymer concrete detectable warning tiles shall have ¼” thick material sectional thickness excluding truncated domes height or reinforcement ribs.
   c. Polymer concrete detectable warning tiles shall have a 1/8” tapered edges on the outside of the finished detectable warning tile.
   d. Slip Resistance of Polymer concrete detectable warning tile when tested by ASTM-C 1028 shall not to be less than 0.80.
   e. Chemical Resistance of Tile when tested by ASTM-D 543 to withstand without any degradation or discoloration-1% hydrochloric acid, Acetic Acid, Sulfuric Acid, Sodium Chloride Sodium Hydroxide, Sodium Sulfate, Sodium Carbonate, Kerosene and Oil.
   f. The material shall be abrasive resistant and shall be warranted for 5 years against excessive wear.
   g. The polymer concrete material shall not sustain burning and be self extinguishing when tested in accordance with ASTM D 635.
   h. The polymer concrete material shall not promote fungus growth when tested in accordance with ASTM G21.
   i. The polymer concrete material surface flammability shall be tested in accordance with ASTM E-162 and shall be less than 25.
   j. Smoke density shall be tested in accordance with ASTM E-662-03 and shall be less than 0.5 at 1.5 minutes and less than 15 at 4 minutes.
   k. Color: Federal Brick Red 30166 Color must be homogeneous throughout the tile.

5. Anchors and Subsystems: Each PC panel is to be attached to the supporting concrete with a minimum of 4-2” concrete anchor and bolt assemblies. Bolts are to be a nominal 3/8” stainless steel with lock washers. Bolts shall be also be installed through a 1x1 steel angle tightened snug to the underside of the tile panel.

6. Dimensions:
   Tile Assemblies must be held within the following dimensions and tolerances:
   Length and Width: 24”x 24” nominal square and triangle,

12” x 24” nominal, plus or minus 1/16”.
Depth: 1.500” ± 5% max.
Face Thickness: 0.1875 ± 5% max. Warpage
of Edge: ± 0.5% max.

2.04 CLEANING AND PROTECTING

A. Protect the tactile detectable warning surface system against damage during the construction period to comply with tactile tile manufacturer’s specification. Materials damaged prior to placement will be replaced at the Contractor’s cost.

B. Protect the tactile detectable warning surface system against damage from rolling loads following installation by covering with plywood or hardwood.

C. Clean the tactile detectable warning surface system not more than four days prior to the scheduled inspection intended to establish date of completion of project. Clean tactile tile by methods specified by the manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall be per the manufacturers recommendations.

B. Maintain a minimum temperature of 40 degrees F in spaces to receive tactile tiles for at least 48 hours prior to installations, during installation, and for not less than 48 hours after installation.

C. Store and protect tactile tile material in the area(s) where they will be installed for at least 48 hours before beginning installation.

D. The physical characteristics of the concrete must be consistent with the contract specifications.

E. PRIOR TO PLACEMENT OF THE TACTILE/DETECTABLE WARNING SURFACE SYSTEM, THE LAYOUT IS TO BE REVIEWED AND APPROVED BY THE RESIDENT ENGINEER. The concrete pouring and finishing operations require typical mason’s tools, however, a 2’ long level with electronic slope readout (SMART LEVEL), 25 lb. weights, vibrator and small sledge hammer with 2” x 6” x 20” wood tamping plate are specific to the installation of the TACTILE/DETECTABLE WARNING SURFACE SYSTEM. The concrete must be poured and finished, true and smooth to the required dimensions and slope prior to tile placement. Immediately after finishing the concrete, the electronic level should be used to check that the required slope is achieved. The tile must be placed true and square to the ramp in accordance with the contract drawings. The TACTILE/ DETECTABLE WARNING SURFACE TILES must be tamped or vibrated into the fresh concrete to ensure that the field level of tile is flush to the adjacent concrete surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes. The tolerance for elevation differences between tile and adjacent surface is 1/16”. Place the second panel next to the first, leaving no gap (tiles must be abutted to one another) and press into the wet concrete using a twisting back and forth motion. Be certain that the second panel is even and level with the first and with the surrounding concrete.

F. Immediately after tile placement, the tile elevation is to be checked to adjacent concrete. The tile elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates. While concrete is workable a steel trowel must be used to trowel the concrete around the tile perimeter to the field level of the tile. Trowel concrete flat, remove any excess concrete and leaving no gap (tiles must be abutted to one another) between the panels. Apply broom finish or other recommended finish to the area immediately surrounding the panels.

G. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets, 2 suitable weights of 25 lb. each must be placed on each tile as necessary to ensure solid contact of tile underside of concrete.

H. During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning or external force placed on the tile to rock the tile, causing a void between the underside of tile and concrete.

I. Following the curing of the concrete, the protective plastic wrap is to be removed from the tile face by cutting the plastic with a sharp knife tight to the concrete/tile interface.

3.02 QUALITY ASSURANCE

A. Provide tactile detectable warning system and accessories as produced by an approved manufacturer.

B. Installer’s Qualifications: Engage an experienced Installer certified in writing by the tactile detectable warning system manufacturer as qualified for installation and who has successfully completed installations similar to that indicated for Project.

C. Americans with Disabilities Act (ADA): Provide a tactile detectable warning surface system which complies with the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, Part 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES.

D. California Code of Regulations (CCR): Provide only approved DSAAC detectable warning products as provided in the California Code of Regulations (CCR). Title 24, Part 1, Articles 2, 3 and 4 and Part 2, Section 205 definition of “Detectable Warning”. Section 1127B.5 for “Curb Ramps” and Section 1133B.8.5 for “Detectable Warnings at Hazardous Vehicle Areas”.

E. Tactile detectable warning surface system shall consist of a surface of truncated domes aligned in a square or radial grid pattern. Truncated domes in a detectable warning surface shall have a base diameter of 0.9” minimum to 1.4” maximum, a top diameter of 50% of the base diameter minimum to 65% of the base diameter maximum, and a height of 0.2”. Truncated domes in a detectable warning surface shall have a center to center spacing of 1.6” minimum and 2.4” maximum, and a base-to-base spacing of 0.65” minimum, measured between the most adjacent domes on a square grid. Detectable warning surface shall contrast visually with adjacent walking surfaces either light–on–dark, or dark–on–light and the field area must consist of a non-slip surface.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of TACTILE/DETECTABLE WARNING SURFACE TILES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of TACTILE/ DETECTABLE WARNING SURFACE TILES, will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 32 17 26

SECTION 32 29 13

FIXED BOLLARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including general and special conditionsand Division 01 specification sections, apply to this section.

1.02 SUMMARY

A. Provide and install crash rated, impact certified, fixed bollards as shown on Drawings. Provide full embedment reinforced concrete foundations to meet specified performance requirements for bollard system.

B. Related Sections:

1. Section 03 30 00, Cast In Place Concrete.
2. Section 05 50 00, Metal Fabrications.

1.03 REFERENCES

A. ASTM F2656-07 - Standard Test Method for Vehicle Crash Testing of Perimeter Barriers.

B. DOS Sd-Std-02.01 R1 - Vehicle Crash Testing of Perimeter Barriers and Gates, Rev. A.

C. ASTM A36 -Specification for Carbon Structural Steel.

D. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

E. ASTM F155 - Specification for Anchor Bolts.

F. ASTM A307-10 - Specification for Carbon Steel Bolts and Studs.

1.04 PERFORMANCE REQUIREMENTS

A. The Compliance: ASTM M30 (DOS K4) Impact Certification.

B. Structural Requirements: Provide and install reinforced concrete foundation in compliance with manufacturer’s design and impact certification requirements.

1.05 SUBMITTALS

A. Product Data: Submit Manufacturer's Product Data, including installation instructions.

B. Shop Drawings: Submit manufacturer's product data, including installation instructions. Show elevations, plans, sections and details. Indicate actual field verified dimensions andinstallation conditions.

C. Samples:

   1. Finish: Provide specifications for specified metal finish. Provide actual samples ofstandard finishes for selection and approval.

D. Galvanizing Certification: For all components including perforated panels and framing; provide certification for hot-dipped galvanizing materials and application.

E. Calculations: Signed and sealed Structural Drawings and calculations, performed by a professional structural engineer licensed to practice in the State of Illinois, for the entire system including foundation structure. provide engineering calculations showing compliance with the specified performance requirements.

1.06 WARRANTY

A. The Contractor must provide manufacturer's standard warranty, warranting materials and installation, including finish, for a period of one year from the date of final acceptance.

1.07 PROJECT CONDITIONS

A. Field Measurements: Check actual locations for bollard installation with accurate field measurements before fabrication and show recorded measurements on shop drawings. Coordinate fabrication and delivery schedules with construction progress to avoid delaying the work. verify the locations of all obstructions and coordinate with adjacent trades as necessary for meeting construction schedule.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited the following:

   1. Secure USA
   2. Calpipe Security
   3. Nasatka Security

2.02 BOLLARDS

A. Type: Fixed, M30 (K4) Certification.

B. Dimensions: Diameter As shown on Drawings, and as required by manufacturer to meet performance requirements. 36” high above sidewalk grade

C. Sleeve Finish: Stainless Steel, Type 316, Schedule 80, #4 Finish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive fixed bollards. notify authority of conditions that would adversely affect installation or subsequent utilization of sidewalk bollards. do not proceed with installation until unsatisfactory conditions are corrected.

3.02 SURFACE PREPARATION

A. Indicate the location of fixed bollards to be installed. Final grades and installation conditions shall be examined to verify compliance with manufacturer’s installation requirements.

3.03 INSTALLATION

A. Install fixed bollards in accordance with manufacturer’s instructions at locations indicated on the Drawings.

3.04 PROTECTION

A. Protect fixed bollards from damage during construction. Provide temporary protective covers.

3.05 CLEANING

A. Clean fixed bollards in accordance with manufacturer’s instructions. Do not use cleaning materials or methods that damage finish.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of Section 32 29 13, Fixed Bollards shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of Section 32 29 13, Fixed Bollards shall be included in the contract lump sum price as shown in the Schedule of Prices for Architectural Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Architectural Work: 090000

END OF SECTION

SECTION 32 91 15
SOIL PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes planting soils specified according to performance requirements of the mixes.

B. Related Requirements:
   1. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

1.3 DEFINITIONS

A. AAPFCO: Association of American Plant Food Control Officials.

B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

C. CEC: Cation exchange capacity.

D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

F. Imported Soil: Soil that is transported to Project site for use.

G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.

H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.

J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.

M. SSSA: Soil Science Society of America.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

Q. USCC: U.S. Composting Council.

1.4 PRE-INSTALLATION MEETINGS

A. Pre-installation Meeting: Conduct meeting at Project Site, Manufacturer’s Facility of Fabricator’s Shop. Confirm with Owner and Landscape Architect 14 days prior to conference.

1. Before submitting submittals, review submittals, mockup and other requirements of this section and examine procedures for ensuring quality of the scope herein. Require representatives of each entity directly concerned with the scope herein, including but not limited to, the following:
    a. Contractor's superintendent.
    b. Subcontractor.
    c. Special Subcontractor.
    d. Independent testing agency responsible for testing.
    e. Product manufacturer and/or local representative.
    f. Authority Having Jurisdiction.
    g. Landscape Architect.

2. Review methods and procedures related to the work of this section, including but not limited to, the following:
   a. Responsibilities of each party.
   b. Coordination of Landscape Architect's review of the work, including but not limited to:
      1) Site or Shop Visits to Review Samples and Mockups
      2) Site Visits to Observe General Construction Progress
      3) Site or Shop Visits to Review Fabrication Progress
      4) Site Visits to Review First Work In Place
      5) Site Visits for Punch List Review
      6) Site Visits for Punch List Completion Review
      7) Site Visit for Warranty Review
   c. Lines of authority and communication for the project. Procedures for resolution of any project document ambiguity.
   d. Methods for documenting, reporting, and distributing documents and reports.
   e. Proposed sources of materials.
   f. Procedures for packaging and storing archive samples.
   g. Review of the time schedule for all installation and testing. Schedule of workdays and/or starting times if third party testing verification is required.
   h. Quality control.
   i. Temperature and weather limitations. Installation procedures for adverse weather conditions. Defining acceptable subgrade or ambient moisture and temperature conditions for working during installation.
   j. Subgrade conditions, dewatering responsibilities, and subgrade maintenance plan.
   k. Deployment techniques including allowable subgrade conditions.
   l. Construction, material placement, and backfilling.
   m. Requirements for protecting work, including restriction of traffic and adjacent work impacting during installation period and for remainder of construction period.
   n. Measurement and payment schedules.
   o. Health and safety.
   p. Procedures and responsibilities for preparation and submission of as-built drawings.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Manufacturer's Product Literature and Specification Data.
2. Manufacturer's written instructions for recommended maintenance practices.
3. Color and finish samples for verification and selection.
4. Written manufacturer's warranty.
5. Product liability insurance certificate with project owner as certificate holder.
6. MSDS for items in Part 2 "Products."

7. Include recommendations for application and use.
8. Include test data substantiating that products comply with requirements.
9. Include sieve analyses for aggregate materials.
10. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:

    a. Manufacturer's qualified testing agency's certified analysis of standard products.
    b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

B. Samples: For each bulk-supplied material, 1-quart (1-L) volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

C. Samples for Verification: For each type of selection made above provide a final sample.

D. Shop Drawings: Prepared by or under the supervision of a qualified professional, detailing fabrication and assembly.

1. Submit shop drawings within a reasonable time so as not to delay the start of material fabrication and installation.
2. Submit shop drawings per above allowing a minimum review time of 10 business days for review and response. Per above, also allow enough time for revisions and resubmittal where reasonably predictable.
3. Shop drawings shall show the proposed layout identifying all components and details based on field verified conditions and measurements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, Fabricator, Manufacturer and Testing agency.

B. Material Certificates: For each of the following, signed by manufacturers:

1. For all materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. For all materials.

D. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.

E. Source quality-control test reports.

A. Field quality-control and special inspection reports.

B. Minutes of pre-installation conference.

C. Maintenance Instructions.

D. Warranty: Written manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data.

1.8 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Authorities Having Jurisdiction for all work included in this section.

B. Codes and Standards: Conform work to all applicable codes and standards.

C. Manufacturer Qualifications: Provide manufacturer qualifications as follows:

1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
2. Submit qualifications of manufacturer.
3. Submit manufacturer's quality control program.
4. Submit example of Material Warranty and any other applicable warranties.

D. Installer Qualifications: Provide installer qualifications as follows:

1. Submit a list of ten completed installations. For each installation provide: name and type of facility; its location; the date of installation; name and telephone number of contact at the facility familiar with the installation.
2. Submit resumes and/or qualifications of installation manager(s).
3. Submit fabrication quality control program.
4. Submit installation quality control program.
5. Submit example of Material Warranty and any other applicable warranties.

E. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1. Laboratories: Subject to compliance with requirements.

2. Multiple Laboratories: At Contractor's option, work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.

F. Mockups: Provide mockup for each type of component per the Drawings and/or shop drawing.

1. Build mockups of full-profile sections to demonstrate including but not limited to overall material quality, typical joints; typical transitions, surface finish, surface texture, color; and standard of workmanship.
2. Build mockups in the location and of the size indicated. Build mockups where directed by Landscape Architect.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Landscape Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may not become part of the completed work.
5. Mockups to be retained on site or at approved location by Owner and Landscape Architect until all related work scope is deemed Substantially Complete.
6. Contractor to rework mockups as necessary until mockups are accepted.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil, imported soil.

1. Notify Landscape Architect seven days in advance of the dates and times when laboratory samples will be taken.

B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

1.10 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Landscape Architect under the direction of the testing agency.

1. Number and Location of Samples: Minimum of three for each soil to be used or amended for landscaping purposes.
2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

1.11 TESTING REQUIREMENTS

A. General: Perform tests on soil samples according to requirements in this article.

B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by one of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":

    a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
    b. Hydrometer Method: Report percentages of sand, silt, and clay.

2. Bulk Density: Analysis according to core method and clod method of SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
4. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
5. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85% compaction according to ASTM D 698 (Standard Proctor).

C. Chemical Testing:

1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.

4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc.

D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAPT NCR-13, including the following:

1. Percentage of organic matter.
2. CEC, calcium percent of CEC, and magnesium percent of CEC.
3. Soil reaction (acidity/alkalinity pH value).
4. Buffered acidity or alkalinity.
5. Nitrogen ppm.
6. Phosphorous ppm.
7. Potassium ppm.
8. Manganese ppm.
9. Manganese-availability ppm.
10. Zinc ppm.
11. Zinc availability ppm.
12. Copper ppm.
13. Sodium ppm and sodium absorption ratio.
14. Soluble-salts ppm.
15. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
16. Other deleterious materials, including their characteristics and content of each.

E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.

1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.
2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm) depth of soil.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged products in an undamaged condition in original containers, displaying manufacturer's labels, along with instructions for handling, storing, unpacking, protecting, and installing.

B. Deliver and store materials in manufacturer's original containers, with seals unbroken and identification labels intact until time of use.

C. Deliver products to achieve the shortest duration of storage time as practicable.

D. Deliver all chemical products in original, unopened containers with original labels intact and legible, which state the guaranteed chemical analysis. Store all chemicals in weather protected enclosure.

E. Comply with manufacturer's written instructions for delivery, storage, and handling, and as required to prevent damage to products and work during construction.

F. Store products and materials in a neat and orderly manner. Maintain clear aisles and access to work areas. Protect stored products from theft and damage. Store products above ground in weathertight, ventilated packaging or enclosures.

G. Store materials under cover and protected from weather and contact with damp or wet surfaces. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

H. Store liquids in tightly closed containers protected from freezing.

I. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.

J. Bulk Materials:

   1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Do not move or handle materials when they are wet or frozen.
   4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.1 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

A. Planting-Soil Type: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:

1. Particle Size Distribution by USDA Textures: Classified as sandy loam according to USDA textures.

2. Percentage of Organic Matter: Minimum 3 percent by volume.
3. Soil Reaction: pH of 6 to 7.
4. CEC of Total Soil: Minimum 7 meq/100 mL at pH of 7.0.
5. CEC of Clay Fraction: Maximum 15 meq/100 mL at pH of 7.0.
6. Soluble-Salt Content: 5 to 10 dS/m measured by electrical conductivity.
7. Bulk Density: 1.0 g/cu. cm to 1.1 g/cu. cm at 85% compaction.
8. Total Porosity: Minimum 45 percent at 85% compaction.
9. Macro Porosity: Minimum 5 percent at 85% compaction.
10. RCRA Metals: Below maximum limits established by the EPA.
11. Phytotoxicity: Below phytotoxicity limits established by SSSA.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through a No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through a No. 60 (0.25-mm) sieve.
2. Class: O, with a minimum of 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through a No. 60 (0.25-mm) sieve.
3. Form: Provide lime in form of ground dolomitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.

E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C 33/C 33M.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:

1. Feedstock: Limited to leaves.
2. Reaction: pH of 5.5 to 8.

3. Soluble-Salt Concentration: Less than 4 dS/m.
4. Moisture Content: 35 to 55 percent by weight.
5. Organic-Matter Content: 30 to 40 percent of dry weight.
6. Particle Size: Minimum of 98 percent passing through a 1/2-inch (13-mm) sieve.

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of [20] [33] [50] percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. (0.5 kg/100 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to installation examine site to confirm that existing conditions are satisfactory for the work of this section to proceed.

B. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the drawings.

C. Confirm that no adverse drainage conditions are present.

D. Confirm that no conditions are present which are detrimental to plant growth.

E. Confirm that utility work has been completed per the drawings.

F. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action prior to proceeding.

3.2 GENERAL

A. Place planting soil and fertilizers according to requirements in other Specification Sections.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

C. Proceed with placement only after unsatisfactory conditions have been corrected.

3.3 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

A. Excavation: Excavate soil from designated area(s) to a depth per plans.

B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

C. Unsuitable Materials: Clean soil to contain a combined maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

D. Screening: Pass unamended soil through a 2-inch (50-mm) sieve to remove large materials.

3.4 COORDINATION WITH PROJECT WORK

A. The Contractor is responsible for investigating, and being aware of, the work requirements of their sub-contractors and other contractors. The Contractor shall coordinate with all other work that may impact the completion of the work herein.

B. Prior to the start of work, prepare a detailed schedule of the work for coordination with other trades.

3.5 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.

C. Mixing: Spread unamended soil to total depth of 4 inches (100 mm), but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Amendments: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.

   a. Mix lime and sulfur with dry soil before mixing fertilizer.
   b. Mix fertilizer with planting soil no more than seven days before planting.

2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 8 inches (200 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.6 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 6 inches (150 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply approximately half the thickness of planting soil over prepared, loosened subgrade. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.

C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

1. Lifts: Apply planting soil in lifts not exceeding 12 inches (300 mm) in loose depth for material compacted by compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.7 BLENDING PLANTING SOIL IN PLACE

A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Preparation: Till unamended, existing soil in planting areas to a minimum depth of 4 inches (100 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Mixing: Apply soil amendments, except compost, and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.

1. Mix lime and sulfur with dry soil before mixing fertilizer.
2. Mix fertilizer with planting soil no more than seven days before planting.

D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D 698 except where a different compaction value is indicated on Drawings.

E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.8 APPLYING COMPOST TO SURFACE OF PLANTING SOIL

A. Application: Apply compost component of planting-soil mix 4 inches (100 mm) of compost to surface of in-place planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade surface to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.9 GRADE AND ELEVATION CONTROL

A. Provide grade and elevation control during installation of the work of this section. Utilize grade stakes, surveying equipment, and other means and methods to assure that grades and contours conform to the grades indicated on the plans.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D 698. Space tests at no less than one for each 1000 sq. ft. (100 sq. m) of in-place soil or part thereof.
2. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.

C. Soil will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

3.12 REPAIR AND REPLACEMENT

A. General: Repair or replace that is damaged by construction operations, in a manner approved by Landscape Architect.

3.13 WASTE HANDLING

A. General: Handle waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

3.14 CLEANING

A. The contractor should clean the job site and remove any excess materials. Coordinate with Owner for storage locations for any Attic Stock materials where applicable.

B. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

   1. Dispose of excess subsoil and unsuitable materials on-site where directed by Owner.

3.15 PROTECTION

A. Contractor shall furnish and install construction fence around new installations to prevent access. Fencing shall be maintained in place for a minimum of 48 hours after completion of installation, or as directed by the Landscape Architect. Drying period may take longer due to weatherconditions.

B. Contractor shall notify Landscape Architect that landscape irrigation shall be restricted near installations until applicable drying period is complete. Standing water on installations shall be restricted at all times.

C. Protection Zone: Identify protection zones according to Section 01 56 39 "Temporary Tree and Plant Protection."

D. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Vehicle traffic.
   4. Foot traffic.
   5. Erection of sheds or structures.
   6. Impoundment of water.
   7. Excavation or other digging unless otherwise indicated.

E. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Landscape Architect and replace contaminated planting soil with new planting soil.

3.16 MAINTENANCE SERVICE

A. Maintenance Service: Provide maintenance by skilled employees of Installer or approved Subcontractor. Maintain as required in "Maintenance" Article. Begin maintenance immediately after scope is installed and continue until final acceptance.

3.17 DEMONSTRATION AND TRAINING

A. Engage a manufacturer-authorized service representative and/or other authorized professional to train Owner's maintenance personnel to adjust and operate all components herein.

B. Train Owner's maintenance personnel in proper maintenance procedures for all components herein.

END OF SECTION

Section 32 91 16

MULCHING

1. GENERAL

1.1 WORK INCLUDES

A. Base Bid

1. General Contractor
    a. Shredded hardwood bark mulch for trees and shrubs in landscape beds
    b. One-step soil conditioner for perennials

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Additional requirements and more stringent requirements found in Division 01 of the RFP shall be included as requirements within this specification.

C. Section 32 91 13 – Soil Preparation and Placement

D. Section 32 93 00 – Plants

1.3 QUALITY ASSURANCE

A. Pre-installation Conferences: Refer to requirements outlined in 32 93 00.

B. Schedule: Refer to requirements outlined in 32 93 00.

C. Ability to Deliver: Refer to requirements outlined in 32 93 00.

D. Landscape Subcontractor Qualifications: Refer to requirements outlined in 32 93 00.

E. Landscape Field Supervision: Refer to requirements outlined in 32 93 00.

F. Labor: Refer to requirements outlined in 32 93 00.

1.4 SUBMITTALS

A. Product Data: For each product indicated.

B. Source List: for each product indicated

C. Samples:

1. Soil Condition: 1-quart volume of each soil conditioner required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of conditioner. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

2. Hardwood Bark Mulch: 1-quart volume of each mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

D. Certifications: Refer to requirements outlined in 32 93 00.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.6 WARRANTY

A. Warranty: Refer to requirements outlined in 32 93 00.

2. PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Products: The design for products described in Part 2 are based on products indicated. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

1. Products:

a. Compost which includes: 1/2" Southern Pine Bark Fines, Compost, Leaf Mulch, Hardwood Fines, Iron Sulfate, Blue Chip, Gypsum, with added Mycorrhizae

2.2 MATERIALS

A. Shredded Hardwood Bark Mulch:

1. From mixed hardwood species and free of sticks weeds, leaves, and wood chips, 60% must range between 1 and 3 in. in length; remaining 40% shall not exceed 1-1/2 in.

2. Maximum of 5% content by weight of shredded wood particles.

B. One-step Soil Conditioner:

1. Provide weed free soil conditioner, used to transition potted plants for growth into topsoil:

   a. Leaf mold organic soil conditioner. Must be thoroughly composted, suitable for amendment to soil in perennial planting beds.
   b. Mushroom compost and chicken manure is not acceptable as an alternate organic soil conditioner.

3. EXECUTION

A. EXAMINATION

1. Verify location of underground utilities with appropriate sources prior to construction. DIGGER 312-744-7000 at least 48 hours before commencing with construction operations. Repair damaged utilities at Contractor’s expense.

2. Remove rock or other underground construction and drain planting areas only when approved by Authority. Payment of extra must be based on in-place volume required to provide normal requirements for plantings.

3. Conflicts with utilities shall be called to the Authority's attention before proceeding with work. Alternate locations may be designated by Authority.

4. When inspected grading work does not comply with requirements, replace rejected work and continue specified maintenance until re-inspected by the Authority and found to be acceptable. Provide immediate adjustment or schedule for adjustment within appropriate season.

5. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

a. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
b. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
c. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.

6. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

7. Proceed with installation only after unsatisfactory conditions have been corrected.

8. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 INSTALLATION

A. Shredded Hardwood Bark Mulch

1. Mulch within five days after installation.

2. Mulch planting beds as each is finished, and mulch each tree after it is planted. Only plant areas which will be mulched and watered the same day. Soil must be moist before mulching. Do not fill in watering saucers level with mulch, but follow soil contour to preserve function of saucer. Keep mulch completely away from tree trunks for a distance of six inches. To prevent suffocation, elevate stems of recumbent shrubs and groundcovers and place mulch beneath. Provide the following thickness of mulch indicated on the drawings:

   a. For trees, provide a minimum 3-inch thickness of shredded hardwood bark or gravel mulch.
   b. For shrub masses, provide a 2-inch thickness of shredded hardwood bark Replenish mulch on tree and shrub plantings in Spring on a yearly basis through the Warranty period. Do not exceed the specified mulch depth.
   c. “Volcano” mulching will be rejected.
   d. Mulch perennial and grass beds only with soil conditioner if needed.

B. One-Step Soil Conditioner

1. Place one-step soil conditioner only in perennial beds to depths indicated on plans.

C. CLEANUP AND PROTECTION

1. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

2. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. DISPOSAL

1. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Using agency's property.

END OF SECTION

Section 329300

PLANTS

1. GENERAL

1.1 SUMMARY

A. Base Bid: Landscaping work as shown and specified.
   1. General Contractor Scope: This section includes, but must not be limited to, provisions for the following items:
      a. Material Sourcing
      b. Landscape Protection and Repair
      c. Project Period Landscape Maintenance
      d. Trees and Shrubs
      e. Perennials, Forbs and Grasses
      f. Project Acceptance
      g. Warranty Period
      h. Replacements

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

B. Additional requirements and more stringent requirements found in Division 01 of the RFP shall be included as requirements within this specification.

C. Section 02 41 19 – Selective Demolition

D. Section 31 13 00 - Tree Protection and Trimming

E. Section 32 91 16 – Mulching

F. Section 32 91 13 – Soil Preparation and Placement

1.3 DEFINITIONS:

A. Provision: to be inclusive of labor, materials, transport, testing, monitoring, samples, mock-up ups, field coordination, communications, as required to meet Authority approvals for this project.

B. Care and Preparation: The standard of care and preparation for live plantings, quality of appearance as defined herein, including monitoring and maintenance, applies also to the provision of Season Exterior Plants and Décor.

C. Topsoil: for purposed of this contract, Top Soil and Planting Soil are synonymous, and define specified weed free planting soil imported to the site for providing plant growth conditions in landscaped areas, fulfilling requirements of Section 31 23 35. Reference 32 91 13, 1.2.B.

D. Weed Free: Soil which is free of live seed and plants from invasive species including bent grass, bermuda grass, bindweed, bird's-foot trefoil, blackberry, brome grass, canada thistle, chickweed, crabgrass, cress, crown vetch, dandelion, foxtail, garlic mustard, horsetail, jimsonweed, johnson grass, lambs quarter, leafy spurge, morning glory, mustard, narrow-leaved cattail, nimble will, nutgrass, nut sedge, perennial sorrel, poison ivy, poison oak, purple loosestrife, quack grass, ragwort, reed canary grass, rush grass, spotted knapweed, sweet clover, tansy, teasel, wild parsnip.

E. City of Chicago, Department of Environment Article XXII: Invasive Species Control Rules and Regulations.

F. City of Chicago, Department of Environment Article XXII: Invasive Species Control Rules and Regulations Addendum, April 7, 2009

1.4 QUALITY ASSURANCE

A. Pre-installation Conferences: Conduct preconstruction conferences at the project site.
   1. Review maintenance procedures for surrounding streets, walks, paving and site amenities.
   2. Review procedures for work on public property.
   3. Review Landscape Specifications
   4. Review project schedule, including timeframes for soil installation, water activation, planting installation.
   5. Review locations and coordination of pavement, backfill, furnishings footings, fencing, irrigation by other trades.
   6. Review removal of debris from planting bed areas prior to backfill with landscape materials.
   7. Review plant locations and procedures for adjustment.

B. Schedule: Include landscape tasks on General Construction schedule. Update regularly with General Construction Schedule. Include time frames for procurement, as well as delivery and installation of plantings within appropriate season.

C. Ability to Deliver:
   1. Investigate sources of supply and confirm they can supply plants specified on plant list in sizes, variety, and quality noted and specified before submitting bid. Failure to take this precaution will not relieve responsibility for furnishing and installing plant material in accordance with Contract requirements.

2. Substitutions may be permitted only upon submission of written proof that specified plant is not locally obtainable. Such substitution may be made upon written authorization by Authority.
3. Furnish and install plants shown on drawings in quantity and size designated.
4. Provide and update Landscape Schedule for duration of project. Include Landscape Schedule dates in the overall project schedule and resolve conflicts between tasks as needed to ensure quality landscape installation within appropriate season of planting.
5. Include dates for Milestone reviews with Authority.
6. Contractor to notify Authority of procurement, phasing, sequencing issues which impact meeting landscape milestones and assist with problem resolution.

D. Inspection:
   1. Submit photos of plant material as grown in the nursery for preliminary review by Authority. Select and tag plant material before requesting inspection by Authority.
   2. In addition to review of plant material photographs, Per Using agency direction, the Authority may inspect and tag plant material at source nursery.
      a. If nursery is located outside a 25 mile radius from Project site, the Authority's direct and indirect cost including normal profit must be borne and paid by Contractor.
   3. Upon delivery and before planting, request inspection of plants by Authority. Plants rejected on site must be replaced with plants as approved by the Using agency, at no additional cost to the contract.
   4. Inspection and approval is for quality, size, and variety only and in no way impairs right of rejection for failure to meet other requirements during progress of Work.
   5. Contractor must be present during required inspection or as may be required by Authority.
   6. The Using agency retains the right to inspect trees and shrubs for size and condition of balls and root systems, insects, injuries, and latent defects, and to reject material damaged during transit and staging. Rejected plants must be removed immediately from the project site and replaced from approved sources. Replacement plants must receive maintenance as required for plant establishment, and must be installed and show signs of establishment prior to project inspection.

E. Landscape Subcontractor Qualifications: The Landscape Subcontractor must specialize in landscape construction, including native planting and restoration, with a minimum of five years experience on projects of comparable scope, materials, and complexity, and maintain qualified labor, and equipment as required to perform work within the Landscape Schedule. Provide written documentation attesting to this experience, including job dates and addresses, scope of work performed, phone numbers of Clients and Using agencys, and other information demonstrating capabilities. Do not begin work until such written documentation has been approved by the Authority.

F. Landscape Field Supervision: Maintain a full-time Landscape Field Supervisor with five years comparable experience to coordinate site work and planting installation during periods landscape work is in progress. The Supervisor must be hold current Certified Field Technician status (CLT) and be responsible for quality assurance and report project status to the Authority. The Supervisor must record and assist with resolution of project issues and must demonstrate fluency in the English language and must be accessible by phone during working hours.

G. Labor: Provide adequate labor force at the time of planting to carefully prepare the site for the Authority’s approval, carefully install plant material, and maintain and water installed material concurrent with ongoing new installation. Labor force and operators must be trained and hold necessary licensure to handle soil and landscape materials within requirements of this contract.

H. Reference Standards:
   1. Plant names used in plant list are in accordance with "Standardized Plant Names," published by American Joint Committee on Horticulture Nomenclature (current edition).
   2. All plants must be of the quantity, size, genus, species, and variety shown and scheduled for landscape work and must comply with recommendations and requirements of ANSI/AAN Z60.1. Prior to shipping, verify that plants are healthy and vigorous, available at the specified nursery and free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, or disfigurement.

I. All plant materials, including their roots and surrounding soil, must be free from disease, harmful insects, and other injurious qualities. All local State and Federal laws pertaining to the inspection, sale, and shipment of plant materials must be complied with. Inspect plant materials as required by State, Federal, and other authorities, and secure all certificates as required. Submit original certificates to the Authority as project records.

J. Label at least one tree and one shrub of each variety with a securely attached waterproof tag bearing legible botanical and common names. Contractor must accurately place plants by variety as per plan.

1.5 SUBMITTALS

A. Submit list of sources for plant material to be provided.

B. Submit photographs of proposed plant material taken in the nursery where they are grown prior to requesting inspection and tagging.
   1. Submit copies of bills of lading which substantiate that plants, trees, shrubs, and planting materials comply with specified requirements. Source of material, quantity, type, size, must be clearly indicated.

C. Submit two copies of Landscape Maintenance Binder at Project Acceptance. Include copies of original nursery invoices, edge, gravel sources, copy of as-landscape built drawing, written maintenance instructions for care of installed plants on a 4 season basis, Contractor contact information, other pertinent information related to care of specified installation.

D. Samples:
   1. Review shall not be construed as approval. Authority may take samples of materials delivered to site and analyze them for compliance with specifications.
   2. Submit sample of temporary watering apparatus.
   3. Submit manufacturer's product information for chemical spray or fertilizer applications to be used in landscape work. Provide safety test data for Authority review and receive approval prior to use. Provide alternate product for review as requested by Authority.
   4. Submit manufacturer's product information and sample of tree guying apparatus if used.
   5. Submit samples of Plant Protection Materials: Staking, Temporary Fencing, Fasteners, Flagging, and Signage.

E. Comply with State of Illinois and federal laws with respect to inspection of all plants for plant diseases and insect infestation. Submit an inspection certificate, required by law to this effect, with each shipment.

F. Plant Protection Record: Provide adequate plant protection, including protection from overhead construction activities, for all existing plantings to remain, and all new planting installations through the Project Acceptance. Provide photo record of existing plantings to remain, note condition and size. Review proposed method of protection with Authority prior to start of work, and install prior to Demolition.

G. Landscape As-Built Drawing:
   1. Submit a Landscaping Record Drawing consisting of a Topographic Survey with spot elevations accurate to .01 foot, showing finished grade contours in one-foot increments. The Topographic Survey must also include the locations and surface elevations of the following:
      a. edges of pavement
      b. architectural features
      c. drainage structures
      d. spot elevation of each tree root ball at the base of the trunk
      e. edge of planting beds
      f. direction of surface drainage flows
      g. spot elevation of high and low points
   2. The Landscape As-Built Drawing must show exact locations of new and remaining trees, the extents of shrub, groundcover, and perennial plant masses, the species of plant and quantity, and the metal identification tag number of trees.

H. Submit copy of current Certified Landscape Technician Certificate (CLT) for Landscape Field Supervisor to be present for all landscape operations.

I. Tree Tagging: Contractor or nursery shall locate all trees and tag them with unique seal numbers. Contractor is to photograph each individual tree and provide each image with the seal number, variety, size, and nursery location labeled on the image. Landscape Architect shall review the images and approve prior to visiting the nursery to approve the trees and place the unique seal of the Landscape Architect on each tree. No trees shall be accepted unless they have a unique seal from the contractor or landscape architect. The contractor is to schedule tagging trips to the various nurseries in coordination with the Landscape Architect.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Preparation for Delivery:
  1. Balled and Burlapped (B&B) Plants:
    a. Dig and prepare for shipment in manner that will not damage roots, branches, shape, and future development of plant.
    b. Originate from soil which will hold good ball when wrapped with burlap or similar material, bound with twine or cord so as to hold balls firm and intact.
    c. Ball Sizes: Not less than standard established by ANSI/AAN.
    d. Root Pruning: All trees must be root pruned at the nursery in the spring prior to excavation of plant material, either before active leaf growth begins or as soon as possible following hardening off of the new growth. If root pruning is not done in the spring, root pruning must be done in late summer, but no later than September 15. Diameter of root-pruned area must be at least one inch but not more than two inches smaller than the final ball size. Maintain watering to supplement natural rainfall for sixty days following root pruning.
    e. Drumlace plants 2 in. in caliper and over. Provide protective metal basket as needed to protect tree ball.
  2. Potted or Container Plants
    a. Provide container to hold ball shape protecting root mass during delivery and handling.
    b. Roots must comprise greater than 70% of the potted soil volume. Plants with insufficient size or root volume may be rejected.

B. Delivery:
  1. Plant Material: Take precautions in accordance with best trade practices to ensure arrival of plant material at job site in good condition and without injury. Cover plants to prevent drying, disease or injury.
  2. Plants must be provided to the site in a moist and turgid state. Do not prune woody plants prior to delivery unless approved. Do not bend or bind tie trees or shrubs in such manner as to damage bark, break branches, or destroy natural shape. Provide protective covering during delivery and installation. Do not mishandle balled and burlapped stock during delivery and staging.

3. Fertilizer: Deliver fertilizer to site in original, unopened containers bearing manufacturer's warranted chemical analysis, name, trade name, trademark, and conformance to state law.
4. Notify the Authority, a minimum of 24 hours before delivery of plant material.
    a. Failure to notify the Authority in advance, in order to arrange proper scheduling may result in loss of time or removal of plant or plants not installed as specified or directed.
5. Each shipment must be accompanied by invoice showing sizes and varieties of plants included in each shipment.
    a. Provide copy of invoice to the Authority upon delivery of plant material.

C. Storage:
1. Plant Material:
    a. Set plants in a temporary nursery area which are not to be planted within 4 hrs, on ground and heal in with peat, soil, mulch or other media. Construct and maintain this area. Irrigate plants as required. Do not remove container grown stock from containers until planting time. Plants will be rejected if a decline due to stress resulting from improper maintenance, including maintenance of adequate protected nursery conditions, is observed.
    b. Protect roots of plant material from drying or other possible injury.
    c. Water plants as necessary until planted.
    d. Plants must not remain unplanted for longer than 3 days.
2. Store fertilizer, humus, and spray materials in weatherproof storage areas and in such manner that their effectiveness will not be impaired.

D. Handling:
1. Handle plants with care. Do not drop material. Trees and shrubs will be rejected due to mishandling and damage to rootballs. Move large trees only with proper equipment and by experienced, qualified operators.

1.7 JOB CONDITIONS

A. Planting Seasons:
1. Spring Planting: From time soil becomes workable through June 15. Fall Planting: September 1 to November 15.
2. Fall Planting Season: September 1 to November 15.
    a. Where plugs are indicated on plans, plant no later than August 1. Should planting schedule not allow for plug installation prior to August 1, the Contractor must upsize plugs to quart or gallon size containers.
    b. Plant evergreen shrub plantings no later than November 1, and evergreen tree plantings no later than October 15.
3. Summer Season: June 2 through August 31. Planting during this season must receive approval by the one month in advance, prior to commencing. Approval to plant under such conditions shall not relieve Contractor from provisions of these specifications.

4. Container Plants: Planting season designated above may be extended for container grown plants when approved by the Authority.
5. Provide necessary maintenance and watering for one year after substantial completion, to ensure specified quality of planting, at no additional cost to this contract.

B. Plant only when weather and soil conditions are suitable in accordance with best practices of industry.

C. Existing Vegetation:
   1. Review existing vegetation prior to bid. Verify Contractor is required to remove and manage existing invasive plant population where shown on drawings, and establish new planting areas free of weeds and existing vegetation, as part of this work. Where existing vegetation is present, apply repeated applications of the Authority approved herbicide, to prepare bed in weed free condition prior to start of proposed landscaping work.

D. Utilities:
   1. Verify location of underground utilities with DIGGER 312.744.7000 and perform work in a manner to avoid possible damage. Hand-excavate as required. Maintain any grade stakes set by others until removal is mutually agreed upon. Repair all utilities, drainage systems, or planter base damaged by excavation and installation at Contractor's expense.

E. Protection:
   1. Protect seeded and planted areas against damage by other work.
   2. Replace, repair, restake or replant sod or plantings which are damaged.
   3. Protect lawn areas, and repair damage resulting from planting operations.
   4. Protect landscaped areas with approved temporary fencing through Project Acceptance, or through period directed by the Authority.
   5. Protect plants from Animal Predation through the Period.
   6. Install tree protection fencing prior to site work and maintain throughout construction period. Fencing of the tree protection zone (tpz) shall extend 1 foot from the trunk for each inch in trunk diameter measured at a height of 4.5 feet. Signage shall be placed on the outside of the tpz which clearly states the purpose of the zone, with instructions to keep construction activities outside of fencing. No storage of materials, vehicular access or any other construction activities permitted within the tree protection zone. See the city of chicago's tree protection detailed specifications for diagrams and more information. Refer to section 3.4 of the UIC 2020 tree care plan.

F. Where landscape work is executed in conjunction with other work, arrange schedule that will permit execution of landscape work as specified.

G. Excavation:
   1. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the General Contractor

and Authority. Resolve the conditions with the General Contractor and Authority and receive approval before planting.

1.8 WARRANTY

A. Contractor must Warranty for period of one year from the date of Project Acceptance, replacement of understory plant material which had died, or is in dying condition, or which has failed to flourish in such manner that its usefulness or appearance has been impaired.

B. Transplanted and newly planted trees must be cared for no less than 2 years by contractor to ensure survival. Contractors are responsible for management of newly planted specimens during the building period, and upon completion of the project for a length of time that is agreed upon through contract with the Grounds department; management responsibilities will be in effect until final inspection of the completed project, and approval of UIC Grounds. Management includes but is not limited to watering, pruning, mulching, and other necessary practices that are needed to ensure tree safety and proper growth during and after construction. For trees damaged not flagged for removal, Contractors will be held accountable for all damage sustained to nearby campus trees as a result of construction processes (those not flagged for removal and replacement). Tree value shall be assessed by the superintendent of Grounds along with the Tree Advisory Committee, through reference of the current Arborscope inventory; value shall be determined based on age, height, and current ecological benefits. Reference, 3.4.4 Tree Damage Assessment 2020 UIC Tree Care Plan. Remove the 1 year warrany language.

2. PRODUCTS

2.1 PLANTS

A. General:
1. Temporary Nursery: no on-site temporary nursery space will be provided, except as directed by the Authority. Protect plants, landscape materials, from damage and theft as part of this work.
2. Deliver fresh nursery material to site in a healthy state. Request Authority inspection priot to time of delivery. Provide copies of delivery ticket. Maintain plants in healthy condition through Project Acceptance and Warranty Period.
3. Provide nursery grown plant material. Provide plants grown within same hardiness zone as project site or have been acclimated to conditions of same hardiness zone for minimum of two growing seasons. Hardiness zones must conform to "Zones of Plant Hardiness" as provided by U.S. Department of Agriculture.
4. Unless specifically noted otherwise, provide plants of selected specimen quality have normal habit of growth and be sound, healthy, vigorous plants with well developed root systems, free of disease, insect pests, their eggs or larvae, and injuries.

5. Do not prune before delivery. Prune only at time of planting and as directed by a certified arborist.
6. Trees which have damaged or crooked leader, or multiple leaders, are not acceptable unless specifically specified. Trees with abrasion of bark, sun scalds, disfiguring knots, or fresh cuts of limbs over 1-1/4 in., which have not completely calloused, are not acceptable.
7. Plants must be freshly dug or container-grown. No heeled-in plants or plants for cold storage will be accepted, except as otherwise specified, unless Contractor makes such request in writing and plants are inspected and approved.

B. Plant Name and Size:
   1. Measure plants when branches are in their normal position. Height and spread refer to plant's main body and not from branch tip to branch tip.
   2. Take caliper measurement at point on trunk 6 in. above natural ground line for trees up to 4 in. in caliper and at point 12 in. above natural ground line for trees 4 in. and over in caliper.
   3. If range of size is given, no plant must be less than minimum size and not less than 50% of plants must be as large as upper half of range specified.
   4. Measurements specified are minimum size acceptable and are measurements after pruning, where pruning is required. Plants meeting measurements specified, but not producing normal balance between height and spread, are not acceptable and will be replaced at Contractor’s expense.
   5. Shrubs must be matched specimens from single block source.
   6. Plants must be true to species and variety and must conform to measurement specified in Plant List. Contractor may provide plants larger than specified, with plants at original spacings or as approved by the Authority. Use of such plants must not result in increase in Contract price. If larger plants are approved, increase ball of earth in proportion to size of plant.
   7. Where plants larger than specified have been submitted in writing for approval and approved in writing by the Authority, Contractor must assume responsibility of Warranty for plant in size as planted.

C. Balled and Burlapped Plants (Designated B&B):
   1. Dig plants with firm natural balls of earth of diameter indicated below and of sufficient depth to encompass fibrous and feeding root system necessary for full recovery of plant.
   2. Plants having balls broken or cracked during delivery or at time of planting will be rejected.
   3. Diameter at top of each ball must be diameter specified above and diameter at bottom of each ball must not be less than 70% of specified top diameter. Top and bottom sources must be parallel.
   4. Ball must be of specified depth at points perpendicular to bottom of ball.
   5. Balls greater than 30" diameter must be drum-laced and shipped in metal reinforcement baskets.
   6. The Authority may reject any plant specified as balled and burlapped which, in his opinion, fails to conform to balling requirements set forth.

  7. Basal flare for trees and shrubs must be located within the top 1-2" of the tree ball, with soil removed from flare at time of planting to set correct planting depth. Trees shipped with the basal flare below this dimension may be rejected pending Authority review, and replaced at no added cost to this contract. Do not shave tree balls.

D. Container or Pot Grown Plants:
  1. Container grown plants must have heavy fibrous root system, or well developed taproot, that has been developed by proper horticultural practice including transplanting and root pruning.
  2. Root system must have developed sufficiently long for new fibrous roots to develop so root mass will retain its shape and hold together when removed from container.
  3. In no case should container strangle or girdle natural growth of plant.
  4. Groundcovers in containers pots must have the minimum number of runners and length of runners in accordance with American Association of Nurserymen, Inc., ANSI Z60.1.
  5. Diameter of spread must determine inside diameter of pot in which they must be grown for at least 3 months prior to delivery.
  6. Plant container sizes must conform to American Association of Nurseryman, Inc., ANSI Z60, 1.
  7. Contractor to place with bid cost add/deduct price for provision of specified material within "eco-pot" type, biodegradable pots, if available.
  8. Contractor to provide substitute price for pre-grown perennial quarts in lieu of gallons, pending contract schedule. Nursery orders for pre-grown quarts for Spring planting are typically placed by August the prior year, and for Fall planting by May of the same year.

E. Deciduous (Shade and Ornamental Trees)
  1. Street tree plantings must be free of branches equivalent to 1/2 of tree height or so that crown of tree is in proportion to trunk as tree grows. Trees with ascending branches may be branched 1 foot or more below branch heights as listed.
  2. Multistem tree plantings must have minimum three main trunks, from which even branching occurs, providing an evenly vegetated appearance.
  3. Provide trees of specimen quality.
  4. Provide trees of height and caliper scheduled or shown and with branching configuration recommended by ANSI/AAN Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed. Provide balled and burlapped (B&B) deciduous trees.

F. Deciduous Shrubs: Provide shrubs of the height shown or listed and with not less than minimum number of canes required by ANSI/AAN Z60.1 for type and height of shrub required.
  1. Provide balled and burlapped (B&B) deciduous shrubs.

2. Container grown deciduous shrubs may be acceptable in lieu of balled and burlapped deciduous shrubs subject to specified limitations for container grown stock and following approval by the Authority.

G. Perennial, Prairie Forbs, Grasses:
   1. Perennial, prairie forbs, and grasses specified as "container" or "pot" must be provided as container grown plants, or must be provided with firm natural balls of earth with diameter and depth in accordance with American Standard for Nursery Stock for size specified on Plant List.
   2. Ship balled plants in open-air boxes or crates that will minimize handling of each plant prior to installation. Do not plant balled plants if ball is cracked or broken either before or during process of planting. Do not plant if desiccated or damaged in shipping.
   3. Notify the Authority to allow review Perennial, Prairie Forbs and Grasses at time of delivery. Landscape Field Supervisor to determine whether plants should be cut back prior to installation.

H. Bulbs:
   1. Provide bulbs of size and species specified to meet ANSI standards for the proposed material. Reject bulbs not of correct size, rotted, mildewed, and replace prior to installation at no added cost to this contract.

2.2 PLANTING MATERIALS

A. Water:
   1. Existing water supply from hose bibs at the project building may be used for all planting operations. Provide hose and equipment necessary for proper watering of plant material. Provide water at no extra cost if it is not available at the project site.
   2. Recycled rainwater may be used for all planting operations through use of the irrigation system. Coordinate system availability with the General Contractor.

B. Soils:
   1. Top Soil: See Section 32 91 13

C. Soil Conditioner for Perennial, Groundcover, Forb, Grass planting beds: See Section 32 91 13

D. Shredded Hardwood Bark Mulch: See Section 32 91 13

E. Fertilizer:
   1. Commercial type, uniform in composition, free flowing, conforming to state and federal laws, and suitable for application with equipment designed for that purpose.
   2. Fertilizer to contain minimum basis percentage by weight of following:
      a. Nitrogen: 6%, 1/4 of nitrogen must be in form of nitrates, 1/4 in form of ammonia salts, and 1/2 in form of organic nitrogen.

    b. Phosphorus: 24%, available phosphoric acid must be derived from super phosphate having minimum analysis of 20% available phosphate.
    c. Potash: 24%, potash must be in form of sulphate of potash.
    d. Balance of fertilizer must be materials usually present in such products, free from dust, sticks, sand, stone, and other debris.
  3. Coordination N-P-K requirements with those recommended by soils consultant, if applicable.

F. Drainage Stone: See Section 32 91 13

G. Aeration/Drainage pipe: See Section 32 91 13

H. Weed Herbicide: Organic and inorganically based spray formulated for control and removal of herbaceous weeds. Includes glycophate, and other commonly used herbicides.

I. Anti-Desiccant:
  1. Provide spray-on anti-desiccant for trees, following manufacturer recommendations as to appropriate application rates and conditions.

J. Wrapping: Provide non-dyed, biodegradable tree wrap tape not less than 4 inches (102 mm) wide, designed to prevent borer damage and winter freezing. Wrap trees from top down. Plastic wrap and cording is not acceptable.

K. Animal Repellent Spray for Plants
  1. Clear, natural ingredient, Thiram-Free liquid repellent

L. Stakes and Guys:
  1. As required, provide stakes and deadmen of sound new hardwood, free of knotholes and other defects. Provide wire ties and guys of two strands, twisted, pliable galvanized iron wire, not lighter than 12-gauge (2.68 mm) with zinc coated turnbuckles. Provide not less than ½-inch (13 mm) diameter rubber or plastic hose, cut to required lengths and of uniform color, material, and size to protect tree trunks from damage by wires. Each wire and stake must be flagged with strands of brightly colored ribbon for visibility.

M. Protection Fencing:
  1. Provide 4' height temporary snow fencing, staked adequately for safety. Fence must be maintained in a safe and durable condition during construction and through the initial establishment period. Remove fence when directed by the Authority.

N. Miscellaneous Materials and Equipment:
  1. 'Gatorbag', hoses, sprinklers, PVC pipe, watering tanks and pumps, and other temporary watering devices. Provide temporary fencing and signage, as required for plant establishment, per approval of the Authority.

3. EXECUTION

3.1 INSPECTION

A. Verify location of underground utilities with appropriate sources prior to construction. Contact DIGGER 312.744.7000 at least 48 hours before commencing with construction operations. Repair damaged utilities at Contractor’s expense.

B. Do not install plantings where depth of soil over underground construction, obstructions or rock is insufficient to accommodate roots or where pockets in rock or impervious soil will require drainage. Where such conditions encountered in excavation planting areas and where stone, boulders or other obstruction cannot be broken or removed by hand methods and where trees to be planted found below overhead wires, bring to the attention of the Authority. Alternate locations for planting may be designated by the Authority.

C. Remove rock or other underground construction and drain planting areas only when approved by the Payment of extra must be based on in-place volume required to provide normal requirements for plantings.

D. Inspect soil installation and soil drainage percolation test reports. V.I.F. all percolation tests results prior to planting. See Section 32 19 13.26 for percolation testing procedures.
   1. Do not proceed with planting unless all percolation tests show positive drainage as indicated in Section See Section 32 91 13.26.
   2. Report and address and resolve all planting pit drainage discrepancies with General Contractor and Authority. Plants that suffer from poor drainage will be replaced at Contractor’s expense at no additional cost to this contract.

E. Conflicts with utilities must be called to the Authority's attention before proceeding with work. Alternate locations may be designated by the Authority

F. When landscape work is substantially completed, the Authority will make an inspection to determine acceptability. Issues of concern by either party will be written down and filed with the project record.
   1. Landscape Work will be inspected for Acceptance in portions as agreeable to the Authority, provided each portion of work offered for inspection is complete, including maintenance during the establishment period, and one year following substantial completion.
   2. Provide a healthy, finished planting of trees, shrubs, groundcovers, and herbaceous perennials by watering, weeding, and generally maintaining planting areas from the time of installation until completion of all Contract Work.

G. When inspected landscape work does not comply with requirements, replace rejected work and continue specified maintenance until re-inspected by the Authority and found to be acceptable. Remove rejected plants and materials promptly from site. Provide immediate replacement or schedule for replacement within appropriate season.

3.2 INSTALLATION

A. Topsoil/Finish Grading:
  1. Verify final grade as shown on drawings. Grades not otherwise indicated are uniform levels or slopes between points where elevations are given or between such points and existing finished grades. Allow for settlement.
  2. Review Soil Drawing. Confirm with the Authority areas where Topsoil is to be added, existing soil removed and replaced, as part of this work. Where soil addition or replacement is required, till the interface between existing and new soil to a minimum depth of 8" to improve drainage.

B. Preparation:
  1. For all soil preparation, See Section 32 91 13.
  2. Schedule planting work to allow for landscape installation within Planting Seasons.
  3. Notify the Authority to allow review and approve finished lines and grades prior to installation of plant materials.
  4. Provide maintenance of finished grades and landscaping through Project Acceptance and Warranty period. Repair grades and landscaping as needed due to erosion, disturbance caused by Contractor activity.
  5. Stake or paint locations of trees, shrubs and bed lines, sod and seed areas. Authority to meet with Contractor to approve staking before excavation is started. Provide 48 hours notice for approval. Make adjustments in locations and outlines as directed by the Authority.
  6. Clear and grub soil, prepare planting soil for planting:
     a. Remove 4" existing soil containing weed crowns and roots. Dispose carefully off site, taking care to prevent weed laden soil from contaminating landscape areas. Treat soil with herbicide, repeat treatment if needed, to remove weeds prior to planting.

C. Excavation for Planting:
  1. Excavate circular pits with vertical side for plants, except for ground cover or other bedding type plant material.
     a. Diameter of pits for trees must be at least 2 ft greater than diameter of ball, or container.
     b. Depth of pits for trees must be as indicated. Excavate to greater depth as suitable to accommodate ball, container or bare roots when plant is set to finish grade allowing for 6 in. of compacted, prepared soil in bottom of pit.
     c. When planting in heavy clay soils, place basal flare of tree 3" above finished grade to ensure ball drainage. Feather edges of ball to match finished grade.

D. Setting and Backfilling Plants:

1. Balled and Burlapped (B&B) Plants:
    a. Set balled and burlapped stock on layer of hand-compacted soil, plumb and in proper alignment, with top of ball and basal flare approximately 3"above adjacent finished landscape grades. Remove burlap, twine, and pins from top half of rootball, retain on bottoms. Remove top 1/3 of wire basket. When plant is set, place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately two thirds full, fill excavation with water and let drain before placing remainder of backfill. Construct 4" to 6" height earthen watering saucer at perimeter of ball, firmed to resist erosion, and water completed planting thoroughly.
    b. Remove twine tied around tree trunk. Remove plastic wrap around ball. Remove wire and other non-degradable materials. Untreated burlap need not be removed, but must be loosened and rolled down around tree trunk.
    c. Backfill planting pits with top soil in 12-in. layers and tamp each layer to fill voids until planting mixture is at final grade.
    d. Remove nursery plant identification tags following approval of the Authority.
    e. Apply anti desiccant, using power spray, to provide an adequate film over trunks, branches, stems, twigs, and foliage.
    f. If deciduous trees are moved when in full leaf, spray with anti desiccant at nursery before moving and spray again two weeks after planting.
    g. Spray conifers with anti desiccant at nursery before moving and spray again two weeks after planting.
    h. Wrap tree trunks of 2 inch (51 mm) caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning, and insect infestation and take corrective measures before wrapping.
    i. Where required, guy and stake trees immediately after planting.
    j.
2. Container Grown Plants:
    a. Open and remove potted plants from containers.
    b. If growing medium is comprised of 75% or more of peat, perlite, sand or like material other than soil, pull visible roots away from container medium so as to leave roots partially exposed.
    c. Place plants in plant pit or trench and carefully backfill with top soil among exposed roots. Continue backfilling and tamping in 6-in. layers until top soil is at final grade. Place plant firmly into soil to stabilize and ensure direct soil contact with roots.
    d. Remove nursery plant identification tags at direction of the Authority.

E. Saucer Formation:
1. Form shallow saucer around each isolated plant pit with top soil.
2. Water plants immediately after planting. Incorporate required fertilizer into prepared planting mixture at rate specified.

3. Mulch individual tree watering saucers at time of installation. Dish top of backfill to allow for mulch. Maintain the proper configuration of mulch ring and depth of mulch through the Warranty Period.

F. Perennial, Forb, Grass, Beds:
   1. Maintain beds through monitoring of plant establishment and weeding, watering. Focus activity on the first month, decreasing as plants establish and weed germination subsides. Review for animal predation and apply deterrent as needed. Replace plants through the Warranty Period, providing requisite initial monitoring and maintenance through establishment, and one year following substantial completion.

G. Bulb Planting
   1. Plant fall bulbs. Procure in appropriate time period for installation. Do not place in areas of poor drainage. Request Authority direction for alternate locations, if needed.

3.3 PRUNING

A. Prune trees and shrubs at time of or after planting. Pruning and repair of existing trees designated to remain shall be performed by a certified arborist.

B. Prune in accordance with standard horticultural practices to retain natural habit and shape of plant.
   1. Shearing of plants will not be accepted, unless instructed by the Authority.
   2. Preserve leader(s) promoting symmetrical growth on multiple leader plants.

C. Prune and trim dead wood, suckers, and injured twigs and branches.

D. Use only clean, sharp tools.

E. Make cuts flush and clean avoiding injury to branch bark ridge or branch collar leaving no stubs.

F. For cuts greater than 3/4 in. in diameter and bruises or scars on bark, trace injured cambium back to living tissue and remove. Smooth and shape wounds so as not to retain water.

G. Prune flowering trees only to remove dead or damaged branches. Do not remove leader.

H. Wrap tree trunks of 2 inch (51 mm) caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning, and insect infestation and take corrective measures before wrapping.

3.4 PROTECTION AND MAINTENANCE

A. Mulching:
   1. Mulch within five days after installation.
   2. Mulch planting beds as each is finished, and mulch each tree after it is planted. Only plant areas which will be mulched and watered the same day. Soil must be moist before mulching. Do not fill in watering saucers level with mulch, but follow soil contour to preserve function of saucer. Keep mulch completely away from tree trunks for a distance of six inches. To prevent suffocation, elevate stems of recumbent shrubs and groundcovers and place mulch beneath. Provide the following thickness of mulch indicated on the drawings:
      a. For trees, provide a minimum 3-inch thickness of shredded hardwood bark
      b. For shrub masses, provide a 2-inch thickness of shredded hardwood bark Replenish mulch on tree and shrub plantings in Spring on a yearly basis through the Warranty period. Do not exceed the specified mulch depth.
      c. “Volcano” mulching will be rejected.
      d. Mulch perennial and grass beds only with soil conditioner.

B. Watering:
   1. Thoroughly water immediately after installation.
   2. Water thoroughly during plant establishment period. Assess site and planting bed soil conditions as part of this work.
   3. Reducing watering as warranted through plant establishment requirements. Provide water in times of heat or drought as needed for plants for healthy growth.
   4. Provide staffing as needed to water and maintain plantings as the installation area increases.

C. Protect landscape work and materials from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and establishment and maintain protection during the Warranty Period, if required, to protect the viability and quality of installation following approval by the Authority. Treat, repair, or replace damaged landscape work as directed.

D. Restore surrounding areas of jobsite, disrupted by the Landscape Work, including delivery routes, to the original condition, or alternate condition as directed by the Authority.

3.5 CLEAN UP

A. Remove soil or similar material brought onto paved areas, keeping these areas clean.

B. Upon completion of planting, remove excess soil, stones, and debris and dispose of off-site in legal manner.

3.6 MAINTENANCE

A. Maintain plant material until landscape operations have received Project Acceptance for the project, and one year following substantial completion.

B. Maintenance begins immediately after each plant is installed and must include watering, necessary cultivation, weeding, pruning, disease and insect pest control, protective spraying, resetting of plants to proper grades or upright position, restoration of damaged planting saucers, and any other procedure consistent with good horticultural practice necessary to ensure normal, vigorous, and healthy growth of work.

C. Remove trash in beds and in plant material as part of work.

D. Maintain perennial beds for the duration of the growing season during which they were installed, through Project Acceptance, and one year following substantial completion.

E. Maintain perennial beds by watering, cultivating beds/ weeding, trimming, as required for healthy growth and clean appearance. Remove litter and windfall.

F. Contractor must continue to provide continued maintenance to tree, shrub, and groundcover plantings following completion of all Contract Work, and one year following substantial completion..

G. Pruning of specific plant materials, through the Warranty period, is included in this contract. Prune flowering plants for form the second year immediately after flowering. Prune woody trees (non flowering), the first winter after a full growing season. Request and receive direction from the Authority, prior to pruning. Unspecified pruning may result in replacement of plantings at no added cost to this contract.

H. Second year watering of woody plants:
   1. Provide deep watering of new trees and shrubs in spring.
   2. Provide watering, including provision of gator bags, if needed to assist in woody plant establishment through the second year following Project Acceptance. This includes review of plantings with the Authority in May of the second year.

I. Perennial, Forb, Grasses, Bulb Seasonal Maintenance: (Note: this work is included in the contract as part of the Project Acceptance and Warranty Period scope)
   1. Provide weeding/cultivation of beds on a monthly/bimonthly basis during growing season, dependent of weed growth.
   2. Provide cleaning of decayed plant materials in October of each year.

3. Provide winter protection of perennial beds for the first winter following installation. Include erection and maintenance of a temporary salt fence at perimeter of installation facing roadways. Remove and dispose of at end of winter season.
4. Review de-icing procedure with building operations during first year fall season, including coordination to eliminate stockpiling of snow, ice, deicer materials in planter beds.
5. Provide cutting back of plants between February-March of each year and removal of decayed plant materials.

3.7 PROJECT ACCEPTANCE

A. Planting Acceptance: Upon substantial completion of the project, the Authority will inspect landscape work for acceptance.
   1. Acceptance requirements:
      a. Inspection must take place while plants are in full leaf.
      b. Planting beds meet finished grades, drainage patterns as indicated on Civil Drawings.
      c. Plant material must conform to drawings with respect to quantity, quality, size, species, and location, except those items accepted or revised in field by the Authority.
      d. Plants must be properly mulched.
      e. Plant material must be in healthy, established growing condition as defined under Warranty Requirements below.
      f. Items must appear to be in general conformance with specifications.
      g. Plantings must be established and able to survive through the remainder of the season without watering provided by the Contractor.

B. Landscape furnishing acceptance: items to be securely installed with all specified items, true, square, plumb, as indicated on drawings.

C. Work through Project Acceptance will constitute 80% of the landscape scope, with the remaining 20% performed during the Warranty, maintenance and Final Acceptance effort.

D. Following Project Acceptance, the Contractor remains responsible for seasonal maintenance of perennial forb and grass beds, and watering of all plants as needed to remain in a viable, healthy growing condition. The contractor will continue site maintenance including removal of trash and weeds within planting beds, cultivation of mulch, and notification of Authority of defects in the installation, general monitoring of plant materials, and coordinating with the Using agency related to protection of landscape items.

3.8 WARRANTY PERIOD

A. The Warranty Period begins upon Project Acceptance and written notification of Project Acceptance by the Using agency.

B. During Warranty Period, Contractor must provide deep watering at beginning of Spring, and seasonal watering of trees, woody plants, perennial and grass beds after Project Acceptance and through the end of the Warranty Period to prevent plants from going into dormancy in periods of drought or low rain, as part of this work.

C. Provide seasonal maintenance per Perennial, Forb, Grasses, Bulb Seasonal Maintenance as part of this work.

D. Remove dead plants within 4 weeks of verification by Authority, and replace within appropriate planting season. Replace any tree with dead main leader or crown which is 25% or more dead. Contractor to provide an extended Warranty for replaced plants, one year from the day of planting, and provide necessary maintenance for establishment.

E. Exclusions:
   1. Inspection of Maintenance:
      a. During Warranty period, Contractor must, from time to time, inspect watering, cultivation, and other maintenance operations carried on by Using agency with respect to such work, and promptly report to Using agency any methods, practices or operations considered unsatisfactory and not in accord with interests or good horticultural practices.
      b. Provide copy of notification and photographs to Authority should Contractor have concerns related to Warranty responsibilities.

F. Remove and replace trees, shrubs, or other plants found to be dead or in unhealthy condition, or do not conform to minimum form and size standards for each species during the Warranty Period. Make replacements during the appropriate growing season prior to the end of the Warranty Period and provide one year extended Warranty for replaced plants.

G. Notify Authority to perform Final Warranty Inspection. Authority will provide in writing verification of completed work following conformance to project requirements.

3.9 REPLACEMENTS

A. Plants which die or require replacement for other reasons during one-year Warranty period must be replaced as soon as possible during following acceptable planting seasons:
   1. Spring Replacement Season: All plants - when ground becomes workable to June 15.

2. Fall Replacement Season:
    a. Deciduous plants - September 1 to November 15.

B. Procedure:
  1. Dispose of plants off-site in legal manner.
  2. Replacements must be of same size and species as original plant unless otherwise approved by Landscape Authority.
  3. Replacements must be supplied and installed in accordance with specifications.
      a. Additional one-year Warranty for replacement plants shall begin on date of final acceptance of plant material by Authority as documented in field report.
  4. Replacement and Damages:
      a. Decisions of Authority for required replacements shall be conclusive and binding upon Contractor.
      b. Contractor must be responsible for repairing damage to property also caused by defective workmanship and materials.
      c. Plant materials must be approved prior to shipment to site.
      d. Sod, perennial, groundcover, ornamental grass, bulbs, will be replaced per the specifications.

END OF SECTION

SECTION 33 01 10.10

CATCH BASIN OR MANHOLE TO BE CLEANED

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This work will consist of cleaning and proper disposal of any accumulation of silt, debris, and foreign matter of any kind from catch basins, or manholes, which are located outside the proposed base course area, such as an existing street return to be resurfaced or a parkway to be graded.

1.03 RELATED SECTIONS

1. Section 33 05 14: Water Valve Box or Buffalo Box To Be Adjusted.

1.04 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, latest edition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 The cleaning must be done after the placing of the HMA overlay material.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of CATCH BASIN OR MANHOLE TO BE CLEANED will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of CATCH BASIN OR MANHOLE TO BE CLEANED will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 01 10.10

SECTION 33 05 13

REMOVAL OR FILLING MANHOLES AND CATCH BASINS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies requirements for the removal, or filling and abandoning existing pipes, manholes, catch basins and inlets. The work under this Section will include furnishing all labor, materials, tools, and equipment required to abandon, remove, or fill existing manholes, catch basins, and inlets.

B. Where catch basins, manholes, and inlets are to be filled, the openings of pipes to be abandoned must be bulkheaded prior to the placement of the special backfill material.

C. Except as modified herein, the work must conform to the applicable portions of the IDOT Standard Specifications, Section 605.

D. Related Sections:

   1. Section 31 23 10 – Excavation, Trenching and Backfilling (Utilities).

E. Except as modified herein, the work must be performed in accordance with the applicable requirements of Special Conditions for Transportation Construction, and Additional Special Conditions, as well as the requirements of the General Conditions, Division 1, and this Section.

1.03 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, latest edition.

PART 2 - PRODUCTS

2.01 BACKFILL MATERIAL

A. Backfill material specified in Section 312323 of these specifications must be used to fill abandoned or removed manholes, or catch basins

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. All cast iron manhole, or catch basin frames and lids that have been removed from existing structures (being the property of the City) must be removed to a location designated by the Commissioner for inspection and storage and for re-use on the project or made available for removal by the City. Manhole and catch basin frames and lids designated for re-use by the Commissioner must then be moved again by the Contractor to the locations of the drainage structures as designated by the Commissioner.

B. The manhole or catch basin must be cleaned of all mud and debris before the special backfill material is placed. Cleaning residue must be properly disposed of by the Contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of REMOVAL OR FILLING MANHOLES, AND CATCH BASINS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of REMOVAL OR FILLING MANHOLES, AND CATCH BASINS will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 05 13

SECTION 33 05 14

WATER VALVE BOX OR BUFFALO BOX TO BE ADJUSTED

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. The work under this Section will consist of the adjustment of existing water valve boxes or water buffalo boxes.

B. Perform in accordance with Section 565 of the Standard Specifications, the details in the drawings, and the Department of Water Managements Requirements, except as herein modified. Obtain copies of Water Service Pipe Plats from the Department of Water Management (312) 744-5078 to verify and confirm the exact location of the water service shut-off boxes.

C. Notify the Department of Water Management (312) 744-3711, 72 hours before the adjustment so that the Department can provide field inspectors to witness the work.

D. The hole formed due to adjustment of the domestic water service boxes must be backfilled with fine aggregate, gradation FA-2. Back filling is included in this item.

E. Repair damaged domestic water service boxes at Contractor's expense.

1.03 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, latest edition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of WATER VALVE BOX OR BUFFALO BOX TO BE ADJUSTED will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of WATER VALVE BOX OR BUFFALO BOX TO BE ADJUSTED will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 05 14

SECTION 33 05 15

CITY ELECTRICAL VAULT OR HANDHOLE TO BE ADJUSTED

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This work will consist of the adjustment of existing City of Chicago Bureau of Electricity vaults or handholes.

B. If the adjustments are to be made within the proposed Base Course Area, the work must be done in accordance with Section 602 of the Standard Specifications.

C. If the adjustments fall within an area to be resurfaced only or a parkway to be graded, the work must be done in accordance with Section 603 of the Standard Specifications.

D. Except as modified herein, the work must be performed in accordance with the applicable requirements of Special Conditions for Transportation Construction, and Additional Special Conditions, as well as the requirements of the General Conditions, Division 1, and this Section.

1.03 REFERENCES

A. Illinois Department of Transportation (IDOT) Standard Specifications for Road and Bridge Construction, Adopted January 1, 2022, or latest edition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of CITY ELECTRICAL VAULT OR HANDHOLE TO BE ADJUSTED will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of CITY ELECTRICAL VAULT OR HANDHOLE TO BE ADJUSTED will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. Civil Work: 020000.

END OF SECTION

SECTION 33 05 22

REPAIR AND ADJUSTMENT OF SEWER MAINS AND STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the requirements associated with the repair, adjustment and abandonment of existing sanitary and storm sewers, private drains, manholes, catch basins and inlets as shown on the Drawings, or as directed by the Commissioner. This Section also includes the requirements for cleaning existing catch basins.

1.03 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete.

B. Section 31 23 10 – Excavation, Trenching and Backfilling (Utilities).

C. Section 33 31 13 – Sewer Main Pipe and Fittings.

1.04 REFERENCES

A. CDWM Regulations for Sewer Construction and Stormwater Management, latest edition.

B. ISPE Standard Specifications for Water & Sewer Construction in Illinois, latest edition.

C. Follow the latest edition of the following references.

1. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
2. ASTM C425 - Compression Joints for Vitrified Clay Pipe and Fittings.
3. ASTM C76 - Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
4. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast for Water.
5. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
6. ASTM C478 - Pre-cast Reinforced Concrete. Manhole Sections.
7. ASTM C32 - Sewer and Manhole Brick (Made from Clay or Shale).
8. ASTM A48 - Gray Iron Casting

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. Sewer piping must conform to the requirements of Section 333113 – Sewer Main Pipe and Fittings.

   1. Sewers 21-Inches in diameter and smaller must be Extra Strength Vitrified Clay Pipe or Ductile Iron Pipe.
   2. Sewers 24-Inches and larger, must be Reinforced Concrete Pipe.

2.02 MANHOLES, CATCH BASINS AND INLETS

A. Manholes, catch basin and inlets must conform to the requirements of Section 333913 – Sewer Manholes, Catch Basins, Inlets and Special Structures.

B. Manhole lids and frames, catch basin or inlet frames, grates, and manhole steps must conform to the requirements of Section 333913 – Sewer Manholes, Catch Basins, Inlets andSpecial Structures.

2.03 SEWER BRICK

A. Sewer brick must conform to the requirements of Section 333913 – Sewer Manholes, Catch Basins, Inlets and Special Structures.

2.04 MORTAR AND GROUT

A. Portland Cement Mortar for sealing pipe connections, structures, manholes and catch basin frames must conform to ASTM C150, and be composed of one (1) part Portland cement andone(1) part sand, and minimal amount of water to make a workable mix.

B. Grout: Portland Cement, Admixtures, and Sand must meet the requirements of Section 033000 – Concrete.

PART 3 - EXECUTION

3.01 GENERAL

A. Existing sewer facilities disturbed or damaged by the Contractor's operation must be promptly reported to the Department of Water Management, (Sewers Engineering Section) and repaired by the Contractor. All repairs must be done using a licensed drain layer, in conformance with Department requirements, and are considered incidental to the Work of the operation. No additional payment will be allowed for this work.

B. Sewer pipe used in the repair or adjustment of sewers and sewer structures must be of the same diameter and pipe material as the existing sewer, with the exception of the conditions listed hereafter, unless otherwise directed by the Commissioner.

   1. Where water mains cross over existing sewers, house drains, catch basins drain

pipes, and where an 18-inch vertical separation cannot be maintained between the bottom ofthe water main and top of existing sewer, the existing sewer pipe must be replaced with a ductile iron pipe with rubber gasketed joints comparable to water main standards, for a of perpendicular distance of 10 feet each side of the water main to be crossed.

2. Where the horizontal separation between a water main and existing sewer is less than 10 feet and less than 18-inches vertically above the crown of the existing sewer pipe, the sewer must be replaced with ductile iron pipe to a distance 10 foot each side ofthe center line of the water main.
3. If a water main crosses under existing sewers, house drains, or catch basin drains, the sewer must be replaced with ductile iron pipe to a distance of 10 feet either side ofthe centerline of the water main, and an 18-inch vertical separation must be maintained.

3.02 LAYING SEWERS

A. Trenches must be kept free from excess water until the sewer has been installed and mortar joints, if used, have set.

B. Each pipe and fitting must be inspected for soundness and damage immediately before being laid, and any pipe or fitting not conforming to the requirements of this Section, is rejected and must be removed from the Site at the Contractor’s expense.

C. Each pipe must be laid to the line and grade as shown in the plans unless directed otherwise by the Commissioner. Pipe must be laid on even firm bedding along the entire bed of the pipe with bedding material shaped to conform to pipe bells or joint sleeves, and so not to bear on pipe bells or joints. Bedding must conform to the requirements of Section 312310 –Excavation, Trenching and Backfilling (Utilities).

D. The socket end of the pipe must be laid upgrade.

E. Pipe must not be trimmed or clipped in order to fit in the socket.

F. The face of the spigot must be brought into contact with the shoulder of the socket.

G. The joints must be sealed in accordance with the manufacturer's specifications.

H. Whenever pipe laying is discontinued, the unfinished end of the sewer must be protected from displacement, cave in, or other injury and a suitable stopper or dam must be placed in the end socket.

3.03 MORTAR JOINTS FOR DRAIN CONNECTIONS

A. Mortar joints used for connections to existing sewer pipes or private drains may be used only when connections cannot be made using gasketed joints as specified or the appropriate pipe adaptor as supplied or recommended by the pipe manufacturer, or as directed otherwise by the Commissioner.

B. When mortar joints are required, they must be constructed using the following procedure:

1. In joining pipe, the spigot must be centered in the socket by means of a packing gasket of twisted impregnated oakum of proper thickness and sufficient length to

pass around the pipe and lap the top.

2. After the pipe has been placed, the gasket must be caulked into the annular space and the remainder of the space filled with Portland cement mortar beveled off with the outside of the socket.
3. Mortar for pipe joints or fittings must be made of one (1) part Portland Cement and one (1) part sand conforming to applicable requirements of Section 033000 - Concrete.
4. Only a sufficient amount of mortar may be prepared for use within forty-five (45) minutes of application. Any mortar that has begun to set must not be used.
5. As each joint is completed, the inside of the pipe must be thoroughly cleaned to remove all excess joint material.

3.04 EXISTING CATCH BASINS

A. Thoroughly clean any existing catch basin to remain to its full depth, removing and properly disposing of all material removed from the basin. No material removed from a catch basin must be allowed to enter any City sewer.

B. Inspect the drain connection from each catch basin and rod-out the drain when said drain is found to have obstructions. Any drain connection found to be defective must be removed and relayed.

3.05 REPAIR AND ADJUSTMENT OF STRUCTURES

A. Remove the existing frames and covers and inspect the existing masonry. Remove and replace defective masonry in the upper portions. Remove or add masonry, as necessary, to meet the elevations as shown on the Plans.

B. For any manhole or catch basin cover or frame raised more than 6 inches, remove the old masonry for the structure to the point where the manhole or catch basin structure reaches its full internal diameter and rebuild the structure as shown on the Plans.

C. Material used in each repair and adjustment must be the same type as in the existing manhole, catch basin or inlet, unless otherwise ordered by the Commissioner.

D. Reset the existing frames and covers on the repaired and adjusted manholes, catch basins and inlets in a full bed of mortar. If new covers are required, they will be furnished and installed at no additional cost to the Commissioner.

E. Examine the drain connection from each catch basin and inlet, and if such connection is found to be defective, then remove and relay the defective portions as ordered by the Commissioner.

F. Place granular trench backfill, as described in Section 312310 – Excavation, Trenching and Backfilling (Utilities), around the repaired and adjusted manholes, catch basins, inlets, valve basins and vaults.

3.06 FINAL ADJUSTMENT OF STRUCTURES

A. To prevent debris from entering the sewers, place 22 gauge galvanized steel plate beneath all perforated lids of all sewer structures prior to the placing of any type of surfacing material. Maintain plates in place until the completion of all paving operation have been completed.

B. After the base course and binder course have been placed, and prior to placing the surface course, the structures must be adjusted to match the final pavement elevation.

C. Remove the binder and base course adjacent to and for a distance not exceeding 12-inches outside the base of the castings.

D. Adjust the castings to final pavement elevation with adjusting rings set in mortar.

E. Fill the space around the casting with Class SI concrete to the elevation of the surface of thebinder course.

3.07 ABANDONMENT OF SEWERS AND SEWER STRUCTURES

A. Fill abandoned sewers, sub-sidewalk space, water tunnels, structures, drains, manholes, catch basins and inlets as shown on the Plans or as ordered by the Commissioner with fine aggregate material meeting the requirements of Section 312310 – Excavation, Trenching and Backfilling (Utilities). A hole must be drilled every 100 feet in abandoned backfilled sewers and drains that are 15 inches and larger in internal diameters to verify the backfilling and to allow refilling if necessary.

B. When called for on the Drawings, abandoned sewers must be completely filled with sewer grout or controlled low strength material / flowable fill. Fill abandoned sewers to a point approximately six (6) inches up in the manhole riser above the top of the sewer crown. Care must be taken so as not to fill any drain connection.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of REPAIR AND ADJUSTMENT OF SEWER MAINS AND STRUCTURE shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of REPAIR AND ADJUSTMENT OF SEWER MAINS AND STRUCTURE shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 05 22

SECTION 33 05 29

HANGERS AND SUPPORTS FOR UTILITY SYSTEM PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the following hangers and supports for utility system piping and equipment as shown on the drawings or as required:

1. Steel pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Pipe stands.
7. Pipe positioning systems.
8. Equipment supports.

B. Related Sections include the following:

1. Section 05 50 00, Metal Fabrications
2. Section 22 05 48, Vibration Controls for Plumbing Piping and Equipment.
3. Section 33 05 00, Common Work Results for Utilities.
4. Section 33 41 00, Storm Utility Drainage Piping.
5. Section 33 67 50, Water Systems
6. Section 33 68 00, Sewer Systems.

1.03 DEFINITIONS

A. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads, stresses across expansion joints, and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

D. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

E. Design equipment supports capable of supporting combined operating weight of support equipment and connected systems and components with a loss of 50% of hangers.

1.05 SUBMITTALS

A. Product Data: For the following:

1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Power-actuated fastener systems.
4. Equipment Supports.
5. Trapeze Hangers.
6. Pipe Stands.

B. Pipe Stress Analysis report.

C. Shop Drawing: Show Fabrication and Installation Details and Include Calculations for the Following:

1. 3-Dimensional Pipe and Equipment Drawing: Field verified water and sewer pipe distribution and equipment system layout. Include location and type of supports for new piping and equipment. Show clearances between existing bridge deck structure and new piping and equipment. Include clearances from existing piping to remain and show access to valves, clean outs and equipment.

2. Pipe supports including trapeze pipe hangers, line stops, anchors and guides.

3. Equipment supports and bracing

4. Plumbing Plan to show routing and hanger and support locations.

5. Professional Licensed Structural Engineer stamped calculations for pipe and equipment support sizes, connections, and details.

6. Hanger and support connection details.

1.06 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

2.02 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Globe Pipe Hanger Products, Inc.
3. Grinnell Corp.
4. Carpenter and Paterson, Inc.
5. Tolco Inc.
6. National Pipe Hanger Corporation
7. Linn Brown and Associates, Inc.
8. Anvil International
9. Approved equal.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

F. Provide adjustable hangers, inserts, brackets, rolls, clamps, supplementary steel, and other devices required for proper support of all pipelines. Hangers shall be designed to allow for expansion and contraction of pipelines and shall be of adequate size to permit covering to run continuously through hangers. Piping at pumps, tanks, and other items of equipment shall be supported independently so that no weight shall be supported by the equipment.

G. All non-copper hangers and supports, including rods which are not plated, shall be furnished with shop coat of rust inhibiting primer. Copper or copper plated hangers and supports shall be used wherever they touch bare copper tubing.

H. Wire or strap hangers are not permitted.

I. Pipe supports at beam and joist construction shall be beam clamps, B-Line Fig. B3054; or approved equal.

J. For insulated hot pipe and cold pipe in all sizes through 8 inches, hangers shall be of Clevis Type, B-Line Fig. B-3108. For non-insulated piping, hangers shall be of Clevis Type B-3100; or approved equals.

K. Piping supported from wall or columns shall utilize a steel bracket, B-Line Fig. 3-3064 with adjustable pipe roll and base; B-Line B-3121 and pipe covering protection saddle B-Line B-3160-3165; or approved equals.

L. Cast iron stacks and galvanized risers shall be supported at each floor with friction clamps bolted together and supported by structural steel or additional channels, B-Line Fig. B-3373 or approved equal.

M. Steel and cast-iron pipe support spacing shall not exceed, and sizes of pipe-hanging suspension rods shall not be less than, the spacing and sizes indicated in the following tables:

Steel Pipe:

Nominal Pipe Size	Maximum Space Between Hangers	Minimum Rod Diameter
½"	5’	3/8"
¾"	6’	3/8"
1"	7’	3/8"
1¼"	8’	3/8"
1½"	9’	3/8"
2" and 2½"	10’	3/8"
3"	12’	1/2"

4"	12’	5/8"
5"	12’	3/4"
6"	12’	3/4"
8" to 12"	15’	7/8"

Copper Pipe:

Nominal Tube Size	Maximum Space Between Hangers	Minimum Rod Diameter
Up to 1”	5’	3/8"
1 ½” to 2”	6’	3/8"
2 1/2"	9’	1/2"
3"	10’	1/2"
4"	12’	5/8"

Maximum distance for cast iron piping shall be 10 feet, 0 inches with all hubs supported and with a minimum of ½ inch rod diameter.

2.03 STAINLESS-STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

C. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.04 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.05 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a Division of Cooper Industries.
2. Globe Pipe Hanger Products, Inc.

3. Grinnell Corp.
4. Carpenter and Paterson, Inc.
5. Tolco Inc.
6. National Pipe Hanger Corporation.
7. Linn Brown and Associates, Inc.
8. Anvil International

9. Approved equal.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.06 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. ERICO/Michigan Hanger Co.
2. Pipe Shields, Inc.
3. Rilco Manufacturing Company, Inc.
4. Approved equal.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.07 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless Steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.08 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

9. Manufacturers:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head.
    - c. Powers Fasteners.
    - d. Approved equal.

Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:

a. B-Line Systems, Inc.; a division of Cooper Industries.
b. Hilti, Inc.
c. ITW Ramset/Red Head.
d. Approved equal.

2.09 EQUIPMENT SUPPORTS

A. Equipment supports require calculation and detail of each unit.

B. Description: Welded, shop- or field-fabricated equipment support made from structural steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.

2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 6, requiring up to 4 inches of insulation.

3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.

4. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.

5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.

6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.

8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 6.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 6, if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with barjoist construction to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

L. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

3.02 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
   2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

I. Install lateral bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

K. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

M. Dissimilar Materials: Install hangers and supports as such to avoid dissimilar materials.

N. Insulated Piping: Comply with the following: 1. Attach clamps and spacers to piping.

  a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

  b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

  c. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

  a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

  a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

  a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  b. NPS 4: 12 inches) long and 0.06 inch thick.
  c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.04 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.05 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.06 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

PART 4 – MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of HANGERS AND SUPPORTS FOR UTILITY SYSTEM PIPING AND EQUIPMENT shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of HANGERS AND SUPPORTS FOR UTILITY SYSTEM PIPING AND EQUIPMENT shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 05 29

SECTION 33 07 00

INSULATION FOR WATER MAIN PIPE AND APPURTENANCES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section covers the requirements for insulating water mains and their appurtenances installed with less than the recommended depth of cover as specified in Section 33 11 13 – Ductile Iron Water Main and Fittings, detailed on the Drawings, or as directed by the Commissioner.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM C578 - Rigid, Cellular Polystyrene Insulation.
2. ASTM D1621 - Test Method for Compressive Properties.
3. ASTM C272 - Test Method for Water Absorption.

B. Illinois Department of Transportation Standard Specifications for Road and Bridge Construction, (SSRBC), latest edition.

PART 2 - PRODUCTS

A. Rigid insulation must be closed cell extruded polystyrene foam meeting the requirements of ASTM C578, Type VI.

B. Minimum width of the insulation board must be 2 feet, the minimum length must be 4 feet, and the minimum thickness must be 2-Inches.

C. The insulation must have the following properties:

1. Compressive strength of 40 pounds per square inch average, when tested in accordance with ASTM D1621.
2. Maximum water absorption of 0.1% by volume when tested in accordance with ASTM C272.

D. Furnish mastic approved by the insulation manufacturer for use with the insulation provided.

E. Sand backfill around insulation board must be of gradation FA 7 and conform to Section 1003, Fine Aggregates, of the SSRBC, unless directed otherwise by the Commissioner.

PART 3 - EXECUTION

A. Provide insulation where water main pipe used for distribution, water service pipe and branch connections have less than 5 feet of cover, or where water main pipe used for transmission has less than 3 ½ feet of cover, when shown on the Drawings or as directed by the Commissioner.

B. Excavate the water main trench to the width required for the rigid board insulation.

C. Spread and compact sand beneath and around all sides of the insulation board. Do not damage the insulation board during compaction. Lay the insulation board flat with no breaks or cracks. Stagger joints of the insulation board not less than 1 foot joint to joint.

D. Insulation must consist of two (2) layers of insulation board. Minimum total thickness of insulation must be 4-Inches.

E. Cover all joints with minimum 2-Inch thick insulation board that is minimum 6-Inches wide. Connect all joints together with mastic. The bond strength of all joints must be proved at least equal to the material strength before any backfill is placed.

F. Spread sand over the insulation board and compact it by suitable mechanical means prior to backfilling.

G. Cut and fit insulation board around valve and service boxes.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of INSULATION FOR WATER MAIN PIPE AND APPURTENANCES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of INSULATION FOR WATER MAIN PIPE AND APPURTENANCES shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAYMENT ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 07 00

SECTION 33 11 13

DUCTILE IRON WATER PIPE AND FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes requirements for the installation of ductile iron water pipe and fittings as shown on the Drawings and specified here.

1.03 RELATED SECTIONS

A. Section 31 23 19 - Dewatering Excavations.

B. Section 31 23 10 - Excavation, Trenching and Backfilling (Utilities).

C. Section 33 11 15 - Thrust Restraint for Water Main Piping

D. Section 33 13 00 - Disinfection and Testing Water Mains.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:

1. AWWA C104 - Cement Mortar Lining for Ductile Iron Pipe and Fittings.
2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
4. AWWA C111 - Rubber Rubber-Gasket Joints for Ductile-Iron Pressure pipe and Fittings.
5. AWWA C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. AWWA C116 - Protective Fusion-Bonded Epoxy Coatings Int. and Ext. Surf.Ductile-Iron/Gray-Iron Fittings.
7. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
8. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
9. AWWA C153 - Ductile Iron Compact Fittings for Water Service.
10. ASME/ANSI B16.1 - Flanges and Flanged Fittings.
11. ANSI B16.21 - Metallic Gaskets for Pipe Flanges.
12. ASME B18.2.1 - Square and Hex Bolts and Screws.

13. ASME B18.2.2 - Square and Hex Nuts.
14. ASTM A123 - Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
15. ASTM A153 - Zinc Coating (Hot Dip) on Iron and Steel.
16. ASTM A240 - Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip, for Pressure Vessels and for General Applications.
17. ASTM A307 - Carbon Steel Bolts and Studs.
18. ASTM A536 - Ductile Iron Castings.
19. ASTM A767 - Zinc Coated (galvanized) Steel.
20. ASTM A775 - Epoxy Coated Steel.
21. ASTM A780-93 - Repair of Zinc Coated (Galvanized)
22. ASTM B308 - Stainless Steel Alloy Standard Structural Shapes, Rolled, or Extruded.
23. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
24. ANSI A21.5/AWWA C105 - Polyethylene Encasement.

1.05 SUBMITTALS

A. Refer to Book 1 for submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples.

B. The Contractor must give notice in writing to the Commissioner, sufficiently in advance of his intention to purchase or place a special order for any pipe required to be installed under this contract. Fully dimensioned drawings and/or manufactures catalog cuts are to be submitted for review.

C. The Contractor must submit to the Commissioner certified copies of all test reports for test conducted on the pipe by the manufacture when so requested by the Commissioner.

D. The Contractor must provide the Commissioner with a notarized statement that all tests have been made and met as specified.

1.06 QUALITY ASSURANCE

A. Each manufacturer supplying pipe for water mains under this contract must furnish all facilities, personnel, and materials to conduct tests required as applicable to the type of pipe being supplied, when requested by the Commissioner. The cost of all plant tests required as proof of the acceptability of the water main pipe will be considered incidental to the Work and no additional payment will be allowed.

B. The Work performed on joining all pipe and fittings, must be performed by a plumber licensed in the State of Illinois or the City. This Work must include, but not be limited to, joining all pipe and fittings, installing joint gaskets, assembling all joints, installing continuity wedges, and tightening all gland nuts and bolts, as applicable for the installation.

1.07 NOTIFICATION AND LIMITATIONS OF WATER MAIN SHUT DOWNS

A. Whenever an existing water main or a section thereof is to be shut down during the courseof construction, every individual consumer must be notified at least seventy-two (72) hours prior to the shutdown. The Contractor must never operate, under any circumstances, an existing valve for a shut down or other purpose without first notifying and obtaining approval from the Commissioner.

B. The time for a consumer shut down must not exceed eight (8) hours. Absolutely no shut downs will be permitted before 8:00 AM without approval from the Commissioner.

C. In case of emergency shut downs, the Contractor must notify customers immediately. Notification may be verbal on a door-to-door basis. However, if a consumer cannot be contacted, a written notice must be placed at the property site showing all pertinent information regarding the shutdown. The notice must show a telephone number the consumer may call for information or to express any problem that the consumer may have with the shutdown.

D. If a consumer cannot withstand a planned shut down due to a dialysis machine being present or other medical reason, the Commissioner must be notified immediately.

E. All valves 16-Inches in diameter and larger must be operated only by personnel of the Department of Water Management. Notify the Commissioner seventy-two (72) hours prior to the need for operation of the valve.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE

A. Ductile iron pipe must conform to the requirements of AWWA C151 and with the additions or substitutions specified in this Section.

B. Pipe bells must be designed to provide a watertight joint without leakage and must be capable of withstanding pressures exceeding those that will rupture pipe of this class and thickness without requiring additional jointing material.

C. Electrical conductivity must be provided at each joint on all push-on and mechanical jointed pipe 16-Inches in diameter and smaller, to facilitate thawing of frozen pipe and building water services. It must also be provided on pipe 24-inches in diameter and larger when building services are directly connected to the water main. Conductivity is to be accomplished by installing serrated silicon wedges as recommended or supplied by the pipe manufacture. The use of lead tip gaskets will not be allowed. Wedges are to be installed in accordance with the requirements of paragraph C in Articles 3.6 and 3.7 of this specification.

D. All pipes must be manufactured so that where a cut is made at any point along the barrel, the cut end will fit properly into a standard mechanical joint bell and be drip tight at hydrostatic test pressure.

E. Exterior of pipe must be coated with a petroleum asphaltic material in conformance with AWWA C110, Section 10-10. Interior of pipe must be cement lined in accordance with AWWA C104.

F. Pipe thickness and classes must conform to standards shown in Table A.

TABLE A PIPE THICKNESS AND CLASS

Pipe Size	Nominal Wall Thickness	Thickness Class
3-inch	0.34-inch	54
4-inch	0.38-inch	55
6-inch	0.40-inch	55
8-inch	0.45-inch	56
10-inch	0.47-inch	56
12-inch	0.49-inch	56
14-inch	0.48-inch	55
16-inch	0.46-inch	54
18-inch	0.44-inch	53
20-inch	0.45-inch	53
24-inch	0.50-inch	54
30-inch	0.47-inch	52
36-inch	0.53-inch	52
42-inch	0.59-inch	52
48-inch	0.65-inch	52
54-inch	0.73-inch	52
60-inch	0.77-inch	52

2.02 JOINTS

A. Lead joints are not to be used under any circumstances.

B. Pipe joints must be push-on type joints unless otherwise noted on the drawings, specifiedhere, or directed by the Commissioner. Push-on type joints must conform to AWWA C111.

C. Restrained joints when specified are to meet the following requirements:

1. Mechanical joint pipe with mechanical joint restraint glands. Mechanical joints must conform to AWWA C110. Gaskets must conform to Section 2.4 of this specification.
2. Restrained joint pipe with manufactured weldment, field weldments or manufactured locking rings, locking segments and runner retainers and appurtenances conforming to AWWA C110. Acceptable products include but are not limited to Super-Lock Pipe manufactured by Clow Water Systems Company; FlexRing Pipe or Lok-Ring Pipe manufactured by American Ductile Iron Pipe; or TRFLEX manufactured by United States Pipe and Foundry Company.

D. Mechanical Joint Restraint Glands.

1. Provide restraint glands at all mechanical joints.

2. Restraint glands must be designed for use with the standardized mechanical joint bell pipe conforming to AWWA C110 and AWWA C153. Restraint is to be incorporated into the design of the gland. Acceptable products for this use include but are not limited to Mega Lugs manufactured by EBAA Iron Works; Uniflange manufactured by Ford Meter Box; or Star Grip manufactured by Star Pipe Products.
3. Restraint is to be accomplished by the use of multiple, wedge style restraints. Proper actuation of the wedges is to be ensured with torque limiting twist off nuts.
4. Glands 3-Inches through 16-Inches are to be pressure rated at 350-psi; glands 18-Inchthrough 48-Inch are to be rated at 250 psi.
5. The gland body and restraint components are to be made from ductile iron conforming to ASTM A536, 65-45-12. Ductile iron wedges are to be heat-treated within a range of 370 to 470 BHN.
6. The joint is to be capable of full deflection during assembly and joint deflection after assembly
7. Provide glands with minimum weights and number of wedges as shown in Table B.
8. Retainer glands are not acceptable.

TABLE B – MINIMUM WEIGHT & NUMBER OF WEDGESPER RESTRAINED JOINT

Pipe Size.	Number of Wedges	Minimum Weight
3-inch	2	6.0-lbs
4-inch	2	7.0-lbs
6-inch	3	11.0-lbs
8-inch	4	14.5-lbs
10-inch	6	23.0-lbs
12-inch	8	28.5-lbs
14-inch	10	46.0-lbs
16-inch	12	52.0-lbs
18-inch	12	63.6-lbs
20-inch	14	71.0-lbs
24-inch	16	90.0-lbs
30-inch	20	190.7-lbs
36-inch	24	226.5-lbs
42-inch	28	400.0-lbs
48-inch	32	488.0-lbs

E. Flanged joints, when shown on the Drawings, specified, or directed by the Commissioner, must conform to the following:

1. Flanged joints must conform to AWWA C115. Flanges must be the long hub type, screwed on the threaded end of the pipe in the shop. There must be no leakage through the pipe threads. The flanges must be designed to prevent corrosion of the threads from the outside.

2. Flanges must be drilled according to the requirements of ANSI/ASME B16.1, Class 125 unless special drilling is called for on the Drawings, specified, or directed by the Commissioner. Bolt holes must be equally spaced, drilled smooth and true. When stud bolts are used flanges must be drilled and tapped to accommodate the studs.
3. The face of the screwed-on flange and plain-end of the pipe must be accurately refaced together, at right angles to the pipe axis. After facing and drilling, the face of the screwed-on flange must immediately be covered with an appropriate rust-preventive coating.
4. Flanged joints must be secured with either bolts and nuts, or stud bolts with a nuts. Bolts, stud bolts, and nuts must meet the requirements of ASTM A307, Grade B. Bolts and stud bolts must conform to ANSI/ASME B18.2.1. Nuts must conform to ANSI/ASME B18.2.2. All bolts, stud bolts, and nuts must be primed with bitumastic paint after the bolts and nuts have been installed and tightened.
5. Gaskets must conform to Section 2.4 of this specification.

2.03 FITTINGS

A. Fittings to be furnished and installed as specified or shown on the Drawings must be mechanical joint, ductile iron in accordance with AWWA C110. Laying length of mechanical joint castings must be as shown in AWWA C110. Wall thickness and allowable variation in the thickness of mechanical joint castings must conform to AWWA C110 and have a 250-psi pressure rating.

B. Compact fittings may not be used unless otherwise approved by the Commissioner.

C. Plain ends of mechanical joint fittings must be beveled and gauged to properly seat in push-on joint bells.

D. The fittings must be smooth and free from defects of every nature that would make them unfit for the use that they were intended. Plugging of fittings is not allowed. Repairing of defects by welding will be allowed if such repairs will not adversely affect the serviceabilityof the fittings or their ability to meet the strength requirements of the referenced AWWA standards.

E. All castings must be coated with a petroleum asphaltic material in conformance withAWWA C110, Section 10-10. Interior of pipe must be cement lined in accordance with AWWA C104.

F. Flanged fittings must conform to AWWA C110, and have a 150-pound per square inch pressure rating.

2.04 GASKETS

A. All gaskets for pipe, fittings and appurtenances must be vulcanized natural or vulcanized synthetic rubber, non-porous, free of foreign materials and visible defects. Recycled rubber may not be used.

B. When sOil conditions do not permit the use of natural or synthetic rubber gaskets and when directed by the Commissioner, all gaskets for pipe, fittings and appurtenances must be Nitrile (acrylonitrile butadiene), nonporous, free of foreign materials and visible defects.

C. Gaskets for flanged joints must be of the ring type, 1/16-Inch thick, and meet the requirements of ANSI Standard B16.21. Acceptable manufactures include but are not limited to for gaskets type as manufactured by the Crane Company; Garlock Packing Company; or U.S. Rubber Company.

D. Gaskets must be stored in a cool place and protected from light, heat, oil, or grease until installed. Any gasket showing signs of cracking, weathering, abrasion or other deterioration will be rejected.

2.05 POLYETHYLENE ENCASEMENT

A. Polyethylene encasement material must be either 8-mil, low density or 4-mil, cross-laminated, high-density polyethylene tubing in accordance with AWWA C105.

2.06 TRANSITION SLEEVES

A. Transition sleeves for pipe 16-inches in diameter and smaller must be of type as manufactured by an approved manufacturer and include but are not limited to Dresser, Style 253 Modular Cast Couplings; Smith Blair, Type 441 Cast Transition Couplings; Ford, Style FC2A Transition Couplings; Power Seal, Model 3501 Transition Couplings; or JCM Industries Model 212 Transition Couplings. Transition sleeves for pipe diameter greater than 16-inches must be of type as manufactured by Ford, Style FC2A or Style FC5 Transition Couplings; Romac Industries, Style 501 Transition Couplings; Dresser Style 38, Style 62, or Style 138 Transition Couplings; or Power Seal, Model 3501 Transition Couplings.

B. Transition sleeves must be designed to join class "B" pit cast iron pipe to AWWA C111/C151 standard ductile iron pipe. They must provide for pipe misalignment and settlement deflection and make a leak proof non-soldered joint, which allows for limited line movement due to expansion and contraction. Design couplings for a minimum rated working pressure of 150-pounds per square inch.

C. Transition sleeves pipe 16-Inches in diameter and smaller must be constructed of ductile iron conforming to ASTM A536. Transition sleeves for pipe diameters greater than 16- Inches must be constructed of ductile iron conforming to ASTM A536 or carbon steel conforming to ASTM A36. Ends must have a smooth inside taper for uniform gasket seating. The follower flanges must be ductile iron conforming to ASTM A536 or carbon steel conforming to ASTM A36.

D. Transition sleeves must be shop coated inside and outside with fusion bonded epoxy coatingconforming to AWWA C-213.

E. Gaskets must be of molded rubber conforming to ASTM C564 for potable water service.

F. Bolts and nuts must be 5/8-Inch in size and must be Grade 304L stainless steel, annealed. Nuts must be Teflon coated to prevent galling during storage.

G. Each transition sleeve must be supplied with four electrical continuity brackets electrical continuity across the sleeve. The angle bracket must be made from ASTM A240-T304 stainless steel with a stainless steel set screw.

H. Contractor must field measure the existing cast iron water main for exact size of outer dimension and degree of out-of-roundness at the location to install the transition sleeve prior to ordering and installing the transition sleeve for that location.

2.07 PIPE SUPPORT SYSTEMS AND HANGERS (INTENDED FOR PERMANENT INSTALLATIONS)

A. Manufactured pipe support systems, fasteners, and miscellaneous hardware must be fabricated from high strength stainless steel conforming to ASTM B308, or hot-dipped galvanized steel conforming to ASTM 123 and ASTM 153. Pipe support systems must be designed to have a minimum load safety factor of three (3) times the anticipated loading.

B. Field fabricated pipe support systems, fasteners, and miscellaneous hardware must be cold- galvanized by painting metal surfaces with a 2-mil thick coating of ethyl silicate in-organic zinc-rich paint primer per manufacturer’s directions. Galvanized primer must be completely dry before backfilling the excavation. Field fabricated pipe support systems must be designed to have a minimum load safety factor of three (3) times the anticipated loading.

C. Repair damaged galvanized coated surfaces in accordance with ASTM A780-93. Apply 2-mil thick coating of ethyl silicate in-organic zinc-rich paint primer per manufacturer’s directions. Zinc primer must be allowed to completely dry before backfilling the excavation.

D. Cold-galvanizing zinc primer paint must be of the inorganic, ethyl silicate type, containing at least 60% zinc dust and 40% adhesive binders, and conform to ASTM 780-93, type as manufactured by an approved manufacturer and include but are not limited to Tnemec Products, Kansas City, MO., Brite Products, Detroit, Mich., or Valspar Coatings, Minneapolis, MN.

PART 3 - EXECUTION

3.01 INSTALLATION

A. All ductile iron pipe, fittings, and appurtenances must be installed in accordance with the manufacturer’s recommendations and requirements.

B. All pipe, fittings, and accessories must be delivered, unloaded, strung, and laid as specified here.

C. The water mains must be laid with depths of cover as indicated under Article 3.12 of this specification, unless otherwise shown on the drawings, or directed by the Commissioner. The pipes must be laid true to line and grade.

D. Fittings as specified must be used where shown on the drawings and where grade or alignment changes require offsets greater than those recommended by the pipe manufacturer.

3.02 TRANSPORTATION, DELIVERY AND STORAGE

A. Every precaution must be taken to prevent damage to the pipe during transportation and delivery. Pipe ends, fittings, valves and hydrants must be sealed with caps or by another suitable method upon transportation from the supplier. Caps or end seals must be sturdy, secure, and wind-resistant so as to protect the pipe at all times prior to installation. Extreme care must be taken in loading and unloading the pipe and fittings. Such work must be done slowly with skids or suitable power equipment and the pipe must be under complete control at all times. Under no conditions may the pipe be dropped, bumped, dragged, pushed, or moved in any way that will cause damage to the pipe. When handling the pipe with a crane, a suitable pipe hook or rope sling around the pipe must be used. Under no condition maythe sling be allowed to pass through the pipe unless adequate measures are taken to prevent damage to the pipe ends and lining.

B. If in the process of transportation, handling, or installation, any pipe or fitting is damaged, such pipe or fitting must be replaced by the Contractor and be considered incidental to the construction and no additional payment will be allowed.

C. The Contractor must store pipe in a manner that will prevent damage. Pipe must be placed on wooden timbers or another suitable support on level ground. The Contractor must prevent the pipe from rolling. The procedures used to prevent rolling must be approved by the Commissioner

3.03 PREPARATION FOR LAYING PIPE

A. Materials, coatings, and linings must be as specified herein, shown on drawings, or directed by the Commissioner. Water mains and services must be installed where shown on the drawings. Installation must be in accordance with standards as recommended by the pipe manufacturer, and as specified herein.

B. Proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fittings must be used.

C. Before lying, all pipe and fittings must be thoroughly examined for defects and no piece may be installed which is known to be defective. If defects are discovered after pipe or fittings have been installed, the Contractor must remove the defective pipe and/or fitting and replace it with a sound one at his expense and to the satisfaction of the Commissioner.

D. The pipe and fittings must be thoroughly cleaned before they are laid and must be kept clean until they are accepted in the finished work. Care must be exercised to avoid leaving bits of wood, dirt, rock and other foreign particles in the pipe. If any such materials are discovered before the final acceptance of the work, they must be removed and the pipe and fittings replaced, if necessary. All pipes must be kept absolutely clean during construction and must be stopped off with night plugs at the end of each day's work. Exposed ends of uncompleted lines and existing water mains and services cut and not abandoned must be capped or otherwise temporarily sealed at all times when pipe laying is not in progress.

E. When cutting ductile iron pipe, it must be neatly cut perpendicular to the longitudinal axis of the pipe without damaging the pipes lining or coating or jointing surface area.

3.04 LAYING WATER MAIN PIPE

A. All pipelines must be laid in trench excavations on bedding or other foundations, as shown on the drawings, specified herein, or ordered by the Commissioner. The pipe must be properly secured against movement and pipe joints must be made in the excavation as required. Pipes must have solid bearing throughout their entire length.

B. At locations where pipe thrust is anticipated to occur, pipe and fittings must be anchored or restrained as shown on the drawings, specified in Section 331115 – Thrust Restraint for Water Main Piping, or as directed by the Commissioner. Polyethylene encasement is to be installed on all new water main pipe and fittings before pipe is installed and braced against movement. Care must be taken so as not to damage the polyethylene encasement during the installation or blocking of the pipe and fittings. If damage occurs, the Contractor must repair or replace the polyethylene encasement at his expense to the satisfaction of the Commissioner.

C. Pipe lying will be permitted only in dry trenches having a stable bottom. Groundwater or water from other sources must be removed as per Section 312319 – Dewatering Excavations. If the trench bottom is unsuitable for the pipes foundation, the kind of stabilization to be utilized will be ordered in writing.

D. If, in the opinion of the Commissioner, the Contractor has failed to obtain a acceptably dry trench bottom using conventional methods of dewatering, the Commissioner may order the Contractor to excavate below the intended grade and to place sufficient sub-grade material as may be suitable over the trench bottom in accordance with Section 312310 – Excavation, Trenching and Backfilling (Utilities).

E. The Contractor must also take such required precautions to prevent flotation of the new pipeline.

3.05 ASSEMBLY OF FLANGED JOINTS

A. Flanged joints must be made with bolts or bolt studs with nuts as specified in Section 2.2 of this specification.

B. Tighten flange bolts as recommended by the gasket manufacturer to ensure an evenly compressed gasket and leak tight joint.

C. After the bolts and nuts have been properly installed, tightened, and cleaned, prime them with bitumastic paint.

3.06 ASSEMBLY OF MECHANICAL JOINTS

A. Thoroughly brush the surfaces with which the rubber gasket comes in contact with a wire brush just prior to assembly of the joint. Brush lubricant over the gasket and the plain end just prior to installation. In making up mechanical joints, the spigot must be centered in the bell.

B. The gasket and gland must be placed in position, the bolts inserted, and the nuts tightened finger tight. The nuts must be tightened by means of a torque wrench in such a manner that the gland must be brought up evenly into the joint.

C. Joints are to be made up to allow electrical continuity from one pipe to another by installing wedges as specified in Article 2.1, paragraph C of this specification and are to be installed in the following manner:

1. Use two (2) wedges per joint for 3-Inch to 12-Inch diameter pipes. Wedges must be placed on opposite sides of the joint at an equal distance apart (9 and 3 o’clock positions) around the joint.
2. Use four (4) wedges per joint for 16-inch to 24-inch diameter pipes. Wedges must be installed side by side in pairs placed on opposite sides of the joint at an equal distanceapart (9 and 3 o’clock positions) around the joint.
3. Use six (6) wedges per joint for pipes larger than 24-inches in diameter only if building services are directly connected to the main. Wedges must be installed side by side in pairs 120 degrees apart at the 12, 4, and 8 o’clock positions around the joint.

D. The following range of bolt torques must be applied as specified in Table C. If sealing is not obtained at the maximum torque requirements listed in Table C, the joint must be disassembled, thoroughly cleaned, and reassembled.

TABLE C – BOLT TORQUE REQUIREMENTS

Bolt Size	Torque Range
5/8-inch	45-60 ft-lbs
¾-inch	75-90 ft-lbs
1-inch	85-100 ft-lbs
1 1/4inches	105-120 ft-lbs

3.07 ASSEMBLY OF PUSH-ON RUBBER GASKET JOINTS

A. Thoroughly brush the gasket seat in the bell with a wire brush and wipe the gasket and gasket seat with a cloth. Place the gasket in the socket with the large round end entering first so that the groove fits over the bead in the seat. Apply a thin film of NSF 61 approved joint lubricant to the inside surface of the gasket that will come into contact with theentering pipe.

B. Thoroughly brush the plain end of the pipe with a wire brush and placed it in alignment with the bell of the pipe to which it is to be joined. Make up the joint by exerting sufficient force on the entering pipe so that its plain end is moved past the gasket until it makes contact with the base of the socket.

C. Joints are to be made up to provide electrical continuity from one pipe to another by installing wedges as specified in Article 2.1, paragraph C of this specification and are to be installed in the following manner:

1. Use two (2) wedges per joint for 3-Inch to 12-Inch diameter pipes. Wedges must be placed on opposite sides of the joint at an equal distance apart (9 and 3 o'clock positions) around the joint.
2. Use four (4) wedges per joint for 16-Inch to 24-Inch diameter pipes. Wedges must be installed side by side in pairs placed on opposite sides of the joint at an equal distance apart (9 and 3 o'clock positions) around the joint.
3. Use six (6) wedges per joint for pipes larger than 24-Inches in diameter only if building services are directly connected to the main. Wedges must be installed side by side in pairs 120 degrees apart at the 12, 4, and 8 o'clock positions around the joint.

D. Assemble restrained joint pipe in accordance with manufacturer's instructions.

3.08 TEMPORARY BULKHEADS

A. At ends of constructed sections where adjoining water mains or structures have not been completed and are not ready to be connected, temporary bulkheads must be used.

3.09 SHORT TUNNEL CONSTRUCTION

A. Pipes to be placed in short tunnels must be jointed prior to being pulled into position. Pipe must be pushed or pulled into position in a manner arranged to keep joints tight and to prevent deflection.

3.10 ENCASING DUCTILE IRON PIPE IN POLYETHYLENE

A. All cast and ductile iron pipe and fittings must be encased in polyethylene tubing before being installed, blocked, or braced.

3.11 USE OF DAMAGED, DEFECTIVE, OR NON-SPECIFIED CASTINGS AND FITTINGS

A. All construction castings and pipe fittings that are determined to be damaged, defective or do not meet these specifications and are stored within the Work area must be marked for non-use and removed and replaced with fittings that conform to these Specifications.

3.12 DEPTH OF PIPE COVER

A. Unless otherwise shown on the Plans or directed by the Commissioner, all water mains and services must be installed so a minimum pipe cover is achieved as shown in Table D.

TABLE D – MINIMUM DEPTH OF COVER FOR WATER MAINS

Size of Pipe	**Depth of Cover**
3/4 to 3-inches	5-ft 6-inches + 3-inches
4-inch	5-ft 6-inches + 3-inches
6-inch	5-ft 6-inches + 3-inches
8-inch	5-ft 3-inches + 3-inches
12-inch	5-ft + 2-inches
16-inch	4-ft 6-inches + 2-inches
24-inch	4-ft + 1-inch
30 to 42-inches	3-ft 6-inches (min) or as detailed on drawings
48-inches & Larger	3-ft (min) or as detailed on drawings

3.13 ABANDONMENT OF EXISTING WATER MAINS

A. All openings on abandoned pipe or conduit are to be sealed with a concrete mortar plug of a minimum of one (1) foot in length within the pipe. Pipe 16-Inches in diameter and larger must be filled with fine graded aggregate or controlled low strength material (CLSM) flowable fill, as appropriate, or directed by the Commissioner. CLSM flowable material must meet standards specified in Section 312310 – Excavation, Trenching and Backfilling (Utilities), paragraph 2.3, C of these specifications.

3.14 DISINFECTION OF PIPE AND FITTINGS

A. Protect new and existing pipe and fittings from water, debris and foreign materials as specified in Section 312310 – Excavation, Trenching and Backfilling (Utilities).

B. All new pipe, fittings, and valves must be disinfected in accordance with Section 331300 – Disinfection and Testing Water Mains, and the requirements of the Bureau of Water Quality which may be contacted at 312.744.8190.

C. Swab all pipe and fittings that will not be pressure tested or chlorinated with a chlorine solution during installation. Extra precautions must be taken to prevent debris or ground water from entering the section of water main to be swabbed. Incorporate untested section of water main into the flushing routine when the work is necessitated, or part of, a water main replacement project. When connecting pipes to the existing city water system use normal operating pressure to visually inspect for leaks. If feasible, inspect for leaks prior to backfilling the excavation. Comply with all standards and requirements of the Bureau of Water Quality.

3.15 WATER MAIN SUPPORT SYSTEMS

A. Support and anchor all piping in proper position and alignment with due allowance for expansion and contraction.

B. The type, location, and arrangement of hangers and supports must be as shown on the drawings, or as directed by the Commissioner. Pipe supports and hardware must be appropriate to meet installation conditions, anticipated loading, and fabricated from corrosion resistant materials described in paragraph 2.7 - Pipe Support and Hangers, of this specification. All support systems whether pre-manufactured or field fabricated must have a minimum load safety factor of three (3) times the anticipated loading. Corrosion protective coatings damaged during installation of the pipe support system must be repaired per the manufactures requirements, or as directed by the Commissioner to maintain corrosion protection.

3.16 SEPARATION BETWEEN WATER AND SEWER MAINS

A. When a water main crosses above a sewer main and the vertical separation is between 18 and 6 inches, as measured between the bottom of the water main and crown of sewer pipe, the sewer must be constructed of ductile iron pipe with rubber gasketed joints to a distance one foot beyond the wall of the trench excavation. Flexible transition coupling must be used to join the ductile iron pipe to the sewer pipe and be encased in betonite as shown on the drawings.

B. When a water main crosses below a sewer main, the sewer pipe must be constructed of ductile iron pipe with rubber gasket joints for a perpendicular distance of 10 feet on either side of the center line of the water main, and an 18-Inch vertical separation must be maintained. Flexible transition couplings must be used to join the ductile iron pipe to the sewer pipe.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DUCTILE IRON WATER PIPE AND FITTINGS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of DUCTILE IRON WATER PIPE AND FITTINGS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 11 13

SECTION 33 11 15

THRUST RESTRAINT FOR WATER MAIN PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes the requirements for providing thrust restraint for the installation of water mains and services as shown on the Drawings and specified here.

1.03 RELATED SECTIONS

A. Section 33 11 13 – Ductile Iron Water Main Pipe and Fittings.

1.04 DESIGN REQUIREMENTS

A. Calculated thrust restraint must be based on the frictional force and bearing resistance between the pipe and the surrounding soil, with an allowance made for the polyethylene wrap on ductile iron pipe installations.

1.05 REFERENCES

A. ANSI B1.1 - Unified Inch Screw Threads.

B. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM A193 – Steel and Stainless Steel Bolting Materials
2. ASTM A194 – Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
3. ASTM A325 – Heat Treated Structural Steel Bolts.
4. ASTM A449 – Quenched and Tempered Steel Bolts and Nuts
5. ASTM A536 – Ductile Iron Castings.
6. ASTM A563 – Carbon and Alloy Steel Nuts
7. ASTM A615 – Standard Specification for Deformed and plain Billet Steel Bars for Concrete Reinforcement.

C. IDOT Standard Specifications for Road and Bridge Construction (SSRBC), latest edition.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE RESTRAINT

A. Mechanical joint thrust restraint glands must be used unless otherwise directed. Where such glands cannot be used to provide sufficient thrust restraint, concrete thrust blocks must be used, unless directed by the Commissioner.

2.02 CONCRETE THRUST BLOCK RESTRAINT

A. All concrete used in the construction of thrust blocks must be Class SI of the SSRBC.

B. All reinforcing steel used in the construction of thrust blocks must conform to the requirements of ASTM A615.

2.03 TIE ROD PIPE RESTRAINT

A. Where the use of tie rods to restrain thrust is approved by the Commissioner, they mustmeet the following ASTM Designations:

Tie Rod Diameter	Rods	Nuts	Washers
Up to 1-1/2"	A449	A563 Grade D	A325
Over 1-1/2"	A193	A194 Grade 2H	A325

B. Tie rod threads must be the Unified Coarse Thread Series conforming to ANSI B1.1 for rods 1-inch in diameter and smaller and 8-inch pitch thread series for larger diameters. Nuts must be hexagonal. Harness tie rod nuts must have a standard chamfer on the back face with finished spherical bearing surface. The nuts must seat in steel plate washers having similar finished concave spherical seats. Where the use of mechanical joint retainer glands are called for on the Plans or approved by the Commissioner, they must conform to ASTM A536. All special castings must be made of good quality ductile iron of such character and so adapted in chemical composition to produce spheroidal graphite structure. The iron must be of such character to provide superior mechanical properties of strength and ductility; the iron must be soft enough to satisfactorily allow drilling and cutting.

C. The minimum physical properties will be as follows:

1. Tensile strength- 60,000 pounds per square inch.
2. Yield strength- 42,000 pounds per square inch.
3. 2-Inch Elongation.-10%.

D. In addition to the standard required tests, the following requirements must be met: Keel Block Tests as detailed in ASTM A536-Standard 0.50-inch diameter tensile test bars must be machined from keel block coupons cast from each heat and of the same hardness rangeas the special castings. Minimum test requirements are as specified above.

PART 3 - EXECUTION

3.01 GENERAL

A. Install all joint anchorage in accordance with the requirements of Section 331113 – Ductile Iron Water Main Pipe and Fittings. Install all joint anchorage for concrete pipe and fittings in accordance with manufacturer’s installation instructions unless directed otherwise by the Commissioner.

3.02 DUCTILE IRON PIPE

A. All fittings and conditions, which result in tangential forces on the piping, must be provided with thrust restraints, unless otherwise specified or approved by the Commissioner.

3.03 CONCRETE PIPE

A. Whenever the harnessing of pipe joints by itself does not provide sufficient thrust restraint, the Contractor must provide additional thrust restraint as required. The Contractor must provide anchorage against thrust for water mains and appurtenances wherever the deflectionof the pipeline exceeds six (6) degrees. The anchorage must be accomplished by placing concrete thrust blocks adjacent to the fittings to be anchored. All anchorage must be designed to withstand working pressure plus surge pressure. The Contractor must submit to the Commissioner complete design calculations and plans for all thrust restraints bearing the seal of a Professional Engineer licensed in the State of Illinois.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of THRUST RESTRAINT FOR WATER MAIN PIPING shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of THRUST RESTRAINT FOR WATER MAIN PIPING shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 11 15

SECTION 33 12 16

WATER MAIN CONTROL VALVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes requirements for the installation of gate valves, resilient wedge valves, and butterfly valves in accordance with the Drawings.

1.03 RELATED SECTIONS

A. Section 33 13 00 - Disinfection and Testing Water Mains.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM A48 - Gray Iron Castings.
2. ASTM A126 - Gray Iron Castings for Valves, Flanges.
3. ASTM A436 - Austenitic Gray Iron Castings.
4. ASTM A439 - Austenitic Ductile Iron Castings.
5. ASTM B584 - Copper Alloy Sand Castings for General Application.

B. AWWA C110 - Ductile Iron and Gray Iron Fittings, latest edition.

C. AWWA C111 - Rubber Gasket Joints for Ductile Iron, latest edition.

D. AWWA C500 - Metal-seated Gate Valves for Water Supply Service, latest edition.

E. AWWA C504 - Rubber Seated Butterfly Valves, latest edition.

F. AWWA C509 - Resilient Seated Gate Valves, latest edition.

G. AWWA C550 - Standard for Protective Epoxy Interior Coatings for Valves and Hydrants, latest edition.

H. Federal Specification FF-B-575C - Bolts; Hex and Square, latest edition.

I. Federal Specification FF-N-836E - Nut; Square, Hex, Cap, latest edition.

1.05 SUBMITTALS

A. Contractor must provide an affidavit stating that all Butterfly Valves, valve operators, and torque overload protectors comply with all applicable provisions shown on the drawings and as specified in this specification.

B. Provide manufactures catalog cuts and/or certified drawings of all valves, valve operators, and torque overload protectors to be furnished. The manufactures catalog cuts and/or certified drawings must provide all necessary information regarding dimensions and materials used and conformance to requirements stated in these specifications.

C. All submittals must be reviewed and approved by the Commissioner prior to installation.

1.06 QUALITY ASSURANCE

A. Each valve must be hydrostatically tested at the manufacturer's shops and proven hydraulically tight at all pressures up to 200-pounds per square inch.

B. For gate valves, the following tests are required:

1. The first test consists of applying a 200-pound per square inch hydrostatic pressure between the discs through an opening in the bonnet casting.
2. The second test consists of applying a 200-pound per square inch hydrostatic pressure against the outside of each disc in the manner prescribed below:

    a. The valves must be plugged or capped on both ends. The caps or plugs must be drilled and tapped to accept the pressure test piping.
    b. With the pressure test piping in place, open the gates of the valve, the test-piping valve, and remove the plug in the bonnet. Fill the valve with water. When a discharge occurs at the outlet side, close the water supply line and insert the bonnet plug.
    c. Close the gates of the valves, open test-piping valve, and apply a 200-pound per square inch hydrostatic pressure on the inlet side.
    d. Hold test pressure for one (1) minute. During this time no water should discharge from the outlet end of the test piping. If no leak occurs, release pressure, reverse the test piping, and repeat the test procedures for the other gate. If a leak occurs, repair and/or replace the valve as directed by the Commissioner. Repeat the test procedures.

3. An affidavit must be furnished from the manufacturer to attest to the fact that each of the valves furnished under this Contract were proven hydrostatically tight in accordance with the specified test procedures.

C. Valves that do not meet the requirements of this Section will be rejected and removed by the Contractor, and replaced with valves that conform to this Section, within the time period allowed by the Commissioner. Gate valve removal and replacement will be considered incidental to the installation of the valves and no additional payment will be allowed.

D. The Work performed for installing valves must be performed by a plumber licensed in the State of Illinois or the City. The Work may include, but not be limited to, setting the valve; cutting and joining all pipe; installing test taps, fittings, adapters, joint gaskets, and continuity wedges; and tightening all gland nuts and bolts, as applicable for the installation.

PART 2 - PRODUCTS

2.01 GATE VALVES

A. All gate valves are to be Chicago Standard Gate Valves of the size shown on the Drawings that are designed, manufactured, tested, and inspected in accordance with AWWA C500, and in accordance with the exceptions noted here. All valves are to be delivered fully assembled.

B. The following characters must be cast in ½-inch letters on the bonnet of each valve:

1. Chicago
2. Year of Manufacture
3. Manufacture’s Name

C. Gate valves must be of mechanical joint type double disk and in the following sizes: 4-inch, 6-inch, 8-inch, 12-inch, and 16-inch. Larger size valves must be of a butterfly style.

D. Material used must meet the requirements as to physical and chemical properties, as specified in this Section.

E. Valves found to contain defects such as blowholes, shrinkage or slag holes, cold shuts, or cracks will be rejected.

F. The thickness of metal in castings, whose standard thickness is less than 0.8-Inch, must not be more than 0.08-inch less than the standard thickness. The deficiency in thickness of castings, whose standard thickness is 0.8- inch or more, must not exceed 10% of the standard thickness. The above allowable deficiencies in thickness, however, must not extend over more than one-half of the area of the casting.

G. After being cleaned and tested, every assembled valve and all metallic parts must be coated inside and outside with coal tar pitch varnish. It must produce a smooth and non-tacky coating tough and tenacious when cold and not brittle nor with any tendency to scale off.

H. The brass castings must comply with ASTM B584, Copper Alloy UNS No. C83600.

I. The bronze in the valve stem and in the stem nut must be manganese bronze, complying with ASTM B584, Copper Alloy UNS No. C86700. Stem seals are to be double O-rings complying with ASTM D2000 and ASTM 568A

J. The gaskets used between the flanges must be fully faced, 1/32-inch thick and made of heavy-duty, asbestos-free, fiber composition, suitable for water service.

K. Bolts and nuts must be made of cast iron or steel. Heads of seal plate bolts must conform to the dimensions shown on the Drawings (an alternate of hex or square head bolt is acceptable) while all other requirements of seal plate bolts must conform to Federal Specification FF-B-575C and nuts must conform to FF-N-836E. Heads of bolts must be unfinished and nuts must be semi-finished. Both bolts and nuts must be hot dipped galvanized as specified in the applicable Federal Specification.

L. The valves herein specified must be furnished complete with mechanical joint accessories. The mechanical joint accessories must consist of mechanical joint thrust restraint glands, rubber gaskets, and tee head bolts and hex nuts, all conforming to AWWA C110. Dimensions and tolerances for mechanical joints must conform to table 1of AWWA C110.

M. It will be the manufacturer's responsibility to provide the patterns and gauges necessary to perform the work to be done hereunder. The Department will not furnish these items.

N. The Department reserves the right to make at any time such tests as it may deem proper to determine that the materials used are proper for the Work and that the valves are of good mechanical construction. The manufacturer must give the authorized inspectors of the Department free access to all places where valves are being made. At the Department's request, the manufacturer must furnish properly prepared standard test specimens of the materials used and must provide facilities for testing them.

O. All valves must open by turning the operating stem clockwise.

P. Operating nuts must be 2 ½-inches square at the base of the nut.

2.02 RESILIENT SEATED WEDGE GATE VALVES

A. The Contractor must furnish and install resilient-seated gate valves that are designed, manufactured, tested, and inspected in accordance with AWWA C509, with following exceptions, deletions, or additions:

1. Exceptions for Section 4.4.7. Valves are to be supplied with 2 ½-inch square operating stem wrench nuts.
2. Exception for Section 4.4.7.2. All valves must open by turning the operating stem clockwise as viewed from top of the valve.

B. Resilient seated wedge gate valves must be of the mechanical joint type supplied complete with joint thrust restraint glands, vulcanized natural or synthetic rubber gaskets, and tee head bolts and hex nuts, all conforming to AWWA C110. Dimensions and tolerances for mechanical joints must conform to Table 1of AWWA C110.

C. All valves must provide an unobstructed waterway of full size when open. Gates or stems must not extend into the waterway. Valves are to be supplied in sizes between 4 and 12-Inches as noted on the drawings.

1. The bronze in the valve stem and in the stem nut must be manganese bronze, complying with ASTM B584, Copper Alloy UNS No. C86700. Stem seals are to be double O-rings complying with ASTM D2000 and ASTM 568A.

2. After being cleaned and tested, every assembled valve and all metallic parts must be coated inside and outside with coal tar pitch varnish. It must produce a smooth and non-tacky coating tough and tenacious when cold and not brittle nor with any tendency to scale off.

2.03 BUTTERFLY VALVES

A. Butterfly valves, as specified here, must be designed, manufactured, tested, and inspected in accordance with AWWA C504, Class 150Band with the requirements of this Section as listed hereafter:

1. Body Type: Short bodied mechanical joint, as specified.
2. Maximum Non-shock Shut-off Pressure: 100psi.
3. All valves must have flow through discs.
4. Each valve furnished must be subjected to the performance, leakage and hydrostatic tests described in Section 5.2 of AWWA C504.
5. A minimum of two (2) weeks prior to the test dates, the manufacturer must notify the Commissioner in writing when the shop testing of the valve will occur. Failure to notify the Commissioner will not be grounds for rejection.
6. The manufacturer must submit to the Commissioner records of all tests performed under Sections 2.3, 3.8.5, and 5.2 of AWWA C504.
7. Shaft seals must be either split V type packing or "0" ring seals. Shaft seals consisting of a stuffing box with pull down packing are not acceptable.
8. The shaft seal area must not be exposed to the environment. Should the valve design utilize an open packing bonnet area, that area must be enclosed with a 304 series type 18-8 stainless steel, minimum 1/4-Inch thick removable shroud. The shroud must be fully sealed and rated for buried service. An access cover must be provided on the shroud with a minimum opening of 6-Inches x 8-Inches.
9. The valve shaft must be 304 or 316 stainless steel.
10. The valve body must be made of cast iron conforming to ASTM A126, Class B or ASTM A48, Class 40 alloy cast iron ASTM A436, Type 1 and 2 or ASTM A439, type D2 with maximum of 0.003% lead. The valve disc must be ductile iron conforming to ASTM A536, and it must have a seating edge of 304 or 316 stainless steel. The seating edge may be installed in the valve body if the rubber seat is applied to the valve disc. The valve seats for 24-inch and larger butterfly valves must be capable of adjustment or replacement at the installation site.
11. Valve discs must be secured to shafts by means of solid, smooth sided stainless steel or monel taper pins or dowel pins having a circular cross section. Each taper pin or dowel pin must be extended through the shaft and mechanically secured in place. The use of bolts, setscrews, knurled or fluted dowel pins, flat sided taper pins, expansion pins, roll pins, tension pins, spring pins, or other devices in lieu of the pins specified herein will not be acceptable.
12. The valves and valve operators must be rated for buried service, except electric actuators.
13. Valve operators must conform to AWWA C504 for Class 150B. Manual operators must be Limitorque worm gear, self-locking type designed to hold the valve in any intermediate position without creeping or fluttering. Operators must be equipped with torque overload protection to prevent over travel of the disc in the open and closed position. Spur gear must be furnished with an operator to increase the number of

turns and reduce operating torque. A separate limit stop device must also be installed in accordance with "Torque Overload Protection", described below. Operators must provide position indication on the housing of the operator. Valves must open with a clockwise rotation of the nut. The valve and valve operator must be rated for bi-directional flow.

14. Valve operators must be equipped with a Chicago standard style hub nut. The hub nut must be attached to the input shaft of the operator by means of a shear pin. The shear pin must be sized such that it fails when 350 foot-pounds of input torque is applied to the hub nut. Three (3) additional shear pins must be furnished as replacement part for each valve ordered.
15. Corrosion resistant nameplates, as described in Section 6.1 of AWWA C504, must be permanently attached to both the valve and valve operator. There must be two (2) valve nameplates. One must be affixed to the valve body and the other must be affixed to the valve operator in a prominent location. In addition to the normal valve data, the plate must also include the number of turns required to operate the valve and the direction to open (clockwise to open). There must be one (1) operator nameplate affixed to the valve operator. The minimum number of turns to close the valve must be no less than 2 turns per inch (5 turns per centimeter) of valve size in order to minimize water hammer.
16. The manufacturer must provide all nuts, bolts, gaskets, and glands required to make connections.

B. Torque Overload Protection

1. Contractor must furnish torque overload protection devices. The device must be installed on top of the Chicago standard hub nut on butterfly valve operators and in conformance to the following requirements.
2. Purpose: The over torque protector must prevent butterfly valve and operator from damage due to excessive operating torque.
3. Operation: The device must transmit applied torque in either direction only up to a preset amount and automatically disengage if greater torque is applied. It must automatically reset if the applied torque is below the preset amount.
4. Description: The device must be of overall rugged and of durable construction suitable for long-term reliable operation and suitable for buried service.
5. The upper end must have an integral 2 ½-Inch square operating nut and the lower endmust have a matching socket. The socket must have one (1) 2-Inch square head set screw in each of two (2) adjacent faces.
6. The operating mechanism must employ spring-loaded tapered rollers engaged in matching tapered detents. A ball bearing type design will not be accepted.
7. The manufacturer's identification must be cast in 3/8-inch or larger letters on an upper surface.
8. Corrosion Protection and Lubrication: The entire housing must be coated inside and outside with two-part epoxy. The outside must have a topcoat of two-part polyurethane similar in color to U.S. Paint #G9337 "Sun Yellow".
9. The operating mechanism must be permanently lubricated and sealed to withstand 50-feet of water head.
10. There must be no water-retaining external cavities.
11. Service Life: The device must have a minimum life of one-thousand (1000) trips from rated capacity.

12. Trip Torque Set Point: The device must be factory set to trip at 200 foot-pounds of applied torque.
13. Trip Torque Adjustment: Trip torque must be adjustable from 10% to 100% of rated capacity without dissembling the unit. The adjustment means must be sealed and concealed to prevent tampering.

2.04 QUARTER TURN AWWA ELECTRIC VALVE ACTUATORS (OPEN-CLOSE SERVICE)

A. When shown on the Plans, specified, or as directed by the Commissioner, the Contractormust furnish electric valve actuators in conformance with the following requirements.

1. The electric valve actuator must include the motor, actuator unit gearing, position limit switches, torque switches, declutch lever, and hand wheel, as self-contained unit. The actuator must meet the latest revision of the applicable AWWA specification. The actuator must be of sufficient capacity to operate the attached butterfly valve in a modulating action against 100-pounds per square inch pressure.
2. The motor must be rated for continuous duty, specifically designed for valve actuator service, and must be of high starting torque, totally enclosed, non-ventilated construction. Motor insulation must be a minimum NEMA Class F, with a maximum continuous temperature rating of 311° Fahrenheit (rise plus ambient) for the duty cycle specified. Provide optional insulation classes where specified or where service conditions warrant.
3. The motor must be of sufficient size to open or close the valve at the maximum torque. The motor must be capable of operating at plus or minus 10% of specified voltage. The motor duty rating must be sufficient for one (1) complete cycle (open-close-open, or reverse) without exceeding its temperature rating. Motor bearings must be of the anti-friction type, and permanently lubricated.
4. The motor must be an independent sub-assembly such that the power gearing mustnot be an integral part of the motor assembly, to allow for motor or gear changes dictated by system operation changes. The motor must be equipped with internal thermal contact, to protect against motor overload, and 120-volt heaters. The motor must be designed to operate on 230/460 VAC.
5. The actuator must be a multiple reduction unit with power gearing consisting of spur or helical and worm gearing. There must be a self-locking worm gear set in the drive train to maintain valve position. The spur or helical gearing and worm gear must be of hardened alloy steel, and the worm gear must be alloy bronze. All power gearing must be accurately cut; non-metallic, aluminum, or cast gearing must not be allowed. Anti-friction bearings with caged balls or rollers must be used throughout.
6. All rotating power train components must be immersed in grease with provisions for inspection and re-lubrication without disassembly. Lubricants must be suitable for ambient conditions between 20° F and 150° F. Adequate seals must be provided on all shafting.
7. The actuator must have a built-in device, which allows the motor to reach full speed before engaging the valve load when required by unseating applications.
8. A metallic hand wheel must be provided for manual operation, with an arrow to indicate "open" rotation. The hand wheel must not rotate during motor operation. A fused motor must not prevent manual operation. When in manual operating mode, the actuator must remain in this mode until the motor is energized, at which time the

actuator will automatically return to electric operation. Changing from motor operation to manual operation must be accomplished by a positive, padlockable declutching lever, which mechanically disengages the motor and related gearing. It must be impossible for simultaneous manual and motor operation to occur. Friction type declutching mechanisms are not acceptable.

9. Position limit switches and associated gearing must be an integral part of the valve actuator. Limit switch gearing must be of the intermittent type, made of bronze or stainless steel, lubricated, and totally enclosed to prevent dirt and foreign matter from entering the gear train. Limit switch contacts must be heavy duty and silver-plated with wiping action. Where specified, the actuator must have sixteen (16) contacts, four (4) contact/four (4) rotor types, all of the same basic design. As an alternative, a limit switch assembly may be directly coupled to the valve stem, eliminating the need for intermittent gearing, and eight (8) single pole, double throw (SPDT) or eight (8) double pole, double throw, (DPDT) contacts. Contacts must be convertible from normally open, to normally closed, or reverse.
10. Switches must be adjustable, allowing for trip points from fully open to fully closed positions of valve travel. They must not be subject to breakage or slippage due to over-travel.
11. Switch design must permit visible verification of switch position without disassembly.
12. Each valve actuator must be equipped with a switch that will interrupt the control circuit in both the opening and closing directions when valve torque overload occurs. Contacts must be silver-plated. The torque switch must have graduated dials for both open and close directions of travel, and each must be independently adjustable. The torque switch must include a positive means to limit adjustability so as not to exceed the actuator output torque capability. The activating spring back must be of the Belleville spring design.
13. The position limit switch and torque switch contact must be rated 600 volts per NEMA standard ICS 2-125, heavy duty.
14. The control compartment must be provided with a 120-volt space heater.
15. The valve and operator must be aligned in such a manner that when installed, the manual hand wheel is in a horizontal plane.
16. The operating time must be two (2) minutes for 90 °- valve travels.

PART 3 - EXECUTION

3.01 FIELD TESTING

A. All valves will be tested as specified in Section 331300 - Disinfection and Testing Water Mains.

3.02 SETTING OF VALVES AND VALVE BOXES

A. Valves must be carefully installed in their proper positions, free from all distortion and strain, with mechanical or flanged joints, and must be packed and left in satisfactory operating condition.

B. Valve boxes must be installed where shown on the drawings, or where ordered by the Commissioner, and must be set vertical and concentric with the valve box. Any valve box which has been moved from its original position by direct or indirect actions of the Contractor, so as to prevent the operation of the valve key extension, must be reset and/or replaced as applicable, by the Contractor. This work will be considered incidental to the construction and not considered for additional payment. Any valve key extension or stem, which has been damaged so that it is inoperable, must also be replaced, and will also be considered incidental to the construction and no additional payment will be allowed.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of WATER MAIN CONTROL VALVES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of WATER MAIN CONTROL VALVES shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 12 16

SECTION 33 12 17

WATER MAIN TAPPING CONNECTIONS AND VALVES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes the requirements for tapping iron and concrete water mains while maintaining the water main under line pressure without disrupting service to customers as shown on the drawings and specified here.

1.03 RELATED SECTIONS

A. Section 03 30 00 – Concrete.

B. Section 33 11 13 – Ductile Iron Water Main Pipe and Fittings.

1.04 REFERENCES

A. ANSI A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings, latest edition.

B. ASME/ANSI B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, latest edition.

C. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM A126 - Gray Iron Castings for Valves.
2. ASTM A240 - Stainless Steel for Pressure Vessels.
3. ASTM A242 - High Strength - Low Alloy Structural Steel.
4. ASTM A285 - Carbon Steel for Pressure Vessels.
5. ASTM A351 - Castings for Pressure Containing Parts.
6. ASTM A536 - Ductile Iron Castings.

D. AWWA C213 - Fusion Bonded Epoxy Coatings, latest edition.

E. AWWA C500 - Gate Valves for Water Supply, latest edition.

F. ANSI/AWWA-C110/A21.0 - Ductile Iron Flanged Fittings, latest edition.

G. MSS-SP60 - Connecting Flange Joint Between Tapping Sleeve and Valve, latest edition.

1.05 SUBMITTALS

A. Refer to Book 1 for submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples.

B. Provide an affidavit stating that tapping valves, tapping sleeves, and all appurtenances comply with all applicable provisions of the Drawings and the Specifications.

C. Provide manufacturer certified drawings (in triplicate) of the valves and sleeves that are proposed for the installation. The drawings must provide all necessary information regarding dimensions and materials used, including the tapping machine.

1.06 QUALITY CONTROL

A. The City reserves the right to make at any time such tests as it may deem proper to determine that the materials used are proper for the Work and that the sleeve and valve are of good mechanical construction. The manufacturer must provide authorized inspectors of the City free access to all places where sleeves and valves are being manufactured, furnish standard test specimens of materials specified for use, and access to testing facilities for testing material samples.

B. The Work necessary for direct tapping of iron or concrete pipe must be performed by a plumber licensed in the State of Illinois or the City. This Work may include, but not be limited to, the installation of tapping machinery and tapping of the pipe; the installation of tapping sleeves and taps; the installation of joint gaskets; the tightening of all gland nuts andbolts; and the tightening of continuity bolts, as applicable for the installation.

PART 2 - PRODUCTS

2.01 GENERAL

A. The tapping connection and valve must provide a branch connection at right angles to the existing water main being tapped without shutting down the main.

2.02 TAPS 12-INCH X 12-INCH AND SMALLER

A. The tapping connection must be the split sleeve, all stainless steel, full gasket type featuring low profile lugs with separate, replaceable bolts for assembly. All welds must be fully passivated to restore the original high corrosion resistance and appearance of the stainless steel. The sleeve sections must be connected with nuts and bolts, and must be designed to fit iron water pipe of the sizes as determined by field inspections. The inside diameter of the branch connection must be of full size so as to allow the free passage of a standard cutter.

B. The branch outlet of the sleeves (connection) must be either CF8 stainless steel per ASTM A351, type 304 stainless steel per ASTM A240, 125-pounds drilling per ANSI B16.1, recessed for tapping valve per MSS-SP60, bonded flanged gasket.

C. All bolts and nuts must be type 304 stainless steel. Bolts must be separate, self-aligning, and replaceable. Nuts must be impregnated with anti-glaring lubricant. Integral bolts welded to the sleeve are not permitted.

D. The side flange gaskets for bolted sleeves to be furnished with each connection must be made of vulcanized natural or synthetic rubber.

E. The body of each connection must be stenciled with a range of pipe diameters that the connection will fit and also the diameter of the branch.

F. All sleeves must be designed for 150-pounds per square inch pressure rating.

2.03 TAPS LARGER THAN 12-INCH X 12-INCH

A. This tapping connection must be of the split sleeve, cast or ductile iron, mechanical joint end type, or the fabricated steel type with epoxy coating and stainless steel nuts and bolts. Sleeves must be sized to compensate for a normal amount of oversize and out-of-roundness in the pipe. In the mechanical joint type, the use of two (2) gaskets of different cross-sections to accomplish this will be acceptable. Supply all necessary mechanical joint accessories. The sleeve sections must be connected by means of bolts and nuts and must be designed to fit iron water pipe of the sizes as determined by field inspections.

B. The sleeve must be designed to fit Class "B" water pipe. The inside diameter of the branch connection must be full size so as to allow the free passage of standard cutters.

C. Sleeve Body

1. Mechanical joint type: must be gray cast iron conforming to ASTM A126 Class "B" or ductile iron conforming to ASTM A536.
2. Fabricated Steel type: Must be steel conforming to ASTM A285 Grade "C". A 10- mil minimum thickness of fusion-applied epoxy must coat the body. This epoxy coating must meet the requirements of AWWA C213.

D. The branch outlet of the sleeves must be flanged, 125-pound drilling per ASME/ANSI B16.1, and recessed for tapping valve as per MSS-SP60.

E. Bolts and Nuts

1. Mechanical joint type: High strength, low alloy steel conforming to ASTM A242 or stainless steel of the type 300 series Austenitic.
2. Fabricated steel type: Stainless steel 18-8 type 304.

F. All bolts must be separate, self-aligning, and replaceable. Stainless steel nuts must be impregnated with anti-galling lubricant.

G. Gaskets

1. Mechanical joint types: Side flange gaskets must be furnished with each connection.
2. Fabricated steel type: A minimum 7/8-Inch wide, recessed, BUNA-N gasket around the outlet.

H. The tapping sleeve must have a 3/4-Inch diameter bronze NPT test plug located in the branch outlet.

I. The body of the tapping sleeve must be stenciled with the range of pipe diameters the sleevewill fit and also the diameter of the branch.

J. All sleeves must be designated for 150-pounds per square inch pressure rating.

2.04 TAPPING VALVES

A. The valves must be double-disc gate valves of a standard design and must open by turningin a clockwise direction.

B. Valves are subject to approval by the Commissioner and must conform to AWWA C500 for valves of sufficient strength to withstand 150-pounds working pressure. Body ring lugs must be cut out leaving an oversized circular waterway suitable for use with a standard sized cutter head.

C. Valves must have flange inlet by mechanical joint outlet. Furnish all accessories required for completing connections at both ends of the valve. The companion flange for the mechanical joint outlet must be designed to accept standard tapping machines.

D. Valve operating nuts must be 2 ½ -Inches square at the base of the nut.

E. The valve stem must show an ultimate tensile strength of not less than 60,000-pounds per square inch and a minimum elongation of 15% in 2-Inches.

F. The castings must be of gray iron conforming to ASTM A126 Class “B” and must be free from defects such as blow holes, blisters; cold shuts, cracks, etc. Castings must be true pattern, boldly filleted at angles, and free from flaws. Castings must not be filled or plugged in any manner.

G. All iron castings must be coated with petroleum asphaltic material and must be given two (2) coats outside and one (1) coat inside. All surfaces to be painted must be free from all rust, residues, and debris and must be in proper, dry condition immediately prior to paint application.

H. The diameter of the castings must not vary from the diameter given on the drawings by more than 0.08-Inch for castings 16-Inches or less in diameter, 0.10-Inch for 20-Inch and 24-Inch castings; 0.13-Inch for 30-Inch, 36-Inch, and 42-Inch castings; and 0.16-Inch for 48-Inch castings.

I. Tapping connections and valves found on inspection to contain defects, such as blowholes, shrinkage, slag holes, cold shuts, cracks, etc., will be rejected, removed from the Work area and replaced with tapping connections and valves that conform to this Section. This process will be considered incidental to the construction of the tapping connections and valves and no additional payment will be allowed.

J. Designs of sleeves to be utilized for use in tapping concrete pipe must be submitted for approval by the Commissioner for the particular pipe and circumstance for which they will be utilized.

2.05 FLANGES AND BOLTS

A. Provide flanged fitting on tapping saddle and provide Ductile Iron Blind Flange meeting ANSI/AWWA-C110/A21.0. Conform to Section 331113 – Ductile Iron Water Main Pipe and Fittings. Class 125 rated for 250 psig working pressure.

B. Provide gaskets bolts, nuts and washers as required meeting requirements of Section 331113 – Ductile Iron Water Main Pipe and Fittings.

2.06 CONCRETE ENCASEMENT

A. Provide concrete encasement as noted on the Plans as specified in Section 033000 – Concrete. Concrete for encasement of water main and appurtenances must not include ash in the mix.

PART 3 - EXECUTION

3.01 TAPPING REINFORCED CONCRETE CYLINDER PIPE

A. Prior to tapping PCCP (Prestressed Concrete Cylinder Pipe) Mains in this work, coordinate with CDWM for isolation of each pipe section from system pressure using existing system isolation valves. Contractor may relieve pressure of isolated pipe section prior to tapping.

B. Coordinate with DWM details.

C. Tap reinforced concrete cylinder pipe to provide flanged outlets as follows:

1. Wire rubber gaskets (part #4, Detail 5-1) under edges of saddle (part #2, Detail 5-1). Assemble saddle on concrete cylinder pipe (part #1, Detail 5-1) with U-bolts (part #3, Detail 5-1). Draw up saddle lightly against gaskets to seal space between saddle and pipe.
2. Pour mortar grout into space between saddle plate and pipe through grout holes (part #5, Detail 5-1). After grout between saddle and pipe has taken its initial set, tighten saddle firmly against grout. Cut circumferential steel wires (part #7, Detail 5-1) or rods away from outside of cylinder, even with edge of hole in saddle.

3. If area of cylinder to be tapped includes a longitudinal seam, carefully file weld down to sheet metal and fill recess with hot or cold solder.
4. For outlets larger than 12-Inches attach concrete lining of pipe to steel cylinder.
5. Place rubber gland gasket (part #8, Detail 5-1) into groove of gland (part #9, Detail 5-1). Insert gland through hole in saddle. Using studs and nuts (part #10, Detail 5-1) pull gland toward the cylinder, compressing the gasket to make a watertight seal.
6. Place special blind flange on gland flange.
7. Fill outlet with water and apply pressure to check tightness of gland gasket. Remove blind flange.
8. For outlets with diameters 12-Inches and larger, wire form around outside of gland flange and saddle flange and pour mortar grout into space between flanges and between necks of saddle and gland. Allow mortar to set-up before cutting. For outlets with diameters less than 12-Inches, this operation can be done after completing the cut.
9. Fill recess between inner end of gland and surface of cylinder with neat cement or mortar.
10. Attach tapping valve and tapping machine equipped with pilot drill and carbide tipped cutter. Drill and cut through cylinder and concrete pipe core. Retract drill and cutter, close valve, and remove tapping machine.
11. Encase all buried metal parts (saddle and U-Bolts) in 1:3 concrete or mortar mix with a minimum cover of 3 inches.
12. After placing the saddle and removing the outside concrete and circumferential reinforcement to expose the section of the core through which the tap is to be made, toggle bolts and stiffening ribs are installed under pressure.
13. Insert the toggle bolts, under pressure, as follows:

    a. Mount frame, shown as part #1, Detail 5-2 on the details, firmly on the flange of the saddle. A gland (part #2, Detail 5-2) with a corporation stop (part #3, Detail 5-2) attached and jacking bolts (part #4, Detail 5-2) are then mounted between the frame and the exposed steel cylinder. Jack the bolts against the frame to compress a rubber gasket between the gland and the steel cylinder and to hold the gland and corporation cock firmly in place. A standard drilling machine is then mounted on the corporation stop. With the corporation stop open, the drill is advanced through the stop and gland and a hole is then drilled through the steel and concrete core. After retracting the drill, the corporation is closed and the drilling machine removed.

14. A toggle inserting machine, part #5, Detail 5-2 on the details, is then mounted on the corporation stop with a specially designed toggle bolt in place in the machine. A detailed sketch of the toggle bolt is shown on the details. The machine is designed so that it will push the toggle bolt through the corporation stop, gland and core, pull it back engaging the toggles against the inner surface of the pipe and rotate the bolt so that it firmly tightens and holds the concrete core to the steel cylinder.
15. Referring to Appendix A showing the details of the toggle bolt, and Appendix A, it will be noted that a conically shaped rubber stopper achieves the seal. The tightness of this seal is checked by a small cock attached to the gland, (part #6, Detail 5-2) on the details. Water stops coming out of the open cock when the seal is achieved. The conical pilot nut shown on the details helps center the toggle so that it will not "hang up" going through the hole in the core. The specially designed head of the toggle bolt allows it to be pushed, pulled, rotated, and released after the toggle bolt is

tightened in place. Two (2) toggle bolts can be installed at each frame setting. As many toggle bolts can be placed as appear necessary to hold the concrete core. Two

(2) have been found sufficient in 14-Inch, 20-Inch, 24-Inch, and 30-Inch taps; four (4) in 16-Inch taps.

16. After completing the installation of the toggle bolts, the stiffening ribs are installed. The ribs (part #7, Detail 5-3) are circumferentially apposed as shown on the top view on the details. Each rib assembly consists of two (2) curved steel bars held parallel by one (1) or more
17. welded steel cross members and they are curved to a radius-less than that of the outside of the cylinder so that they contact the cylinder only at their ends. Each rib is placed so that the two curved bars straddle a pair of toggle bolts, and two (2) screws (part #9, Detail 5-3) on the details, passing through the clamp plates (part #8, Detail 5-3) into holes threaded in the heads of the toggle bolts, hold the ribs tight to the cylinder.

D. The intent of the toggle bolts is to tie the concrete lining or sections of the concrete, if there is any cracking, to the cylinder so that the concrete portion of the core will be retracted with the steel cylinder portion of the core.

3.02 TAPPING IRON PIPE

A. Excavate and expose all iron pipes to be tapped and measure the outside diameter prior to ordering the taps. Install tapping connections per manufacturer's instructions.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of WATER MAIN TAPPING CONNECTIONS AND VALVES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of WATER MAIN TAPPING CONNECTIONS AND VALVES shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 12 17

SECTION 33 12 19

FIRE HYDRANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes requirements for supplying materials for and the installation of fire hydrants, as shown on the Drawings and specified here.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM A108 - Standard Quality Carbon Steel Bars.
2. ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. ASTM A153 - Hot Dip Zinc Coating for Iron and Steel Hardware.
4. ASTM A307 - Carbon Steel Bolts and Studs.
5. ASTM A536 - Ductile Iron Castings.
6. ASTM B62 - Composition Bronze or Ounce Metal Castings.
7. ASTM B584 - Copper Alloy Sand Castings.
8. ASTM B633 - Electrodeposited Zinc Coatings on Iron and Steel.
9. ASTM C700 - Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
10. ASTM D395 - Test Methods for Rubber Property Compression Set.
11. ASTM D412 - Test Methods for Rubber and Elastomers.
12. ASTM D2000 - Classification of Rubber Products in Automotive Applications.
13. ASTM D2240 - Durometer Test for Rubber Hardness. B. AWWA C502 - Dry

Barrel Fire Hydrants, latest edition.

C. Federal Specification FF-B-575C - Bolts; Hexagon and Square, latest edition.

D. Federal Specification RR-C 271D - Chains and Attachments, latest edition.

1.04 SUBMITTALS

A. Provide an affidavit from the manufacturer to attest to the fact that all hydrants furnished under this Contract were tested and proven hydrostatically tight and mechanically sound in accordance with the specified test procedures.

1.05 QUALITY ASSURANCE

A. After each hydrant is completely assembled, it must be mechanically and hydrostatically tested in conformance with AWWA C502, Sec 5.1.

B. The Work performed for the hydrant installation must be performed by a plumber licensed in the State of Illinois or the City. The Work may include, but not be limited to, setting hydrants; joining all pipe, fittings, and valves; installation of joint gaskets and continuity wedges; and tightening of all gland nuts and bolts, as applicable for the installation.

PART 2 - PRODUCTS

2.01 GENERAL

A. The hydrants must be of the City of Chicago standard design with mechanical joint bottom. The completed hydrants must be delivered finished, painted, and fully assembled.

2.02 FIRE HYDRANTS

A. The standpipe must include the manufacturer’s name, year of manufacturing, and the letters "C.W.W." in letters 1-Inch high. This lettering must be positioned approximately 1 foot below the top flange.

B. Materials from which the various parts of the hydrants are constructed must be of the kind designated on the details. Each kind of material used must meet the requirements as to physical and chemical properties hereafter specified. Test bars required to established quality grade or strength under the ASTM standards must be made and machined by the manufacturer as part of the work.

C. 3/4-Inch x 2-3/4-Inch unfinished hex head machine bolts and 3/4-Inch American Standard regular hot press hex nuts must conform to Federal Specification FF-B-575C, Class B Steel, Class 1 fit or, hex head bolts and hex nuts must conform to ASTM A307 Grade A. All nuts and bolts to be hot dipped galvanized conforming to ASTM A153 or must be coated by the rust proof electrozinc process ASTM B633, Type G.S., or SS Type 18-8SS, ANSI Type 302, 303, or 304.

D. Iron castings must conform to ASTM A126 Class B. The thickness of metal castings, whose standard thickness is less than 0.8-Inch, must not be more than 0.08-Inch less than the standard thickness. The deficiency in thickness of castings, whose standard thickness is 0.8-Inch or more, must not exceed 10% of the standard thickness. The above allowable deficiencies in thickness must not extend over more than one-half of the area of any casting. The diameter of the castings must not vary from the standard dimensions by more than 08Inch.

E. All bronze castings, with the exception of the stem nut, stem screw, and valve seats must conform to ASTM B62 for Leaded Red Brass Copper Alloy UNS No. C83600. The valve seat must conform to ASTM B584 for Leaded Manganese Bronze, Copper Alloy UNS No.

C86700. The stem nut and stem screw must conform to ASTM B584 for Silicon Brass, Copper Alloy UNS No. C87600 with the following mechanical properties:

1. Minimum Tensile Strength - 45,000-psi
2. Minimum Yield Strength - 25,000 psi
3. Minimum Elongation - 16% of length
4. Brinell Hardness - 110

F. The stem nut and stem screw must be stamped SI for identification purposes.

G. Wrench nuts made of ductile iron must be marked “D.I.” on the flange portion opposite the arrow indicating the direction of turn to open.

H. Ductile iron castings must comply with compositions and physical properties in accordance with ASTM A536 Grade 65-45-12.

I. The City will furnish neoprene-seating valves if requested by the Contractor. The Contractor’s charges for transporting the neoprene seating valves must be considered incidental to the construction and no additional payment will be allowed.

J. Full face gasket of suitable material, 1/16-inch thick, 8 ½-inches X 13 ½-inches, with eight (8) 7/8-inch diameter holes on an 11 3/4-inch bolt circle must be provided for the hydrant flange gaskets.

K. Steel hydrant chain must comply with Federal Specification RR-C-271D (1), Type II, Class 2, with an approximate weight of 25-pounds per 100 feet, and have a hot galvanized coating. This chain, approximately 26-Inches long, must be connected to hydrant cap hooks and fastened at its center to the hydrant by means of the ½-Inch X 1-Inch cap screw with chain angle and "S" hook of ½-Inch mild steel stock "S" hook and cap hooks which engage the chain, must be securely welded in the closed position or fastened in a suitable manner to hold the hooks securely in a closed position.

L. Where the Plans call for finish and drilling, all such work must accurately comply with the dimensions shown, so that all parts are interchangeable from one hydrant to another. It will be the manufacturer’s responsibility to provide the patterns and gauges necessary to perform the work specified.

M. Where machining tolerances are not indicated on the drawings, the following must be used where applicable:

1. If dimension is in decimals, tolerance is ± 0.005-Inch.
2. If dimension is in inches, tolerance is ± 1/64-Inch.

N. Appropriate lubricant must be applied to threads on hydrant bottom, ½-Inch X 1-Inch cap screw and valve seat before assembly.

O. Operating stem must be of cold rolled steel, ASTM A108 Grade 1018. Stem must be coated, excluding bottom 3-7/8-Inch of the section below shoulder including threads, with a bituminous coating.

P. Rubber Gaskets must comply with ASTM D2000; Type SC-715B, as follows:

1. Shore A Durometer Hardness - 70 + 5 ASTM D2240.
2. Tensile Strength - 1500-psi minimum ASTM D412.
3. Compression Set - 35% maximum ASTM D395.

Q. The City reserves the right to make at any time such tests as it may deem proper to determine that the materials used are proper for the work and that the hydrants are of good mechanical construction. The contractor must give the authorized inspectors of the City free access to all places where hydrants are being made. At the City's request the manufacturer must furnish properly prepared standard test specimens of the materials used and must provide facilities for testing them.

R. Fire Hydrants that do not meet the requirements of this Specification will be rejected and, when so ordered by the City, the Contractor must remove all inferior hydrants not meeting the Specification and replace rejected items within the time limits as specified. The removal and replacement of the hydrants will be considered incidental to the construction and no additional payment will be allowed.

2.03 PAINT

A. All ferrous metal parts of the hydrant, inside and outside, must be thoroughly cleaned before coating. Coatings used on interior surfaces of the hydrant that are in contact with potable water must be suitable for contact with drinking water. Prepare hydrant surfaces and apply paint in accordance with paint manufacturer’s recommendations. Do not paint exposed hydrant nozzle threads or other useable threads.

B. Primer must be red oxide primer; acceptable products are W. C. Richards Metal primer #WRFA-13-127; or Benjamin Moore Universal Metal Primer # M07.

C. Top coat must be alkyd high-gloss enamel; acceptable produces are Benjamin Moore Impervo #C13320 (Brilliant Red), or Sherwin Williams Industrial Enamel Safety Red #6174064.

D. Paint for color coding flange must be as follows:

1. White colored pigment; acceptable products are Seymour Stripe #16-652 Spray (White), Rustoleum High Performance Acrylic 5200 System (#5292 Gloss White), or Sherwin Williams PM 200 AES Pure White #5178-99993.
2. Yellow colored pigment; acceptable products are Benjamin Moore Impervo #C133 Alkyd High-Gloss Metal and Wood Enamel (Safety Yellow), or Sherwin Williams Industrial Enamel Safety Yellow #617-4072, #617-8000, or #617-50320.
3. Blue colored pigment: accept products are Seymour Stripe #16-653 Spray (Precaution Blue), or Rustoleum High Performance Acrylic 5200 System (#5225 Safety Blue), or equal.

E. Shop Coating of Fire Hydrants.

1. Exterior ferrous surfaces of the hydrant must be painted with a coat of primer to two feet below the top flange.
2. Exterior ferrous surfaces of the hydrant must be given a topcoat of alkyd high-gloss enamel to two feet below the top flange.
3. All exterior ferrous surfaces below the ground line not coated with primer and topcoat must be shop coated with two (2) coats of asphaltic coating, each a minimum of 1 mil thick. The first coat must be allowed to dry thoroughly before applying the second coat.

2.04 HYDRANT DRAIN

A. Hydrant drains must be constructed of 6-Inch diameter, extra strength, perforated clay pipe, conforming to ASTM C700, with mortared bell and spigot type joints.

PART 3 - EXECUTION

3.01 GENERAL

A. Install fire hydrants and hydrant drain with drainage bedding, and connect to hydrant drain outlet as detailed on the drawings.

B. Securely connect fire hydrant to the water main using mechanical joint thrust restraint glands or other restrained joint fittings as shown on the drawings.

C. Pressure test the fire hydrant installation with full line pressure to the fire hydrant without blocking behind the fire hydrant.

D. Hydrant leads must be 8-Inches in diameter, or as otherwise specified or shown on the Plans.

E. Spool pieces are not allowed for the vertical adjustment of hydrants. If a vertical adjustment is required due to the depth of the water main, an offset must be utilized prior to installing the hydrant.

3.02 COLOR CODING HYDRANT FLANGES

A. Contractor must color code the vertical edge of the hydrants top flange, (located approximately 6-Inches from the centerline of the nozzle cap), on all installed hydrants in accordance with the Department’s “Color Code for Fire Hydrants”.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of FIRE HYDRANTS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of FIRE HYDRANTS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 12 19

SECTION 33 12 20

WATER MAIN VALVE BASINS AND METER VAULTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes requirements for construction and/or adjustment of water main valve basins and meter vaults using precast concrete or masonry structures as indicated on the Drawings.

1.03 RELATED SECTIONS

A. Section 03 20 00 – Concrete Reinforcement.

B. Section 03 30 00 – Concrete.

C. Section 31 23 10 – Excavation, Trenching and Backfilling (Utilities).

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement.
3. ASTM A197 - Standard Specification for Cupola Malleable Iron.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM A615 - Standard Specification for Deformed and Plain Billet- Steel Bars for Concrete Reinforcement.
6. ASTM C32 - Standard Specification for Sewer and Manhole Brick.
7. ASTM C55 - Standard Specification for Concrete Building Brick.
8. ASTM C139 - Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
9. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets
10. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections

11. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
12. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. IDOT Standard Specification for Road and Bridge Construction (SSRBC), latest edition.

C. American Association of State Highway Transportation Officials, Standard Specifications for Highway (AASHTO), latest edition.

1.05 SUBMITTALS

A. Refer to Book 1 for submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples.

B. Shop Drawings: When not indicated on the Contract Drawings in sufficient detail or definition, submit detailed drawings of cast-in-place and precast concrete utility structures and related metal work.

C. Product Data: Submit manufacturers' product data for standard manufactured precast concrete sections and structures, for metal gratings and covers, and for other, related miscellaneous metal items.

D. Certification: Submit certification or other acceptable evidence that covers and grates to be provided for roadways and parking areas meet proof-testing requirements for AASHTO H2O traffic loading.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE STRUCTURES

A. Fabrication standards - Circular precast concrete base and riser sections furnished for manholes, valve basins and other structures must conform to ASTM C478. Non-circular precast concrete monolithic and sectional structures for meter vaults, riser manholes and other structures must conform to ASTM C858.

B. Furnish riser sections in various heights, including an offset tapered section, as detailed on the Drawings, or as directed by the Commissioner.

C. Precast reinforced concrete flat slab tops for manholes must conform to ASTM C857, and be designed to accommodate a minimum AASHTO loading of HS-20, unless directed otherwise by the Commissioner.

2.02 JOINT SEALANTS

A. Rubber gaskets must conform to ASTM C443.

B. Preformed butyl rubber flexible rope type gaskets must conform to ASTM C990.

2.03 ADJUSTING RINGS

A. Adjusting rings are to be precast concrete in conformance with ASTM C478.

B. Mating Faces:

1. Smooth
2. Parallel
3. Free from cracks, chips, spalls or casting irregularities interfering with watertight mating to structure top or casting.
4. Provide grooves in faces to contain extrudible preformed gasket material when possible.

2.04 CASTINGS

A. Iron castings are to be ductile iron castings conforming to ASTM A536, Grade 60-40-18, or gray iron conforming to ASTM A48, free from blowholes, shrinkage, cracks and other defects.

B. Allowance for shrinkage must be made in the patterns to meet the specified thickness. Frames and lids are to seat at all points.

C. Malleable castings are to conform to ASTM A197.

D. All castings are to be made accurately to dimensions shown on the plans, and planed, filed, or ground where otherwise necessary to secure flat and true surfaces.

2.05 STEPS

A. Steps are to be polypropylene plastic encased Grade 60 steel reinforcement conforming to ASTM C478.

2.06 CAST-IN-PLACE CONCRETE

A. Concrete in accordance with Section 033000 – Concrete.

B. Concrete reinforcing in accordance with Section 032000 – Concrete Reinforcing.

2.07 CONCRETE AND MASONRY BLOCKS AND BRICKS

A. Precast concrete brick must conform to ASTM C55 quality designated Grade N-1.

B. Clay brick must be best quality sewer brick conforming to the qualifications of ASTM C32, except where modified here.

1. Brick must be uniform, sound, hard burned, of compact texture, free from lime and cracks with a clear ringing sound when struck, whole and with edges full and square, and of standard dimensions.
2. Brick, when thoroughly dried and immersed in water for twenty-four (24) hours, must not absorb more than 15% by weight of water.
3. If in any load of brick more than 10% are inferior, the whole load is rejected.
4. If in any load of brick less than 10% are inferior, the brick is accepted provided the Contractor pulls out all inferior bricks, and immediately removes them from the Site of the Work.

2.08 MORTAR

A. Mortar for brickwork is to be composed of one (1) part Portland cement and two (2) parts screened sand.

1. Portland cement must conform to the requirements of Section 1001 of the SSRBC.
2. Sand must be class A quality and gradation FA-9 as specified in Article 1003.02 of the SSRBC.

B. The cement and sand must be proportioned by volume and thoroughly mixed in a tight box.

C. After the initial mixing, water is to be added gradually and the ingredients mixed until the mortar is of proper consistency. The amount of water must be no more than necessary to produce a workable, plastic mortar.

D. Prepare only a sufficient amount of mortar for immediate use and any mortar that has begun to set must not be retempered or used in any way in the Work

2.09 REINFORCING STEEL

A. Reinforcing steel in accordance with Section 033000 – Concrete.

PART 3 - EXECUTION

3.01 GENERAL

A. Excavate backfill and compact in accordance with Section 312310 – Excavation, Trenching and Backfilling (Utilities).

B. All brick must be thoroughly wetted immediately before being laid.

C. Old brickwork must be thoroughly cleaned and wetted before new work is jointed thereto.

D. No masonry work is to be done when the temperature is below 33° Fahrenheit unlessotherwise approved, and then only under conditions for protecting it from frost.

3.02 PRE-CAST STRUCTURE INSTALLATION

A. Carefully place precast sections for all structures on prepared bedding so as to fully anduniformly support the structure and allow pipes to be laid to proper grade.

B. All lift holes on precast sections must be completely filled with mortar, smoothed on both inside and outside surfaces.

C. Seal joints between riser sections with approved mastic sealant or rubber gaskets, or asdirected by the Commissioner.

D. Place one adjusting ring (only) on manhole top. Select thickness of adjusting ring to bring completed structure to required elevation.

E. Seal joints between adjusting rings and frames with approved mastic sealant before backfilling structures.

F. Install manhole frame and cover.

3.03 MASONRY STRUCTURE INSTALLATION

A. Install precast concrete or cast in place base as shown on the Drawings.

B. Lay brick courses to the line, straight and parallel, breaking joints with those in adjacent courses.

C. Lay brick radially as headers in a full bed of mortar with joints not exceeding 3/8-Inch in thickness.

D. Fill joints with mortar. Interior joints must be trowel-struck.

E. Fresh masonry must be plastered inside and outside and must be protected from damage ofall kinds.

F. New work, unless immediately covered with earth or brick backing, or an approved form of curing compound, must be kept moist until the mortar has hardened.

G. Install manhole frame and cover.

3.04 FINAL ADJUSTMENT OF STRUCTURES

A. After the base course and binder course have been placed, and prior to placing the surface course, the structures must be adjusted to match the final pavement elevation.

B. Remove the binder and base course adjacent to and for a distance not exceeding 12-Inches outside the base of the castings.

C. Adjust the castings to final pavement elevation with adjusting rings set in mortar.

D. Fill the space around the casting with Class SI concrete to the elevation of the surface of the binder course.

3.05 ABANDONMENT OF VALVE BASINS AND OTHER STRUCTURES.

A. Valve basins and other structures being abandoned, the Contractor must remove the existing frame and lid and return it the City as requested by the Commissioner. The remaining parts of the structure are to be remove to a depth of 36-Iinch below grade and filled with fine graded aggregate or controlled low strength material (CLSM) flowable fill, as appropriate, or directed by the Commissioner. CLSM flowable material must meet standards specified in Section 312310 – Excavation, Trenching and Backfilling (Utilities), paragraph 2.3, C of these specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of WATER MAIN VALVE BASINS AND METER VAULTS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of WATER MAIN VALVE BASINS AND METER VAULTS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK 020000

END OF SECTION 33 12 20

SECTION 33 13 00

DISINFECTION AND TESTING WATER MAINS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes requirements for hydrostatic testing and disinfecting water mains as shown on the Drawings and specified here.

1.03 RELATED SECTIONS

A. Section 33 11 13 – Ductile Iron Water Main Pipe and Fittings.

B. Section 33 12 16 – Water Main Control Valves.

1.04 REFERENCES

A. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances, latest edition.

B. AWWA C651 - Disinfecting Water Mains, latest edition.

C. AWWA C509 - Resilient Seated Gate Valves for Water Supply Service, latest edition.

1.05 SUBMITTALS

A. Prior to starting work, furnish the Commissioner a detailed outline of the proposed sequence of operation. Include the manner of filling and flushing the water main, the method of disposing of the water flushed from the main, the hydrostatic testing procedure, the disinfecting procedure, relevant safety procedures and other relevant procedures to be used. Include the name of the Contractor that will be disinfecting the water main.

B. All submittals will be subject to review by the Water Quality Surveillance Section (WQSS) of the Department.

1.06 QUALITY ASSURANCE

A. Hydrostatic testing of water mains must be performed in accordance with AWWA C600 and the Department’s requirements specified here. The disinfection of water mains must be performed in accordance with IEPA Regulations, AWWA C651, and the Department's requirements specified here.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PRESSURE TESTING AND FLUSHING WATER MAINS

A. All flushing and pressure testing of water mains must meet the requirements of AWWA Specification C600.

B. All flushing and pressure testing of fire protection mains must meet the requirements of NFPA 13 and NFPA 24.

3.02 TEST SECTIONS

A. New water pipe must be tested in sections isolated from the existing city water system. All existing valves must be tested to determine if they are water tight when in the closed position. If valves are not found to be water tight, they must be repaired or replaced before proceeding with the testing and chlorination procedure.

3.03 INITIAL FILLING

A. Each valved section of pipeline must be slowly filled with water. The test sections may be filled through the isolation valves via the test taps if they are available. Before applying the specified test pressure, all air must be expelled completely from the pipeline section to be tested. When venting air from the pipeline, it is important to limit the pipeline fill rate to avoid excessive surge pressures when the water reaches the air venting opening(s). When the pipeline has been filled, do not permit water to backflow into existing water mains.

3.04 PRELIMINARY FLUSHING

A. All new water mains, extensions, connections, and hydrant branches must be flushed priorto the hydrostatic testing so that water flows clear from all hydrants and test taps. The flushing operation must continue uninterrupted for a minimum of eight (8) hours or until the water flows clear. Flushing operations may be extended longer when directed by the Commissioner.

3.05 HYDROSTATIC TESTING

A. Setup: Water-pressure testing is the only method allowed for performing hydrostatic tests. Compressed-air testing methods are not permitted. Ensure that all air has been expelled after the preliminary flushing. Use a suitable pump connected to the existing water main system to apply the test pressure. Allow the pipeline to stabilize at the test pressure before conducting the hydrostatic test.

B. Testing: The test must subject the water main to a minimum hydrostatic pressure of 100 psi for a minimum period of two (2) hours. The minimum hydrostatic pressure is to be maintained at the highest point of the pipe in the test section. The test pressure may not vary by more than ±5 psi for the duration of the test. Test pressure is to be maintained within this tolerance by adding makeup water into the pipeline through the pressure test pump. The amount of makeup water added must be accurately measured in gallons (accurate to two decimal places) by suitable methods.

C. Allowable Makeup Water: The amount of makeup water added during the test must not exceed the amount calculated using the following equations:

$$L = \frac{S \times D \times T \times \sqrt{P}}{148000} \quad \text{Equation 1}$$

L = allowable makeup water, gallonsS =
length of pipe tested, feet
D = nominal diameter of pipe tested, inchesT =
duration of the test, hours
P = average test pressure, pounds per square inch (gauge)

When testing against closed metal-seated valves, additional makeup water is allowedper valve, as follows:

$$L_V = D \times T \times .0078 \quad \text{Equation 2}$$

L_V = allowable makeup water per metal-seated valve, gallons
D = nominal diameter of valve, inchesT =
duration of the test, hours
For a 1,000’ section of pipe tested for 2 hours at 100 psi against one closed metal-seated valve, the allowable makeup water is equal to:

Table 1
Allowable Makeup Water per 1,000 feet of Pipe, gallons
Tested at 100 psi for 2 hours

Nominal Pipe Diameter									
8”	12”	16”	24”	30”	36”	42”	48”	54”	60”
1.21	1.81	2.41	3.62	4.52	5.43	6.33	7.24	8.14	9.04

D. Visual Examination: Any and all exposed pipe, fittings, valves, hydrants, and joints must be examined carefully during the pressure test. Any damaged or defective pipe, fittings, valves, hydrants, or joints that are discovered during or following the pressure test must be repaired or replaced with reliable material. All visible leaks are to be repaired regardless of the allowance used for testing.

E. Acceptance: Hydrostatic testing is to be repeated until all visible leaks are repaired and the amount of makeup water used is below the allowable amount. After all visible leaks have been repaired, acceptance will be determined on the basis of allowable makeup water only. If any test of a new pipeline discloses a small amount of makeup water greater than that specified above, repairs or replacements are to be accomplished in accordance with the contract documents or directed by the Commissioner.

3.06 SECONDARY FLUSHING

A. After each test section has satisfactorily passed the hydrostatic pressure test, a secondary flushing must be performed. The secondary flushing must be performed before the pipeline is disinfected. The Contractor must give a minimum forty-eight (48) hour notice to the Commissioner before performing the secondary flushing procedure.

B. For water mains less than 24-Inches in diameter, the test section must be flushed at a minimum velocity of 2.5 feet per second for a minimum of four (4) hours until the water flows clear. Flushing operations may be extended longer when directed by theCommissioner.

C. For water mains 24-Inches in diameter and larger, the test section must be flushed for a minimum of twenty-four (24) hours while maintaining a discharge flow of approximately 2,500 gallons per minute through at least one fire hydrant within the test section until the water flows clear. Flushing operations may be extended longer when directed by the Commissioner.

3.07 DISINFECTING WATER MAINS

A. After the secondary flushing has been completed and the water flows clear from the pipeline being tested, the water main must be disinfected. The disinfection procedure must be performed by a Contractor qualified to conduct such work. The Water Quality Surveillance Section (WQSS) of the Department of Water Management will observe the disinfection procedure.

3.08 FINAL FLUSHING

A. After completion of the chlorination process, the chlorination water must be thoroughly flushed from all pipelines. The water main must be flushed until the water flows clear and has representative distribution system chlorine residual as determined by the WQSS of the Department.

3.09 SAMPLING

A. When the WQSS of the Department has determined that the pipeline is ready to be sampled,the samples are to be collected under the direction of the WQSS. The samples are tested for bacterial content before the pipeline can be approved for service.

3.10 APPROVAL

A. Final approval of the water main rests with the WQSS of the Department.

3.11 DISPOSAL OF FLUSHING WATER

A. For all types of flushing, limit flow rates to capacity of existing City sewers.

3.12 SAFETY

A. The Contractor must have sufficient equipment to properly carry out the hydrostatic testing and disinfecting operations and have the necessary safety equipment on hand; including a Chlorine Institute Emergency Kit "A" and self-contained breathing apparatus. Failure to provide such equipment will be cause for not allowing the disinfection operation to be performed.

3.13 CONTRACTOR RESPONSIBILITY

A. The Contractor must have overall responsibility for hydrostatic testing, disinfecting, and sampling. The Contractor must provide all the necessary personnel to: assist in the disinfection operation; perform the final flushing operation; and assist the WQSS of the Department in the water sampling. The Contractor must be responsible for guaranteeing that sufficient and necessary sanitary precautions are taken during construction to ensure approval of the main for service.

3.14 DISINFECTION PROCEDURES WHEN CUTTING INTO OR REPAIRING EXISTING MAINS

A. Swab pipe and fittings that will not be pressure tested or chlorinated with chlorine solution during installation and use extra precaution to prevent soil and debris from entering the pipe. Incorporate untested pipe into the flushing routine when possible. When connecting new pipe to the existing water system, use operating pressure to visually inspect for leaks. When feasible, perform inspection prior to backfilling. Comply with all standards and requirements of the WQSS of the Department.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DISINFECTION AND TESTING WATER MAINS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of DISINFECTION AND TESTING WATER MAINS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 13 00

SECTION 33 31 13

SEWER MAIN PIPE AND FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section includes requirements for the installation of sewer mains, service piping and accessories, adjustment of sewer pipes, house drains, manholes, catch basins, inlets and associated appurtenances specified here, shown on the Drawings, or directed by the Commissioner.

1.03 RELATED SECTIONS

A. Section 31 23 19 - Dewatering Excavations.

B. Section 31 23 10 - Excavation, Trenching and Backfilling (Utilities).

C. Section 03 30 00 - Concrete.

D. Section 33 39 13 - Sewer Manholes, Catch Basins, Inlets and Special Structures.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:

1. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings
2. ASTM C12 - Practice for Installing Vitrified Clay Pipe Lines
3. ASTM C14 - Specification for Concrete Sewer, Storm Drain and Culvert Pipe.
4. ASTM C76 - Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe.
5. ASTM A48 - Gray Iron Castings.
6. ASTM C32 - Sewer and Manhole Brick (Made from Clay or Shale).
7. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
8. ASTM C425 - Specification for Compression Joints for Vitrified Clay Pipe andFittings.
9. ASTM C443 / AASHTO M198 - Specification for Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets.

10. ASTM C506 - Specification for Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe.
11. ASTM C507 - Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe.
12. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
13. ASTM C700 - Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
14. ASTM C 1173 - Standard Specifications for Flexible Transition Couplings for Underground Piping.
15. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

B. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast for Water, latest edition.

C. ANSI A21.11 - Rubber Gasket Joints for Cast Iron and Ductile Iron Pressure Pipe and Fittings, latest edition.

D. AWWA C104 - Cement Mortar Lining for Ductile Iron Pipe and Fittings, latest edition.

E. AWWA C110 - Ductile-Iron and Gray-Iron Fittings, latest edition.

F. AWWA C150 - Thickness Design of Ductile-Iron Pipe, latest edition.

G. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast, latest edition.

H. ISPE Standard Specifications for Water & Sewer Construction in Illinois, latest edition.

I. CDWM Regulations for Sewer Construction and Stormwater Management, latest edition.

1.05 SUBMITTALS

A. Reference City of Chicago, Department of Procurement, Book I -“Terms and Conditions for Construction” for submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples.

B. The Contractor must give notice, in writing to the Commissioner, sufficiently in advance of the intention to commence the purchase and/or manufacture of the pipe for use under this contract.

C. Before starting fabrication of the pipe and fittings, the Contractor must submit fully dimensioned drawings or catalogs to the Commissioner showing the pipe, joints and fittings to be used in the Work in full detail.

D. Submit a copy of sewage bypass plan to the Commissioner.

E. The Contractor must submit to the Commissioner certified copies of all test reports.

F. The Contractor must provide the Commissioner with a notarized statement that all tests have been made and met as specified here, unless waived by the Commissioner.

1.06 QUALITY ASSURANCE

A. The contractor must furnish all facilities, personnel, and materials to conduct tests required as applicable to the type of pipe being supplied. The cost of all plant tests required as proof of the acceptability of the material will be considered incidental to the Work and no additional payment will be allowed.

B. The Work performed on joining all pipe and fittings, must be performed by a licensed drain layer in the City of Chicago. This Work must include, but not be limited to joining all pipe and fittings, coring sewer pipe sections, installing joint gaskets, assembling all joints, installing continuity wedges, and tightening all gland nuts and bolts, as applicable for the installation.

C. All pipe and fittings must be inspected for soundness and damage due to handling, immediately before being laid and any not conforming to these requirements of this Section is rejected and must be immediately removed from the site.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS

A. VITRIFIED CLAY PIPE

1. Vitrified clay pipe to be used for all pipes 21” in diameter and smaller.
2. Vitrified clay pipe and fittings must be extra strength clay bell and spigot pipe conforming to the requirements of ASTM C700.

    a. Reinforced Concrete Pipe

        1) Reinforced concrete pipe to be used for all pipes greater than 21” in diameter.
        2) Circular reinforced concrete pipe and fittings must conform to the requirements of ASTM C76, Class III, IV or V, Wall B or Wall C with circular reinforcement. For pipe thirty (30) inches or more in diameter, the length of the unit must not be less than six (6) feet. Elliptical section reinforced concrete pipe and fittings must conform to ASTM C507, minimum class HE-III or HE-IV. Arch section reinforced concrete pipe and fittings must conform to ASTM C506, minimum class A-III or A- IV.
        3) Preformed tapered holes of the proper dimensions as shown on the Plansfor the connection of drains and future drain connections must be provided during the manufacture of the pipe. Tapered holes must be so formed that the drain connection will enter the sewer at an angle of approximately 90 degrees with the axis of the sewer. Whenever the diameter of a preformed tapered hole is equal to or exceeds 50 percent of the diameter of the pipe, additional reinforcement steel satisfactory to the Commissioner must be placed around the hole.

4) Selection of Pipe Class for Reinforced Concrete Pipe must comply with Tables 1, 2 or 3 of this Section.

Table 1
Required Pipe Class by Diameter and Type for Circular Pipe

Pipe Size (inches)	Type 1 1	Type 2 2	Type 3 3	Type 4 4	Type 5 5	Type 6 6	Type 7
24	IV	III	IV	V	V	V	V
27	IV	III	IV	V	V	V	V
30	III	III	IV	V	V	V	V
36	III	III	IV	IV	V	V	V
42	III	III	IV	IV	V	V	V
48	III	III	IV	IV	V	V	V
54	III	III	IV	IV	V	V	V
60	III	III	IV	IV	V	V	V
66	III	III	III	IV	IV	V	V
72	III	III	III	IV	IV	V	V
78	III	III	III	IV	IV	V	V
84	III	III	III	IV	IV	V	V
90	III	III	III	IV	IV	V	V
96	III	III	III	IV	IV	V	V
102	III	III	III	IV	IV	V	V
108	III	III	III	IV	IV	V	V

TABLE 2
Required Pipe Class by Size and Type for Elliptical Pipe

Equiv. Round Dia. (inches)	Span (inches)	Rise (inches)	Type 1 1	Type 2 2	Type 3 3
24	30	19	HE-IV	HE-III	HE-III
27	34	22	HE-III	HE-III	HE-III
30	38	24	HE-III	HE-III	HE-III
36	45	29	HE-III	HE-III	HE-III
42	53	34	HE-III	HE-III	HE-III
48	60	38	HE-III	HE-III	HE-III
54	68	43	HE-III	HE-III	HE-III
60	76	48	HE-III	HE-III	HE-III
66	83	53	HE-III	HE-III	HE-III
72	91	58	HE-III	HE-III	HE-III

TABLE 3
Required Pipe Class by Size and Type for Elliptical Pipe

Equiv. Round Pipe Size (inches)	Span (inches)	Rise (inches)	Type 1 1	Type 2 2	Type 3 3
24	28 ½	18	A-IV	A-III	A-III
27	36 ¼	22 ½	A-III	A-III	A-III
30	36 ¼	22 ½	A-III	A-III	A-III
36	43 ¾	26 5/8	A-III	A-III	A-III
42	51 1/8	31 5/16	A-III	A-III	A-III
48	58 ½	36	A-III	A-III	A-III
54	65	40	A-III	A-III	A-III
60	73	45	A-III	A-III	A-III
66	88	54	A-III	A-III	A-III
72	88	54	A-III	A-III	A-III

Notes For Tables 1, 2 & 3:

1. Type 1 – Depth: 3-feet and <
2. Type 2 – Depth: >3-feet and <10-feet.
3. Type 3 – Depth: 10-feet and <15-feet.
4. Type 4 – Depth: 15-feet and <20-feet.
5. Type 5 – Depth: 20-feet and <25 feet.
6. Type 6 – Depth: 25-feet and <30 feet.
7. Type 7 – Depth: 30–feet and >.

B. DUCTILE IRON Pipe (If not Required to be deleted for next submittal)

1. Ductile iron pipe must conform to the requirements of AWWA C151, Class 52 and with the additions or substitutions specified in this Section. Fittings 12” and larger must be gray or ductile iron conforming to ASTM C110. Fittings 10” and smaller must be gray or ductile iron conforming to ASTM C153.
2. Bells must be designed to provide a watertight joint without any leakage and be capable of withstanding pressures exceeding those that will rupture pipe of this class and thickness without requiring additional jointing material.
3. All pipe must be manufactured so that where a cut is made at any point along the barrel, the cut end will fit properly into a standard mechanical joint bell and be drip tight at hydrostatic test pressure.
4. Exterior of pipe and fittings must be coated with a petroleum asphaltic material in conformance with AWWA C110, Section 10-10. Interior of pipe must be cement mortar or ceramic lined in accordance with AWWA C104.

C. Masonry

1. Sewer brick and mortar must conform to the requirements of Section 333913 – SewerManholes, Catch Basins, Inlets and Special Structures.

2.02 PIPE JOINTS

A. Vitrified Clay Pipe

1. Vitrified clay pipe joints must be resilient, compression-type joints conforming to ASTM C425. Joints may be provided in one of the following ways:

    a. Joints made of polyurethane must have an integral compression ring formed aspart of the factory made joint.
    b. Where rubber gaskets are used, they must be continuous precision molded gaskets manufactured from a compound containing a basic polymer of not less than 50% by volume of isoprene and must contain no vulcanized vegetable oil, reclaimed rubber or dry deleterious substance.

B. Reinforced Concrete Pipe

1. Reinforced concrete pipe joints must be flexible rubber gasket joint type conforming to ASTM C361, ASTM C443 and AASHTO M198.

C. Ductile Iron Pipe (If not Required to be deleted for next submittal)

1. Pipe joints must be push-on type joints with rubber gaskets unless otherwise shown on the Drawings, specified, or directed by the Commissioner. Push-on type joints must conform to AWWA C111.

D. PVC JOINTED PIPE

1. For vitrified clay pipe size 12-inch in diameter or smaller, Contractor may substitutea polyvinyl chloride (PVC) sleeve with a polyurethane jointing material for the joint in 2.2.A. PVC collar conforming to ASTM D1784, Class 12454-B must be installed on the extra strength clay pipe at the factory. The finished joint must meet or surpass all applicable material and performance tests specified for clay pipe joints under ASTM C425.

E. JOINING PIPE OF DISSIMILAR MATERIALS

1. For pipes 15-inches and smaller in diameter, connect pipe of dissimilar material together with manufactured flexible transition couplings specifically made for this purpose, conforming to ASTM C 1173. Transition couplings are to be molded from synthetic elastomeric materials fitted with attached adjustable stainless steel band type clamps to stabilize and seal the joint. Acceptable products are “Band Seal Couplings made by Naylor Inc., “Mission Couplings” made by Mission Rubber Co.,or “Fernco Couplings” made by Fernco Systems, Inc.
2. For sewer pipes larger then 15-inches in diameter, transitions between different pipe materials must be as directed by the Bureau of Sewers.

2.03 POLYETHYLENE ENCASEMENT FOR CAST OR DUCTILE IRON PIPE (IF NOT REQUIRED TO BE DELETED FOR NEXT SUBMITTAL)

A. For cast iron and ductile iron pipe, polyethylene encasement material must be 4-mil, cross-laminated, high-density polyethylene tubing. The tubing must comply with AWWA C105.

2.04 SEWER CLEANOUTS (IF NOT REQUIRED TO BE DELETED FOR NEXTSUBMITTAL)

A. At grade cleanouts must be cast iron pipe and have an adjustable sleeve-type housing, a threaded brass plug with countersunk clot and cast iron frame and cover.

2.05 CAST-IN-PLACE CONCRETE

A. Cast in Place Concrete must conform to the requirement of Section 033000 – Concrete.

2.06 PIPE BEDDING

A. Pipe bedding must conform to requirements set forth in Section 312310 – Excavation, Trenching, and Backfilling (Utilities), of these specifications.

PART 3 - EXECUTION

3.01 GENERAL

A. All pipe, fittings, and appurtenances must be installed in accordance with the manufacturer’s recommendations and requirements.

B. All pipe, fittings, and accessories must be delivered, unloaded, strung, and laid as specified here.

3.02 TRANSPORTATION AND DELIVERY OF PIPE, FITTINGS AND STRUCTURES

A. Every precaution must be taken to prevent damage to the pipe during transportation and delivery. Extreme care must be taken in loading and unloading the pipe and fittings. Such work must be done with the pipe under complete control at all times. Under no conditions may the pipe be dropped, bumped, dragged, pushed, or moved in any way that will cause damage to the pipe.

B. If in the process of transportation, handling, or installation, any pipe or fitting is damaged, such pipe or fitting must be replaced by the Contractor and be considered incidental to the construction and no additional payment will be allowed.

C. The Contractor must prevent the pipe from rolling. The procedures used to prevent rolling must be approved by the Commissioner.

3.03 SEWAGE DIVERSION

A. By-pass pumping will be required for sections of sewer main being replaced as indicated on the Drawings. All pumping shall be included as incidental to construction of the new sewer main.

B. The Contractor must include in his construction procedure adequate means for pumping and diverting all sewage flow around the work area to keep the trench free of water and sewage until all structures, pipe, and connections have been completed. During heavy rains, the Contractor must anticipate additional flow from surface runoff and in existing sewers. The Contractor must be prepared to handle the increased flow under these conditions and protect the new work from damage while keeping all excavations as dry as possible and existing sewers in operation. Any additional pumping needed during times of heavy rainfall will be considered incidental to the cost of the by-pass pumping and will not be considered for additional payment.

C. No open pumping or discharge of water will be allowed onto City streets. All discharge flows must be discharged via pumping through a closed system of pipelines to an approved discharge point. It is part of the work of this section for the Contractor to submit a bypass pumping plan for the review and comment of the Department of Water Management, Sewer Section, before starting any work. The Contractor must provide all temporary flumes or pipe lines and pumping equipment required for the proper diversion of sewage and removal of drainage from the work. Contractor must remove any temporarily- installed dams or bulkheads after completion of the work.

D. Whenever the Contractor, at the downstream end of his Contract, removes an existing bulkhead which was placed as part of a previous contract, he must install a screen suitable for the purpose of preventing his construction debris from floating into the completed portions of the sewer system. As his work progresses, he must also clean the completed portions of the sewer by removing rails, jacks, lumber, sandbags and all other construction equipment, excess material and debris.

E. The Contractor must place and maintain all temporary dams, flumes, bulkheads or other structures necessary to prevent water from adjacent sections of the sewer system from entering the work under this Contract in such a manner as to injure it, and must completely remove all such temporary structures from the completed portion of the work as rapidly as practicable. The Contractor must not place a dam, flume or bulkhead in any sewer without first obtaining the approval of the Commissioner. The Contractor must ascertain the possibility of sewage backing up into basements and causing damage and he will be held responsible for any such damage.

F. The City does not assume responsibility for providing the Contractor with an outlet for any storm water or sewage which must be disposed of during the construction work under this Contract. Until the acceptance of the work, the Contractor will, if so ordered by the Commissioner, keep the entire work pumped free of water and sewage and before the acceptance of any part of the work, must clean the entire length of such finished part of the work to the satisfaction of the Commissioner.

G. Water must not be allowed to flow over or stand on the invert in such a manner as to cause scouring of the concrete surface.

H. Water pumped from trenches or other excavations must be routed to settling basins before entering the City of Chicago sewer system. The settling basins must be 5 feet by 10 feet with three compartments or baffles having a minimum depth of 2 feet. Discharge from the settling basin must be by gravity to the catch basin.

3.04 STORAGE OF CONCRETE PIPE AND STRUCTURES

A. In order to minimize inconvenience to adjacent property owners, the Contractor must not store pipe or structures on the job site for a distance of more than 600 feet ahead of the trench excavation. Stacking of concrete pipe is not allowed.

3.05 PREPARATION FOR LAYING PIPE

A. Materials, coatings, and linings must be as specified and as shown. Installation must be in accordance with standards as recommended by the pipe manufacturer, and as specified here.

B. Proper and suitable tools and appliances for the safe and convenient cutting, handling, and laying of the pipe and fittings must be used.

C. Before lying, all pipe and fittings must be thoroughly examined for defects and no piece may be installed which is known to be defective. If defects are discovered after pipe or fittings have been installed, the Contractor must remove the defective pipe or fitting and replace it with a sound one in a satisfactory manner.

D. The pipe and fittings must be thoroughly cleaned before they are laid and must be kept clean until they are accepted in the finished work. Care must be exercised to avoid leaving bits of wood, dirt, rock and other foreign particles in the pipe. If any such materials are discovered before the final acceptance of the work, they must be removed and the pipe and fittings replaced, if necessary. All pipes must be kept absolutely clean during construction and must be stopped off with night plugs at the end of each day's work.

E. Excavate pipe trenches as specified in Section 312310 – Excavation, Trenching and Backfilling (Utilities). Hand trim bottom of trench to six (6) inches below bottom of pipe.

F. Place and compact pipe bedding as specified in Section 312310 Excavation, Trenching and Backfilling (Utilities).

G. Keep trench bottom free from excess water. Groundwater or water from other sources must be removed as per Section 312319 – Dewatering Excavations. If the trench bottom is unsuitable for the pipes foundation, the kind of stabilization to be utilized will be ordered in writing.

H. If, in the opinion of the Commissioner, the Contractor has failed to obtain an acceptably dry trench bottom using conventional methods of dewatering, the Commissioner may order the Contractor to excavate below the intended grade and to place sufficient sub-grade material as may be suitable over the trench bottom in accordance with Section 312310 – Excavation, Trenching and Backfilling (Utilities).

3.06 LAYING PIPE

A. Lay pipe to line and grade in prepared bedding as indicated on the Drawings. The pipe must be properly secured against movement and pipe joints must be made in the excavation as required. Pipe must have compacted bearing along its entire length. When completed, the sewer must have a smooth and uniform invert.

B. The pipe laying must begin at the downstream end of the pipe. Install pipe so that bells and grooves are on the upstream end. Install vitrified clay pipe in accordance with the requirements of ASTM C12.

C. Prevent dirt, rock and other foreign particles from getting into the open end of the pipe and any pipe joints.

D. Clean interior of pipe of cement, dirt and extraneous material as the work progresses.

E. Lateral and service connections are to be made with manufactured wye fittings or preformed tapered holes or field cored holes. Openings for service connections are to be at an elevation between seven (7) feet and eight (8) feet below the ground grade.

3.07 DRAIN CONNECTIONS

A. Each slant, tapered hole or wye branch and new drain connection must be the same size as the existing drain or sewer unless otherwise shown on the Plans or ordered by the Commissioner.

B. If existing cast-iron drains are encountered which must be connected to the new sewers, the Contractor must furnish and place cast-iron pipe and fittings as required or as ordered by theCommissioner.

C. That portion of each drain connection and drain stack between the barrel of the sewer and the side of the trench must be encased and supported on a concrete or masonry pier as shown on the Plans, except that 8-inch drain connections from catch basins where such catch basins are located within the lines of the sewer trench must be supported on trench backfill. Drain connections constructed outside the neat lines of the sewer trench must be placed on a minimum of six (6) inches of granular embedment as described in Section 312310 – Excavation, Trenching and Backfilling (Utilities).

D. Drain stacks for future drain connections must have socket ends closed by suitable stoppers mortared in place.

E. The Contractor must examine all house drains, catch basin outlets and other existing drains or sewers to be connected to the new sewers, and if any such drain is found defective, as determined by the Commissioner, the Contractor must remove and relay the defective portions in accordance with the Specifications.

3.08 PIPE JOINTS

A. Pipe joints must be made secure and watertight.

B. Employ appropriate equipment to draw the sections of the pipe tightly together.

C. Apply lubricant to rubber gaskets immediately before joining pipe sections.

D. Joints of bell-and-spigot pipe and tongue and groove pipe must be filled with cement mortar so as to make a strong and watertight joint. Finish joints smooth on inside of pipe with cement mortar.

E. Inside joint recesses of pipe shall be filled with cement mortar prior to closure of the joint. After closure is made, the joint must be pointed inside of the pipe and excess mortar removed.

F. Inspect each joint for proper assembly prior to backfilling.

G. Mortar joints used for connections to existing sewer pipes or house drains may be used only when connections cannot be made using gasketed joints as specified or the appropriate pipe adaptor as supplied or recommended by the pipe manufacturer, or as directed otherwise by the Commissioner.

   1. When mortar joints are required, they must be constructed to the following standards:
   2. Center spigot of pipe in the socket using a packing gasket of twisted impregnated oakum of proper thickness and sufficient length to pass around the pipe and lap the top.
   3. After the pipe has been placed, caulk the gasket into the annular space and fill the remainder of the space with Portland cement mortar beveled off with the outside of the socket.
   4. Mortar for pipe joints or fittings must be made of one (1) part Portland Cement and one (1) part sand conforming to applicable requirements of Section 033000 – Concrete.
   5. Only a sufficient amount of mortar may be prepared for use within forty-five (45) minutes of application. Any mortar that has begun to set must not be used.
   6. As each joint is completed, thoroughly clean the inside of the pipe to remove all excess joint material.

3.09 CLEAN OUTS

A. Risers must be the same size as the pipe, and must consist of a wye or 1/8 bend extended to another 1/8 bend to the cleanout housing.

3.10 TEMPORARY BULKHEADS

A. At ends of constructed sections where adjoining mains or structures have not been completed and are not ready to be connected, construct temporary bulkheads.

3.11 SHORT TUNNEL CONSTRUCTION

A. Pipes to be placed in short tunnels must be jointed prior to being pulled into position. Pipe must be pushed or pulled into position in a manner arranged to keep joints tight and to prevent deflection.

3.12 ENCASING DUCTILE IRON PIPE IN POLYETHYLENE

A. Encase all cast and ductile iron pipe and fittings encased in polyethylene tubing.

3.13 SEPARATION BETWEEN WATER AND SEWER MAINS

A. When a sewer main crosses below water main and the vertical separation is between 18 and 6-inches, as measured between the bottom of the water main and crown of sewer pipe, the sewer must be constructed of ductile iron pipe with rubber gasketed joints to a distance one foot beyond the wall of the trench excavation. Flexible transition coupling must be used to join the ductile iron pipe to the sewer pipe and be encased in betonite as shown on the drawings.

B. When a sewer main crosses above a water main, the sewer pipe must be constructed of ductile iron pipe with rubber gasket joints for a perpendicular distance of 10 feet on either side of the centerline of the water main pipe, and an 18-inch vertical separation must be maintained. Flexible transition coupling must be used to join the ductile iron pipe to the sewer pipe.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of SEWER MAIN PIPE AND FITTINGS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SEWER MAIN PIPE AND FITTINGS shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 31 13

SECTION 33 39 13

SEWER MANHOLES, CATCH BASINS, INLETS AND SPECIAL STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section includes the requirements for constructing and/or adjusting of sewer manholes, electrical manholes, catch basins, inlets, junction chambers, tumbling basins, vaults, and other structures constructed of cast-in-place or precast concrete, or masonry structures shown on the drawings and specified here.

1.03 RELATED SECTIONS

A. Section 03 30 00: Concrete.

B. Section 31 23 10: Excavation, Trenching and Backfilling (Utilities).

C. Section 31 23 19: Dewatering Excavations.

D. Section 33 05 22: Repair and Adjustment of Sewer Mains and Structures.

E. Section 33 07 00: Insulation for Water Main Pipe and Appurtenances.

F. Section 33 31 13: Ductile Iron Water Main Pipe and Fittings.

1.04 REFERENCES

A. American Society for Testing and Materials (ASTM), latest edition:

1. STM A48 - Standard Specification for Gray Iron Castings.
2. ASTM A185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete Reinforcement.
3. ASTM A197 - Standard Specification for Cupola Malleable Iron.
4. ASTM A536 - Standard Specification for Ductile Iron Castings.
5. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
6. ASTM C32 - Standard Specification for Sewer and Manhole Brick.
7. ASTM C55 - Standard Specification for Concrete Building Brick.

8. ASTM C139 - Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
9. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
10. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
11. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Pre-cast Concrete Utility Structures.
12. ASTM C858 - Standard Specifications for Underground Precast Concrete Utility Structures.
13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. IDOT Standard Specification for Road and Bridge Construction (SSRBC), latest edition.

C. American Association of State Highway Transportation Officials, Standard Specifications for Highway (AASHTO), latest edition.

D. CDWM Regulations for Sewer Construction and Stormwater Management, latest edition.

E. ISPE Standard Specifications for Water & Sewer Construction in Illinois, latest edition.

1.05 SUBMITTALS

A. Refer to Book 1 for submittal requirements and procedures for Shop Drawings, Product Data, Records and Samples.

B. Shop Drawings: When not indicated on the Contract Drawings in sufficient detail or definition, submit detailed drawings of cast-in-place and precast concrete utility structures and related metal work.

C. Product Data: Submit manufacturers' product data for standard manufactured precast concrete sections and structures, for metal gratings and covers, and for other, related miscellaneous metal items.

D. Certification: Submit certification or other acceptable evidence that covers and grates to be provided for roadways and parking areas meet proof-testing requirements for AASHTO H2O traffic loading.

PART 2 - PRODUCTS

2.01 PRECAST CONCRETE STRUCTURES

A. Precast concrete base and riser sections furnished for manholes, valve basins, catch basins and other structures must conform to ASTM C478.

B. Furnish riser sections in various heights, including an offset tapered section, as detailed on the Drawings, or as directed by the Commissioner.

C. Precast reinforced concrete flat slab tops for manholes must conform to ASTM C857, and be designed to accommodate a minimum AASHTO loading of HS20, unless directed otherwise by the Commissioner.

2.02 JOINT SEALANTS

A. Rubber gaskets must conform to ASTM C443.

B. Preformed butyl rubber flexible rope type gaskets must conform to ASTM C990.

2.03 ADJUSTING RINGS

A. Adjusting rings are to be precast concrete with sufficient steel reinforcing to prevent cracking in normal handling and use.

B. Mating Faces: Must be smooth, parallel, free from cracks, chips, spalls or casting irregularities which interfere with creating a watertight mating surface between the adjusting ring and top of the utility structure.

   1. Provide grooves in faces to contain extrudible preformed gasket material when applicable.

C. Adjustment rings shall not exceed two (2) rings, or a maximum of 8 inches.

2.04 CASTINGS

A. Iron castings are to be ductile iron castings conforming to ASTM A536, Grade 60-40-18, or gray iron conforming to ASTM A48, free from blowholes, shrinkage, cracks and other defects.

B. Allowance for shrinkage must be made in the patterns to meet the specified thickness. Frames and lids are to seat at all points.

C. Malleable castings are to conform to ASTM A197.

D. All castings are to be made accurately to dimensions shown on the plans, and planed, filed, or ground where otherwise necessary to secure flat and true surfaces.

2.05 STEPS

A. Aluminum alloy WP 6061 or WP 6063 conforming to ASTM B361. Coat the portion of aluminum step embedded in concrete and the portion extending two (2) inches beyond embedment with bituminous paint.

2.06 CAST-IN-PLACE CONCRETE

A. Concrete in accordance with Section 033000 – Concrete.

2.07 CONCRETE AND MASONRY BLOCKS AND BRICKS

A. Precast concrete brick must conform to ASTM C55 quality designated Grade N-1.

B. Sewer brick must conform to the qualifications for “brick for sewers or drainage structures”, Grades SS or SM, as established in Table I of the current ASTM C32, except where modified here.

1. Brick must be uniform, sound, hard burned, of compact texture, free from lime and cracks with a clear ringing sound when struck, whole and with edges full and square, and of standard dimensions.
2. Brick, when thoroughly dried and immersed in water for twenty-four (24) hours, must not absorb more than 15% by weight of water.
3. If in any load of brick more than 10% are inferior, the whole load is rejected.
4. If in any load of brick less than 10% are inferior, the brick is accepted provided the Contractor pulls out all inferior bricks, and immediately removes them from the Site of the Work.

2.08 MORTAR

A. Mortar for brickwork is to be composed of one (1) part Portland cement and two (2) parts screened sand.

1. Portland cement must conform to the requirements of Section 1001 of the SSRBC.
2. Sand must be Class A quality and Gradation FA-9 as specified in Article 1003.02 of the SSRBC.

B. The cement and sand must be proportioned by volume and thoroughly mixed in a tight box.

C. After the initial mixing, water is to be added gradually and the ingredients mixed until the mortar is of proper consistency. The amount of water must be no more than necessary to produce a workable, plastic mortar.

D. Prepare only a sufficient amount of mortar for immediate use and any mortar that has begunto set must not be retempered or used in any way in the Work

2.09 REINFORCING STEEL

A. Reinforcing steel is to meet the requirements of ASTM A615, Grade 60 and A185 for wire fabric.

PART 3 - EXECUTION

3.01 GENERAL

A. Excavate, backfill and compact in accordance with Section 312310 -Excavation, Trenching & Backfilling (Utilities).

B. All brick must be thoroughly wetted immediately before being laid.

C. Old brickwork must be thoroughly cleaned and wetted before new work is jointed thereto.

D. No masonry work is to be done when the temperature is below 33º F unless otherwiseapproved, and then only under conditions for protecting it from frost.

3.02 PRE-CAST STRUCTURE INSTALLATION

A. Carefully place precast sections for all structures on prepared bedding so as to fully anduniformly support the structure and allow pipes to be laid to proper grade.

B. All lift holes on precast sections must be completely filled with mortar, smoothed on both inside and outside surfaces.

C. Seal joints between riser sections with approved mastic sealant or rubber gaskets, or asdirected by the Commissioner.

D. Place one adjusting ring (only) on manhole top. Select thickness of adjusting ring to bring completed structure to required elevation.

E. Seal joints between adjusting rings and frames with approved mastic sealant before backfilling structures.

F. Install manhole frame and cover.

3.03 MASONRY STRUCTURE INSTALLATION

A. Install precast concrete or cast in place base as shown on the Drawings.

B. Thoroughly wet all brick immediately before laying.

C. Lay brick courses to the line, straight and parallel, breaking joints with those in adjacent courses.

D. Lay brick radially as headers in a full bed of mortar with joints not exceeding 3/8-Inch in thickness.

E. Fill joints with mortar. Interior joints must be trowel-struck.

F. Fresh masonry must be plastered inside and outside and must be protected from damage of all kinds.

G. New work, unless immediately covered with earth or brick backing, or an approved form of curing compound, must be kept moist until the mortar has hardened.

H. Install manhole frame and cover.

3.04 CAST-IN-PLACE CONCRETE STRUCTURES

A. Construct Cast-In-Place Concrete Structures in accordance with Section 033000 – Concrete.

3.05 FINAL ADJUSTMENT OF STRUCTURES

A. To prevent debris from entering the sewers, place 22 gauge galvanized steel plates beneath perforated lids of all structures prior to the placing of any type of surfacing. Maintain platesin place until the completion of all surface restoration.

B. After the base course and binder course have been placed, and prior to placing the surface course, the structures must be adjusted to match the final pavement elevation.

C. Remove the binder and base course adjacent to and for a distance not exceeding 12-inches outside the base of the castings.

D. Adjust the castings to final pavement elevation with adjusting rings set in mortar.

E. Fill the space around the casting with Class SI concrete to the elevation of the surface of thebinder course.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of SEWER MANHOLES, CATCH BASINS, INLETS AND SPECIAL STRUCTURES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SEWER MANHOLES, CATCH BASINS, INLETS AND SPECIAL STRUCTURES shall be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 33 39 13

SECTION 34 01 23
TRACK REMOVAL

PART 1 GENERAL

1.01 SUMMARY

This Specification covers procedures for the removal of trackwork materials as indicated in the Contract Drawings. The work includes all labor, material, and equipment necessary to complete the track removal in accordance with the Contract Drawings.

1.02 REFERENCES

A. American Association of Railroads (AAR)

B. American Railway Engineering and Maintenance-of-Way Association (AREMA)

C. United States Environmental Protection Agency (EPA) guidelines for disposal of Special Waste (most recent version)

D. Definitions

1. Track Removal - may include some or all of the following: running rails, contact rail, contact rail chairs, contact rail anchors, restraining guard rails, steel inside guard rails, special trackwork components, ties, timber guard, rail anchors, splices, nuts, bolts, washers, walkways, wayside platforms, a variety of tie plates, joint bars, rubber pads, resilient clips and other appurtenant items scheduled to be removed or protected for reinstallation.

1.03 RELATED WORK

A. Section 01 18 00 Project Utility Coordination

B. Section 34 11 10 Elevated Track Construction

1.04 SUBMITTALS

Submit to the CTA in accordance with the requirements of the submittal section and the following:

A. Diagrams and load data of all equipment the Contractor plans to use on the project for material handling, removal, transport, disposal and storage purposes. All equipment must be approved by Skokie Shop personnel and included on the Bulletin of Approved Foreign Equipment, issued by Rail Operations, prior to use on the track structure.

B. A list of all disposal sites and a copy of all permits. All material removed from within the Contract limits is to be disposed of legally and in full accordance with all federal, state and local laws and requirements. If the disposal site is on private property the CTA is to be given a copy of all written permission from the property owner allowing disposal. Submit disposal documentation for all ties and other treated wood materials removed as specified elsewhere in the Contract Specifications.

C. A copy of all permits required for track removal activities that obstruct the public way. Costs for these permits are to be paid by the Contractor.

D. Submit a Construction Process Plan (CPP). In addition to the requirements in Division 1, the plan must include the following:

   A. The sequence, site access, equipment and procedures of material removal including a lift plan if a crane is to be utilized for the removal operations.

   B. Removal, protection and/or disassembly for reinstallation including, but not limited to, the items as follows:

      a. Ties and associated planking

      b. Plates and fasteners

      c. Running rail

      d. Contact rail and chair removal

      e. Timber guard removal

      f. Footwalks and footwalk support ties

      g. Special trackwork components

      h. Steel Inside Guard (SIG) rail

   3. How items intended to remain during the work will be protected in place, removed from the work site and re-installed, or kept free from damage either intentional or inadvertent.

E. A Fire Prevention/Watch Plan to the CTA for review and approval prior to the start of work. The plan is to include items to protect the work on site as well as any staging locations or places where materials are stored in advance of the work.

PART 2 MATERIAL

2.01 REPLACEMENT MATERIALS

A. Any material intended to be removed and re-installed that is lost, missing or stolen is to be replaced by the Contractor at no additional Contract time or Contract cost. All material replaced by the Contractor must be approved in writing by the CTA prior to purchase or use.

2.02 MATERIAL TO BE PROTECTED AND DELIVERED TO THE CTA

A. All existing track gage rods in the renewal areas as indicated in the Contract Drawings are to be removed, protected and delivered to the CTA West Shops.

2.03 MATERIAL TO BE RETAINED FOR REINSTALLATON

A. Existing running rails, running rail joint bars, and SIG rail joint bars deemed suitable for reuse by the CTA must be protected for reinstallation, and must be reinstalled under this project.

PART 3 EXECUTION

3.01 GENERAL REMOVAL

A. Remove only those materials intended for removal and must not damage, mar, or deface material or objects intended to be protected in place or removed/disassembled for reinstallation.

B. All necessary safety precautions and protection must be made for personnel both on site and off site, passersby, equipment in, around, or adjacent to the work. The Contractor's work operations are to be completed in such a manner to avoid interference with the use of adjacent areas or traffic outside of CTA property of the permitted work site.

C. Special care and safety precautions must be taken to avoid the spread of dust and flying particles outside of CTA property or the permitted work area.

D. Whenever equipment is used that may ignite a fire, suitable fire extinguishers must be at the ready for immediate use. Users of such equipment must be instructed in the proper method of preventing and extinguishing fires. Any and all oxygen and acetylene tanks used for work not during the line cuts are to be brought in for each day of work; on-site storage is strictly prohibited.

E. The Contractor retains responsibility for all requirements related to fire protection and prevention.

F. Any damaged facilities resulting from movement of the Contractor's equipment or personnel must be replaced per section 2.01 of this specification at no additional Contract cost or Contract time.

3.02 CLEANUP AND DISPOSAL OF MATERIAL

A. Rubbish, debris and all other foreign materials or waste, of whatever nature including scrap ties, running rail, guard rail, and other track material, when the Contractor arrives at the work zone are to be collected and disposed of legally. Provide suitable means for the removal of said materials, debris and rubbish including necessary facilities to saturate all rubbish and debris with water to the extent required to prevent dust arising from the Work.

B. Steadily and daily remove all materials, debris and rubbish from the site resulting from the work or workers. Under no circumstance are debris or rubbish allowed to be stored or accumulate on the site and potentially migrate from CTA property onto the roadways, alleys or adjacent property.

C. Materials removed from the project site must be disposed of legally and in accordance with all appropriate federal, state, and local government laws, codes, ordinances and permit requirements.

D. Provide the name and location of all disposal sites to the CTA for approval prior to the removal of material from the CTA's right-of-way.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of TRACK REMOVAL shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of TRACK REMOVAL shall be included in the contract lump sum price as shown in the Schedule of Prices for TRACK WORK

4.03 PAY ITEM ACCOUNT NUMBER

A. TRACK WORK: 340000

END OF SECTION 34 01 23

SECTION 34 11 06
DISPOSAL OF TREATED WOOD MATERIALS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification sections, apply to this section.

1.02 SUMMARY

A. This Specification covers procedures for removal, handling, and proper disposal of all treated wood material. The work includes all general conditions, labor, material and equipment necessary to complete the work.

B. All treated wood materials, regardless of size or shape, to be managed in accordance with this Section.

1. All weathered treated wood to be disposed at an approved landfill located in Illinois as allowed in this Section. Landfill means any open and active permitted Resource Conservation and Recovery Act (RCRA; 40 CFR 258) Subtitle D solid waste landfill facility permitted to accept nonhazardous waste. The landfill must be licensed/open, active, and permitted by the Illinois Environmental Protection Agency and other local regulatory agencies as applicable.

2. Treated wood that is not weathered nor has surface deposits or surface staining to be managed separately in accordance with this Section.

C. The Contractor must perform the work in accordance with all applicable local, county, state, and federal regulations. In the event that local, state or federal regulations change during the contract period and the Contractor is required to follow the new or revised regulations; the Contractor must comply and provide written notification to the CTA.

D. Related Sections:

1. Division 34 Sections, Track.

1.03 REFERENCES

A. Title 40 Code of Federal Regulation (CFR) Part 258, Criteria for Municipal Solid Waste Landfills.

B. Title 40 Code of Federal Regulation (CFR) Part 261, Identification and Listing of Hazardous Waste.

C. Title 40 Code of Federal Regulation (CFR) Part 262, Standards Applicable to Generators of Hazardous Waste.

D. Title 35 Illinois Administrative Code (IAC), Part 721, Identification and Listing of Hazardous Waste.

E. Title 35 IAC Part 722, Standards Applicable to Generators of Hazardous Waste.

F. Title 35 IAC Part 810, Solid Waste Disposal: General Provisions.

1.04 DEFINITIONS

A. Treated Wood: Treated wood refers to wood what has been treated with inorganic copper chromated arsenical compounds, pentachlorophenol, creosote, creosote borate, copper napthenate or copper napthenate-borate.

1. Weathered treated wood: Treated wood that has weathered or has no surface deposits and no surface staining.

2. Un-weathered treated wood: Treated wood that is not weathered or has surface deposits and remaining surface staining.

1.05 SUBMITTALS

A. Submit to the CTA in accordance with the requirements of the Division 01 Section, “Submittals” items as follows:

1. A management plan that details how the treated wood to be safely and properly handled and tracked, from the time the material is removed from the work site until it has been disposed. The management plan to include a flow diagram that graphically illustrates the movement of treated wood, weathered or unweathered, from removal to disposal. The management plan to describe the following at a minimum.

   a. Segregation as either 1) weathered and with no surface deposits/staining or 2) unweathered or with surface deposits/staining.
   b. Waste characterization (e.g., sampling and analysis procedures, name and address of analytical laboratory accredited in accordance with the Illinois Administrative Code, Title 35, Subtitle A Chapter II, Part 186).
   c. On-site processing/staging prior to transport (e.g., maximum amount requested to be stockpiled onsite, location, processing, and security).
   d. Direct loading for transport (i.e., method of loading).
   e. Transportation (e.g., means of transport, transport company information including permits and licensing, haul route, as applicable).
   f. Disposal

      1) Facility Name, Address, and Telephone Number.
      2) Site Contact Person.
      3) Facility Identification Number and permit number issued by Illinois EPA, USEPA, or other state licensing agencies.
      4) Certified Statement from the facility that the facility complies with all local, state, and federal laws, rules and regulations and the requirements of this Section.
      5) Waste stream (i.e., waste profile) authorization form to be reviewed and approved by the CTA.
      6) Contingency plan for the safe and effective response to emergencies or other unexpected events.

2. Permits and Licensing: All permits and licenses required for the management, transport, and disposal of treated wood are to be submitted to the CTA prior to the start of any treated wood removal. Permits or licenses are to include, but are not limited to, permits for right-of-way lane closures, transportation permits, disposal facility permits/authorizations, etc.

3. Weight Certificates

   a. The Contractor to submit weight tickets from the disposal facility that identify the weight of treated wood material, which may include other metal railroad other track material that is received at the disposal facility.
   b. The Contractor to keep a log on site to track the movement of the material. The log is to contain, at a minimum, information such as quantity of railroad timbers removed, whether the ties contain metal railroad track or other material, the name of hauler, receiving facility, truck number, time leaving the site, and arrival time at facility. The log to be updated continuously. A summary of the log activity to be included as the heading for the log. An updated log to be posted to the project website within a week of any changes to the log.

1.06 QUALITY ASSURANCE

A. All work to be done in full compliance with applicable federal, state, and local codes and regulations and OSHA and EPA requirements.

B. Follow all applicable regulations, codes and ordinances when removing, transporting and disposing of weathered or non-weathered treated wood.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor to remove only those materials intended for removal and must not damage, mar, or deface material or objects intended to remain and be protected in place.

B. Removal to not commence until all required submittals have been approved by the CTA . The Contractor may not change any processors, haulers, or disposal facilities without receiving prior written authorization from the CTA .

C. All necessary health and safety precautions and protection to be made for personnel both on site and off site, passersby, equipment in, around, or adjacent to the work.

   1. Work operations require that treated wood be handled and processed by workers wearing appropriate personal protective equipment that prevents the creosote or other chemicals from contacting bare skin.

   2. Safety precautions to be taken to avoid the spread of dust and flying particles including areas outside of CTA property or the worksite.

D. Work protection and worker protection to be done in full compliance with all applicable codes and regulations and OSHA and EPA requirements.

E. All work to be done in full conformance with federal, state and local regulations.

   1. Neither the presence nor oversight of work by employees of the CTA to create any obligation on the CTA to monitor the health or safety of the Contractor’s employee’s or general jobsite safety. The Contractor is solely responsible for

maintaining the safety of the jobsite, and ensuring that visitors, its workers and others are protected.

2. The Contractor to maintain insurance in accordance with the stated requirements for the duration of the project.
3. The Contractor to submit for the CTA review and approval a work schedule and work plan prior to beginning the work.

F. Whenever equipment is used that may ignite a fire, suitable fire extinguishers to be at the ready for immediate use to extinguish any fire that may have started.

D. The Contractor retains responsibility for all requirements related to fire protection and prevention.

E. Any damaged facilities resulting from movement of the Contractor's equipment or personnel to be replaced or repaired at no additional Contract cost or Contract time considered.

3.02 SEGREGATION, HANDLING, AND CHARACTERIZATION OF UNWEATHERED TREATED WOOD OR WOOD WITH SURFACE STAINING/DEPOSITS

A. As approved by the CTA, unweathered treated wood or any treated wood with surface staining or surface deposits to be segregated and managed separately.

B. Treated wood that is unweathered or has surface staining or surface deposits to be characterized in accordance with 35 IAC 721 (40 CFR 261). Waste characterization to include testing for, at a minimum, Toxicity Characteristic Leaching Procedure (TCLP) o-cresol, m-cresol, p-cresol and cresol.

C. Perform any other analytical testing required by the landfill for waste characterization as necessary to secure all required waste authorizations for all materials. All costs associated with collecting waste characterization samples and performing analytical tests to be at the Contractor's expense.

D. If the treated wood is determined to be hazardous, it is to be managed and disposed of in accordance with 35 IAC 722 (40 CFR 262), as approved by the CTA.

E. Treated wood that is determined to not be hazardous to be managed as weathered treated wood, or in accordance with applicable regulations, whichever is more stringent.

3.03 PROCESSING, TRANSPORTING, AND DISPOAL OF MATERIAL

A. Any treated wood material present on the project site when the Contractor arrives at the work zone, whether it was generated by the Contractor or otherwise, is to be collected and disposed of in a manner consistent with the requirements of this Section, regardless of the size or shape of the treated wood encountered.

B. Any required processing to comply with disposal facility's requirements, such as removal of metal plates/fasteners, must be done onsite as approved by the CTA, prior to loading for transport. Processing may include removal of contact rail chairs, rail plates, or other track-related material; or cutting to certain lengths.

C. Notify the CTA no less than 48 hours prior to loading or transporting any treated wood material from the Project Area.

D. Loading and transportation are to be performed in accordance with the approved management plan.

E. All loads of treated wood for disposal to be transported directly to the receiving facility on the same day. No off-site temporary storage is allowed.

F. All weathered treated wood to be transported to the landfill to be bagged or otherwise contained if required by applicable codes or regulations, if required by the transporting company or if required by the landfill facility. Similarly, the truck bed to be lined with approved liner and/or the payload to be covered if required by applicable codes or regulations or if required by the transporting company.

G. All weathered treated wood to be disposed of at an approved, licensed landfill.

  1. Landfill facility must be on CTA's list of approval landfill facilities for this type of waste.

H. Notify the CTA of any treated wood loads rejected by the receiving facility within 12 hours of the rejection. Any rejected load to be immediately returned to the project site and not transported for alternative disposal until approved by the CTA.

I. The CTA is to be provided the necessary documentation so that all truck loads are accounted for in the final review. The weights of material removed to be verified to ensure that all treated wood material has been properly disposed of and the trail of ownership traceable back to the CTA has been terminated.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of DISPOSAL OF TREATED WOOD MATERIALS shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of DISPOSAL OF TREATED WOOD MATERIALS shall be included in the contract lump sum price as shown in the Schedule of Prices for TRACK WORK

4.03 PAY ITEM ACCOUNT NUMBER

A. TRACK WORK: 340000

END OF SECTION 34 11 06

SECTION 34 11 10
ELEVATED TRACK CONSTRUCTION

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies work necessary to improve the trackwork system on the CTA's open deck elevated structure within the limits as shown on the Contract Drawings. The Contractor is to furnish all labor, materials, tools, and equipment necessary to complete the full scope of work shown on the Contract Drawings and as specified herein.

B. Work described in this section includes work on, but is not limited to, ties and fasteners, footwalk, and contact rail chair replacement and all other components and accessories necessary to complete the improvement of the open deck elevated trackwork system as specified to make a complete functioning transit railroad.

C. All materials required to complete the full scope of work are to be furnished and installed by the Contractor.

D. The Contractor is to schedule the work necessary to complete the renewal of the open deck elevated trackwork so as to not interfere in any way with the safe and timely operation of the CTA operations except as noted elsewhere in the Contract Documents.

1.02 STANDARD SPECIFICATIONS

A. The CTA may alter standard references as necessary; however, the most recent version of each standard referenced in the Contract is as follows:

1. AREMA MRE - American Railway Engineering and Maintenance-of-Way Association Manual for Railway Engineering
2. ASTM – American Society for Testing and Materials
3. ANSI – American National Standards Institute
4. AISI – American Iron and Steel Institute
5. CFR – Code of Federal Regulations
    a. Title 49, Chapter II Part 213

1.03 RELATED WORK

A. Related work includes all other specification sections and the plans.

1.04 TRACK STANDARDS

A. Track gage is to be measured between points located five eighths of an inch (5/8") below the top of rail head and from inside face to inside face of the running rails. Track gage is to be four feet eight and one half inches (4'-8 1/2"). Track gage is to be maintained throughout the project.

B. Contact rail gage is defined as the horizontal distance between the gage line of the running rail and the centerline of the contact rail and is to be one foot eight and one eighth of an inch (1'-8 1/8"). Contact rail gage is to be maintained throughout the project by the Contractor.

C. Contact rail height is defined as the vertical distance between the plane of the top of the running rails and the top of the contact rail and is to be six and one half inches (6 1/2”). Contact rail height is to be maintained throughout the project by the Contractor.

D. Tolerances From Design: Final established gage, cross-level, superelevation, vertical and horizontal alignment of tracks are to be as indicated on Contract Drawings, and are to be within tolerances from design specified below:

   1. Track gage variation: plus one-eighth of an inch (+1/8”), minus zero inches (-0”)

   2. Contact rail gage variation: plus/minus one eighth of an inch (±1/8”)

   3. Contact rail height variation: plus zero inches (+0”), minus one eighth of an inch (-1/8”)

   4. Deviation of middle ordinate in sixty-two foot (62’) chord: one eighth of an inch (1/8”)

   5. Cross level variation: one quarter of an inch (1/4”) unless otherwise approved by the CTA.

   6. Superelevation variation: one eighth of an inch (1/8”) unless otherwise approved by the CTA.

E. No tolerances from design are to be allowed at locations where vertical and horizontal clearances are restricted by the Contract Drawings such as abutments, station platforms, etc.

1.05 SUBMITTALS

Submit each item in this Article according to the conditions of the contract and Division 01 Specification Sections for review and approval prior to the start of work, unless otherwise indicated:

A. Survey Control plan

B. Construction Process Plan which includes descriptions of items as follows:

   1. The sequence of all construction activities.

   2. The details of construction for activities and expected durations as follows:

      a. Installation of the ties for the proper alignment and profile of the track.

      b. Procedures to acquire the final profile and alignment.

      c. Means and methods for setting the required temperature adjusted joint gaps.

        d. Footwalk installation.

        e. Means and methods for protecting in place or removing and reinstalling the contact rail.

        f. Means and methods for protecting in place or removing and reinstalling the steel inside guard rail.

        g. Means and methods for protecting various wires and cables in the construction area.

        h. Incidental work.

    3. Diagrams and load data of all equipment the Contractor plans to use on the project.

C. List of equipment, material, personnel and equipment workloads that the Contractor would like to place on aerial structures during construction.

D. Engineering calculations performed and sealed by a licensed Structural Engineer for all equipment to be placed on aerial structures during construction.

E. Product data, cut sheets, template drawings and shop drawings for all material furnished to the CTA prior to the start of work for the installation of each item as described herein.

F. Product samples and specifications for all track components described herein.

G. Detailed shop drawings for all fabricated items to the CTA for review and approval before fabrication. Also submit shop drawings for the complete installation of all parts and associated hardware based upon actual field verified conditions and dimensions.

    1. Shop drawings are to show dimensions, tolerances, welds, materials, finishes, and any other details required to adequately demonstrate that the requirements of this specification have been met.

    2. Describe the procedures for installation and any applicable lateral adjustment ability.

H. To expedite delivery, precedence will be given to shop drawings for components that require the greatest lead time to manufacture or fabricate. It is the Contractor’s responsibility to call out the items needed first, otherwise submittals will be reviewed on a first come first reviewed basis.

I. Detailed tie layout plans, where applicable, for review and approval prior to tie procurement.

J. Certified copies of mill certificates, reports for all analyses and tests/inspection forms. The CTA may waive this requirement dependent upon the experience of the vendor selected to fabricate any of the material required by these specifications.

K. Lot traceability documentation from steel source through processing to delivery for all rail and rail components furnished for installation as a part of this project.

L. Rail grinding equipment, detailed grinding process plan, and detailed fire and protection plan as described in this Specification.

M. Track marker product data and installation details.

N. Clearance check log from centerlines of the tracks.

1.06 PROJECT SITE

A. The Contractor is responsible for thoroughly investigating the entire site of the work. The entire scope of work may be seen from a CTA train or street level below.

B. There are multiple wires and cables attached throughout the structure, including the street lighting system. No matter who the owner of those cables is, it is the Contractor’s responsibility to identify the cable as either part of the scope of this Contract or outside the scope of this Contract. In either case it is to be the Contractor’s responsibility to adequately protect all cable or wire. Any cable or wire damaged must be repaired by the Contractor immediately to restore whatever function those cables or wires provided. If required by the Owner of the wire or cable affected, the entire length of the affected wire or cable must be replaced within a reasonable time period to the Owner’s satisfaction in order to complete the repair.

C. Any appurtenance that exists on the CTA structure is to be considered to remain during the length of the Contract and must be protected from damage by the Contractor. All work must be staged to allow for the protection of anything connected to or hanging on the CTA structure within the Contract limits.

PART 2 - PRODUCTS

2.01 RAIL ACCESSORIES

A. Rail to Tie Fasteners

1. Each rail to tie fastener, unless otherwise indicated in the Contract Drawings or Specifications, is to be a cast iron tie plate with a double studded rubber insulating seat pad with ears, two (2) heavy duty nylon insulators with a steel plate pressed into nylon to bear against the toe load of the spring clip and two “e” style elastic spring clips.

2. The rail to tie fasteners are to be installed with four cut spikes to secure the plate to the tie on tangent tracks and through curves with a radius of greater than fifteen hundred feet (1500’) and associated spirals.

3. The rail to tie fasteners within the limits of special trackwork and curves of radius less than fifteen hundred feet (1500’) and the associated spirals are to be installed with four drive spikes to secure the plate to the tie.

4. Only track fastening assemblies, and their component parts, that have been approved by the CTA, or have been accepted as being approved equal, are to be installed.

B. Spring Clips

1. The rail is to be held down and anchored by elastic, heat treated, alloy steel rail clips of a proven design. At least five (5) years of documented and successful in-

track experience is required. The clip is to be a resilient and detachable one-piece, threadless spring clip. One each is to be used on the field and gage side of the rail. The right-hand (standard) clip is to be furnished with a galvanized finish. The left-hand (opposite) clip is to be furnished with a galvanized finish and then painted green to distinguish that they are the opposite hand for future identification purposes. A sample of each is to be submitted to the CTA for review and approval prior to the start of work.

2. The spring clip is to be forged from alloy steel bar and quenched/tempered. The spring clip is to have a nominal diameter of seven hundred eighty seven thousandths of an inch (0.787”). The nominal weight of the spring clip is to be within the range of one and three quarters (1 3/4 lbs.) pounds to two and three quarters (2 3/4 lbs.) pounds.

3. The resilient fasteners are to generate rail holding force by spring action. The minimum working toe load clamping force for the “e” clip style resilient fastener held vertically against the rail base of 115 RE rail is to be two thousand seven hundred fifty (2,750 lbs.) pounds generated elastically with a minimum total force of three thousand six hundred (3,600 lbs.) pounds per rail fastener assembly. The minimum nominal installation deflection of the spring clip is to be four tenths of an inch (0.4”) when installed on 115 RE rails. The nominal working spring rate of the clip at plus/minus twenty (20%) percent of the installation deflection is to be within a range of four thousand pounds per inch (4,000 lbs./in.) to six thousand pounds per inch (6,000 lbs./in.) when installed on 115 RE rail.

4. The plate and fastener assembly are to generate a minimum constant longitudinal restraint of two thousand four hundred pounds (2,400 lbs.) per assembly when installed. The clip is to contact the base of rail within one inch (1”) from the edge of the base edge. The clip is to be suited for installation on either the field or gage side of the rail without variation of design.

5. The clip is to be installed parallel to the base of rail. The clip is to be installed or removed with standard hand tools and is to be re-usable after removal through repeated applications with little negative effect on the clip’s performance. No part of the clip is to protrude below the tie surface or into the tie. The clip’s toe is to have a nominal eight tenths square inches (0.8 in.^{2}) of contact area with the base of rail.

6. An adequate supply of clips for the right-hand rail positions are to be accompanied by an adequate supply of left-hand green clips and joint assemblies to secure the rail at joint locations, or about every thirty nine (39’) feet in curved sections and eighty (80’) feet in tangent sections. A shop drawing for both types of proposed spring rail clips and the joint assembly is to be submitted to the CTA for review and approval prior to the start of work. The number of existing rail joints will determine the number of joint assemblies required to be furnished and installed. The joint assemblies are to consist of a bolt, locknut, washer and insulator that does not use spring clips. All joints are to be complete with joint fasteners for all joints wherever the joint bars cross the ties.

C. Cast Tie Plates

1. Tie plates for the 115 RE running rail, 115 RE restraining rail are to conform to cast plates as shown on the plans and be made complete with all of the components except as described herein. The geometry, dimensions, tolerances,

number of holes and the shape of the holes on the plate are to conform to those shown on the plans.

2. Tie plates are to come with all components that make up the complete assembly. The plate is to be cast from ASTM A536, Grade 80-55-06 ductile cast iron material.

3. The plate and the resilient fasteners (clips) are to be from the same manufacturer to ensure compatibility.

4. The plates are to be free from injurious warp and other projections in surface and projecting fins of metal caused by shearing or punching.

5. The assembly is to be submitted for review and approval by the CTA. A sample is to be furnished to the CTA for review and approval by the CTA prior to the start of work.

6. Plates are to be uncoated.

D. Pads

1. The pad installed between the plate and the base of the running rail on the cast plates is to be double studded rubber pads fabricated to the dimensions and configuration to fit in the rail seat as shown on the plans and is to be fabricated from virgin rubber.

E. Spikes

1. Drive spikes are to be furnished and installed in special trackwork construction, curved track construction for curves of less than fifteen hundred foot (1500') radius, and contact rail anchors and are to conform to the design and dimensions indicated on the plans. A cut sheet for the drive spikes is to be submitted to the CTA for review and approval prior to the start of work. Four drive spikes are to be furnished and installed in all cast tie plates.

2. Cut track spikes are to be furnished and installed in all trackwork not included in item 1 above. The cut spikes are to be five eighths (5/8") of an inch square and six inches (6") long. A cut sheet for the cut track spikes is to be submitted to the CTA for review and approval prior to the start of work. Four spikes are to be installed to fasten plates in tangent sections and two for each segment of SIG that lies upon any tie.

3. Longer cut spikes or drive spikes are to be used where shims greater than one half of an inch (1/2") are used. Spikes and drive spikes are to increase in lengths suitable to provide the penetration necessary to provide holding power that matches the standard installation.

F. Joint Bars

1. For locations where the existing running rail is to be reinstalled, the existing running rail joint bars deemed suitable for reuse are to be protected for reassembly using new bolts, washers and nuts.

2. Joint bars to replace existing joint bars that are cracked, show excessive wear, or have been modified are to be replaced with new thirty-six inch (36”) long joint bar assemblies. Additional holes are to be drilled in the rails if required so that all six (6) bolts can be installed.

3. Joint bars are to be as specified elsewhere in the Contract Specifications.

G. Insulated Joints

1. For track signal and interlocking train control circuits, the Contractor is to furnish and install 6-hole; thirty-six inch (36") heavy duty polymer encased steel rail joints, to be installed where shown on the plans. Insulated joints and poly plates are to be Portec Poly joints, Allegegheny (Toughcoat) or CTA approved equal, complete with all insulation, bolts, security type lock nuts, and spring lock washers. The end post is to conform to the rail section with the same height as the running rail and be flush with the top of rail or just below the top of rail when installed. All insulated joints in areas without insulated track fasteners where the center of the joint falls on or within six inches (6”) of the edge of any tie is to have a poly type (insulated) plate installed. The poly plate is to have square holes for cut track spikes and the cant is to match adjacent plates.

2. The required back-up plates are to be made from rolled steel and have provision for a staggered bolt hole pattern to allow use of one inch (1”) diameter oval neck, heat treated bolts with lock washers conforming to AREMA specifications. Insulated joints furnished and installed on the heel rails of frogs may require the back-up plates to have all oval holes in one plate.

3. Spring washers are to have reactive pressure of not less than five thousand (5,000 lbs) pounds and are to conform to AREMA specifications.

4. Insulated joint end posts are to be full rail cross section with flare and are to be provided by the insulated joint manufacturer.

5. Each insulated joint assembly is to be manufactured to meet the following test for electrical resistance:

   a. With 500 volts direct current (DC) applied to the rail on either side of the insulated joint for a duration of three minutes, the actual current flow throughout the joint is to be measured to the nearest 0.1 microampere and recorded.

   b. The impedance after three minutes is to be measured with an accuracy of ±(10)% and recorded for each frequency.

6. The acceptance criterion for the 500 volts DC is to be 10 megaohms.

7. Existing rail is to be drilled as necessary in accordance with AREMA specifications at all locations where a thirty-six inch (36”) insulated joint bar assembly is replacing a twenty-four inch (24”) joint bar assembly.

H. Track Bolts, Nuts, and Washers

1. Track bolts for jointed running rail are to be standard AREMA heat treated, oval neck design with rolled or cut threads, one inch (1”) in diameter and six inches (6”) long.

2. If the existing SIG rail is not disassembled, the existing track bolts may be reused. Missing bolts, bolts required to reassemble existing SIG rail or bolts required for new SIG rail installation are to be standard AREMA heat treated, oval neck design with rolled or cut threads, one inch (1”) in diameter and at the necessary length to fasten smaller rail sections.

3. Track locknuts are to be square, heavy duty with elliptical spring steel collar inserts. The nut is to be tapped 1"-8 UNC class 2B. The nut body is to have between four tenths (0.40%) percent and fifty five hundredths (0.55%) percent carbon content. The elliptical spring steel insert collar is to be made of ANSI 1045 steel and heat treated to a Rockwell C scale of 41 to 43. AREMA Specifications and Industrial Fastener Institute ANSI B18.2.2 latest revision is to apply.

4. Thread fit is to be a wrench turn fit having a free fit for at least two (2) threads in starting the nut on the bolt. The remainder of the screw length is to achieve a pounds pull of five (5 lbs) pounds minimum to fifty five (55 lbs) pounds maximum applied to the end of a twenty-four inch (24”) wrench.

5. The washers furnished for this Contract are to be designed strictly for track work, and are to comply with the most recent version of the AREMA standard. Heavy spring washers manufactured for general industrial applications per ANSI/ASME B18.21.1 are NOT acceptable. The inside diameter of the washer is to be one sixteenths of an inch (1/16”) larger than the major diameter of the bolt. Material for spring washers is to be steel, manufactured by the electric-furnace, open-hearth, basic oxygen or crucible process. The heavy helical spring washers are to fully comply with the most recent version of AREMA “Specifications for Spring Washers.” Spring washers are to have reactive pressure of not less than five thousand (5,000) pounds.

I. Steel Shim Plates

1. Steel shim plates are to be used in superelevated track sections or at locations to correct structure cross levels or longitudinal vertical deviations at the bents. Steel shims are to be one piece A36 carbon steel or better milled or fabricated to the thickness required. The steel shim plates are to have the exact same hole pattern as the tie plate they support. The thickness is to start at one eighth of an inch (1/8”) thickness and increase in thickness by increments of one eighth of an inch (1/8”) up to and including two inches (2”).

2. Shim plates for direct fixation fasteners on through-girder bridges are to be as above with the exception of being furnished in increments of one sixteenth of an inch (1/16”).

3. Shim plates are to be plain steel and are not to have a smaller footprint than the plates they support. The minimum number of shim plates is to be used to achieve the desired elevation.

J. Lag Screws for Timber Guard

1. Lag screws are to be manufactured of copper bearing steel in accordance with the American Iron and Steel Institute specifications, latest revision, covering No. C-1115 carbon steel with a minimum of two tenths (0.20%) percent copper, or No. C-1020 carbon steel with a minimum of two tenths (0.20%) percent copper.

2. The design dimensions and threading are to include a gimlet point and conform to those shown on the plans.

3. The combination washer-head is to be forged by the upsetting process from one piece of steel and is to be concentric to the body of the screw. A slight draft on the sides of the head is permissible to prevent sticking in head shaping die, providing angle of draft is at a minimum so it will not contribute to wrench slippage.

4. Tolerances allowable in the dimensions are to be within those shown on the plans.

5. The lag screws are to be neatly formed and free from fins, nicks or injurious defects and are to have a workmanlike finish.

K. Hook Bolts

1. Hook bolts are to be hot forged in accordance with dimensions and details shown on the plans. Longer hook bolts are to be provided at locations where ties are thicker or track stringer flange thickness exceeds typical sizes, with the minimum increase to allow for one half of an inch (1/2”) of tie cover over the top of the hook bolt shank.

2. The chemical composition of the metal for the hook bolts is to conform to Specification No. AISI-C-1045, latest revision. The bolts are to be heat-treated to a Brinell hardness of between one hundred ninety seven (197) and two hundred fifty five (255).

3. The bolts are to be neatly formed, free from fins, nicks, injurious defects and have a workmanlike finish. The body of the bolt is to be straight and the hook is to be in alignment with the body of the bolt.

4. Hook bolt nuts are to be hexagon head, heavy steel (ANSI-B18.2.2), hot pressed, single chamfer, 3/4 in. - 10 UNC 2B.

5. Hook bolt washers are to be flat, wrought steel, thirteen sixteenths of an inch (13/16”) inside diameter by two inches (2”) outside diameter by five thirty-seconds of an inch (5/32”) thick.

L. Miscellaneous Material

1. Non-hardening roof cement is to be a non-hazardous material containing no asbestos. It is to have an asphalt base, be trowel grade, cling tightly to creosote treated ties and form a flexible, rubbery surface over time.

M. Track markers

1. A track marker is to be fabricated and installed for each one hundred foot station increment along the survey chaining length of each track based upon the

structure centerline alignment. The markers are to be fabricated from porcelain coated metal with metal grommets in the holes as described in the Contract Documents. The coating is to be yellow with black numbers and letters. The identification is to be LP with three numbers following to indicate what the whole station number is to identify the chaining along that portion of the track, or right-of-way. A pre-production sample of the marker is to be submitted to the CTA for review and approval prior to the start of work.

2. Refer to specification section 10 42 50 – Vitreous Enameled Steel Signs.

2.02 RAIL

Rail is to be as specified elsewhere in the Contract Specifications.

2.03 STEEL INSIDE GUARD RAIL (SIG)

A. The existing steel inside guard (SIG) rail is to be reinstalled and the joint bars, bolts, nuts and washers may be reused only if the joint bars are not disassembled. All missing or damaged joint bar assemblies are to be replaced. If the SIG is disassembled, the existing joint bars may be reused but new bolts, nuts and washers are to be furnished and installed.

C. The SIG is to be bonded to the structure at a bent and as shown on the Contract Drawings throughout the limits of the project.

D. SIG joint is to be bonded across the joint gap with two bonds welded to the head of rail as shown on the Contract Drawings throughout the limits of the project.

E. SIG bonds are to be installed away from the centerline of the track.

2.04 DELIVERY AND HANDLING

A. The Contractor retains the responsibility for the timely delivery of all material needed to complete the full scope of work defined by the Contract.

B. Handle all materials in a manner which will prevent damage or fouling during loading, transporting, uploading and distributing.

PART 3 - EXECUTION

3.01 SURVEY AND PROPOSED GEOMETRY

A. Refer to Book 1

3.02 TRACKWORK INSTALLATION

A. Track Construction:

1. All materials are to be transported to the worksite, unloaded, staged or stored in a manner that will prevent damage.

2. Not more than the bridge design loading is to be transported over the elevated

structure in the form of equipment or a combination of equipment, manpower and any concentration of material.

3. Any on-track equipment the Contractor would like to use must be certified by Skokie Shop personnel for compliance with CTA requirements and CTA clearance standards. The CTA will assist in coordinating the schedule with Skokie Shop to test any equipment not on the current bulletin of foreign equipment approved for use on CTA property.

4. Torch cutting of any rail at any time is prohibited. The exception to this requirement is for the expansion ends of the SIG. The end of the SIG rail is to be altered and torch cutting is allowed to configure the rail as shown on the Contract Drawings.

5. A comprehensive list of equipment, materials, personnel, and equipment workloads which the Contractor will place on the elevated structure during the trackwork construction is to be submitted. The list of equipment loads is to be checked by a licensed Structural Engineer registered in the State of Illinois. The Engineer is to certify that any probable arrangements of the above listed equipment, materials, personnel and equipment workloads will not result in stresses greater than the design stresses used in the design of the CTA structure.

6. Track is to be constructed to conform to the alignment data as proposed by the Contractor and accepted by the CTA following the track survey and analysis. Alignment, crosslevel, and profile are to be corrected where required. Alignment is based on the centerline of track, equidistant between the gage sides of the running rails and is to conform to clearances and dimensional requirements through each station platform area.

7. Installation of running rails is to be per AREMA specifications and will require the items as follows:

    a. All rail joints within the track renewal limits are to be disassembled and re-gapped following AREMA MRE Chapter 5 section 5.3.

    b. The base of rail is to be properly cleaned before the rail is laid.

    c. All holes necessary for application of joint bars are to be drilled with an approved rail drill. Punching or burning of holes in the rail is strictly prohibited. Rail drillings and shavings are to be removed prior to final installation of the joint bars.

    d. All joints for new rail, if required to be installed, and for existing rail to be reinstalled are to be assembled with new bolts, lock nuts and spring washers

    e. The existing disassembled rail is to be allowed to run prior to clipping to ensure the jointed rail can be gapped according to the temperature at the time of installation. The Contractor is to furnish the necessary quantity of new 115 RE running rail blanks to accommodate the staged construction. Blanks are to be cut to the required lengths to account for temperature lengthening of the rail and are not to be installed at lengths less than nineteen and one half (19.5’) feet.

8. New rails are to be installed at full thirty-nine foot (39') or eighty foot (80') lengths; any deviation must be approved in writing by the CTA prior to the start of work.

9. Installation of track ties, contact rail chair ties, and footwalk ties are to be per details shown on the Contract Drawings and per special tie drawings where applicable. Only one end of each non-chair tie may be predrilled for the hook bolt. One hook bolt is to be installed up tight to the edge of the track stringer before the other side hook bolt hole is drilled for hook bolt installation. Hook bolt nuts are to be torqued to 75 ft-lbs. Track ties are to be hook bolted, set, counter bored and drilled on the structure. Hook bolt holes are to be treated with copper naphthenate prior to installation of the hook bolt and filled with non-hardening roof cement after the installation of the hook bolt.

10. All ties are to be installed square to the track structure and/or the track centerline unless otherwise approved by the CTA in advance.

11. The counter bore holes to set the hook bolts in the track ties are to be drilled to a depth no greater than two inches (2") to allow for the proper engagement of the nut and washer and still provide adequate cover below the top surface of the tie.

11. All ties which are to be hook bolted are to be fully hook bolted before rail is set. Care is to be taken to ensure that the spikes in the tie plate and the lag screws in the timber guard do not touch the hook bolts. Should the signal system be fouled due to improperly installed spikes, the Contractor is responsible to make the necessary repairs to clear the signals. No extra Contract time and no extra Contract cost will be considered when the signal system is fouled.

12. Where identified for replacement, existing footwalk, planking/grating, and wayside platform decking/grating is to be removed, disposed of, and replaced with new materials as specified in the Contract Documents.

13. All footwalk ties are to be hook bolted to the structure. Hook bolts used for the installation of footwalk ties are to be counter bored.

14. Footwalk stringer joints are to be installed within one inch (1") from the centerline of the supporting tie.

15. Install all track bolts with the nuts fully tightened. If the insert pops out, then the lock-nut is considered spoiled and is to be replaced.

16. All rail joints on each track in the tangent sections are to be squared to allow each joint to be supported by the same three track ties. One tie is to be installed directly under the joint and one tie on each side abutting against the tie beneath the joint bar. This method of installation is a priority during construction. The Contractor is to notify the CTA if a location prevents standard installation practice prior to the start of work.

17. At locations where the cross-bents are higher than the stringers, the rail joint locations are to be planned for the adjustments necessary to properly space the ties and joints around the raised bents. No joint may fall over a bent.

18. Locations of cross level and longitudinal shimming are to be field verified by the Contractor after the structure has been loaded with the new track material. The

shim thickness is to start at one eighth of an inch (1/8") thickness and increase in thickness by increments of one eighth of an inch (1/8") every two ties up to and including two inches (2"). Cross level shimming is not required for deviations less than or equal to one half of an inch (1/4"). Longitudinal shimming is not required for deviations less than one eighth of an inch (1/8") unless otherwise approved by the CTA.

19. Tie spacing is not to be adjusted to clear bolts, rivet heads or other structural connections on the top flange of the stringers. Ties are to be installed one inch (1") away from raised top plates on the bents, except at locations indicated on the Contract Drawings where ties are installed across the raised bents. Notching of the ties may be required from the underside to allow the tie to fit on and around obstructions on the structure. Notching locations require approval of the CTA and are not to be done with a chain saw. All notching is to be considered included in the cost of the Contract. All notches and cuts are to be treated with Copper Napthenate before installation.

20. Timber guard is to be installed as shown on the Contract Drawings. Lag screws are not to be installed into every tie. Lags are to be positioned to ensure that they are not installed in conflict with the track fasteners or hook bolts. Ties split by improperly installed lags are to be removed and replaced by the Contractor with no extra Contract time and no extra Contract cost considered by the CTA. Some timber guard may need the base notched to enable installation around longer plates for curves or special trackwork. All notching is to be considered included in the cost of the Contract. All notches and cuts are to be treated with Copper Napthenate before installation.

21. Ties that support contact rail insulator chairs do not get installed with hook bolts, all other ties are to be hook bolted with two hook bolts each to the structure as shown on the Contract Drawings.

22. Standard tie spacing in tangent track and curved track of radius greater than fifteen hundred foot (1500') is twenty-four inches (24") maximum center to center, and in curved track of radius less than fifteen hundred feet (1500') and the associated spirals track ties are to be spaced eighteen inches (18") maximum center to center measured at the centerline of track. Spacing is to be adjusted where wayside steel platforms are located, exterior footwalk or skewed bents are present. The platforms may be for switch machines, impedance bonds, grease machines or other signal and traction power equipment.

23. At transitions between cast baseplates and rolled plates, steel shim plates are to be used to adjust for height differences between the plates. Shim plates are to be tack welded onto the baseplates after installation.

24. At transitions between cast baseplates and direct fixation plates, steel shim plates are to be used to adjust for height differences between the plates. Adjacent plates are not to have a height difference of more than one sixteenth of an inch (1/16").

25. Date nails, as specified in Section 34 11 34 Softwood Railroad Ties, are to be installed in a conspicuous location at or near the center of the top of the tie after the tie and other trackwork components have been installed.

B. Clearance Check:

1. The Contractor will perform an automated clearance check on all tracks impacted by the Contract. The track area is to be scanned in slices no greater than six inches (6”) apart using a proven device suitable for the purpose and is to provide measurements in relation to the CTA standard clearance envelope. Personnel performing the clearance analyses are to have at least three (3) years of verifiable experience performing similar tasks and operating the measurement system on passenger rail transit systems.

2. An example of a system that may be used is the Amberg Technologies GRP 5000 system or approved equal.

3. The Contractor will identify:

    a. Continuous structures (20" or longer) such as beams, piers, handrails, etc. that occur within the seven foot two inch (7'-2") clearance line, measured perpendicularly to the centerline of track, on both sides of and above the top of rail.

    b. Intermittent structures such as signals, poles, signs, electrical equipment boxes, pipes, doors, cables, and handrails which occur within the five foot seven inch (5'-7") clearance line or the six foot one inch (6’-1”) clearance at cab height, measured perpendicularly to the centerline of track, on both sides of and above the top of rail.

    c. Distance from track centerline to top and nearest edge of passenger platforms at each end of the platform and at maximum of ten foot (10’) spacing along the length of the platform. Distance to edge is to be taken from a plane orthogonal to the plane across the tops of both rails.

4. In identifying all of the above infringements of the clearance requirements, the Contractor will report to the CTA:

    a. Track number and stationing.

    b. Type of structure.

    c. Minimum distance from centerline of track to the structure, and direction left or right.

    d. Elevation above top of rail.

    e. Radius of track, if any.

5. Continuous infringement will be reported at minimum twenty (20’) foot spacing.

6. Contact rail location, gauge, and alignment will be measured separately to ensure compliance with listed tolerances.

7. The CTA will be available to assess the infringement and Contractor proposed corrective measures for each location as required. After corrective measures have been completed, another clearance check will be required to verify clearances have been met.

C. FINAL TRACK GEOMETRY CHECK

1. Final horizontal and vertical alignment, gage, superelevation and cross level will be within the tolerances specified. In order to determine the acceptability of finished track, the Contractor is to run a track measurement device suitable for purpose and capable of measuring the required measurements to within the tolerances specified elsewhere in this specification section before revenue service is resumed. The track measurement device is to be approved by the CTA and is to record the measurements taken in an electronic format suitable for record and presentation to the CTA. Personnel operating the measurement device are to have at least three (3) years of verifiable experience performing similar tasks and operating the measurement equipment on passenger rail transit systems.

2. An example of a system that may be used to conduct the above track geometry work is the Amberg Technologies GRP 1000 system or approved equal.

3. Track deviations disclosed by inspection, which exceed tolerances specified herein, will be corrected by the Contractor at no additional Contract time or cost considered by the CTA. The track will be re-measured as specified above by the Contractor to ensure that corrections have been made.

3.02 RUNNING RAIL

A. The Contractor must use care when handling the rail to prevent damage. The preferred method for rail handling is to pick up the rail at the head with tongs. If rails are handled using a forklift, the forks are to be smooth and lubricated prior to any rail handling. It is also acceptable to glue wood to the forks for protection. If rails are stacked for shipment or storage, wood spacers are to be placed between layers of rail.

B. The Contractor is to use an abrasive cutting disc for cutting rail. Care is to be taken to not overheat the rail while performing the cutting operation.

C. All rail joints are to be fully bolted with new bolt assemblies.

D. Running rail is to be connected to impedance bonds as required.

E. Running Rail Bonding: Two bonds are to be installed at each joint as shown on the Contract Drawings. Bonding will be for traction power negative return and/or signal continuity as shown on the Contract Drawings. The location of the welded bond on the rail must be properly cleaned prior to installation of the bond.

3.03 STEEL INSIDE GUARD RAIL (SIG)

A. SIG rail is not to be fastened until after the ties and running rail have been lined and shimmed to final line and grade.

B. SIG rail is to be placed directly on the ties and is to be installed parallel to the running rail with a clearance between rail heads and spiked as shown on the Contract Drawings. No SIG is to be higher than one half of an inch (1/2”) below the top of running rail.

C. End sections of each SIG rail are to be bent downward and also to flare toward the centerline of track as shown on the Contract Drawings.

D. The SIG rail is to be fastened to cross ties with two cut spikes per rail per tie and is to be installed without plates as shown on the Contract Drawings. Expansion gaps of two feet are to be provided at special trackwork, curved track or every two thousand (2,000’) feet along the SIG rail. Install the gap as shown on the Contract Drawings.

E. Existing joint bars to be reused are to be a minimum of twenty four inches (24”) long. Existing SIG rail is to be reinstalled and the joint bars, bolts, nuts and washers may be reused only if the joint bars are not disassembled. Missing or damaged joint bar assemblies are to be replaced. If the SIG is disassembled, the existing joint bars may be reused but new bolts, nuts and washers are to be furnished and installed. Any joint bar assemblies damaged as a part of the track renewal activities are to be replaced.

F. The SIG rail joints are not to be spiked. SIG rail is also not to be spiked within twelve inches (12”) of a SIG rail joint.

G. All existing SIG is to be bonded with two joint bonds at each joint in accordance with the Contract Drawings.

3.04 CONSTRUCTION WORK ZONES

A. The Contractor’s action plan and method of construction is to be submitted for review and approval prior to the start of construction. The submittal is to include, but not be limited to, the manpower numbers to be used, any and all equipment for both the demolition of the existing track and subsequent reconstruction, the ground forces used to support track construction and the number and type of vehicles and other heavy equipment to be used.

B. If the Contractor’s means and methods include the use of cranes, the Contractor will detail where the cranes will be deployed and provide verification that any and all surfaces the outriggers will set upon are not vaulted. The plan of operation for the use of cranes will also include the radius of operation to ensure that buildings in the area will not be damaged during operation. The plan of operation for the use of cranes will include the details for counterweights and verification that the loads to be lifted will be safely counterweighted to ensure that the crane will not tip over during work. The Contractor retains the responsibility for any and all liability for the use of cranes.

C. The Contractor’s plan of operation will include demonstration that adequate ground forces will be supplied to ensure that pedestrian and/or automobile traffic does not inadvertently or intentionally enter a work zone. The Contractor retains the responsibility and all liability for the safety of the public.

3.05 CENTER OF THE TRACK PLANKING AND STATION PLATFORM CLOSURE BOARDS

A. Center track planking is to be furnished and installed as indicated on the Contract Drawings. Planking is to be three (3) rows of two inch (2”) by six inch (6”) nominally sized treated wood boards. The minimum length of planking is to be eight feet (8’). Each end of the board is to occur at the center of a tie. The planking is to be installed using twenty (20d) penny, hot dipped galvanized, spiral shank nails; two (2) per board per tie, with each end securely nailed down. All boards are to be installed bark side up. Any cut ends are to be treated with Copper Napthenate prior to installation.

B. Two inch (2”) by six inch (6”) treated wood station closure boards are to be installed through the station limits between the outside timber guard and station platform supporting structure and are to follow the requirements stated above for center track planking except that it may be limited to one or two boards based on the gap width.

C. Two inch (2”) by six inch (6”) treated wood closure boards are to be installed between all exterior footwalks, platforms, and timber guards and are to follow the requirements stated above for center track planking except that it may be limited to one or two boards based on the gap width.

D. Track planking and closure boards are to be installed with one half of an inch (1/2”) spacing between each plank.

3.06 TRACK MARKER INSTALLATION

A. Track markers are to be installed as shown in the Contract Drawings.

B. Track markers are to be attached to the timber guard with three inch (3”) long, one-quarter of an inch (1/4”) diameter stainless steel lag screws with appropriately sized stainless steel flat washers installed between the lag screw head and the track marker. Pilot holes of an appropriate diameter are to be drilled before installation of the lag screw.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of ELEVATED TRACK CONSTRUCTION shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of ELEVATED TRACK CONSTRUCTION shall be included in the contract lump sum price as shown in the Schedule of Prices for TRACK WORK

4.03 PAY ITEM ACCOUNT NUMBER

A. TRACK WORK: 340000

END OF SECTION 34 11 10

SECTION 34 11 34
SOFTWOOD RAILROAD TIES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This specification section details the requirements to furnish dual-treated softwood railroad ties for open-deck, elevated rapid transit tracks.

B. Related Work:

1. Section 01 43 00, Quality Assurance
2. Section 01 45 00, Quality Control
3. Section 01 45 23, Testing and Inspection
4. Section 34 11 10, Elevated Trackwork Construction
5. Section 34 11 23, Special Trackwork Construction
6. Section 34 11 93, Miscellaneous Timber

1.03 DEFINITIONS

A. Railroad Tie Treating Plant – Location where railroad ties are seasoned and treated with preservative.

B. Independent Inspector – Third party inspector hired by the Contractor to verify that ties produced meet required material specifications.

C. CTA Representative – CTA employee or other person designated by the CTA to perform inspection and audits of railroad tie production at the plant.

D. Charge – Group of ties which have been exposed to the preservative treatment process.

1.04 REFERENCES

A. In all instances, the most recent version of each reference related to softwood railroad ties is to apply:

1. AREMA – American Railway Engineering and Maintenance-of-Way Association
2. AWPA – American Wood Preservers Association – Book of Standards
3. SPIB – Southern Pine Inspection Bureau – Standard Grading Rules for Southern Pine Lumber
4. ASTM – American Society for Testing and Materials

5. The Tie Guide – Handbook for Commercial Timbers Used By the Railroad Industry by David A. Webb

1.05 SUBMITTALS

A. Submit each of the following items in this Article according to the conditions of the Contract and Division 01 Specification Sections to the CTA for review and approval, unless otherwise indicated:

1. Prior to the Beginning of Production:

    a. Signed and notarized certification document from the Railroad Tie Treating Plant that all materials furnished will conform to the requirements of this specification.

    b. Signed and notarized certification attesting that the timber from which the ties were, or will be, sawn is in compliance with all governmental regulations. The certificate is to state any national forestry laws and regulations governing inspection of the forest areas and any limitations of the felling of the species supplied.

    c. Schedule of tie dimensions and quantities to be supplied.

    d. Schedule of tags for tapered ties, showing dimensions and quantities of ties associated with the tags.

    e. Tie Product Data:

        i. Location of forests from which wood is to be harvested.

        ii. Means and methods of transportation from harvesting areas.

        iii. Species of wood to be supplied.

        iv. Product data sheet showing the physical properties of each species of wood to be used.

    f. Operation Plan, which is to include, but not be limited to:

        i. Method of seasoning.

        ii. Name and location of the Railroad Tie Treating Plant.

        iii. Creosote treatment process and method of application.

        iv. The method of borate treatment and any documentation supporting the effectiveness of the method of borate treatment.

        v. Other substitute methods of preservative treatment requested to be used.

    - vi. Key Railroad Tie Treating Plant personnel and inspectors and their qualifications.
    - vii. Quality Control Process Plan.
  - g. Product data and pre-production sample of the date nail.
  - h. Product data and pre-production sample of tapered tie identification tags.
  - i. Product data sheet showing the dimensions and physical properties of the proposed anti-splitting multi-nail plate and pre-production sample of the anti-splitting multi-nail end plate.
  - j. Proposed means of delivery of ties to the specified delivery location.
  - k. Independent Inspector:
    - i. Contact information and qualifications of Independent Inspector.
    - ii. Testing and inspection procedure of the Independent Inspector describing how the Independent Inspector will ensure that all ties produced under the contract are in compliance with the Contract Documents.
- 2. Within two (2) weeks following the first charge:
  - a. Preservative penetration core sample reports and physical samples from the first charge.
  - b. Treatment report for the first charge.
  - c. Daily inspection reports of the Independent Inspector.
- 3. Within two (2) weeks following completion of all tie production:
  - a. Signed and notarized certificate which verifies that the ties furnished are in compliance with all Contract requirements.
  - b. Preservative penetration core sample reports and physical samples for all charges.
  - c. Treatment reports for every treatment charge of ties.
  - d. All daily inspection reports of the Independent Inspector.

1.06 QUALITY ASSURANCE

- A. The Contractor is to employ, at his own expense, a qualified Independent Inspector, with at least five (5) years experience performing similar work, to conduct specified Source Quality Control and provide reports to the CTA.
- B. The role of the Independent Inspector is to provide an independent review of the Quality Control process plan of the Railroad Tie Treating Plant and ensure that it is being implemented.

C. CTA reserves the right to inspect or appoint a representative to act on behalf of CTA, to inspect and verify the Contractor's QC processes.

D. CTA's representative and the Independent Inspector are to be afforded, at no additional cost to CTA, reasonable access to all the necessary facilities, equipment and labor at the tie supplier's facilities to enable verification of the Contractor's QC and to perform product inspection at all stages of production, or as deemed necessary by CTA, during normal working hours.

E. Any tie that does not comply with the CTA's specifications or which, not with-standing tests, inspection or acceptance at any previous time or location, is found to contain deficiencies, will be rejected.

F. Any inspector designated by the CTA to inspect ties on its behalf or the Independent Inspector may interrupt production of the ties if the daily rejection rate exceeds twenty (20%) percent, as computed on a board footage basis and determine the cause of rejection prior to restarting production of the ties.

G. All treating reports are to be made available for the review of the CTA's representative and Independent Inspector.

PART 2 – PRODUCTS

2.01 GENERAL

A. Timber Properties:

1. All ties furnished and installed are to be Southern Yellow Pine and are to be visually graded in accordance with ASTM D245 and the grading rules of the Southern Pine Inspection Bureau (Standard Grading Rules for Southern Pine Lumber) and meet the requirements of Dense Select Structural or better.

2. All ties are to be produced from the AREMA softwood group Tb, species Southern Yellow Pine.

3. Ties produced from needle-leaved trees are to be of compact wood throughout the top fourth of the tie, where any inch of any radius from the pith is to have six or more rings of annual growth.

4. Timbers from which ties are produced are to be cut from straight, sound trees.

5. The rail bearing areas (RBA) of ties are to have the maximum amount of clear, straight grain. Rail bearing areas are those sections between twenty (20) inches and forty (40) inches from the center of the tie. Tie dimensions are to be as indicated in the Contract Documents.

6. The top face of the tie is to be the wide face farthest from the heart or pith center of the tie.

B. Dimensions:

1. All ties furnished are to conform to AREMA, six (6) inch grade. Non-tapered timbers, prior to seasoning, are to measure six (6) inches thick by nine (9) inches wide by nine (9) feet long, with switch ties furnished in one (1) foot length increments from ten (10) feet to twenty-four (24) feet, with all lengths measured

throughout the section defined by planes normal to the axis of the tie and located twelve (12) inches from each end.

2. Tapered tie thicknesses will be specified individually within another specification section.

3. All ties furnished are to be sized within tolerances as follows:

    a. Width: Zero (0) inches under the specified width and one-half (1/2) inch over the specified width.

    b. Thickness: One-eighth (1/8) inch under the specified thickness and Zero (0) inches over the specified thickness.

    c. Length: Zero (0) inches under the specified length and three (3) inches over the specified length.

4. Ties are to be straight on all surfaces with the opposite sides parallel. Ties will be considered straight when determined as follows:

    a. Straightness for members twelve (12) feet long and less:

        i. Thickness Dimension: Ties will be considered straight when a straight line along the depth face from the middle of one end to the middle of the other end is no closer to the edge of the tie than one-half the tie width dimension, plus one-quarter (1/4) inch or minus one-quarter (1/4) inch.

        ii. Width Dimension: Ties will be considered straight when a straight line along the width face from the middle of one end to the middle of the other end is no closer to the edge of the tie than one-half the tie width dimension, plus one-half (1/2) inch or minus one-half (1/2) inch.

    b. Straightness for members greater than twelve (12) feet long:

        i. Thickness Dimension Ties will be considered straight when a straight line along the depth face from the middle of one end to the middle of the other end is no closer to the edge of the tie than one-half the tie depth dimension, plus one-half (1/2) inch or minus one-half (1/2) inch.

        ii. Width Dimension: Ties will be considered straight when a straight line along the width face from the middle of one end to the middle of the other end is no closer to the edge of the tie than one-half the tie width dimension, plus one (1) inch or minus one (1) inch.

5. All ties are to be S4S to dimensions of six (6) inches thick by nine (9) inches wide, unless otherwise noted, and have lengths as indicated on the Contract Drawings.

6. Tapered ties are to be furnished for open deck super-elevated curved track as indicated. The width of tapered ties is to be nine (9) inches.

7. Head-block ties are to be S4S with dimensions of six (6) inches thick by eight (8) inches wide and lengths as indicated on the Contract Drawings.

8. Ties are to be well sawn and cut square at both ends. A tie is not well sawn when its surfaces are cut into with score-marks more than one-half (1/2) inch deep, or when its surfaces are not even.

9. Ties are not to be bored or adzed.

C. Imperfections:

1. The ties are to be visually graded in accordance with the grading rules of the West Coast Lumber Inspection Bureau and Southern Pine Inspection Bureau (SPIB) Special Product Rules for Structural, Industrial and Railroad-Freight Car Lumber.

2. All members are to be straight grained.

3. Ties are to be free from the following defects:

   a. Decay - All ties furnished are to be free from any defects that may impair strength and durability in service. Timber is to be fresh cut, free from “White Rot” or other deformities, so as not to contain extensive checking or twisting of the member.

   b. Holes - Ties with hole diameters greater than one-half (1/2) inch and depths of three (3) inches will be rejected.

   c. Knots - Sound knots of two (2) inches in diameter or less are acceptable. The sum of the diameters of all knots in any one (1) foot length is not to exceed four (4) inches. Open or loose knots are not acceptable. Knots in clusters are not acceptable.

   d. Shakes - Ties with a shake more than one-eighth (1/8) inch wide and/or length of more than two (2) feet and within one (1) foot of any face will be rejected.

   e. Checks - Ties with checks over one and one-half (1-1/2) inches deep or over one-half (1/2) inches wide on any face or longer than two (2) feet will be rejected.

   f. Splits -Ties containing a split one-half (1/2) inch in width or wider or five (5) inches in length or longer will be rejected. End splits and shrinkage cracks found in the tie after seasoning, which are not located within the bearing area of the tie and do not impair the fastening or strength of the material, may be permitted with the approval of the Independent Inspector or CTA representative.

   g. Slanting Grain - Ties with loose cross grain will be rejected and ties with slanting grain in excess of one (1) inch in any ten (10) inches of length will be rejected.

   h. Wane – The maximum wane across the top and bottom surfaces (faces) of the tie is not to exceed one (1) inch.

   i. Bark Seams – Bark seams if more than two (2) inches deep or more than ten (10) inches long anywhere in the tie will not be accepted.

   j. Twist – Ties with twist will be rejected.

2.02 PREPARATION

A. Seasoning:

1. The ties are to be seasoned per the Contractor’s submitted and approved tie seasoning plan.

2. Ties are preferred to be air seasoned prior to treatment. Ties are incised and then stacked for seasoning in accordance with the AREMA Manual. Seasoning is to ensure that the entire cross section of the timber is at or below a moisture content of twenty (20%) percent (moisture levels are to be determined by a moisture meter) as specified for the size of each piece by the most recent version of SPIB.

3. As an alternative to air-seasoned ties, the Boulton drying process may be used with approval of the CTA.

4. Prior to seasoning, a hot-dipped galvanized, steel standard anti-splitting multi-nail plate is to be applied to each end (cross-section) of every tie. Each plate is to have a tooth density of four point three (4.3) teeth per square-inch.

5. Plates are to be positioned and installed to cover the greatest area of splitting and to hold both vertical and horizontal splits together. Plates are to allow for at least a one-quarter (1/4) inch, but no more than one and one-half (1-1/2) inch, of space between the edge of plate and the edge of tie. Nail plates are to be installed after the ties have been inspected. More than one nail plate may be required for tapered ties. Non-standard manufactured end nail plates may be utilized with approval of the CTA.

6. All steel nail plates used are to be made of eighteen (18) gage galvanized sheet steel ASTM A653/A653M Structural Steel (SS) Grade forty (40) or better with a minimum coating designation of G60. ASTM A653/A653M SS Grade forty (40) G60 mechanical properties are as follows:

   a. Yield Strength – Forty-thousand (40,000) psi minimum

   b. Ultimate Tensile Strength – Fifty-five thousand (55,000) psi minimum

   c. Elongation in two (2) inches – sixteen (16%) percent minimum

7. Employ adequate means and methods to minimize defects caused by the seasoning process.

B. Preservation:

1. Ties are to be marked prior to preservative treatment, or at the time of delivery to the Railroad Tie Treating Plant, in accordance with the current AREMA Manual, except as specified below:

   a. Marking is to indicate the manufacturer’s name or trademark and year of production and the manufacturer’s plant identification in figures at least one-half (1/2) inch high.

   b. If plant is so equipped, kerf marks are to be made on the top face of the tie, the wide face farthest from the heart or pith center of the tie.

2. Each tie furnished is to have a date nail furnished, separately, that is to be installed in the field after ties have been installed. The date nail is to be no less than two (2) inches long under the head and the head is to be no less than one-half (1/2) inch in diameter. The date on top of the nail head is to have the last two (2) digits of the year the tie was treated and those numbers are to be raised no less than one-eighth (1/8) inch above the surface of the head. The nail may not have depressed or cut numbers for the date. The nail may be either aluminum or hot dipped galvanized steel.

3. Each tapered tie furnished is to be tagged at the Railroad Tie Treating Plant with a stamped, embossed zinc metal tag, attached to the tie by means of a galvanized roofing nail. These tags are to be installed on the top side of the tie at the middle of its length dimension.

4. The one and one-half step treatment process may be acceptable if proposed by the tie producer and approved by the CTA. Additional documentation of the treatment process may be required to be submitted to the CTA.

5. All ties are to be treated by the AREMA Standard Rueping Process (empty cell process) in conformance with the AWPA T1, section C, ‘Ties and Switchties Processing and Treatment Standard’.

6. Ties are to be subjected to a final vacuum treatment, after the creosote process treatment, to minimize dripping and bleeding of the preservative from the faces of the timber.

7. Finished ties are to be clean and free of all dirt, debris and excess treatment solution.

8. Retention:

    a. Treatment is to be measured by gauge retention.

    a. All ties are to be treated according to AWPA U1 Commodity Specification C: Ties and Switch ties.

    b. Per AWPA T1, the net retention in any charge is to not be less than ninety (90%) percent of the retention specified, but the retention of five (5) consecutive charges are to be at least one hundred (100%) percent.

9. Penetration:

    a. Borings two and one-half (2-1/2) inch deep are to be taken at random, representative locations from the center of the narrow face of a representative sample of twenty (20) ties per charge to ensure proper creosote retention. Per AWPA T1, if eighty (80%) percent of the borings meet the penetration requirements, with no single reading below two (2) inches, then the charge is to be accepted.

    b. AWPA treatment requirements related to creosote treatment are to apply to all wooden ties.

    c. Core holes are to be saturated with the preservative solution prior tothe insertion of plugs.

    d. Core holes are to be fitted with tight, creosote-treated plugs after sampling.

   e. Timber failing to meet the penetration requirement may be re-treated and re-tested at the Contractor’s option. If the charge continues to not meet penetration requirements, the ties will not be accepted.

10. Reporting: All charge reports must list:

    a. Borate Preservative Solution Gauge Retention, if applicable.

    b. Borate Preservative Solution Concentration (% DOT borate).

    c. Creosote or Copper Naphthenate Preservative Solution Gauge Retention.

    d. Creosote or Copper Naphthenate Preservative Solution Concentration.

    e. Creosote Preservative Solution Concentration (% DOT borate).

    f. Retention of active ingredients (pcf of DOT borate).

C. Borate Dual-Treatment

1. Due to the properties of the borate preservative solution, no sterilization period is required.

2. The preferred borate treatment method is to treat all ties with (DOT borate) prior to placing the ties in the air-seasoning yard. The borate treatment is to be conducted on “green ties” in such a way that the borate is able to fully diffuse throughout the entire tie.

3. Required retention for borate treatment is to be zero point twenty-seven (0.27) pounds per cubic foot (pcf) of active ingredient (DOT borate) for all species groups.

D. Creosote Ties:

1. The preservative used must conform to AREMA Manual for Railway Engineering and American Wood Protection Association (AWPA) Standard P2. The creosote preservative must allow the ties to be properly dual-treated as specified. The solutions are to be checked periodically by the Railroad Tie Treating Plant and the Independent Inspector to verify that their concentrations meet the requirements of the specifications throughout the treatment process and that the treatment test reports show that treatment requirements are being met.

2. Creosoted ties must be dual-treated using the two-step process, utilizing Disodium Octaborate Tetahydrate (DOT borate) during the first step and Creosote during the second step.

E. Copper Naphthenate Ties:

1. The preservative used must conform to AREMA Manual for Railway Engineering and American Wood Protection Association (AWPA) Standard P36. The solvent used will be No. 2 fuel oil meeting AWPA standard HASA.

2. The penetration must adhere to the minimums in 2.02 B 11 and with exceptions as follows:

    a. Core holes must be saturated with Copper Naphthenate solution prior to the insertion.

b. Core holes will be tight fitted, pressure treated hardwood plugs after sampling.

c. Cores must be furnished to the CTA or CTA's contractor upon request.

3. Ties will be subject to a final vacuum treatment, after the Copper Naphthenate pressure treatment, to minimize dripping and bleeding of the preservative from the faces of the timber.

2.03 SOURCE QUALITY CONTROL

A. Railroad Tie Treating Plant, at a minimum, is to perform the following:

1. Test each charge to quantitatively obtain tie moisture content, creosote penetration and retention, borate penetration and retention and other physical properties required by this specification.

2. Take twenty (20) boring samples of a representative number of ties per charge of preservative.

3. Prepare treatment reports, containing, but not limited to, all information recorded during conditioning and treatment as detailed in AWPA M2, 'Standard for Inspection of Wood Products Treated with Preservatives'.

B. Independent Inspector:

1. Serves as a third party verifier of product quality.

2. Performs one-hundred (100%) percent inspection of the ties, during the grading process, prior to the preservative treatment. Makes reasonably close inspection to the top, bottom, sides and ends of each tie prior to the preservative treatment. Each tie is to be judged independently without regard to decisions on other ties in the same lot.

3. Inspects materials, processes and preservative treatment of the Railroad Tie Treating Plant in accordance with AWPA M2.

4. Performs a visual penetration inspection of all borings taken from the ties, as detailed in the AWPA standards.

5. Performs one-hundred (100%) percent inspection of ties after the treatment process.

C. In accordance with AWPA, the Contractor is to provide written notification to the CTA at least two weeks prior to the commencement of the various inspections identified in the standard.

D. CTA may choose to perform any additional inspections of the ties during fabrication and after delivery to determine conformity to these specifications. CTA may also choose to witness any inspections performed by the Independent Inspector.

PART 3 – EXECUTION

3.01 DELIVERY, STORAGE & HANDLING

A. At all times during the transportation, seasoning, manufacturing and delivery process, the Contractor is to protect the product from destructive agents including, but not limited to, fungal infection, disease and insect infestation. The Contactor is to immediately correct any conditions found to be detrimental.

B. Ties are to be shipped to the location(s) as indicated in the Contract Documents.

C. Ties are to be double-banded in bundles of the same size and type. Unless otherwise indicated, each bundle will contain thirty-six (36) ties stacked six (6) ties high by six (6) ties wide. The bundles are to weigh no more than six thousand (6,000) pounds each.

D. Each bundle of ties is to be labeled in such a way that allows them to be easily categorized, either by use of color-coding or a numbering system. Timber tie bundles are to be identified with the name and address of the customer, the name of the Railroad Tie Treating Plant, the tie size dimensions and the quantity of ties within the bundle.

E. Ties are to be stored at all times prior to shipment in accordance with AREMA practices and the current AWPA M4 ‘Standard for the Care of Preservative-Treated Wood Products’.

F. Tie bundles are to be stored so that all bundles are accessible for inspection.

G. Stored ties, stacked in layers, are to be separated by at least two (2) inches between sides and two (2) inches vertically to allow for good air flow between layers. The individual stacks need at least three (3) feet of free space between stacks. The yard must be well-drained and free of weeds. Ties are to be stored on four (4) inch by four (4) inch timbers every four (4) feet along the length of the ties.

H. Bundles of ties to be shipped are to be stacked and secured on an open bed trailer truck, suitable for removing the tie bundles with a forklift loader.

I. Final acceptance of ties will be subject to verification of count and inspection after delivery to the locations indicated in the Contract Documents and receipt of required shipping documents, inspection reports and certificate of compliance.

J. The Contractor will bear the cost of handling and transporting rejected material, regardless of when and where the rejection is made.

K. All ties furnished and delivered are to be clean and free of all dirt, debris and excess creosote.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of SOFTWOOD RAILROAD TIES shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of SOFTWOOD RAILROAD TIES shall be included in the contract lump sum price as shown in the Schedule of Prices for TRACK WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. TRACK WORK: 340000

END OF SECTION 34 11 34

SECTION 34 11 93
MISCELLANEOUS TIMBER

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This Section specifies the requirements to furnish and install treated timber guard, footwalk decking, platform decking, station platform timber, footwalk ties, center planking, closure boards and other treated lumber required to complete the scope of work detailed on the plans and specified elsewhere.

B. The Contractor is to furnish all labor, tools, equipment and incidentals as necessary to install the required sizes and quantity of treated timber.

C. Related work specified elsewhere includes:

1. Section 34 11 10 Elevated Trackwork Construction.

2. Section 34 11 33 Softwood Railroad Ties.

1.03 REFERENCES

A. The most recent version of each standard that relates to softwood lumber as follows:

1. AREMA – American Railway Engineering and Maintenance of Way Association.

2. AWPA – American Wood Protection Association

3. SPIB – Southern Pine Inspection Bureau

1.04 SUBMITTALS

A. The Contractor is to submit shop drawings and other appropriate documentation to the CTA for review and approval prior to the start of work to verify conformance with the Contract for the materials and the treatment required.

B. The Contractor is to submit certification from the lumber mill that verifies the structural density of the material furnished and certification from the treatment plant that the lumber has been treated to the specific density required by Contract. The certification is to be presented on each respective company’s letterhead and signed by an appropriate representing officer of each company.

C. Samples per Section 2.06 Quality Control and Inspection.

PART 2 – PRODUCTS

2.01 GENERAL

A. The Contractor is to furnish and install all treated timber required for the completion of the work as shown on the plans and as specified herein.

B. All timber, planking and decking is to be Southern Yellow Pine, Dense Structural Grade or better.

C. The timber guard is to not have gang nail plates or ‘s’ irons installed on the ends.

D. All required fasteners will be galvanized in accordance with ASTM 153 D.

2.02 SEASONING

A. The seasoning process chosen by the Contractor is to ensure that the entire cross section of the timber is seasoned to be at a moisture content of twenty-five (25%) percent or less. It is suggested that the material should be air dried; however, various methods of artificial seasoning may be acceptable. It is suggested that the material should be kiln dried; however, air seasoning is acceptable. Documentation indicating that the Contractor has verified the moisture content of the lumber was as specified is to be submitted for review and approval by the CTA prior to the start of work.

B. The Contractor is to employ adequate means and methods to minimize defects caused by the seasoning process.

C. Kiln dried material is acceptable; however, all other artificial seasoning methods must be submitted to the CTA for review and approval prior to the start of work. The CTA will not consider extra Contract time or extra Contract cost for the Contractor if a method is not accepted.

D. Incising of lumber is strictly prohibited.

2.03 PRESSURE TREATMENT

A. The Standard Rueping Process in strict conformance with the current AWAP T1 Specification must be used to treat all timber products by Pressure Processes.

B. The Creosote preservative used must conform to American Wood Protection Association (AWPA) Standard P2.

C. Copper Naphthenate preservative used must conform to American Wood Protection Association (AWPA) Standard P36. The solvent used is to be No. 2 fuel oil meeting AWPA standard HASA.

D. After the pressure treatment, all treated lumber is to undergo a final vacuum treatment and a final steaming treatment to minimize dripping and bleeding of the preservative from the faces of the timber.

D. Retention and Penetration

1. The timber must be treated by an empty cell process to a minimum retention of eight (8 lbs/ft^3) pounds per cubic foot ~~with~~ per AWPA P2 for Creosote-Coal Tar or P36 for Copper Naphthenate.

2. The penetration must meet the minimum requirements set by AWPA T1.

2.04 QUALITY CONTROL AND INSPECTION

A. Treatment penetration is to be determined by destructive testing using bored cores taken from the center of no less than twenty (20) randomly selected pieces of timber guard from each charge of material treated. If the borings meet the penetration requirement, with no single reading below two (2”) inches, the lot is to be accepted.

   1. Core holes must be saturated with the same preservative solution used to treat the timber product prior to the insertion of plugs.

   2. Core holes must be fitted with tight plugs treated with the same preservative solution used to treat the timber product after sampling.

   3. Timber failing to meet the penetration requirement may be retreated and re-tested at the Contractor’s option.

   4. Cores must be furnished to CTA or CTA’s contractor for review and approval prior to the start of work.

B. All sections furnished smaller than the timber guard are to have (3) three randomly selected pieces from every five hundred (500) pieces treated that will be sawn in half to reveal the full penetration of preservative. A four (4”) inch length of those pieces shall be submitted to the CTA for review and approval prior to the start of work.

C. The treatment plant is to submit the test samples under a cover letter of certification that the samples are representative of the full quantity of material furnished. The certification is to be signed by an authorized officer of the company.

2.05 DIMENSIONS

A. The timber guard is to be sized six (6”) inches by eight (8”) inches. The eight (8”) inch dimension must be exact in order to comply with the CTA clearance diagram. The footwalk ties are to be sized six (6”) by six (6”) and shaped as shown on the plans. All timber in this section is to be full size and surfaced S4S. The minimum length of timber guard is to be no less than sixteen (16’) feet.

B. The decking (2”x6”), platform (4”x4”), and footwalk support timbers (4”x6”) are to be nominally sized.

2.06 FINISH

A. No gang nail or ‘s’ irons are to be installed on any timber furnished under this specification.

PART 3 - EXECUTION

3.01 TIMBER GUARD

A. The timber guard is to be furnished and installed with the eight (8”) inch side vertical and lagged into each tie, with a twelve (12”) inch copper bearing steel lag screw, in a serpentine pattern as shown on the plans. The bark side is to be installed upward. For timber guard with vertical grain the bark side shall be installed toward the field side of the track.

B. When installed in curve locations, the timber guard is to be sliced vertically every three (3’) feet through the piece in order to allow for the timber to be bent and conform to the curved track geometry detailed on the plans.

C. When the timber guard is modified for the curve, if the cut is deep enough to expose the untreated portion of the tie, then non-hardening roof cement shall be used to cover the exposed un-treated wood to prevent moisture from entering the exposed interior timber.

3.02 PLATFORM AND FOOTWALK DECKING

A. The two by six (2” x 6”) inch deck boards are to be furnished in thirty (30”) inch lengths and eight (8’,) twelve (12’,) or sixteen (16’) foot lengths as necessary. The various lengths must be furnished to minimize field cutting of the timbers.

B. In all locations for all wood furnished and installed, when the grain is flat, the bark side is to be installed facing upward. For vertical grain pieces the bark side is to be installed toward the base of rail. Failure to comply with this directive is to result in replacement of all wood improperly installed with new wood at no change in Contract time and no change in Contract cost considered.

C. All boards are to be installed with the entire piece fully treated. Cut ends are to be minimized at all times everywhere on the project. Untreated ends are to be suitably treated with an acceptable product. The treatment product must be submitted for review and approval by the CTA, if it is necessary. The treatment product is to be considered incidental cost to the Contract and the application is to be done at no change in Contract time and no change in Contract cost.

D. All decking is to be installed using twenty penny (20d, .162” minimum diameter, 4”), spiral shank, hot dipped galvanized deck nails. All nails are to be driven at a slight angle from perpendicular. Nails found driven perpendicular are to be removed and the entire board replaced at no change in Contract time and no change in Contract cost.

E. Track planking, wayside platform decking and footwalk decking is to be installed with one-half (1/2”) inch gaps. Wayside platform decking is to be installed with a one-eight (1/8”) inch between deck boards to allow for air circulation, drainage and expansion.

1.01 FOOTWALK SUPPORT

A. The footwalk shall be supported throughout the project using nominally sized four by six (4”x 6”) inch timbers.

B. Raised decking around special trackwork must be supported on nominally sized four by six (4”x 6”) inch timbers.

C. Footwalk supports are to be installed using hot-dipped galvanized metal clips and straps as shown on the Contract Drawings.

D. Each end of each support timber must fall within one (1”) inch of the centerline of that tie.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of MISCELLANEOUS TIMBER shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the Work of MISCELLANEOUS TIMBER shall be included in the contract lump sum price as shown in the Schedule of Prices for TRACK WORK

4.03 PAY ITEM ACCOUNT NUMBER

A. TRACK WORK: 340000

END OF SECTION 34 11 93

SECTION 34 21 25

TRACTION POWER CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 01 Specification sections, apply to this section.

1.02 SUMMARY

A. This section specifies the requirements for providing 500, 929, 1,000, 1,111, 1,500, and 2,000kcmil traction power cables, which are used in the traction power distribution circuit of Chicago Transit Authority's (CTA) Rapid Transit system.

B. Provide new, ethylene propylene rubber (EPR) insulated, thermoset, low smoke, non-halogen cross-linked polyolefin jacketed cables which will be rated for 2,000 volts, or higher, for use on the DC distribution system. The cable will have excellent heat and moisture resisting characteristics and be rated for 90ºC normal operation in wet/dry locations, 130ºC for emergency and 250ºC for short circuit operation. The cable will have special fire resistant characteristics. The cable insulation and jacket will be halogen free. The cable will be listed and approved by UL where applicable.

C. Procure the cables only from well known experienced manufacturers engaged in regular commercial production of the specified cables. The manufacturer will have not less than ten (10) years of practical and successful commercial field experience with the EPR insulation and low smoke, non-halogen, cross-linked polyolefin jackets. The manufacturer will furnish complete technical information to demonstrate that the insulation and jacket meet the requirements of this specification for the type and size of cable involved. Failure to supply satisfactory evidence of this experience will be sufficient cause for rejection of the manufacture.

D. Related Sections: Related work specified elsewhere includes:

   A. Section 34 21 61 - General Provisions Traction power

   B. Section 34 24 23 - Contact rail Bonding

   C. Section 34 21 46 - Traction Power Cable Lugs

   D. Section 34 21 47 - Cable Tags

   E. Section 34 21 41 - D.C. Disconnect (Knife) Switches Enclosures

1.03 REFERENCES

A. The construction and testing of the cables will conform to the latest editions of the following applicable standards:

1. ASTM Standard B 8-99 Specification for Concentric Lay Stranded Copper Conductors
2. ASTM Standard D 470-99 Test Methods for Cross Linked Insulations and Jackets for Wire and Cable
3. ASTM Standard D 471-98 Test Methods of Rubber Property – Effect of Liquids
4. ASTM Standard D 573-99 Test Method of Rubber – Deterioration in Air
5. ASTM Standard D 2240-02 Test Method for Rubber Property – Durometer Hardness
6. ASTM Standard D 2802-98 Specification for Ozone-Resistant Ethylene-Alkene Polymer Insulation for Wire and Cable
7. ASTM Standard D 2863-00 Test Method for Measuring the Minimum Oxygen Concentration for Candle Like Combustion of Plastics

8. ASTM Standard E 662-03 Test Method for Specific Optical Density Smoke Generated by Solid Materials
9. ICEA S-19-81 (NEMA WC 3)(1990)
10. ICEA S-95-658-1999Standard for Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
11. IEEE Standard 383
12. MIL C-24643
13. Naval Engineering Standard - 711
14. Naval Engineering Standard – 713
15. National Fire Protection Association 70-2005 Edition
16. Underwriter Laboratories 1072

B. Where standards are at variance with each other or with other parts of this specification, the most stringent requirements, as determined by an Engineer from the Chicago Transit Authority, will apply.

1.04 SUBMITTALS

A. Submit shop drawings showing the cable construction details and cable ratings in accordance with Division 01 Section, Submittals. Also include:

1. Test data from previous tests
2. Suggested cable pulling compound and storage/handling requirements
3. Maximum allowable pulling tension
4. Maximum allowable sidewall pressure
5. Minimum bending radius
6. Size of cable
7. Quantity of cable in feet
8. Cutting lengths in feet
9. Reel size

B. Submit certified test reports for all specified technical data that illustrates the manufacturer’s ability to successfully manufacture the cable. Include a detailed list identifying previous users, date cable was supplied, and name and telephone number of references. If the Contractor is unable to provide this information upon request, the manufacture may be rejected.

C. The Contractor will supply a signed statement that the cable insulation and jacket proposed has been tested for, and complies with the requirements of this specification. The Contractor will furnish a certified copy of the result of these tests.

D. Submit the trade name of the insulation and jacket which is proposed to be furnished on this Contract.

E. Cable identification will be printed on jacket at 3 feet intervals with manufacturer's name, year of manufacture, conductor size, voltage, insulation and jacket type. The center strand of 500, 1,000, 1,500 and 2,000 kcmil cable will be stamped at six (6) inch intervals, as follows: manufacturers and customer’s (CTA) ID and year of manufacturing.

F. The Contractor will furnish complete technical information to ensure that the insulation and jacket are compatible for the type and size of cable involved. The Contractor will quote the insulation and jacket thickness as specified. The Contractor will have had not less than seven (7) years of practical and successful commercial field experience with the EPR insulation and low smoke, non-halogen, cross linked polyolefin jacket. Failure to be able to supply satisfactory evidence of this experience will be the cause for rejection of his/her proposal.

PART 2 - PRODUCTS

2.01 INTENDED USE AND STRANDING

A. Cables covered in this section are intended for use in dc traction service operated on a 600 Volt nominal system subjected to additional voltages as may occur on the account of switching and operation of trains and rectifier equipment. Cables will be suitable for installation in wet or dry locations, in exposed or underground/encased conduits, trays, cable racks, direct buried or exposed.

B. Cable Conductor - The conductor will be uncoated soft-drawn annealed copper conductor, 98.16% (min.) conductivity at 25 degrees Celsius, Class B stranded compressed concentric round per ASTM B 8. The conductor will conform to all requirements called for in ICEA S-96-659 for Ethylene Propylene Rubber-Insulated Wire and Cable for Transmission and Distribution of Electrical Energy and in ASTM B-8.

C. Conductor stranding and insulation thickness will be in accordance with Table 1 of this specification and will be in conjunction with the size of the cable as called for in the Contract Documents.

Table 1 – Conductor Stranding, Insulation and Jacket Thickness

Size (KCMIL)	**Number of Strands**	**Insulation Thickness (Mils)**	**Insulation AC Test Voltage (V)**	**Jacket Thickness (Mils)**	**Maximum Conductor Resistance (Ohms/1000ft)**
500	37	110	10,000	90	0.02197
929	2300 to 2331	90 to 125	11,000	65 to 110	0.0122 to 0.0129
1000	61	125	11,000	110	0.01098
1111	2745 to 2750	115 to 145	13,000	95 to 110	0.0104 to 0.011
*1500	91	145	13,000	110	0.00732
*2000	127	145	13,000	110	0.00549

*Not UL Listed

2.02 INSULATION

A. The cable insulation will be ethylene propylene rubber (EPR) insulation rated at 90 degrees Celsius wet or dry for normal operation. The insulation will be rated for 130°C emergency overload temperature and 250°C short circuit temperature.

B. The insulation will comply with ASTM D: 2802-1998 “Ozone-Resistant Ethylene Alkene Rubber Insulation for Wire and Cable”. However, relative to Para 5.3.2 of ASTM D 2802, the insulation resistance will be not less than 100% (not 60%) of that required for the primary insulation based of the thickness of that insulation even if a non-conducting separator is used.

C. The EPR insulation will conform to the physical and electrical requirements, including moisture and voltage tests, as called for in Tables 1 and 2 of this specification.

D. All test samples will pass all moisture and voltage tests called for in this specification.

E. The insulation will strip easily and cleanly from the conductor. An opaque polyester tape is optional and, if used, will be applied between the conductor and EPR insulation to facilitate ability to strip.

F. The insulation thickness and AC test voltage will be in accordance with Table 1 of this specification.

G. The insulation will be circular in cross-section and concentric to the conductor. The minimum thickness at any point will not be less than 90% of the specified thickness called for in Table 1 of this specification.

2.03 JACKET (SHEATH)

A. Directly over the EPR insulation, provide an extruded layer of flame retardant, thermoset, low smoke, and non-halogen cross-linked polyolefin jacket (sheath). The jacket compound will have been listed by Underwriters Laboratories (UL) for use with cable rated for 90^{o} C operation (except 1,500 & 2,000 kcmil). The jacket (sheath) will be black in color.

B. The jacket thickness will be in accordance with Table 1 of this specification and will be in conjunction with the size of the cable as called for in the Contract Documents. The jacket thickness will be circular in cross-section, concentric to the conductor. The minimum thickness at any point will be not less than 90% of the specified thickness listed in Table 1 of this specification.

C. The jacket will conform to the physical and electrical requirements, including moisture and voltage tests, as called for in Tables 1 and 3 of this specification.

2.04 MANFACTURERS

A. Okonite
B. Draka
C. Approved equal

PART 3 - EXECUTION

3.01 TESTS AND INSPECTIONS

A. The Contractor will perform tests on the insulation, jacket and completed cables in accordance with applicable standards as listed in this specification. Where standards are at variance with each other or with other portions of this specification, or the cable insulation and/or jacket thickness preclude obtaining samples of sufficient size for testing, special arrangements will be made with the Engineer. All tests will be conducted on the cable called for in this specification.

B. The Contractor will submit, prior to shipment, preliminary certified test reports for review by the CTA inspector. All preliminary certified tests will be performed with the cable on the shipping reels. The preliminary certified test report will include the conductor DC resistance, insulation resistance, and physical dimensions of the insulation and jacket (i.e.: minimum, maximum and average thicknesses for each reel). Each preliminary certified test report will include cable footage identification and reel number.The CTA inspector will utilize this information in selecting the reels that will be witness tested for detailed tests.

C. All tests identified in Tables 1, 2, and 3 will be performed on the selected reels and witnessed by the inspector. Included in these tests will be a 70,000 BTU per hour flame test in accordance with IEEE 383 for sizes of cable ordered.

D. The inspector will select a sample at random for testing from each 25,000 feet or less batch produced for each size of cable. In no case will the samples be taken closer than 1,500 feet apart. The inspector will witness tests on a minimum of 5% of each size of cable manufactured for this Contract.

E. The inspector representing the CTA will have free entry to the manufacturer’s facilities at all times while work on the contract for the CTA is being performed and to all parts of the manufacturer’s works which concern the manufacture of the cable. The Contractor will afford the inspector, without charge, all reasonable facilities to satisfy the inspector that the cable is being furnished in accordance with this specification. Tests and inspections may be made at the manufacturer place prior to shipment. Acceptance of material by the CTA at the manufacturer’s plant after inspection means that no apparent reason was found to reject the inspected material.

However, the CTA reserves the right to reject all material, after delivery to the CTA, which does not conform to this specification.

F. Prior to the shipment of any cable, the Contractor will furnish to the CTA three certified copies of the final certified test results which includes the itemized tests required by this section, using procedures as called for by the respective ASTM specifications and any other tests in this section. The Contractor will furnish dimensional cross sections of each size of cable with the certified test results. The certified test reports will also include the identification number of each shipping reel and the footage on each reel.

G. The Contractor has the responsibility to ensure that all cables supplied will meet this specification. Cable not in accordance with this specification will be rejected.

H. If the Contractor's final certified tests results demonstrate compliance with this specification and are approved by the inspector acting as a representative for the CTA, the Contractor will be so notified to ship the cable. The Contractor will not ship cable without approval.

I. To accommodate the inspectors travel requirements, the Contractor will provide the inspector at least a twenty-one working day notice prior to any scheduled testing.

3.02 INSPECTION COSTS

A. All transportation (air-coach class, or other necessary taxi, bus service, etc.) and lodgings required for testing outside the Chicago Metropolitan Area by Chicago Transit Authority personnel or authorized representatives which are necessary to accomplish the satisfactory inspection of cable ordered on this Contract will not be included in the Contract price. It is anticipated that one trip for two persons will be made to the manufacturer's plant to inspect the manufacturing process, and one trip for two persons will be made to witness each specified test. In each case, the cost of first trip to inspect the manufacturing process and as well as to witness the test will be borne by CTA.

B. If problems develop as a result of the Contractor's negligence necessitating additional trips, all expenses associated with these additional trips will be charged to the Contractor.

3.03 TEST RESULTS AND DATA REQUIRED

A. The following data will be included in the certified test reports:

1. Type of cable, insulation and jacket (sheath); cable size, conductor stranding and specification number.
2. A statement indicating the cable complies with this specification.
3. Conductor resistance per 1,000 feet.
4. Test results for EPR Insulation per Tables 1 and 2 of this specification.
5. Test results for cross-linked Polyolefin Jacket per Tables 1 and 3 of this specification.

3.04 PACKAGING

A. Cable will be shipped on non-returnable reels. The length of cable on each reel will be provided by the Contractor.

B. Prior to shipment, cable reels will be wrapped with cardboard or other approved wrapping complete with an overlay of 2 inches by 4 inches of wood lagging.

C. Cables will be supplied with the ends capped and sealed with heat shrinkable caps to exclude moisture.

D. Each reel or coil will carry suitable tags showing name of consignee, address, reel identity, order number, name of manufacturer, and type of cable, size, weight and length.

3.05 DELIVERY

A. All transportation charges, including the transit insurance, to the delivery location will be paid by the Contractor and will be included in the Contract price.

B. Handling or re-handling of material, at the Contractor's manufacturing and storage locations, prior to delivery will be considered incidental to the Contract.

3.06 INSTALLATION

A. General

1. The Contract requires installation of new cables in new ducts installed as part of the civil contractor's work for permanent as well as temporary work. Obtain conduit/duct log from the Civil Contractor and confirm that the log matches field conditions by visually checking all runs. Verify that all conduits have a nylon cord and a plug to seal the ends to keep ducts free of dirt and other debris.
2. Continued revenue operation of CTA's transit system during execution of this contract is required. The Contractor will schedule and perform all work in a manner that this basic requirement is not compromised. No connections to existing operating equipment or circuits will be made without specific authorization by CTA.
3. All work which, in CTA's opinion, affects the operation of the transit system will be performed during track/power outages or shutdowns in such a manner that the system will be operational when the revenue service is resumed.
4. Install dc traction power cables as shown on the Contract Drawings.

B. Cleaning Ducts

1. Use a flexible rodding device and pass it through each conduit to check for continuity and cleanliness.
2. After rodding, pull a mandrel, which should not be less than ¼" smaller than the inside diameter of the conduit, preceded by a wire brush tied to the same string, through the conduit, once in each direction. If any difficulty is encountered in passage of the duct rodding device or mandrel, a series of wire brushes will be drawn through the conduit, once in each direction, using a trailing line. Continue with the wire bushes until the final brush is 1/8"diameter less than the inside diameter of the conduit. If the correct size cannot be passed through on the initial pull, the operation must be repeated until accomplished.
3. When the conduit is partially or fully obstructed with mud, dirt, or gravel, the duct must be flushed clean with water using flushing nozzle which should be pushed into the conduit and applied until the duct is clear. After cleaning, follow the procedure outlined above for the rodding and wire brushing.
4. After all obstructions have been removed and the conduits wire brushed clean, pull a nylon cord of suitable strength into each cleaned conduit and attach to the nearest pulling eye with a six foot length left at each end. Immediately upon completion of installation of the nylon cord, both ends of the conduit will be plugged to prevent entry of foreign matter before the cables are pulled.
5. If the duct is not cleared in spite of performing duct cleaning and rodding operations as described above, the Contractor will immediately give written notice to the CTA with the field measurements from each end to the point of blockage. CTA will advise Contractor on how to proceed.

C. Installation and Protection of Cable

1. Strip cable reels of all nails on outside edges of reel heads before pulling of cable. Conveniently locate reels for feeding cable into the duct or conduit without excessive bending or possible injury to cable by abrasion on concrete or sides of duct. Jack reels by at least 6 inches to clear ground level before pulling of cable.
2. Attach pulling ropes to cables with ball bearing swivels to prevent twisting of cable during pulling.

3. Pull cables only after conduits have been cleaned, rodded, mandrelled, and are free of all obstructions. Pull cables after authorization is received from CTA. Pull only one cable into each duct or conduit.
4. Cable-ends will be sealed per manufacturer's recommendations before pulling into ducts. The ends of cables when cut will not be left with the insulation exposed to moisture. Protect cables until proper termination or lug is installed.
5. Use the installation method recommended by the cable manufacturer utilizing an approved cable grip.
6. Pull cable into ducts/conduits under moderate tension. Manufacturer's recommended maximum pulling tensions will not be exceeded. Pulling tension will be measured and documented.
7. Any lubricant used will not have a deleterious effect on the conductor insulation or jacket. Use cable pulling compounds which are recommended by the cable manufacturer. Do not use petroleum jelly.
8. Use sufficient personnel between the reel and the duct entrance during pulling operation to inspect, control, and direct passage of cable. Ream duct/conduit mouth where applicable and equip with a fair lead to prevent chafing of the cable.
9. Minimum bending radii as measured to inside surface of the cables will not be less than those recommended by the manufacture, or not less than eight times the outside diameter of the cable, whichever is the larger.
10. Do not allow cable to chafe on the ground, concrete or sharp surface during pulling. Provide timbers and flexible cable pulling tubes to guide and protect the cable, where necessary.
11. Install duct shields to protect cable at the duct mouth. Use split nylon tube or equal.
12. Label all cables, as required by CTA, with printed numbers on cable tags at all terminal points and duct entrances. CTA will provide cable numbers as requested.
13. Install cables with freedom of horizontal movement to accommodate expansion and contraction of the cables in the ducts.
14. Do not work on energized cables.
15. No fireproofing tape is required.
16. Inform CTA about any field conditions encountered which are not covered or differ substantially from those shown or specified in the contract documents. Perform the work in question in accordance with CTA's instruction.

D. Connection of the Cables to the Contact Rail

1. Connect the positive cables to the contact rail as shown in contract drawings. Provide heat shrinkable tape on the exposed portion of the cable. Use lugs and make connections as shown in contract drawings.

3.07 TESTING

A. Upon completion of the installation of each cable, test the cable insulation as recommended by the manufacturer or as directed by CTA.

B. If no specific test is recommended, test the cable by 1000 V megger. The insulation resistance should not be less than 3,000 megohm divided by the cable length in feet.

C. Do not energize the cables until approved by CTA.

Table 2 – Ethylene Propylene Rubber (EPR) Insulation

Requirement/Test	Applicable Standard	Requirement	Additional Requirement
Operating Temperature, Normal		90°C	Dry or Wet

Unaged Tensile Strength	ASTM D470	1,200 psi, minimum	
Unaged Elongation at Rupture	ASTM D470	250%, min.	
Original Set Maximum	ASTM D470	50%, maximum	
Hot Creep Test (ICEA T-28-562) Elongation Set	ASTM D470	50%, maximum 5%, maximum	Condition at 150° +/- 2 Celsius Sample will be from completed cable.
Tensile Strength after 168 hours at 121° C, Air Oven Test	ASTM D470	75% of the unaged value, min.	
Elongation after Air Oven Test	ASTM D470	75% of the unaged value, minimum	
AC Voltage Test	ICEA S-96-659, Table 4-2	13kV, 5 minutes	Perform tests in watertank on selected completed reels of cable after 6 hours of immersion and while still immersed
DC (Triple AC) Voltage Test	ICEA S-96-659, Table 4-2	35kV	Perform tests in water tank on selected completed reels of cable after 6 hours of immersion and while still immersed -
Insulation Resistance K Constant for Insulation Resistance	ICEA S-96-659, Table 4-5 ICEA S-68-516, Table 3.1	30,000 MΩ/1,000 ft	Perform tests in water tank on selected completed reels of cable after 6 hours of immersion and while still immersed
Power Factor after 24 Hours at Room Temperature	ICEA S-68-516	3.5%	
Ozone Resistance test 3 hours	ASTM D 470	Pass	
Moisture Absorption Test	ICEA S-68-516, Method EM 60		Immersed in 75°C±1°C Water
Dielectric constant after 1 day immersion	ICEA S-68-516, Method EM 60	4.5	Note: 75°C requirement, test will be performed on #14 AWG wire using insulation originating from the same batch compound Mixture
Increase in capacitance 1 to 14 days	ICEA S-68-516, Method EM 60	3.5%	
Increase in capacitance 7 to 14 days	ICEA S-68-516, Method EM 60	2.0%	
Stability factor, after 14 days	ICEA S-68-516, Method EM 60	1.0, maximum	
Moisture Absorption (Gravimetric Method)	ASTM D740	15 mg/sq. inch, maximum	168 hours at 82°C

Table 3 – Low Smoke, Non-Halogenated Jacket

Requirement/Test	Applicable Standard	Requirement	Additional Requirement
Unaged tensile strength	ASTM D470	1,700 psi, min.	
Unaged Elongation at rupture	ASTM D470	150%, min.	
After air oven test (168 hours at 121°C) (i) tensile strength (ii) elongation	ASTM D573	(i) 75% of the unaged value, min. (ii) 60% of the unaged value, min.	
After air oven test (168 hours at 150°C) (i) tensile strength (ii) elongation	ASTM D573	(i) 60% of the unaged value, min. (ii) 60% of the unaged value, min.	
After oil immersion (18 hours at 121°C) (i) tensile strength (ii) elongation	ASTM D471	(i) 60% of the unaged value, min. (ii) 50% of the unaged value, min.	Table #1, No. 2 oil
Moisture absorption, gravimetric method 168 hours at 70°C	ASTM D470	20 mg/in. sq., maximum	
Durometer Shore C, hold for 1 sec.	ASTM D2240	76±4	(Test to be performed on completed piece of 1500 Kcmil cable)
Limiting oxygen index	ASTM D2863	35%, minimum	
Smoke density test on materials used in the manufacture of cables Uncorrected/Corrected specific optical density during first 4 minutes of test	ASTM E662		
- Flaming Mode		50/45, max.	
- Non-Flaming Mode		50/45, max.	
Uncorrected/Corrected specific optical density value obtained during 20 minutes of test			Material will be prepared in slab of 100 Mils thick, plus or minus 5 Mils
- Flaming Mode		200/190, max.	
- Non-Flaming Mode		300/290, max.	
Ozone Resistance Test, 24 hours at 150 PPM	ASTM 470	Pass	
Smoke Index	NES-711	20, max.	Material will be prepared in slab of 100 Mils thick, plus or minus 5 Mils

Table 3 – Low Smoke, Non-Halogenated Jacket (continued)

Requirement/Test	Applicable Standard	Requirement	Additional Requirement

Requirement/Test	Applicable Standard	Requirement	Additional Requirement
Acid Gas Equivalent	MIL C-24643	0.1 ppm/mg, max.	Hydrochloric detector tube, with measuring range 0.5 to 25 PPM, similar to National Draeger Tube Part #CH29501
Toxicity Index	NES 713	1.5	
Cold Bend- 24 hours, 8 times cable diameter (at -25°C)	ICEA S-68-516	Pass	
Tear Strength	ASTM D470	35 lbs./in., minimum	
Fluid Immersion Tests			
Hydraulic Fluid (24 hours immersion at 49°C)	MIL-DTL-915/1F		Use Hydraulic Fluid MIL-H-17672
Tensile strength		50% of the unagedvalue, min.	
Elongation		50% of the unagedvalue, min.	
Diesel Fuel (24 hours immersion at 49°C)			
Tensile strength		50% of the unagedvalue, min.	
Elongation		50% of the unagedvalue, min.	
Lubricating Oil (24 hours immersion at 99°C)			
Tensile strength		50% of the unagedvalue, min.	
Elongation		50% of the unagedvalue, min.	
Salt Water (10% by weight)			24 hour immersion at 20°C
Tensile strength		90% of the unagedvalue min.	
Elongation		90% of the unagedvalue min.	
Methanol	ASTM D471		24 hour immersion at 25°C
Tensile		50% of the unaged value, min.	
Elongation		50% of the unaged value, min.	

Requirement/Test	Applicable Standard	Requirement	Additional Requirement
Gasoline (24 hour immersion at 25°C)			24 hour immersion at 25°C
Tensile strength		50% of the unagedvalue, min.	
Elongation		50% of the unagedvalue, min.	

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of TRACTION POWER CABLES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of TRACTION POWER CABLES must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 21 46

TRACTION POWER CABLE LUGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this section.

1.02 SUMMARY

A. The Contractor will furnish and install cable/wire termination lugs for all traction power and control cables as noted herein.

B. Related Sections: Related work specified elsewhere includes:

1. Section 34 21 61 - General Provisions Traction Power
2. Section 34 21 65 - Basic Electrical Materials And Methods – Traction Power
3. Section 34 24 23 - Contact Rail Bonding
4. Section 34 21 25 - Traction Power Cable
5. Section 34 21 40 - D.C. Disconnect (Knife) Switches
6. Section 34 21 41 - D.C. Disconnect (Knife) Switch Enclosures

PART 2 - PRODUCTS

2.01 TRACTION POWER CABLE LUGS

A. Cable lugs used for termination of traction power cables will be either solder type or bolted compression type as described herein:

B. Solder Lugs:

1. Solder type, straight terminal lugs will be installed at cable connections to hand operated knife switches and at contact rail taps. Lug construction and material are as detailed on the drawings.
2. Acceptable manufacturers
   a. AFL Dossert
   b. Approved Equal
3. Where lugs are bolted together, as in potheads, the hardware will be 3/4 inch brass bolts and nuts as shown on the drawings. Solder will conform to ASTM Designation B32 Solder Metal, Alloy Grade 50A, 50 percent tin, 50 percent lead. Soldering will be non-corrosive.

C. Soldering Procedure:

1. Cable to Straight Lug in Upright Position:

   a. The Contractor will cut and skin cable insulation to proper length (approximately 1/8 inch copper exposed beyond lug).
   b. The Contractor will clean cable and lug (inside) with fine wire brush or abrasive pad.
   c. The Contractor will apply non-acid flux (paste) liberally to cable and lug (inside).
   d. The Contractor will put lug on cable (lug has a pre-drilled 1/4 inch diameter hole in top of barrel).
   e. The Contractor will tape lug and cable at connection with friction tape.
   f. The Contractor will heat lug in center until it is hot enough to take solder in molten form at contact.

        g. The Contractor will feed string solder (50:50 ratio of tin and lead), into hole at top of barrel while constantly heating lug until it starts to overflow. Cold solder joints are not acceptable.
        h. The Contractor will remove heat from lug and continue feeding solder until molten solder stops flowing to eliminate air pockets.
        i. The Contractor will let assembly air-cool.
        j. The Contractor will wait until after assembly has cooled down, remove friction tape to see if solder flowed into the bottom of the lug. If not, repeat steps e thru h.
        k. The Contractor will clean assembly with wire brush or abrasive pad. (Make sure lug machine surfaces are clean of excess solder.)
        l. The Contractor will install heat-shrinkable tube (5 inch approx.) at joint.

    2. Two, Three or Four 300 KCMIL Bonds to Straight Lug:

        a. The Contractor will clean rim and inside of lug with fine wire brush or abrasive pad.
        b. The Contractor will apply non-acid flux (paste liberally to lug (inside).
        c. The Contractor will squeeze bonds in lug.
        d. The Contractor will put assembly in vice in upright position.
        e. The Contractor will heat lug from bottom up until it is hot enough to take solder in molten form at contact.
        f. The Contractor will feed string solder (50:50 ratio of tin and lead) from rim of the lug while constantly heating lug until it starts to overflow. Cold solder joints are not acceptable.
        g. The Contractor will remove heat from lug and continue feeding solder until molten solder stops flowing to eliminate air pockets.
        h. The Contractor will let assembly air cool.
        i. The Contractor will wait until after assembly has cooled down; check if solder flowed around bonds and lug rim. If not, repeat steps e thru g.
        j. The Contractor will clean assembly with wire brush or abrasive pad. The Contractor will make sure the lug machine surfaces are clean of excess solder.

D. Bolted Compression Lugs:

    1. Bolted compression terminal lugs will be installed for traction power cable connection to bus bars. Lugs will be bronze with NEMA standard tongue drilling complete with silicon-bronze bolts and brass self-locking nuts.
    2. Lug tongue surfaces, both sides, will be machined smooth for good electrical contract.
    3. The Contractor will furnish silicon bronze bolts, washers, and brass self-locking nuts (1/2 inch diameter for 1500 KCMIL cable and 3/8 inch diameter for 500 KCMIL cable) for tongue bolting the lugs to bus bars as shown on the drawings. Length of bolts to be determined in field.
    4. Contact surfaces will be cleaned of oxide and made bright metal before assembly.
    5. Acceptable manufacturers
        a. AFL Dossert
        b. Approved Equal

E. Crimped Compression Lugs:

    1. Lugs will be made from annealed high-purity, heavy-wall annealed copper tube. Lug will be suitable for outdoor use and thus will not employ an inspection hole.
    2. Lugs will be tin plated and mating surface will be generally smooth for good electrical contact.
    3. Crimped lugs will be assembled following manufacture's installation procedures using factory approved hydraulic crimp tools. Use of mechanical crimp tools is not allowed for cable larger than #2 AWG.
    4. Contact surfaces will be cleaned of oxide and made bright metal and will be coated with approved oxide inhibitor before assembly.
    5. Acceptable manufacturers
        a. AFL Dossert
        b. Approved Equal

F. Control Cables:

1. Control cable/wire termination lugs will be solder-less pressure indented (crimp) type. Lugs will be insulated eye or ring-tongue type (open or fork tongue type are not permitted). Termination lugs will be as manufactured by T&B Corp. (STA-KON type), Burndy (small hydrant type), or approved equal.
2. The Contractor will prepare control cable/wire for termination using cable manufacturers and termination lug manufacturers recommended procedures.
3. Any spare conductors will be left neatly coiled with the ends taped. Spare conductors will be minimum of 36 inches from cable end.

PART 3 - EXECUTION

NOT USED

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of TRACTION POWER CABLE LUGS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of TRACTION POWER CABLE LUGS must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 21 47

TRACTION POWER CABLE TAGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and other specification sections apply to this section.

1.02 DESCRIPTION

A. All traction power and control cables installed by the Contractor will be tagged. Cable tags, furnished and installed by the Contractor, will be either “brass” or “nylon” tags as described by locations listed herein.

PART 2 - PRODUCTS

2.01 BRASS CABLE TAGS

A. Brass cable tags will be 2 inch x 3 inch x 1/4 inch for 1 line or 2 lines designation of information.

2.02 NYLON CABLE TAGS

A. Nylon cable tags, 3/4 inch x 2 inch neatly and legibilty hand marked with indelible ink characters 1/4 inch high and covered by surface film protection.

PART 3 - EXECUTION

3.01 BRASS CABLE TAGS

A. Brass cable tags, 2 inch x 3 inch x 1/4 inch, die-stamped with 1/2 inch high characters will be attached to cables with 14 AWG solid copper tie wires. This type cable tag will be used in the substation, at the duct line entrances and above the cubicle enclosures. Also in manholes, at the entrance and exit duct openings, at the top of conduit risers, under passenger stations platform, under structured decks or similar locations where cables will be accessible for inspection and maintenance.

3.02 NYLON CABLE TAGS

A. These tags will be attached to cables with nylon tie straps. This type cable tags will be used in switch enclosures, negative return bus enclosures, substation, and all other similar locations where cables are protected by enclosures.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of TRACTION POWER CABLE TAGS will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of TRACTION POWER CABLE TAGS must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 21 61

GENERAL PROVISIONS TRACTION POWER

PART 1 - GENERAL

1.01. RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02. SUMMARY

A. This Section details general provisions for electrical work necessary to support the sections, specifying the categories of traction power distribution, substation equipment, building facilities and electrical work. The work under this section includes detail design and furnishing labor, materials, tools, equipment and incidentals necessary to provide, install and test the electrical work.

B. This Section specifies general provisions that are applicable to all Sections of related to traction power. Additional general provisions applicable only to individual Sections are specified under each such Section.

C. The Contract Drawings show the general arrangement required for the installation of equipment, cable tray, and other associated traction power items. The Contractor will follow these Contract Drawings as closely as possible. Should conditions necessitate any rearrangement, the Contractor will prepare and submit drawings showing the changes to the CTA for approval before proceeding with the work.

D. Due to the small scale of the Contract Drawings, it is not possible to show all the offsets and detail every point at which exigencies of construction may require special attention. Any additional fittings, conduits or specialties and other appurtenances due to field conditions and / or local code requirements will be furnished and installed by this Contractor at no extra cost to the CTA.

E. All items, accessories and/or devices necessary for completion and proper operation of any system will be designed and provided by this Contractor or Subcontractor for such system whether or not they are specifically called for by Specifications or Drawings.

F. Relocation or rearrangement of equipment within 10 feet of locations shown on the Contract Drawings, when directed by the CTA, will be done by the Contractor at no additional cost to the CTA, provided that the foundation(s), support(s), or actual equipment items have not been permanently set in place.

G. At the conclusion of the work, the Contractor and a manufacturer's representative will demonstrate and explain to the Engineer the function, operation and maintenance of all equipment and systems installed.

1.03. REFERENCES

A. All equipment, material and work furnished and/or installed under this Specification for traction power work, will conform to all Federal, State or Municipal laws or ordinances, and if any work shown or specified conflicts with such laws or ordinances, this Contractor will make such changes as are necessary to meet said requirements. The cost of such changes will be borne by the Contractor and will be included in the Contractor's original bid. Where any standards shown on the Contract Drawings or specified herein exceed the minimum standards set by law, the Contractor will adhere to the higher standard.

B. The Contractor will obtain all permits, pay all fees, and arrange for all inspections required for the installation of the work under this Division of the Specification.

C. All work will comply with the latest edition of the applicable standards and codes of the organizations listed below:

1. IEEE – Institute of Electrical and Electronic Engineers
2. AISI – American Iron and Steel Institute
3. ASME – American Society of Mechanical Engineers
4. ASTM – American Society for Testing Materials
5. AWS – American Welding Society
6. IES – Illuminating Engineering Society
7. IPS – Iron Pipe Size
8. ICEA – Insulated Cable Engineers Association
9. NEMA – National Electrical Manufacturers Association
10. ANSI – American National Standard Institute
11. CFR – Code of Federal Regulations
12. FTA – Federal Transportation Administration
13. NEC – National Electrical Code
14. NESC – National Electrical Safety Code
15. NBFU – National Board of Fire Underwriters
16. NFPA – National Fire Protection Association
17. UL – Underwriters' Laboratories, Inc
18. OSHA – Occupational Safety & Health Administration
19. AREMA – American Railway Engineering and Maintenance Association.

D. In addition to the National Codes, the Contractor will comply with all local codes and standards insofar as they apply to this installation and equipment.

E. Failure to mention any governing codes in this Specification does not relieve the Contractor from adhering to all codes applicable to the work.

F. Electrical equipment and material(s) furnished by this Contractor will bear the UL label wherever standards have been established by that agency.

G. At the completion of the work, the Contractor will obtain and turn over to the CTA a Certificate of Inspection indicating approval and acceptance of the work by the appropriate inspection authority.

1.04 SUBMITTALS

A. Pre-Installation submittals of the following types are required for the listed categories.

1. Equipment details for panel boards, wired enclosures.

2. Catalog cuts will cover common materials and supplies such as conduit, wire, nuts, bolts, etc.

3. Installation drawings will cover equipment, materials supplies where installation is not adequately detailed on the Contract documents.

4. Complete rating data for all equipment will be provided.

5. Instruction books, operation and maintenance manuals with spare parts manuals will be provided.

6. Catalog cuts for all equipment proposed.

7. Cable, wire, Contact Rail, Insulator, and Rail Anchor test reports.

8. Cable connections, lugs, conduits, raceways, supports, and supporting hardware.

B. Post construction submittals are required for the following types of documents:

1. Shop drawing installation drawings will be updated to" As-Built" status.

2. Unless otherwise noted, three sets of reproducible As-Built drawings will indicate the actual "as installed" status of all equipment, cables, raceways, supports, controls and materials incorporated into the facility.

3. Test data will be provided for all equipment and wiring as required by various sections of these specifications.

C. Shop drawings will include manufacturers' names, catalog numbers, cuts, diagrams and other such descriptive data as may be required to identify and approve the equipment.

1.05. SCOPE OF WORK

A. Detail Scope of Work

1. The work will be performed in stages to facilitate the minimum interruption for CTA’s Schedule Service. The work, which requires interruption of service, will be conducted only at night or during the week-ends to minimize the inconvenience of CTA’s riders. The work under this Contract includes furnishing design services, labor, materials, equipment, tools and incidentals for performing all operations as described. See Division 01 Section, Summary of Work, Project Description.

2. The Contractor will furnish all equipment and perform all work integral to final design, construction, testing and commissioning of the project scoped The work will include obtaining all necessary permits, site improvements, landscaping, foundations, building structures, underground utilities, electrical and mechanical systems as shown on the Contract Drawings or specified in the specifications. For detail Elements of Work, see Division 01 Section of this Specification.

1.06. QUALITY ASSURANCE

A. Materials and installation will conform to the applicable codes and standards.

B. After all equipment, devices and raceways are installed and wires and cables are in place and connected to devices and equipment, the Contractor will test the system for continuity, short circuit, improper grounds, and other defects. If any defective conditions are present, the Contractor will make all necessary corrections and retest for compliance.

C. Each major component of equipment will have the manufacturer's name, address, model number and rating securely affixed in a conspicuous place.

1. The nameplate of a distributing agent is not acceptable.

2. Code ratings, labels or other data, including any that are die-stamped into the surface of the equipment, will be in a visible location.

1.07. STAGING FOR TRACTION POWER WORK

The basic staging for the replacement of the traction power equipment is described in Division 01 Section, Summary of Work.

The detail staging for this work as well as request for power outage will be submitted by the Contractor for the CTA's approval.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Materials and equipment will be new unless indicated otherwise on the drawings and will be UL labeled where applicable and will bear the manufacturer's name, model number and other identification markings.

B. Materials and equipment will be the standard product of a manufacturer regularly engaged in the production of the required type of material or equipment for at least five years (unless specifically exempted by the Engineer) and will be the manufacturer's latest design with published properties, that meet the specification requirements.

C. Equipment and materials of the same general type will be of the same manufacturer throughout the project to provide uniform appearance, operation and maintenance.

D. Equipment and materials will be without blemish or defect and will not be used for temporary purposes without the Engineer's written authorization.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor will perform all work with trained mechanics of the particular trade involved in a neat and workmanlike manner as approved by the Engineer.

B. The Contractor will perform all work in cooperation with other trades and the approved project schedule to allow speedy and efficient completion of the project.

C. The Contractor will furnish other trades with advance information on locations and sizes of frames, boxes, sleeves, openings and other items needed for the work, and also furnish information and shop drawings necessary to permit trades affected to install their work properly and without delay.

D. Where there is evidence that the work of one trade will interfere with the work of other trades, all trades will cooperate and assist in allocating and working out the work space to make satisfactory adjustments and will be prepared to submit and revise coordinated shop drawings and installation drawing accordingly.

E. With the approval of the Engineer and without additional cost to the CTA, the Contractor will make minor modifications in the work as required by structural interferences, by interferences with work of other trades or for proper execution of the work.

F. Minor changes in the locations of equipment will made at the direction of the Engineer prior to rough-in and will be at no additional cost to the CTA.

G. The equipment will be installed with ample space allowed for removal, repair or changes to equipment. Ready accessibility to removable parts of equipment and to wiring will be provided without moving other equipment which is to be installed or which is in place.

H. The Contractor will refer to the electrical, structural, civil, track, communications, and signal design documents for installations of adjacent systems.

I. The Contractor will protect the materials and work of other trades from damage during installation of the work provided under this contract.

3.02 TRANSMISSION OF VIBRATION

A. Traction power equipment, conduit, and fittings will not be mounted to or supported by elements subject to vibration except by method specified here in and/or shown on the drawings.

3.04 INSTALLATION OF WORK FOR OTHER SECTIONS

A. The Contractor will coordinate all traction power work and will complete all wiring, conduit, material and traction power equipment as required for equipment installed under other divisions of these specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of GENERAL PROVISIONS TRACTION POWER will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of GENERAL PROVISIONS TRACTION POWER must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 21 65
BASIC ELECTRICAL MATERIALS AND METHODS - TRACTION POWER

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this section.

1.02 SUMMARY

A. This Section specifies all raceways and boxes as well as appurtenances thereto required for the electrical portion of the Traction Power work, as indicated on the Contractor Drawings and as specified herein these specifications.

B. Related Sections: Related work specified elsewhere includes:

1. Section 34 21 25 - TRACTION POWER CABLES
2. Section 34 21 46 - TRACTION POWER CABLE LUGS
3. Section 34 21 47 - TRACTION POWER CABLE TAGS
4. Section 34 21 68 - TRACTION POWER UNDERGROUND DUCTBANK AND MANHOLES

1.03 REFERENCES

A. NFPA 70, National Electrical Code
B. Municipal Code of Chicago, Title 18, Chapter 27 - The Chicago Electrical Code

1.03 SUBMITTALS

A. All materials will be new and the best of their respective kinds. The use of other than "prime" grades will not be accepted.

B. The Contractor will specify products of manufacturers for consideration. Submittals will be made to the Authority for approval. Submit all data necessary for products offered for approval.

C. In all cases, where a device or part of the equipment is herein referred to in the singular number, it is intended that such reference will apply to as many such devices as are required to complete the installation.

D. Comply with shop drawings, brochures and samples.

PART 2 PRODUCTS

2.01 RACEWAYS

A. Conduit and fittings

1. Metal and Fittings:

a. Material:

1) Conduit will be thin walled, galvanized steel EMT conduits or galvanized rigid metal conduit (GRC), as shown in the contract drawings. GRC Conduits will be hot-dipped

galvanized steel with uniform chromate coating for added protection inside and outside. Threads, galvanized after cutting, will be ¾ inch taper National Pipe Thread. GRC Conduits will comply with the latest revisions of the following specifications and standards: Federal Specification WWC-581 ANSI, C80.1 UL 6 and 1242. EMT Conduits will comply with the latest revisions of the following Standards: NEMA Standard FB-1, UL Standard 514B and Federal Specification A-A-50553.

2) Each full length of conduit will bear the UL label
.
3) Fittings for metal conduit will be galvanized malleable iron or steel, and will be UL listed.

B. Plastic Conduit

1. Material:

a. Plastic conduits will be polyvinyl chloride (PVC) suitable for 90^0C cable and for installation in direct sunlight. For concrete encasement Type I application and for normal duty above ground Type III application, conduit will be heavy wall Schedule 40. For direct burial Type II application and for heavy duty above ground Type IV application, conduit will be extra heavy wall Schedule 80. Conduit will be UL listed and comply with the latest requirements of the NEMA Standards Publication TC-2.

b. Fittings for plastic conduit will be made from rigid PVC compounds, and will comply with the latest requirements of the NEMA Standards Publication TC-3.

C. Reinforced Thermosetting Resin Conduit (RTRC)

1. The Contractor will be adhered to when procuring rigid non-metallic fiberglass epoxy conduit. The Contractor will submit certifications of compliance and/or samples of the conduit to be installed. No alternatives to the Specification will be allowed.

2. Fiberglass reinforced epoxy conduit will be lightweight, fire and ultraviolet ray resistant, and suitable for overhead installation and concrete encasement construction. End bells, couplings, deflection couplings, adapters, bends, sweeps and other fittings will be furnished as required. Conduit and fitting will be UL listed, and will be durably labeled. Fiberglass reinforced epoxy conduit will meet the following specifications:

a. Conduit will be fiberglass-reinforced epoxy, composed of glass filaments encapsulated in an epoxy matrix size as shown on contract documents. All conduits will be filament-wound, and will have pigment dispersed homogeneously throughout the epoxy glass matrix for ultraviolet protection. Conduit installed encased in concrete or exposed will be low smoke type. Each conduit length will have an integral wound-in expanded coupling.

b. Average wall thickness will be .070 inches (standard wall), 0.25 inches (extra heavy wall). RTRC conduits used for the above ground installations will be the extra heavy wall type.

c. Conduit and fittings in the 2 inch through 6 inch sizes, inclusive, will have inside diameters equal to the trade size.

d. Conduit will be suitable for continuous operation from -40 degrees C to +110 degrees C without significant change in mechanical properties.

e. Conduit will have a burning point in excess of 130 degrees C (124 degrees C for above ground installation) and combustion will cease when the heat source is removed. When tested in accordance with ASTM D635, conduit will not outgas chlorine. Other toxic gases will not outgas in excess of .0015 cubic feet per square foot of material.

f. Conductor will not adhere to conduit or fittings in fault conditions.

g. Conduit will have the following minimum physical properties:

    1) Tensile strength, longitudinal: 11,000 psi, when tested per ASTM D2105.

    2) Compressive strength, axial: 12,000 psi, when tested per ASTM D695.

    3) Ultimate elongation: 2 percent when tested per ASTM D2105.

    4) Modulus of elasticity in tension: 1,250,000 psi, when tested per ASTM D2105 -for below ground and 1,300,000 - for above ground.

    5) Modulus of elasticity in bending: 2,280,000 psi, when tested per ASTM D2105 - for above ground and 2,500,000 - for below ground.

    6) Thermal conductivity: 0.828 BTU/Hr./Sq.Ft./Degrees F/Inch per ASTM D335.

    7) Coefficient of linear thermal expansion: 1.37 x 10 -5 Inch/Inch/Degrees F, when tested per ASTM D 696.

    8) Specific gravity 1.94, when tested per ASTM D 792.

    9) Temperature range: Minus 40 Degrees C to plus 110 Degrees C for below ground and minus 40 Degrees C to plus 124 Degrees C for above ground.

    10) Dielectric Strength: 500 volts/mil, when tested per ASTM D 149-94.

    11) Dissipation factor: 0.5 percent average at room temperature, when tested per ASTM D150.

    12) Water absorption: less than 0.175 percent (14 days at room temperature) when tested per ASTM D570-95.

h. The conduit will be thoroughly cured and will be free of any material. It will be straight and will have a circular bore with the inner surface smooth and free from dents, obstructions, or any other defects which would cause damage to cables. The bores will pass freely a mandrel 36 inches in lengths and 1/4 of an inch less in diameter than the nominal diameter of the conduit.

i. The conduit will have passed UL flammability tests UL 2515 (2515A).

j. All conduit elbows, bends, sweeps, deflection fittings, expansion fittings, and miscellaneous fittings will conform to NEMA TC and will be UL listed.

k. Each 10-foot length of conduit, sizes 2 inch through 6 inch, will be provided with an integral end bell or factory-installed double end bell, containing a urethane seal. The other end of each 10-foot length will be provided with a scribe mark, indicating the proper distance to which the conduits must be mated to ensure a secure (100-pound pull out), water-tight (15 psi) connection. 20-foot lengths will only be used where permitted by CTA.

l. No threads or adhesives will be required to assure water-tight joints for in ground and concrete encased installations.

m. Each length and each fitting will be listed by the Underwriters Laboratories and will be provided with an appropriate label affixed thereto.

n. Contractor will submit for approval, shop drawings and descriptive literature for all conduit, fittings, spacers, support devices, anchors, and hangers.

D. Phenolic Conduit

1. Use

   a. Low smoke, zero halogen, heat resistant rigid non-metallic conduit for exposed subway and tunnel applications.

2. The Contractor will be adhered to when procuring rigid non-metallic phenolic conduit. The Contractor will submit certifications of compliance and/or samples of the conduit to be installed. No alternatives to the Specification will be allowed.

3. Extra heavy wall. 0.25 inch nominal.

4. Minimum characteristics

Property	Value	Testing Method
Temperature Range	-60^{o}F to +1850^{o}F	ASTM E119 (1850^{o}F 2 hours)
Vertical Flame Test FT4	passed	CSA 22.2
Surface Flammability	<5	ASTM E162
Tunnel Test, Flame Spread	<1	ASTM E84
Tunnel Test, Smoke Density	<1	ASTM E84
Tensile strength, ultimate	7,000 psi	ASTM D2105
Flexural Strength	>30,000 psi	ASTM D638
Dielectric Strength	150 volts/mil	ASTM D149
Smoke Density, $D_{S4\ min}$	<5	ASTM E662
Smoke Density, D_{max} flaming	<30	ASTM E662
Smoke Density, D_{max} non-flaming	<20	ASTM E662
Water Absorption	<1.5%	ASTM D570
Coeff of Thermal Expansion	0.51x10^{-5} in/in/^{o}F	ASTM D696
Specific Gravity	1.7-1.75	ASTM D792
Barcol Hardness	48-52	ASTM D2583
Glass Content	60-70%	API 15LR
Modulus of Elasticity	1.2 x 10^{+6} psi	ASTM D2105

5. Toxicity

The following will be the maximum values when tested in accordance to ASTM E-800:

Gases (p.p.m.)	Values (max
Hydrogen Chloride	0
Hydrogen Bromide	0
Hydrogen Cyanide	< 1
Hydrogen Sulfide	0
Ammonia	0
Oxides of Nitrogen	< 5
Carbon Dioxide	< 10,500
Carbon Monoxide	< 350

E. Flexible Conduit

1. Flexible conduit connections, approximately 18 inches in length, will be made to all motors and other devices where rigid connection is not practical or advisable.

2. Flexible conduit will be liquid-tight, consisting of flexible steel construction covered with an extruded jacket of neoprene or PVC. Conduit will be American Flexible Conduit Company, Anaconda Metal hose Div., Electric-Flex Company or approved equal. Bare "BX" type flexible conduit will not be acceptable.

3. Fittings for liquid tight flexible metal conduit will be UL listed and approved for grounding.

4. Flexible conduit above 1-1/4 inch trade size will have grounding conductor run within the flex.

   Conductor must be sized on the basis of the rating of the overcurrent protective device for the circuit run within the flex, all in accordance witch NEC, US and any local governing codes.

5. All flexible conduits will have a grounding conductor run inside the conduit, code sized for all circuits indicated.

F. Inserts and Sleeves

1. General:

   Lay out work in advance of construction of slabs or construction of walls. Provide all inserts and sleeves necessary to complete the work.

2. Conduit Sleeves:

   a. Wall Sleeves: Unless otherwise established by Contractor all exterior and interior wall sleeves will be of fiberglass reinforced epoxy conduit. All exterior sleeves will be made watertight, using watertight sealing bushings.

   b. Floor Sleeves: Conduits passing through floors will be sleeved with fiberglass reinforced epoxy conduit and will be sealed with neoprene rope and caulk. Sleeves will extend 1 inch above finished floor surface.

2.02 METALLIC CABLES TRAY SYSTEM

A. An aluminum cable tray system will be furnished and installed for control cable routing. System will be complete and including fittings and accessories as may be required for workmanlike installation.

B. Aluminum cable tray and fittings will be of standard width with approximately 4 inch deep sides. Trays and fittings will be fabricated of aluminum throughout and furnished complete with required splice plates and cadmium plated bolts and nuts.
Trays will be 18-inch ladder with 9-inch rung spacing, M. P. Husky (Cat. #A9CA-18-144) or approved equal.

C. Aluminum cable tray system will be UL classified for use as an equipment grounding conductor.

2.03 WIRES AND CABLES

A. General

1. Contractor will install and connect all wires and cables for substation auxiliary power, control, lighting, etc.

B. Cable (600 volt and below)

1. Wire and cable for all controls, for substation auxiliary power and for substation lighting will be furnished and installed by the Contractor. Conductors, insulating and jacketing materials will be in accordance with applicable ICEA and ASTM Standards, and will conform to the following specifications:

   a. Multi-Conductor Cable: Multi-Conductor Cables for control and miscellaneous power will be stranded copper conductor, #12 AWG minimum size, XHHW, VW-1 flame retardant moisture resistant 600 Volt, cross linked synthetic polymer insulation, rated 90C dry, 75C wet, flame and moisture resistant.

   b. Single-Conductor Wire: Single-Conductor Wire for miscellaneous control and power will be copper conductor, #12 AWG minimum size, stranded conductor, XHHW, VW-1 flame retardant moisture resistant 600 Volt, cross linked synthetic polymer insulation, rate 90C dry, 75C wet. Wire will be suitable for conduit or duct installation, wet or dry locations.

   c. Lighting Wire:

      1) Wire for lighting feeders and branch circuits will be single conductor, solid copper wire, #12 AWG or #10 AWG as required, with XHHW, VW-1 600 Volt insulation. Minimum wire size will be #12 AWG.

      2) Fixture wire will be type SFF-1, stranded, tinned copper, silicone rubber insulated, glass braid covering, rated 600 volts, 160 C. Use of wire nut is allowable.

   d. Color Coding:

      1) All 208 volt branch circuits will be color coded with either colored tracers or solid colored jacketing, using black for-"A" phase, red for "B" phase, blue for "C" phase and white for neutral.

      2) All multi-conductor control cables will be color coded in accordance with ICEA standards S-66-524, NEMA WC-7 Table K-2.

   e. Wire and Cable Take-Offs:

      1) It will be the Contractor's responsibility to furnish and install wire and cable as herein specified. The Contractor will be responsible for making cable take-offs for ordering sufficient wire and cable for the project requirement.

         The Contractor will fill-in the column “As Installed” indicating cable lengths installed in the cable schedule included with the Contract Documents.

   f. Cable Manufacturer's Data:

      1) Data to be supplied by the Contractor for each type of size of wire and cable furnished will include:

         a) Number of conductors, materials, and stranding.

         b) Voltage rating of insulation.

c) Temperature rating of insulation.

d) Insulation material and thickness.

e) Jacket material and thickness.

f) Overall diameter.

g) Weight, lbs/1000'.

h) Manufacturer's test report.

C. Tray Bonding Tie: 500 MCM bare conductor cable as shown on the Contract Drawings.

D. Traction Power Cable - See section 34 21 46.

2.04 BOXES - METALLIC

A. Junction Boxes

1. Where necessary to terminate, tap-off, or redirect multiple conduit runs, the Contractor will furnish and install appropriately designed junction boxes.

2. Unless otherwise noted, boxes not over 100 cubic inches in size will be standard UL label, pressed steel boxes. Boxes over 100 cubic inches in size will be constructed as NEC specified cabinets. Covers will be of same thickness and material as boxes and will be secured by brass screws or bolts of the similar material. All boxes will be hot dipped galvanized steel.

3. Unless otherwise noted, box sizes will be as required by the National Electrical Code or local governing code for the number of conduits and conductors entering and leaving them. Minimum acceptable junction box size will be 4 inches square by 1-1/2 inches deep.

4. Boxes over 100 cubic inches will be of oil tight JIC box construction, and unless otherwise directed by the Engineer, with continuous hinge cover.

B. Terminal Boxes

1. Where necessary for conductor terminations, the Contractor will furnish and install NEMA 12 type enclosure with continuous hinged covers for indoor installations and NEMA IV for outdoors.

2. All terminal boxes will be made up from No. 14 gauge galvanized steel. Boxes will be finished with gray primer inside and outside over phosphatized surfaces.

3. Each box will be provided with a removable No. 12 or No. 14 gauge galvanized steel panel mounted on collar studs (panels having 400 square inches of surface or more will be No. 12 gauge). Panel will be given one prime coat over phosphatized surface and be finished with one coat of white enamel.

4. Terminal blocks will be suitable for the size of wire, voltage and current rating of the conductor being terminated. Blocks will include standard terminals, mounting rails, barriers, covers, end stop insulating section and clamp, ground clamps and markers. The terminal strip used will include a minimum of 10 percent spare terminals.

C. Outlet Boxes

1. Fixture, electrical device, switch and outlet boxes will be of the cast metal type with integral threaded conduit hubs. Size will accommodate device noted and be at least 1-1/2 inches deep.

2. Where three more devices are at one location, use multiple gang box. Install one device per gang unless otherwise determined by the Engineer.

3. Boxes will be furnished with gasketed covers. Covers will be screw fastened.

4. Surface outlets on exterior walls and in interior locations where exposed to moisture, and where specifically established by the Contractor, will be cast metal outlet boxes with conduit hubs and matching device plate.

5. Outlets installed back-to-back in the same wall will be offset 6 inches horizontally from each other, to preclude noise transmission.

6. Outlet boxes will be attached to masonry or concrete construction by use of expansion anchors and to steel beams by use of clamps, bolts, etc.

D. Pull Boxes

1. Pull boxes will be furnished and installed by the Contractor to facilitate conductor installation. Pull box construction details will comply with the same specifications as for junction box construction.

2. In general, conduit runs of more than 100 feet, or with more than three right angle bends, will have a pull box installed at a convenient intermediate location.

3. All pull box installations by the Contractor are subject to the approval of the Engineer and must be noted on the "as built" drawings.

4. Boxes will be supported independently of conduits entering them. Brackets, rod hangers, mounting channels or other Engineer-approved supporting methods will be used.

5. Pull boxes will be provided with suitable barriers where required. Vertical offset pull boxes will contain cable supports at turns to prevent cables from resting on corners.

2.05 WIRE CONNECTIONS AND CONNECTING DEVICES

A. Cable and Wire Tags

1. Each cable will be tagged at both ends and in each pull box or junction box where terminations are made or where the cable passes through. Each conductor of each cable will be tagged at all terminations with its circuit or wire number.

2. Cable tags, furnished and installed by the Contractor, will be as described for the locations listed below:

   a. Nylon Cable Tags: Nylon cable tags, 3/4 inch x 2 inch, neatly and legibly hand marked with indelible ink characters 1/4 inch high and covered by surface film protection, will be attached to cables with nylon ties where cables are indoors or protected by equipment or enclosures.

   b. Wire Markers: Each conductor of multi-conductor control cable or each individual single conductor wire, at the point of termination, will be identified by plastic-coated or colored plastic, slip-on type wire markers with factory printed numbers or letters. The factory printed numbers or letters will not be affected by cleaning solvent. Wire marker designations will conform to designations on wiring diagrams or to designations on control terminal block marking strips.

3. For traction cable tags, see section 34 21 47.

B. Terminal Lugs and Splicing

1. Terminal Lugs:

   a. The Contractor will furnish and install solderless lugs or studs for power, control and miscellaneous cables for his connections. Bolting hardware for all lugs will be silicon-bronze. Terminal lugs for traction power cables will be as described in Section 34 21 46. All other terminal lugs furnished for power and ground cables will be heavy duty, bolted type, of high copper content alloy, complete with silicon bronze bolts, nuts and lock washers. Lugs will have tongues with either two or four ½"-13 bolts, as specified, spaced per standard NEMA drillings, and four-bolt cable clamps. All contact surfaces will be machined smooth and silver plated. The lugs for control and miscellaneous cables will be crimp type. Note that all lugs for control cables will be insulated ferrule, ring-tongue type (open or fork-tongue are not permitted).

   b. All cable lugs will be of the compression indent type requiring the use of a special tool.

   c. Cable lugs will be as listed by Underwriters Laboratories Inc. or meet UL 486 heating and pullout tests for compression-indent type.

   d. Branch circuit conductor lugs for cable sizes #10 AWG and smaller, will be ring type only with insulated barrel.

   e. Branch or feeder circuit conductor lugs for cable sizes #8 to #2 AWG will be single-hole type.

   f. Branch or feeder circuit conductor lugs for cable sizes #2 AWG and larger will be two-hole type. Bolt hole spacing will conform to NEMA standards.

   g. All enclosures will be sized to accommodate the specified connectors so that conductors are bent to radii larger than that recommended by the cable manufacturer.

2. Cable Splicing and Termination:

   a. Joints in branch circuit wiring will be made mechanically and electrically secure with solderless connectors as listed by Underwriter's Laboratories Inc., UL 48 or UL 486.

   b. Terminal blocks, for control circuit interconnections external to equipment, will be furnished and installed by this Contractor. These terminal blocks will be heavy duty, barrier type, 600 Volt rating, #10-32 washer head screw terminals with marking strip.

2.06 NAMEPLATES

A. Each major component of equipment will have, as a minimum, the manufacturer's name, address, and catalog number, model, style or type on a nameplate securely attached to the item in an area easily accessible to normal visual demands by maintenance and service personnel. Nameplates for electrical apparatus will conform to the referenced standards and as specified elsewhere in this Specification.

B. Each switchgear assembly, circuit breaker and auxiliary unit, transformer, rectifier, transfer switch, battery charger, panel board, terminal box, and all panel mounted and individually mounted equipment and devices will be provided with nameplates for proper identification. Panel mounted devices will be identified in the rear with designations indicated on manufacturer's connection diagrams. Internally mounted devices will be similarly identified.

C. Nameplates identifying major equipment will have lettering two inches high, minimum, unless otherwise specified. Two nameplates will be provided, one on front, the second on the rear of the equipment.

D. Nameplates identifying ac and dc circuit breaker and auxiliary units will have lettering one inch high, minimum, unless otherwise specified. Inscription will include circuit breaker number and service. One nameplate will be provided on front, the second on the rear of each unit.

E. Nameplates for panelboards, terminal boxes and similar equipment will have lettering ¾ inch high, minimum, unless otherwise specified.

F. Nameplates for panel mounted relays, meters, control and instrument switches, fuses and auxiliary devices and individually-mounted circuit breakers, disconnect switches, etc., will have ¼ inch, minimum, lettering, unless otherwise specified. For protective and auxiliary relays, the nameplate inscription will include device number and function. Nameplates for fuses will note the type and rating of fuse, polarity and identify the circuit.

G. All nameplates will be laminated plastic with dull white surface and black core unless otherwise specified. Letters will be engraved through outer layer to expose black core. All exposed edges will be beveled. Nameplates will be fastened with machine screws. Use of self-tapping screws or adhesives will not be permitted.

H. The legends of all nameplates will be submitted to the Engineer for approval.

2.07 MISCELLANEOUS ITEMS

A. The Contractor will furnish, install and connect all miscellaneous panels, motor starters, contactors, disconnect switches, push buttons, selector switches, indicating lights, or other control devices including all mounting hardware, unless such devices are definitely specified herein as being furnished by an equipment supplier.

B. The Contractor will furnish, install and connect all mechanical exhaust and ceiling fans, unit, toilet room and water heaters, sump pump, temperature control panel, etc., as shown on the Contract Drawings.

B. If detailed specifications are not given herein such miscellaneous devices will be furnished in NEMA type I push buttons, switches, etc. or type 1A (motor starters) enclosures for indoor service. They will be approved by the Underwriter's Laboratories, Inc. and so labeled wherever such approved equipment is commercially available.

C. For each miscellaneous device described above, the Contractor will furnish a suitable non-metallic nameplate, (black with white lettering), not smaller than 1 inch x 3 inches, suitably engraved with the appropriate device name or number. Contractor will submit nameplate schedule to the Engineer for approval. Nameplates will be held in place with self-tapping screw--not rivets. If the device itself is too small to support its nameplates, the plate will be attached to a bracket, column or other support in reasonable proximity to the device.

D. Contractor will furnish all other miscellaneous material required to complete the installation in a workmanlike manner.

PART 3 EXECUTION

3.01 INSTALLATION OF CONDUIT AND FITTINGS

A. Conduit runs will be no smaller than 3/4 inch trade size.

B. Conduit will be run in straight lines parallel with or at right angles to building walls, partitions, floors and ceilings. When the location of a conduit is not shown on the Contract Drawing, or the location indicated thereon interferes with other work in place or subsequently to be placed, the Contractor will work out a satisfactory location free from interferences and, subject to the Engineer's approval, will proceed on the basis of the selected location.

C. In all cases, conduits and fittings will be located so as to be accessible for maintenance, to permit removal or repairs to equipment to which conduit is attached and so as not to obstruct or inconvenience personnel in performance or operation and maintenance duties. High temperature or damp location will be avoided to insure proper ventilation. Where a number of conduits are run together, they will be grouped in a neat and logical manner.

D. When installing metallic conduit, all conduit will be taper threaded. Use of running threads will not be permitted, including field cut threads. Each conduit will be threaded to its full thread length in the conduit coupling or conduit fitting hub to ensure good metallic contact for the ground return path. All conduit ends must be cut square and reamed clean of burrs.

E. Before conduit joints are made, the threads will be cleaned and then coated with anti-seize, electrically conductive compound.

F. Secure all conduits to outlet boxes, junction boxes or cabinets by placing locknuts on outside of box, and locknuts and bushings on inside of box. Conduit terminations 1-1/4 inch and larger will be equipped with insulating bushings.

G. Conduits and fittings will be kept clean and dry during installation. Conduit sleeves will be used where conduits pass through walls, partitions, floors, ceilings and foundations to prevent shear conditions.

H. Conduit hangers and fasteners will be made of malleable iron (galvanized or cadmium-plated) appropriate in design and dimensions for the particular applications. Metallic conduits, surface mounted on walls and/or ceilings, will be supported by means of one-hole clamps and clamp backs. Conduits will be clamped on steel work, where required, with approved clamps.

I. All conduits penetrating building exterior walls, roofs, or membranes will be provided with a watertight fitting, pitch pocket, flange, or membrane clamping ring to provide a watertight construction.

J. Avoid using bends and offsets wherever possible. Field bends will be made so as to avoid changing the internal diameter of conduit and so as not to damage its protective coating either outside or inside. Field bends will be free from kinks, indentations, or flat surfaces and will be made with approved conduit bending machines or devices. Individual bends will not exceed 90 degrees and no more than 270 degrees total bend will be allowed in any one conduit run, except where a pull box is used.

K. Radius of curvature to the inside edge of field bends will be a minimum of eight-times the trade size of conduit.

L. The Contract Drawings show the approximate routing of the Conduits. Exact routing and termination locations will be determined by the Contractor in the field, subject to final approval by the Authority.

M. Empty conduits will be plugged at both ends prior to cable installation.

N. All conduit elbows, offsets and bends will be uniform and symmetrical. Installation and workmanship will be of the best quality and skill to provide a firm mechanical assembly.

O. Conduits will be continuous from outlet to outlet and from outlet to cabinets and junction/pull/terminal boxes with entry secure in such manner that each system will be electrically continuous. Entry connections will be made with two locknuts and an insulated conduit bushing or an insulated grounding bushing as required. The locknuts will electrically connect the conduit to the cabinet or box. Exterior conduit connections to the cabinets or boxes will be made by using insulated watertight, threaded hubs as manufactured by the Myers Electric Products, Inc. ("Scru-tite" Type), Thomas & Betts Company ("Bullet" Series 401) or OZ/Gedney (type 4Q).

P. Conduit systems will be completed before conductors are drawn-in. Conduits will be firmly fastened within 3 feet of each outlet box, junction box, cabinet, offset or bend, and will be supported at the intervals listed in paragraph Q below:

Q. Maximum acceptable support spacing for rigid conduit, in feet, will be in accordance with the following table:

Conduit size	Wall	Ceiling	Vertical
¾ inches	5	7	8
1 inch and larger	6	8	10

R. Channel type metal framing systems to support conduit and/or cable systems will be based on a channel 1-5/8 inches square, No. 12 gauge steel, mill galvanized conforming to ASTM Specification A-525 and will be furnished complete with all associated or required mounting hardware.

S. Expansion joints will be provided wherever construction joints occur in the concrete slabs. Conduit runs will be adjusted so that expansion joints are at right angles to the slab joints.

3.02 INSTALLATION OF PLASTIC CONDUIT

A. Plastic conduit, furnished and installed by this Contractor, will be installed with plastic fittings in accordance with the conduit manufacturer's instructions. Joining method will be solvent cement technique to provide strong watertight joints in the conduit system.

B. Exposed plastic conduits will be supported and clamped as shown on the Contract Drawings. Conduit runs will be no smaller than 3/4 inch trade size.

C. In general, plastic conduit will not be permitted on this project, except in specific cases where permitted by the Authority.

3.03 INSTALLATION OF REINFORCED EPOXY CONDUIT

A. Conduit and fittings will be run in straight lines parallel with or at right angles to elevated structure. When the location of a conduit is not given on the Contract Drawings or the location indicated thereon interferes with other work in place, the Contractor will work out a satisfactory location free from interferences and, subject to the Authority's approval, will proceed on the basis of the selected location.

1. In all cases, conduits and fittings will be located so as to be accessible for maintenance, to permit removal or repairs to equipment in which conduit is attached and so as not to obstruct or inconvenience personnel in performance of operation and maintenance duties.

B. Conduits and fittings will be kept clean and dry during installation.

C. When installing fiberglass reinforced epoxy conduit overhead, conduit fittings will be from the same manufacturer.

D. All conduit elbows, offsets and bends will be uniform and symmetrical. Installations and workmanship will be of the best quality and skill to provide a firm mechanical assembly.

E. Conduit routes shown on the Contract Drawings are approximate. Exact routing and termination locations will be determined by the Contractor in the field subject to final approval by the Engineer.

F. Where aerial conduits cross alleys or streets a minimum of 14 feet – 6 inch clearance must be maintained.

G. All attachments to structure will be drilled and bolted. No beam clamps will be allowed.

H. When fiberglass reinforced epoxy conduit is installed under the elevated structure for traction power cable distribution, it will be 3 inch diameter conduit supported at intervals determined by calculating the total weight of the traction power cable and conduit using the modulus elasticity of the fiberglass conduit. Midpoint deflection will not exceed 5/8".

I. Vertical and horizontal expansion capability will be provided at each elevated structure expansion joint.

J. For fiberglass reinforced conduit installation in encased concrete duct see spec section 34 21 68 Traction power underground ductbank and manholes.

3.04 INSTALLATION OF WIRE AND CABLE

A. Unless otherwise noted, all wire and cable runs external to equipment assemblies will be installed in conduits.

B. The Contractor will obtain and observe recommendations of the manufacturer as to installation, care and handling of the various cables. Minimum bending radius will not be less than that allowed by the ICEA Standards.

C. No splices will be permitted in any power or control cable runs. Cables must be continuous from termination to termination. No splices or joints will be permitted in lighting feeders or branches except at outlets or accessible junction boxes. Joints in branch circuit wiring for conductors not larger than #10 AWG will be made mechanically and electrically secure using screw-on connectors.

D. Any spare conductors will be labeled as such and be left neatly coiled, with the ends taped and extending from the cable a minimum of 36 inches.

E. The Contractor's cable pulling will be in accordance with accepted modern practices so as to prevent damage to the cable. Before pulling cables, a round test mandrel will be pulled through the duct which is to be occupied, in order to be sure that it is cleared of all obstructions. The test mandrel will be of a size especially designed for the duct being tested. The mandrel will be of the rigid type not less than 12 inches in length and will have tool-steel cutting ends to remove obstructions. Cable pulling tensions, speed, lubricants and other pertinent factors in connection with pulling and handling will be in accordance with the cable manufacturer's recommendations, or as approved or directed by the Authority. A cable protector will be fitted in the end of the duct during pulling operation in order o prevent injury to the cable. The cable will be fed into the duct through a flexible metal pull-in guide. Where more than a single cable is being pulled in, all cable will be pulled directly into the duct from the coil or reels on which they are received.

F. Cables will not be pulled off and laid on the ground prior to installation. Cable grips will be designed for the purpose and will not cut or otherwise damage the cable. No cable will be pulled with ends open. A rubber tape seal will be maintained at all times. The cable will be continuously inspected during installation and any cuts, abrasions, or otherwise injured portions will be brought to the attention of the Authority and repaired or removed as directed.

G. Conductors will not be drawn into conduit until the conduit is free of moisture. In drawing wires into conduit, sufficient slack or lead will be allowed to permit the connections to devices without splices.

H. For installation of traction power cable, see section 34 21 25.

3.05 CABLE TRAY SYSTEM

A. The Contractor will adequately protect cables in trays until all construction work is complete. If, in the opinion of the Authority the cable has been damaged by falling objects, welding debris or other reason attributable to construction practices, the damaged cable will be completely replaced at the Contractor's expense.

B. Cable trays will be assembled and installed in such a manner as to provide smooth inside surfaces, free from any abrasions which might cause damage to cables. Damaged pieces will not be used unless they can be removed and straightened in a manner satisfactory to the Authority. All parts will be installed in such a manner that they will support cable loads for which they are designed.

C. Cable trays will be adequately supported from walls or underside of roof beams. All trapezes, brackets, clamps, rods, couplings and suspension fittings, expansion shields, hardware and miscellaneous steel will be provided to insure a complete support system in accordance with recognized high quality practice. All metallic elements of the support system will be hot dipped galvanized steel.

D. Tray routing will be adjusted in the field to clear interferences with installation of other trades. Any rerouting of trays to clear interferences will be subject to prior approval of the Authority.

E. Grounding conductor and tray bonding tie - 500 KCM bare conductor cable as shown on the Contract Drawings.

3.06 CABLE RACK SYSTEM

A. The Contractor will furnish and install cable rack system for support of 2000V DC insulated cables within the building. Individual support racks will be made up of fiberglass channel members, maple cable clamps and associated accessories as required to complete the installation in a workmanlike manner. All steel details will be galvanized and grounded.

3.07 CABLE SUPPORTS ON STRUCTURES

A. Contractor will furnish and install cable support racks on elevated and aerial structure as shown on the drawings. Cable support rack locations and installation details will be as shown on drawings.

3.08 CABLE SUPPORTS IN THE MANHOLES AND IN THE SUBWAY

A. Unless otherwise noted within this specification or shown on drawings, the Contractor will furnish and install non-metallic cable support racks in the manholes, splicing chambers and similar other locations where cables are to be in open runs supported from racks. Cable support racks and mounting channels will be heavy-duty construction, consisting of molded, fire retardant, non-corrosive glass reinforced nylon with high dielectric properties.

B. Mounting channels will be surface type and will be anchored to concrete with stainless steel, heavy duty, one piece, wedge type concrete anchor bolts with nut and washer. Length of anchor bolts will be long enough to exceed the minimum embedment in concrete, recommended by the anchor bolt manufacturer.

C. Cable will be tied to the cable racks with cross-wise nylon cable ties at each rack (two ties at each point of support).

D. Cable support racks will be "Underground Devices" Cat. No. RA20 or approved equal. E.

Cable rack channels will be "Underground Devices" Cat. No. CR36 or approved equal.

3.09 FILLING OF OPENINGS

A. Where conduit and raceway pass through fire-rated walls, ceilings or floor, provide seals to prevent passage of fire and fume and to maintain integrity of fire-rated structure.

B. Close unused openings or spaces in floors, walls and ceilings. Plug or cap unused conduit and sleeves.

3.10 IDENTIFICATION

A. At end of each run, use brass with stamped markings to establish identification of conduit, raceway and ducts.

B. Test metallic conduit and boxes for electrical continuity. Conduct tests in presence of Authority and record results in writing.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of BASIC ELECTRICAL MATERIALS AND METHODS – TRACTION POWER will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of BASIC ELECTRICAL MATERIALS AND METHODS – TRACTION POWER must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 21 68
TRACTION POWER UNDERGROUND DUCTBANK AND MANHOLES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this section.

1.02. SUMMARY

A. This Section covers the construction and placement of underground traction power duct banks and manholes as site infrastructure.

B. Furnish and Install

1 The following items and accessory materials are addressed:

a. Ducts in concrete-encased duct banks.
b. Manholes and manhole accessories.

B. Related Sections: Related work specified elsewhere includes:

1. Section 03 30 00 - Cast-In-Place Concrete
2. Section 31 20 00 - Earthwork
3. Section 31 20 10 - Earthwork for Underground Utilities
4. Section 34 21 65 - Basic Electrical Materials and Methods - Traction Power

1.03 REFERENCES

A. AASHTO - Standard Specification for Highway Bridges.

B. AREMA – Manual for Railway Engineering.

C. ASTM A153 – Standard Specification for Zinc Coating of Iron and Steel Hardware.

D. ASTM A48 – Standard Specification for Gray Iron Castings

E. ASTM C478 – Standard Specification for Precast Reinforced Concrete Manhole Sections.

1.04 SUBMITTALS

A. The Contractor will submit catalog data as required per Standard Specification, Section 01 33 00, Submittal Procedures.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials will be new and applicable as listed, labeled, or approved by the Underwriters' Laboratories, Inc. Defective equipment or equipment damaged in the course of installation or test will be replaced or repaired in an approved manner.

2.02 UNDERGROUND CONDUIT DUCTS:

A. The Contractor will furnish materials and construct underground conduit ducts. Ducts will be cast-in-place monolith construction and will be of reinforced construction as shown on the drawings.

B. The Contractor will cooperate with other contractors in installing work which may affect his work. He will make proper arrangements to avoid interference with other trades, and will cooperate with the Commonwealth Edison Co., SBC and Peoples Gas Co. in their installation of underground ducts to underground duct extension sleeves and/or openings provided under this Contract.

C. Concrete and metal reinforcement for ducts will be as follows: Peripheral reinforcing will be #5 deformed bars with 20 times the diameter overlap on 10 inch centers. Ties will be #4 with minimum 12 inch overlaps 18 inch centers.

D. All conduit will be 3-1/2 inches non-metallic fiber reinforced epoxy conduit (RTRC). General requirements for RTRC conduit are specified under section 34 21 65 – "Basic Electrical Materials and Methods - Traction Power".

E. Conduits furnished and installed will be complete with all couplings, adapters, bends and supports as required. Unless otherwise specified, all conduits entering manholes or ending inside substation spaces (walls or floors) will be terminated using end bells. Where ducts by the Contractor will connect to existing ducts, the Contractor will make the required conduit connections at the construction joint.

F. To maintain proper spacing between the conduits in the duct/banks the Contractor will install conduit spacers. Spacers will be used for 3 1/2 inch fiberglass reinforced epoxy conduits to achieve approximately a 2 inch separation between the conduits. The spacers mentioned above are specified to achieve required spacing for fiberglass reinforced epoxy (RTRC) 3 1/2 inch conduit. If other approved manufacturers conduits or spacers will be used, the Contractor will make sure that proper spacing will be maintained and/or specified. Contractor is also required to purchase at least 3 extra spacers to provide for breakage during construction.

G. The conduit couplings will be staggered so that no coupling is less than six inches from the coupling on an adjacent conduit row or tier so as to provide a duct line having maximum strength.

H. To prevent duct distortion during concrete installation, the conduits will be strapped together with nonmetallic straps of proper strength, at no more than 8 feet intervals. A sufficient number of hold-down bars, will be installed to prevent conduit uplift during concrete installation.

I. The Contractor will have fiber reinforced epoxy conduit manufacturer's representative advice and check on proper concrete enclosed duct bank installation procedures before the duct is covered with concrete. However, the fact that the manufacturer representative checked the installation and advised on procedures will not relieve the Contractor of his responsibility under this Specification.

J. During construction, partially completed duct will be protected from the entrance of debris such as mud, sand and dirt, by means of suitable conduit plugs. As each section of a duct is completed, a testing mandrel not less than 36 inches long with a diameter 1/4 inch less than the size of the conduit, will be drawn through each conduit, after which a brush with stiff bristles will be drawn through until the conduit is clear of all particles of earth, sand or gravel, conduit plugs will then be immediately installed.

K. Backfilling in areas away from the tracks will be well compacted by means of hand or machine tampers. Backfill will be placed in successive layers not more than 12 inches deep and each layer will be thoroughly compacted with tampers before the next layer is placed. Backfill will be entirely free of frozen earth, vegetation, lumber, brickbats, rocks or concrete rubble

L. .All conduit runs will be terminated with end bells so as to provide a smooth, rounded surface for cable to rest on as it enters the conduit.

M. To avoid water seepage to the substation the Contractor will install sealing bushings 0Z GEDNEY, Mac Products or approved equal inside the substations. Blank sealing bushings will be installed on all spare conduits.

2.03 PRE-CAST MANHOLES

A. Manufacturer will have documented experience in the manufacture of manholes for a minimum of five years.

B. Sub base material will be 3 to 4 inches of sand over native subgrade compacted to 95% standard Proctor density.

C. Precast concrete: Air-entrained, 5,000-psi compressive strength at 28 days.

D. Roof design live load: AASHTO H20 highway loading with 30% increase for impact.

E. Wall design live load: AREMA Cooper E80 train loading.

F. Inside Dimensions: As indicated on drawings.

G. Manhole Shape: As indicated on drawings.

H. Ductbank openings: As indicated on drawings.

I. Provide grooved opening in top section for frame and cover.

J. Provide end bell type terminators for each ductbank conduit entry.

K. Provide cable support hardware and all supports for all cable, cable splices and cable terminations as required for support of cables inside manhole.

L. Provide 24 inches inside diameter by 36 inches deep (minimum dimensions) precast sump. Slope floor toward sump.

M. Provide cover, frame, and collar as shown on the drawings.

N. Ram-Nek, Kent Seal or approved equal sealants will be used to seal the joints in the manhole.

2.04 CAST-IN-PLACE MANHOLES

A. Excavate, install base material, and compact base material. Compact subgrade to 95% standard Proctor density or as required by manufacturer.

B. Concrete: Air-entrained, 4,000-psi compressive strength at 28 days.

C. Install, seal, and waterproof precast sections in accordance with manufacturer’s instructions.

D. Use precast ring sections to bring manhole entrance to proper elevation.

E. Install manhole plumb.

F. Provide cable support hardware and all supports for all cable, cable splices and cable terminations as required for support of cables inside manhole.

G. Provide 24 inches inside diameter by 36 inches deep (minimum dimensions) sump. Slope floor toward sump.

H. Set the top of each manhole cover to finished elevation.

I. Install a one-foot wide concrete (3,000 psi, ¾-inch aggregate) collar around the manhole, unless noted otherwise on drawings.

J. As a minimum the height of the concrete collar should go from the top of the manhole cover to eight inches below grade.

K. The top of the concrete collar will slope down away from the cover so that no water will accumulate around the cover.

2.05 MANHOLE ACCESSORIES

A. Unless otherwise noted within this specification or shown on drawings, the Contractor will furnish and install non-metallic cable support racks in the manholes, Cable support racks and mounting channels will be heavy-duty construction, consisting of molded, fire retardant, non-corrosive glass reinforced nylon with high dielectric properties.

B. Mounting channels will be surface type and will be anchored to concrete with stainless steel, heavy duty, one piece, wedge type concrete anchor bolts with nut and washer. Length of anchor bolts will be long enough to exceed the minimum embedment in concrete, recommended

C. Pulling Irons: 7/8-inch diameter steel bar forming a triangle of 9 inches per side when set. Galvanize to ANSI/ASTM A153 for irregular shaped articles. Locate opposite of each duct entry.

D. Cable will be tied to the cable racks with cross-wise nylon ties.

E. Cable support racks will be “Underground Devices”, Catalog No. RA20 or equal.

F. Cable rack channels will be “Underground Devices”, Catalog No. CR36 or equal.

G. Manhole Ladder: One ladder for each manhole entrance will be fire retardant yellow fiberglass reinforced plastic (FRP), extruded structural shapes. Ladders will have 2 inch x 2 inch square tube ¼ thick side rails 18 inches apart, and 1 3/8 inch round rungs with grit top non-skid surface set into and joined to side rails and spaced approximately 14 inches apart. The length of the ladder will extend from the bottom of the manhole to within 3 inch of the cover, and will be anchored top to bottom. Anchors and hardware will be stainless steel, and will be designed so that ladders can be readily removed.

H. Grade Rings: Pre-cast concrete (5000 psi. compressive strength at 28 days) with inside diameter equivalent to manhole opening specified in Part 2.5A. The ring will have circumferential rebar #3 minimum with a trowel finish to provide a true plane within 1/8 inch, as determined with a 5-ft straight edge.

I. Sump Covers: ASTM A48; Class 30B gray cast iron.

J. Manhole Frames and Covers: Per STP-900 or STP-901 unless indicated otherwise on the drawings.

PART 3 EXECUTION

3.01 CONDUITS

A. Where underground crossings are known, field verify horizontal and vertical locations prior to excavation and placement of conduit. Notify the Engineer of any deviations to the drawings. Any profile changes and existing utility line crossings are to be as built on drawings showing: type of line, size, and depth below the surface.

B. Install at 36” minimum depth of burial to top of electrical ductbank (top of concrete to finished grade), unless otherwise noted in drawing. If site conditions do not permit this depth of burial, contact the Engineer for instructions.

C. The ducts will have a continuous slope downward toward manholes and away from the substation buildings with a pitch of not less than 2 inches in 100 feet unless noted otherwise. Changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, will be accomplished by long sweep bends having a minimum radius of curvature of 25 feet, except that manufactured bends may be used at ends of short runs of 100 feet or less, and then only at or close to the end of the run. The long sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends will have a minimum radius of 36 inches for all ducts. No more than 270 degrees total bend will be allowed in any one run.

D. Ducts will be laid in trenches having solid, level and undisturbed bottoms. The Contractor will perform all excavation and backfilling, including breaking of and/or replacement of concrete necessary for the installation of his work. If excavation is made to a depth greater than elevation required, the Contractor will backfill with properly tamped CA-6 or CA-7 aggregate at his own expense to correct elevation. Method of conduit installation will be in strict accordance with manufacturer's recommendations

E. Spacers will be used where more than one duct is installed and will be the standard product of the duct manufacturer for the type and size duct. They will be located at not more than five-foot intervals, secured to the ducts with #16 gage wire. The spacers will be securely anchored every ten (10) feet to the bottom of the trench to prevent ducts from floating during concrete pouring. Unless otherwise noted on drawings, provide a minimum of 2 inches clear spacing between conduits, horizontally and vertically and minimum of 3 inches clear concrete cover.

F. Preparation and placing of concrete will be in accordance with provisions of Section 03 30 00, “Cast-In-Place Concrete.” Concrete mix design will be a minimum of 3000 psi with maximum 3/4” aggregate and maximum 6” slump. Care will be taken in the placement to prevent voids around the ducts. The top of the concrete encasement will be a smooth finish accomplished by mechanical vibrator or spading the surface.

G. Terminate conduits in an end bell at manhole and building foundation penetrations. Stub-ups of rigid or IMC duct in equipment pads will have insulated grounding bushings.

H. Conduit and duct runs will be short, straight runs between points of the system.

I. Conduits and duct runs will be installed on compacted soil when entering a manhole, building foundation, crossing a road, railroad track, or bridge abutment to prevent shear stress on the conduit.

J. All paving and concrete cuts will be made with a concrete saw. All surfaces and structures to be replaced will match existing condition.

K. Conduit penetrations into buildings, or through aboveground foundations, will be sealed with duct seal or conduit sealer to prevent gas or water entry.

L. Trenching and backfilling will be in accordance with section 02 20 00, “Excavation”.

M. Empty ducts running between manholes will have a 1/4” polypropylene pull rope provided in each duct, with 3 feet of slack at each end, and with the ends secured to a suitable structure (not a conductor) inside each manhole.

N. Empty ducts not running between two manholes (i.e. between switchgear and a manhole, or switchgear and a transformer, etc.) will be labeled at both ends with a Panduit Marker Plate (Model # MP350-C). The label will be marked with a Sharpie Permanent Ink Pen and secured to the pull rope on the inside of the duct so as to indicate destination of the duct.

O. When multiple channel inner ducts (FO-DUCT) are pulled through conduit, secure every 10-ft section so as to prevent rolling of channels within conduit. Leave one-foot ends protruding from face of manhole.

P. Conduit and duct banks will maintain 1-foot vertical and 1 foot horizontal separation from other utility lines where possible.

Q. Identify the ductbank location with metallic safety tape or vinyl tape with magnetic tracer marked "CAUTION! BURIED HIGH VOLTAGE ELECTRICAL LINE". Tape will be located 12 inches above the ductbank.

R. Swab the duct at completion of construction. A mandrel approximately 1/4" smaller than the conduit will be pulled through each conduit. A circular plastic wire brush with the same diameter as the conduit will be pulled through the conduit. After cleaning, install caps as herein specified, to protect against the entry of dirt or moisture.

3.02 PRE- CAST MANHOLES

A. Excavate, install base material, and compact base material. Compact subgrade to 95% standard Proctor density or as required by manufacturer.

B. Install, seal, and waterproof precast sections in accordance with manufacturer's instructions.

C. Use precast grade ring sections to bring manhole entrance to proper elevation.

D. Install manholes plumb.

E. Set the top of each manhole to finished elevation.

F. Install a one-foot wide concrete (3,000 psi, 3/4-inch aggregate) collar around the manhole, unless noted otherwise on drawings.

G. As a minimum the height of the concrete collar should go from the top of the manhole cover to eight inches below grade.

H. The top of the concrete collar will slope down away from the cover so that no water will accumulate around the cover.

I. Backfill around manhole using native material.

3.03 TRENCH BACKFILLING

A. Backfill using fine material up to 24 inches above the top of the ductbank placed in 6-inch lifts and thoroughly tamped.

B. Consolidate the ductbank fill material under roads or similar traffic areas in such a manner as to provide an unyielding foundation for the paving. Remove all excess materials.

C. Compact backfill by tamping or other method as approved by the Engineer. Maintain compaction at a minimum of 95 percent standard Proctor density.

D. Contractor will assume full responsibility for any deficiency in quantity of material or filling of depressions caused by settlement of backfill material. Damage to other trade's work caused by settling will be corrected at the Contractor's expense. Contractor will assume full responsibility for damages to any underground utility lines or other structure.

E. Dispose of all excess material from the construction site as directed by the Owner. Contractor should remove excess spoils and other material from the site.

3.04 RECORD DRAWINGS

A. All duct bank locations will be located with respect to site horizontal controls. All ductbanks will be located at ends and change of directions. Record accurately all ductbank bends (radius and center point) on the construction As-Build drawings.

B. Record the installed length of each conduit in the ductbank to the nearest foot and transmit to the Owner's representative.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of TRACTION POWER UNDERGROUND DUCTBANK AND MANHOLES will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of TRACTION POWER UNDERGROUND DUCTBANK AND MANHOLES must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 21 95

TRACTION POWER DISTRIBUTION SYSTEM TESTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions apply to this section.

1.02 SUMMARY

A. This section covers the requirements for field testing of traction power distribution equipment installed along the right-of-way.

B. All traction power equipment furnished and installed under this contract will be subject to the test program described herein.

C. The Contractor will formulate overall test program of the equipment which will include but not be limited to the tests specified in this Section to ensure equipment compliance with the relevant standards, this Specification and satisfactory and reliable performance in intended operation.

D. This section does not cover field testing of substations or substation apparatus but is intended as a functional test prior to energizing wayside equipment such as cable, switches, and contact rail.

1.03 FACTORY TESTS

A. This section does not cover factory testing.

1.04 FIELD TESTS

A. Tests in the field will include but not be limited to:

1. Manufacturer's standard tests
2. Test as per currently applicable NEMA, IEEE and ANSI Standards.
3. Any other tests to ensure satisfactory performance of the traction power equipment.

1.05 TEST REPORTS

A. The Contractor will submit certified copies of test reports for all the tests conducted in field for Authority's approval. Test reports will be submitted to the Authority within seven days after completion of tests. Test reports will contain the characteristics curves, etc. where required for interpretation of results.

1.06 CONDITIONS FOR TESTS

A. General Conditions

Prior to testing of any equipment specified in this Section, all of the following conditions will be fulfilled by the Contractor:

1. All shop drawings of the equipment to be tested have been approved by the Authority.
2. The Contractor will submit a step by step test procedure including pass-fail criteria to the Authority two weeks in advance of the commencement of the test. The Authority reserves the right to add, delete and make necessary changes in the test procedure. The Contractor will arrange to conduct all tests per the Authority’s approved procedure.
3. Testing will not commence without an approved test procedure.

B. Witnessing Tests

1. The Authority's personnel and/or their authorized agents will witness testing of all equipment unless a waiver is granted, in which case test reports of equipment for which waiver was granted, will be submitted for review. Waiver of witnessing tests on equipment will not be construed as a waiver for all remaining equipment either of the same type or different type. Contractor will provide the Authority a minimum of one (1) week notice prior to commencing the test, so the Authority can schedule personnel for witnessing the tests.

C. Responsibility

1. The Contractor will assume full responsibility during the field testing of all equipment and installation provided by him. Should there be any loss or damage to such equipment, materials or the building as result of these tests, the Contractor will be fully responsible for replacing the damaged equipment and repairing the building. Replacement of damaged equipment will include all costs, including but not limited to, transportation of, testing and installation of replacement equipment.

D. Rejection and Retesting

1. Failure of equipment to successfully pass the tests or to meet ratings will be sufficient grounds for rejection of equipment.
2. Any equipment rejected will be retested in presence of the Authority after rectification. If the modifications or changes are such as to affect any of the drawings, diagrams or any other documents submitted and accepted by the Authority, revised drawings or diagrams will be submitted, showing proposed changes and Authority's approval obtained before changes or modifications are made on the equipment. Modifications or changes which do not warrant revision of any drawing will be furnished to the Authority along with notice of retesting.
3. If it is not possible to rectify rejected equipment, new equipment will be manufactured, and the requirements of the drawings and design calculations of the original unit will be applicable for the new unit.

E. Cost of Rectification or New Unit

1. The entire cost of rectification or new unit will be borne by the Contractor including retesting and cost of witnessing retesting.

1.07 SUBMITTALS

A. At a minimum, the following will be submitted for review:

1. Field test procedure.
2. Test equipment specifications.
3. Field test results.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 FIELD TESTS

A. General

1. Contractor will perform the field tests on all equipment specified in this Section after installation of the equipment.
2. The work includes furnishing labor, material, test instruments and services necessary to perform required testing and checking of electrical equipment installation.
3. All tests will be successfully completed to show that the installation meets the specification requirements and that the equipment and devices operate as intended, before final acceptance by the Authority.
4. Tests and checkouts will be conducted in accordance with the Authority's approved test procedure specified herein and in National Electrical Code, and applicable Standards and Specifications' of ANSI, NEMA, etc.
5. Contractor will provide properly qualified personnel who will be responsible for supervising, coordinating, and performing all the electrical field testing and checking work and who will maintain a written record of tests conducted.
6. Testing and checkouts will be performed in the presence of the Authority.
7 Contractor will furnish four copies of all tests results to the Authority. Result sheets will include date of test, personnel involved, items tested, type of tests and test data.
8. Any equipment or material damaged due to improper test procedure or test apparatus handling will be replaced or restored to original condition by Contractor at his expense.
9. Safety devices including but not limited to rubber gloves and blankets, screens and barriers, danger signs, padlocks, etc., will be used to protect and warn all personnel in the vicinity of the tests.
10. All test instruments used will have a certified calibration sticker showing last date of calibration and expiration date.

B. Field Test Requirements

1. Contractor will formulate a complete Field Test procedure for all equipment to be furnished and installed under this Contract. Test procedure will be comprehensive and will include the required tests as specified in relevant standards of ANSI, NEMA and IEEE, supplementing the Factory Test Procedure.
2. The Contractor will submit the test procedure to the Engineer for review and approval well in advance to the commencement of field tests. Engineer reserves the right to add, delete or make necessary changes in the test procedure. The Contractor will arrange to conduct all the field tests as per the Engineer's approved procedure. Since the Contractor is responsible for the performance and installation of the equipment furnished under this Section, he will, therefore, prior to testing, verify that the installation is proper and in accordance with all applicable installation instructions specified herein.

C. The following tests will be performed.

1. Traction Power Cables:

   a. After cable installation, and immediately before the splices are made or terminal lugs applied, the protecting caps or tape will be removed and each length of cable so exposed will be immediately tested with a portable megohm-measuring instrument having a minimum range to 10,000 megohms and a 1,000 volt constant potential generator. These insulation resistance tests will be made to earth ground for surface or underground installation, where ground is a temporary rod electrode driven for connection to the megger instrument. The remote ends of cable (other end from test location) will be open during this test. Splicing and termination of cables will proceed immediately after testing, provided insulation resistance exceeds the following minimum values, which are based on 500' cable length or less, and are adjusted to allow for lower readings that could be caused by high ambient temperature and/or high relative humidity.
   b. Above ground installation will use CTA elevated structure for reference.

Cable-Size	Minimum Insulation Resistance
1,500 KCMIL	20 meg-ohm-mile
500 KCMIL	20 meg-ohm-mile

c. If the insulation resistance is lower than the minimum megohms listed above, the Contractor will report the condition to the Authority for determination of appropriate remedial procedures.

d. After all splices and lugs are applied, but before the connection are made to apparatus, contact rails and other equipment, each continuously connected length of cable will again be tested with the megohm-measuring instrument specified above. If the insulation resistance of a wire or cable so measured is less than the permissible megohms of resistance set forth in the following table for cable being tested, the cause of the defect will be determined by the Contractor and corrected to the satisfaction of the Authority and the cost of such remedial work will be borne by the Contractor.

Minimum Insulation Resistance in Megohms to Ground for Range of Cable Length are:

Cable Size	Up to 500 feet	500 feet to 1000 feet	1000 feet to 1500 feet
500 KCMIL	650 Mohm	650 to 325 Mohm	325 to 215 Mohm
1,500 KCMIL	500 Mohm	500 to 250 Mohm	250 to 170 Mohm

e. The Contractor will keep a record of the insulation tests and will forward the required copies to the Authority for examination and approval. See a sample of the test form.

DATE____
PROJECT NAME____
FEEDER NUMBER FROM____________________LOCATION______________
FROM___________________________TO______________________________
_
CABLE SIZE______________________CABLE LENGTH___________________
NUMBER OF CONDUCTORS______________INSULATION TYPE__________
MANUFACTURER__________________LINE VOLTAGE__________________
TEMPERATURE___________________HUMIDITY_______________________
MEGGER TYPE____________________SERIAL NUMBER________________
TEST VOLTAGE____________________MULTIPLIER____________________

REMARKS____

Where Applicable, all shields must be properly grounded prior to testing.

Cable No. Phase A	MEGOHMS Phase B	MEGOHMS Phase C	MEGOHMS

TEST PERFORMED
BY:____
SIGNATURE DATE

TEST WITNESSED BY: ____
SIGNATURE DATE

D. Hand Operated Switches and Motor operated switches (MOS):

1. Before traction power cables are connected, the following inspections and tests will be made on the switches by the Contractor.

    a. Test insulation resistance to ground employing 1,000 Volt megger with test ground electrode. If insulation resistance is less than 50 megohms, the Contractor will make required corrections to the satisfaction of the Authority without cost to the Authority.
    b. Inspect blade and clip parts of switch for proper alignment, clean and dry contact surfaces. Operate the switch, checking switching action, wipe, and action of quick break mechanism.
    c. Operate all disconnect and sectionalizing switches to ensure positive operation without binding or otherwise mis-operating.
    d. Open, close, latch, unlatch, lock, unlock all cabinet doors to ensure correct operation and clearance.
    e. Inspect switch terminal pads for clean, dry surfaces for electrical connections.
    f. Before connecting traction power cables, the Contractor will make continuity tests to ascertain that the correct traction power cable is in place for connection.
    g. After cables are connected, the Contractor will test the clamping force of bolted electrical connections with an accurate torque wrench. Bolted electrical connections will be tested for the following torques:

Minimum Torque (Lb-In)

Bolt Size	Hardware not Lubricated	Hardware Lubricated
3/8 inch-16	240	170
1/2 inch -13	480	300
3/4 inch 10	840	720

    h. Verify the remote operation of the MOS, after removing power from both sides.

E. Contact Rail System:

1. Perform continuity and dielectric tests to prove contact rail is properly connected and insulated. With cables feeding contact rail disconnected, test resistance to ground (elevated structure) using a 1000 volt ohmmeter test set ("Megger"). Minimum resistance will be 300Mohm/ft.
2. Perform continuity test to prove that contact rail is properly connected and that no inadvertent connections exist (such as temporary connections to kick/lap rail etc.)

    a. Check that all contact rail, cable connections, rail taps, and other traction power elements are properly set and clear of interference with rail cars and other traffic.
    b. Verify that all the gaps are installed as per the drawings.
    c. Verify that a minimum of 40 ft gap is maintained at all the section gaps.
    d. Verify that contact rail anchors are installed at the required locations as per the standard drawings.
    e. Verify that chairs are installed at regular intervals and maintain the clearance requirements specified in the standard drawings.

f. Verify that all rail taps are installed with clearances as required per the standard drawings and specifications.

g. Verify that the chairs are properly shimmed and a 6.5” height difference is maintained between the top of contact rail to the top of running rail.

h. Verify that the resistance of each welded cable at the point of application will not exceed 40 micro-ohms. Perform this test (Ductor test) on 10% of welded cables. Based on the results of the resistance test, the Authority will determine if to reduce or increase sampling

i. Verify that the electrical resistance of finished splice/joints in composite contact rail measured 36 inches across the joint with the center of the joint at the center of the measurement be equal or less than the electrical resistance of 36 inches of non-jointed composite contact rail. Perform this test (Ductor test) on 10% of splice joints. Based on the results of the resistance test, the Authority will determine if to reduce or increase sampling

F. Negative Return

1. Verify that all the negative return bonds including rail to rail bonds, rail to structure bonds, impedance bonds, cross bonds, auxiliary negative bonds, bypass cables, substation negative return bonds, etc are installed as per the drawings and the Authority’s standards.
2. Each weld will be mechanically tested by striking the weld with a mallet. In addition, verify that the resistance of each welded cable at the point of application will not exceed 40 micro-ohms. Perform this test (Ductor test) on 10% of welded cables. Based on the results of the resistance test, the Authority will determine if to reduce or increase sampling
3. Verify that the electrical resistance of finished splice/joints in ANR measured 36 inches across the joint with the center of the joint at the center of the measurement be equal or less than the electrical resistance of 36 inches of non-jointed rail. Perform this test (Ductor test) on 10% of splice joints. Based on the results of the resistance test, the Authority will determine if to reduce or increase sampling
4. Bolted electrical connections of the impedance bond and negative bus will be tested using a torque wrench as per Section 3.01 D.1.g.

G. Contact Rail Heaters

1. After all wires and cables are in place and connected to devices and equipment, test system for shorts, grounds or other resistances.
2. Perform functional and operational tests of all equipment. Test and verify local and remote operation and control of contact rail heating system.

H. Section Proving test

1. Upon completion of the installation, disconnect and completely remove any temporary work prior to commencement of testing. Perform section proving tests for the contact rail, cabling, switches, and return system for proper sectionalization and insulation.

   Section proving tests should include testing of sections to ensure there are no inadvertent or improper connections between sections of contact rail especially at section breaks.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of TRACTION POWER DISTRIBUTION SYSTEM TESTING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of TRACTION POWER DISTRIBUTION SYSTEM TESTING must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 24 19
CONTACT RAIL SYSTEM

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Special Conditions, apply to this section.

1.02 SUMMARY

A. The Contact Rail System consists of composite contact rail, support insulators, anchors, bonds, cables, disconnect switches, jumper system, and other ancillary devices required to complete the contact rail system and deliver power to the trains.

B. The contact rail layout is coordinated with the track layout to ensure that operating requirements are met. Wherever possible, the contact rail will be located opposite from station platforms and emergency walkways.

C. The contact rail system is designed to the track alignment and will be coordinated with the car clearance envelope.

D. Any temporary cable work required to maintain service during and throughout the construction period is described in Paragraph 3.01.G of this specification. All temporary work will be installed and allow for normal train operations and removed prior to final acceptance. Note: The work required for moving between temporary phases of work to the final configuration including removal of all temporary work will be included in this Contract as part of completing the work.

E. The completed contact rail system will perform its intended function of supplying electrical current to trains without injurious effect to itself or train current collectors including arcing from improperly installed contact rail. It will provide a smooth and level interface between itself and collectors in a constant relation to the running rail in horizontal and vertical planes.

F. The completed end approach inclines will exhibit no undue lifting and their base will be in the same plane as the completed section of contact rail to which they are attached. The inclined plane will be such that there will be smooth gradual transition of contact rail shoes onto the contact rail.

1.03 SUBMITTALS

A. Submit shop drawings, product data, test procedures, as-built drawings, and samples of contact rail, insulator chairs, shims, contact rail anchors, splice bolts (for temporary installation of contact rail and end approaches) for CTA approval before purchase.

PART 2 – PRODUCTS

2.01 CONTACT RAIL

A. Type

1. The contact rail will be replaced with new contact rail and contact rail inclines fabricated from 85 lb. ASCE steel base rail, fishplates and 85 lb. ASCE steel base rail clad with aluminum extrusions on each side of the web, including aluminum splice plates, compression fasteners and steel fishplate assemblies for use as contact rail for rapid transit trackwork as outlined in the contract specifications.
2. At least five (5) years of documented and successful in track experience is required.

B. End Approach Inclines

1. Contact rail inclines will be fabricated from the 85 lb. ASCE base rail and as shown on the Contract Drawings.
2. Cutting and welding of the contact rail inclines will be in accordance with AWS D15.2 Recommended Practices for the Welding of Rails and Related Rail Components for Use by Rail Vehicles and will be performed by certified welders who have been requalified within twelve months of performing this work. The Contractor will submit the welder certificates and welding procedures to the CTA for approval prior to commencing fabrication work performed in the field.
3. The joint ends of the single inclines will be drilled as indicated on the Contract Drawings.

C. Contact Rail Anchors

1. Provide insulated anchors to restrain the contact rail in the longitudinal direction from expansion and contraction also to prevent the longitudinal forces from being transmitted to the insulators.
2. Provide anchor system that allows full stress to develop in the anchors without deformation or pull-out of threaded rods.
3. The Contractor will provide new angle brackets per Contract Drawings. The existing brackets will be removed and scrapped to the benefit of the Contractor.
4. Remove the existing anchors and provide new anchors at midpoint of the section length. The locations of the anchors are not shown on the drawings.

D. Splice/Joint Bars

1. An aluminum splice joint assembly will be used to join sections of aluminum clad contact rail. The aluminum splice joint assembly will consist of two 6101-T6 aluminum alloy extrusions, 24 inches long, and four 7/8 diameter compression fasteners with necessary flanged collars.
2. The steel splice joint assembly will consist of two steel fish plates, and four track bolts, washers, and nuts.
3. Install the splice bars to avoid interference with the operation of contact rail shoes or ice scrapers in use by CTA.

E. Contact Rail Insulators

1. The Contractor will provide insulators in accordance with the plans to support the contact rail. Use the table shown on STP-101 to determine proper height of insulator based on running rail and contact rail present in the area. For the closed deck area, since the insulator heights will be different than the STP-101 table, appropriate size insulators shall be installed based on the plinth height and the height of the tie plates and pads used.

F. Contact Rail Insulator Shims

1. Shims for increasing the height of the insulator will be allowed for making small adjustments in height of the insulator.
2. The thickness of shims will be 1/8”, ¼” and 3/8” as required, and conform to the size and shape of the insulator base and holes.
3. The shims will be made from weather resistant high density polyethylene.

G. Electrical Properties

1. The assembled composite contact rail will be capable of carrying a current of 5,000 amperes on a continuous basis without exceeding a temperature rise of 40ºC above ambient temperature in still air.

H. Contact Rail Taps

1. Each cable to rail connection will be made with a contact rail tap assembly. Contact rail tap assemblies will not be located within two feet of a contact rail joint or contact rail insulator chair. The number and length of the 300 MCM bootleg bonds will be as shown on the Contract Drawings. The terminal ends of the bootleg bonds are designed to hook over the flange of the contact rail and so hold the bonds in position during welding. The terminal lug will be soldered to the bonds such that the bonds will not be twisted when applied to the rail.
2. When it is indicated on the drawings that a contact rail tap is to remain in place, it will be understood that the portion of the rail tap connected to the old rail will be replaced in its entirety. For example, the bond(s), bronze bolt(s), and lug(s) to contact rail will be replaced, while the existing cables(s) to lug(s) connection may remain in place, as indicated on the Contract Drawings.

I. Contact Rail Chair support block

1. A support block shall be installed under the contact rail chairs on the closed deck area to maintain the 6 ½ inch height difference between top of contact rail and top of running rail.
2. Contact rail blocks shall be 10” wide x 15” long made of plastic composite materials, or fiberglass reinforced. The height of the contact rail block varies based on the plinth height. The block shall be black color, electrically non-conductive, resistant to decay and insect attack. Water absorption will not cause loss of strength. Material will be non-hazardous and non-leaching; and UV resistant. Shear strength per ASTM D6117-97 will be 1,000 psi min.; and lag screw withdrawal strength will be 2,500 lbs. min. per ASTM D6117-97.
3. Contact rail block inserts will be nylon, minimum three and three-quarters (3-3/4”) inches long for one (1”) inch diameter stainless steel bolts and positioned to be flush with the top of the concrete deck. The bolts will be a minimum of 8 1/4” long for holding the contact rail blocks to the concrete deck.
4. The block is to be designed so that water cannot be trapped by any parts of the block.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Contact Rail Insulators

1. Provide contact rail support fiberglass insulators that are uniform and similar to the existing insulators. The insulators will be as shown on the plans.

2. Contractor will apply for and receive approval from CTA of final proposed location of all contact rail support insulators including locations of end approach inclines to ensure final insulator layout conforms to CTA standards, as shown on the Contract Drawings, before commencing work.
3. Insulators when installed will provide 6 1/2", plus 0" or minus 1/8" vertical distance between the plane made by the top of the running rails and the top of contact rail. Use a gauge bar template to ensure both are in the same plane. Should a particular location cause the insulator to be too low, shimming will be allowed. The maximum shimming height is 1/2 inch, except for the super-elevation areas and the maximum number of shims in any one location is two. Insulators requiring shimming greater than ½" at any locations except the super-elevation areas need to first be approved by CTA, and then proceed at their direction. Horizontal distance between the gauge face of the running rail and the centerline of the contact rail will be 1'-8 1/8", plus or minus 1/8 of an inch.
4. Contractor will utilize a gauge bar template which lays across both running rails for installing insulators to ensure the correct and uniform height and alignment to the running rail. Design of gauge will be approved by the CTA.
5. Locate insulators no more than eight feet (six feet on curves) apart in accordance with contract drawings.

B. Contact Rail

1. Contact rail will be installed to line and grade, with relationship to track plane, as indicated herein and shown on contract drawings. The contact rail will rest evenly and uniformly on all insulators.
2. For curves of 2,500 foot radius or less, the contact rail will be pre-curved. After curving, the contact rail will be free of kinks, twists, nicks, or other undesirable conditions.
3. When two pieces of contact rail are joined, the outer surface of the aluminum extrusions will be first cleaned of oxide, and then immediately coated with an approved oxidation inhibiting compound. Similarly, the inside surface of the splice/joint bars will be cleaned of oxide and immediately coated with the oxidation inhibiting compound. The joint between the rails will be butted and the splice/joint bars and compression bolts applied.
4. Once temporary connections in contact rail are no longer required replace mechanical nuts, bolts and washers with Huck pins and collars for final configuration. Use 4 (four) Huck pins for each joint/splice bar assembly. Contractor needs to re-test joint resistance (see item 9 below) and ensure surfaces are prepared properly before and after Huck bolts are installed.
5. At every joint if required, lightly grind the rails to ensure even surfaces between the two rails or between the rail and end approach incline.
6. Once a section of contact rail is complete (end approach incline to end approach incline) anchor it at the midpoint of the run. Anchors will be installed on the field side of the contact rail as shown on contract drawings as required for the particular situation. If the Contractor is unable to install the anchor as shown on the drawing, then the Contractor will install the anchor as directed by the CTA.
7. End approach inclines will be attached to each end of a contact rail section (see Contract Drawings for proper size end approach for the particular contact rail section). End approach inclines will be installed to line and grade with relationship to the running rail.
8. End approach inclines will rest uniformly on all insulators. When connected to complete a section of the contact rail, the end approaches will not lift off from the insulators. The base will be on the same plane as the contact rail to which it is connected.
9. Electrical resistance of finished splice/joints in composite contact rail measured 36 inches across the joint with the center of the joint at the center of the measurement

will be tested to be equal or less than the electrical resistance of 36 inches of non-jointed composite contact rail. The test will be made in the presence of CTA or their approved representative.

10. Should any splice/joint fail this test then the Contractor will replace the splice/joint with a new installation. If the splice/joint fails a second time the Contractor will notify CTA and proceed as CTA directs. If this situation cannot be resolved then the Contractor may have to install special rail bonds across the joint as directed by CTA, at no additional cost.
11. Assemble and align the contact rail sections, in both horizontal and vertical planes, so that when a 6 foot level is placed on the top of the rail head, no deviation greater than 1/64th of an inch is observed between the ends of the level.
12. The splice/joint should result in a minimum of electrical resistance across the interface for the transfer of electric current. The splice/joint bars will be predrilled to match the two-drilled holes in the end of the composite contact rail so that when two pieces of rail are butted together, the splice/joint bars can be applied with Huck bolts without field alterations of any kind.
13. The assembly will butt tightly together allowing no more than 1/8 inch gap between rail sections. All completed contact rails and end approach inclines will be smooth on heads and bases, straight in line and surface, without twists, kinks, waves or defects of any kind.

C. Cable Connections to Contact Rail

1. Contact rail tap cables from either disconnect switches, gap jumpers, auxiliary, or parallel cables will be welded to the contact rail as shown on contract drawings. Contractor will submit welding details for approval by CTA.
2. The surface of rails where cables(s) are to be connected will be ground clean with a vitrified grinding wheel. After grinding the surface will be cleaned with a non-toxic solvent to remove all traces of dirt and grease. After the surface has been ground and cleaned the surface will be heated to drive out any moisture. The cable will be welded to the rail in such a manner as to ensure a thorough mechanical and electrical connection. In the event the weld is not made immediately after grinding the surface it will be coated with a rust prevention material. Follow the cleaning procedure specified above before making the weld.
3. Before commencing work of welding, the Contractor, at his expense, will require each welder to weld, in the field, under conditions similar to those of the actual work area, not less than three complete rail connections and as many more as required by CTA to determine the welds are being made satisfactorily, The welds will be subject to inspection and test by CTA and their approval as to method and quality of workmanship will depend on the results of these inspections and tests. Final approval of welders will be by CTA.
4. Each rail connection will be thoroughly welded to the rail. To reduce the possibly of these welds breaking in service, the CTA will require a test of each weld by hammer (weight to be determined by the size of cable and weld) furnished by Contractor, or in a manner which, in the opinion of CTA, is reasonable.
5. Any bond, weld, or connection which in the opinion of the CTA is found to be defective, will be removed and a new bond, weld, or connection will be installed at the expense of the Contractor.
6. The resistance of each welded cable at the point of application shall not exceed 40 micro-ohms. The measurement shall be taken from directly across the weld. Any weld which in the opinion of CTA does not meet this resistance level shall be removed and reconnected at the expense of the Contractor.
7. Cables will not be welded to an end approach incline under any circumstances.
8. Cables will be installed with respect to insulators as shown on contract drawings.
9. The finished cable installation and connection to the contact rail will have sufficient clearance (minimum of 6 inches) so that the cable(s) do not chafe or encroach on

the contact shoe or any other fixed or movable structure. Stub-ups at switch locations should extend up to the bottom of the switch box. The stub-ups should ensure that the cable is completely protected all the way into the switch enclosure.

D. Contact Rail Gaps and Sectionalization

1. The contact rail will be installed in sections of no more than 2,000 feet. Each section will terminate with an end approach incline. Each section will be anchored at a point within 2 feet of its midpoint.
2. Non-sectionalizing contact rail gaps will not exceed 30 feet (unless approved by CTA) to ensure that one shoe of the car is always in contact with the contact rail at all times. However, power section breaks will be 40 feet minimum to ensure that the car cannot bridge two isolated sections of contact rail. All gaps will be in accordance with CTA Standards.

E. Transition Contact Rail

1. The Contractor should make every effort to install complete sections of contact rail during each work window since the contact rail lengths are relatively short. Effort should be made to only install complete sections of contact rail and avoid making temporary ends and temporary connections.
2. If the Contractor is unable to install a complete section of contact rail, temporary end approach inclines will need to be installed although no gaps will exceed 30 feet.
3. Two temporary 1,500 kcmil jumper cables will be run between gaps to ensure electrical continuity if situation happens outside of by-pass cable area. The cables will be welded to each rail in a manner approved by CTA. Cables will be temporarily protected and fastened to the invert to prevent interference with vehicles, contact rail shoes or personnel.
4. Costs for temporary end approach inclines and temporary cables, if required, will not be paid separately, but will be in the Contractor's overall costs of contact rail installation.
5. This temporary type of installation should not persist for more than seven calendar days and typically be corrected/completed the next day if it cannot be avoided altogether.

F. Contact Rail Anchors

1. Contact rail anchors will be installed on each continuous length of installed contact rail and located midway between the two inclines as shown on contract drawings.
2. The steel angles attached to the base of the contact rail and to the timber guard will be parallel to the contact rail.
3. Angles to be installed on the contact rails will be welded to the rail by the electric arc welding process. Welding rods used will conform to American Welding Society Standard AWS A-5.I, latest edition, "Specification for Mild Steel Covered Arc Welding Electrodes", Electrode Classification No. E601Dr E7018.
4. Only properly qualified and certified welders will be employed by the Contractor for the welding attachment of the angle. The Engineer will make any tests which in his opinion may be necessary to locate defective workmanship, and the Contractor will replace without additional compensation, including material so ordered, all defective welding, which may be found, or which may result from tests, during the progress of the work and before acceptance by the CTA.
5. Before welding, all surfaces will be thoroughly cleaned of scale, grease, rust, paint and other substances by approved methods. The weld between each angle and the steel rail will be the built up electric arc welding process.
6. Angles to be installed on the timber guard will be fastened with galvanized bolts

and nuts as shown on contract drawings.

G. Temporary Work

1. Provide work necessary to relocate temporary cabling, contact rails, related equipment and materials during construction work. This may involve several movements of these items as construction progresses.
2. Provide any required negative bonding to ensure integrity of the negative return circuit during construction work.
3. Disconnected cable that is to be reused will be de-energized, secured to the structure and protected from water intrusion.

3.02 TESTING

A. Upon completion of the installation, disconnect and completely remove any temporary work prior to commencement of testing. Perform section proving tests for the contact rail, cabling, switches, and return system for proper sectionalization and insulation. Submit test procedure(s) in accordance with the Contract, for approval by CTA. Test procedures must be approved four weeks prior to performing any tests.

1. Section proving tests should include testing of sections to ensure there are no inadvertent or improper connections between sections of contact rail especially at section breaks.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of CONTACT RAIL SYSTEM will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of CONTACT RAIL SYSTEM must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 24 23

CONTACT RAIL BONDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Special Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This section specifies the requirements for the furnishing and installing of all contact rail bonding.

B. The work under this section includes furnishing all labor, tools, equipment and incidentals necessary to install the contact rail bonding.

C. Related Sections: Related work specified elsewhere includes:

1. Section 34 21 61 - General Provisions Traction Power
2. Section 34 24 20 - Contact Rail

PART 2 - PRODUCTS

2.01 CONTACT RAIL BONDING

A. The Contractor will furnish and install all contact rail bonding as shown on the Contract Drawings and/or specified, including the furnishing of all collateral material.

B. This work includes the installation and welding of contact rail joint bonds and the installation and welding of contact rail tap assembly boot leg bonds.

C. Each base contact rail joint will be bonded with 500 MCM type AEE bond, as shown on the Contract Drawings or as specified herein.

PART 3 - EXECUTION

3.01 GENERAL

A. Each cable to rail connection will be made with a contact rail tap assembly. Contact rail assemblies will not be located within two (2) feet of a contact rail joint or contact rail insulator chair. Number and length of the 300 MCM boot leg bonds will be as shown on the Contract Drawings. The terminal ends of the boot leg bonds are designed to hook over the flanges of the contact rail and so hold the bonds in position during welding. The terminal lug will be soldered to the bonds such that the bonds will not be twisted when applied to the rail.

B. When it is indicated on the drawings that a contact rail tap is to remain in place, it will be understood that the portion of the rail tap connected to the old rail will be replaced in its entirety. For example, the bond(s) and lug(s) to contact rail will be replaced, while the existing cable(s) to lug(s) connection may remain in place, as indicated on the Contract Drawings.

C. Each bond will be welded to the rail by the electric welding process. Welding rods used will conform to American Welding Society Standard AWS A-5.1, latest edition, "Specification for Mild Steel Covered Arc Welding Electrodes," Electrode Classification No. E6012.

D. Only properly qualified and licensed welders will be employed by the Contractor for the welding attachment of the bonds. The Engineer will make any test which in his opinion may be necessary to locate defective workmanship, and the Contractor will replace without additional compensation, including material if so ordered, all defective welding, damaged or defective bonding which may be found, or which may result from tests, during the progress of the work and before acceptance by the CTA.

E. Before welding, all surfaces will be thoroughly cleaned of scale, grease, rust, paint and other substances by approved methods. The weld between each bond terminal and the steel rail will be built up by the electric arc welding process until every portion of the welded joint has a cross section area greater than that of the bonding cable.

F. It will be the Contractor's responsibility to insure that each contact rail tap is free to move with the linear thermal expansion and contraction of the contact rail. In cases where existing ties may interfere with this movement, the Contractor will shorten these ties only in the area from gauge side of the contact rail to the field side of adjacent wood guard rail.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of CONTACT RAIL BONDING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of CONTACT RAIL BONDING must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 24 30
RAIL CONNECTIONS AND RUNNING RAIL BONDING
TRACTION POWER

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including general and special conditions and the contract, apply to this section.

1.02 SUMMARY

A. The work under this section consist of providing rail connections, cross bond connections, substation return connections, and structure cross bond connections at impedance bond locations. Impedance bond locations and structure cross bond locations will be in accordance with the contractor's final approved design plans.

B. Typical rail connection and running rail-bonding details for rail joint, rail connections, and track cross bonding connections are shown on the contract drawings.

C. Connection and bonds to negative-return rail can be expected to carry dc currents in excess of 10,000 amps. Care must be taken to ensure that all aspects of the negative return circuit have sufficient capacity to carry the traction power return current loading.

1.03 QUALITY ASSURANCE

A. The contractor will install each welded bond and mechanical rail connector in accordance with the requirements of this section.

B. Before beginning work on these bonds, the contractor, at his expense, will require each welder to weld in the field under conditions similar to those of the regular installation, not less than three complete rail and structure connections, and as many more as the CTA considers necessary to determine that the welds are being made satisfactorily. Such welds will be subject to inspection and test by the CTA, and his approval as to method and quality of workmanship will depend on the results of these inspections and tests.

C. All bonds and bonding material will be the products of a manufacturer who has been regularly engaged in furnishing railway bonds for at least ten years. Samples of the bond and welding rods will be approved prior to shipment of the remainder of the materials.

D. All electric arc welding will be in accordance with the latest codes of the American Welding Society.

E. Bolted connections will be tightened with a torque wrench in accordance with the manufacturer’s recommended torques for rail and plate type connection.

F. For exothermic welded connections, no portion of the formed terminal within the confines of the weld should be exposed. Maximum depression under the riser on horizontal connections (after the slag has been removed) should be no lower than the top of the formed terminal.

1. Low fill indicates incorrect weld metal size, excessive leakage of molten metal, or improper conductor positioning.
2. Excessively high fill indicates that too large weld metal size was used (connection is still acceptable), apparent volume increases due to contaminants in conductor of mold, or improper terminal positioning (terminal inserted too far in weld cavity).

1.04 SUBMITTALS

A. The contractor will submit the following to the CTA for approval:

1. Samples and material composition of electrical and mechanical characteristics for signal bonds, and cross bonds.
2. Catalog cuts of molds to be used for exothermic welds.
3. Catalog cuts for all types of lugs, bolted rail connections, drilling devices and crimping tools to be used for the bolted rail connections.
4. Field installation procedures for all welded and bolted connections.
5. Field test procedures for all types of welded, mechanically fastened rail and bolted structure connections.
6. All mechanical devices for securing and protecting running rail bonding.
7. Plan showing detailed final design for bonding of special track work to assure that all pieces of the special track work are properly connected electrically.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Return Rail Joint Bonds and Double Rail Track Circuit Joint Bonds:

One power bond will be provided for each rail joint in double rail track circuit areas. Two power bonds will be provided for each rail joint in single rail negative return areas. Return rail bonds in AC track circuit areas and rail bonds for double rail traction power return areas will be rail head exothermic type as specified in the contract drawings.

1. Exothermic weld:

   The bonds will be 300 kcmil by 54 inch, insulated copper cable, Cadweld Type PBC or approved equal. The cables will be connected to each rail by exothermic weld.

B. Rail Return to Structure Bonds:

1. Rail return to structure bonds will be 300 kcmil bare copper bonds. One bond will be provided for every stick rail within the power frequency track negative rail track circuit. (One bond to structure between each two track joints will be provided). Bonds will be arc welded to the structure, with exothermic weld connection to the rail.

C. Special track work area Joint Bonds:

1. Joint bonds for special track work areas will be 2-300 kcmil bonds for negative return. Joint bond connections will be copper exothermic type.
2. Lengths of joint bonds will be determined by the Contractor.

3. All the signal transposition bonds in the special track work areas will be (2) 300 kcmil bonds, copper exothermic weld.

D. Impedance Bond and Structure Return Cross Bond Connections:

1. Cables for impedance bond and for cross bond to rail connections will be in accordance with the Traction power Cable Section of these specifications, and will consist of a combination of the following:

    a. One length of extra flexible 1000/1111 kcmil cable with 1000/1111 kcmil lugs on one end and three 300 kcmil on the other for each rail connection will be provided. (2-1000/1111 kcmil cables total typical for each impedance bond).
    b. Rail connections will be exothermic weld type

    Exothermic weld:

    The bonds will be three (3) 300 kcmil bare uncoated copper, Class G rope lay, Cadweld Type PBC or approved equal.

    c. Connection to the impedance bond terminal will be with a copper lug and bronze bolts, locknuts, and washers. Contractor will use “NO-OX-ID” grease for all the cable lug connections.
    d. All lugs will be stamped with a batch number during manufacture.

2. Cables for Connection to Structure:

    a. Cable connections from the impedance bonds to the cross bonding in elevated structure will be a 1000 kcmil cable with three 300 kcmil bare cables as shown on the contract drawings. The three 300 kcmil cables will be arc welded to the elevated structure. The 1000 kcmil cable end will be fitted with a copper lug and connected to the impedance bond terminal with bronze bolts, washers, and locknuts.
    b. Where impedance bond to single rail connections are required, such as at interlocking signal locations, the connection will consist of a connection from the impedance bond to the structure, and a connection from the structure to the single power return rail within the interlocking. The cable connection from the impedance bond to the structure will be as described above. The cable connection from the structure to the single power return rail within the interlocking will consist of a 1000 kcmil with three 300 kcmil bare cables as shown on the contract drawings. The three 300 kcmil cables will be arc welded to the elevated structure. The 1000 kcmil cable will be connected to the power return rail with a Cembre type connection or exothermic weld connection.

3. Cables for substation and structure return connections will consist of the following:

    a. Four 1000 kcmil cables or three 1500 kcmil cables per bond pair, with lugs sized appropriately for the cable utilized, will be provided from the center taps of the bonds to the structure.
    b. All negative return connections to the substation bus will be made to the web elevated structure track support members.
    c. As an alternate, where substation negative return connections are made to elevated structure and there exists at least four cross-bond connections

to elevated structure on all tracks (along the respective third rail power section), two 1000 kcmil impedance bond connection between running rails and elevated structure per track will be permitted as the end of power section negative return.

E. Cable connections to Auxiliary Negative Rail

1. Cable connections from the impedance bonds to the Auxiliary Negative rail will be two (2) 1000/1111 kcmil cable with three 300 kcmil bare cables as shown on the contract drawings. The three 300 kcmil cables will be arc welded to auxiliary negative rail. The 1000/1111 kcmil cable end will be fitted with a copper lug and connected to the impedance bond terminal with bronze bolts, washers, and locknuts.

F. Special Track work By-Pass Cable:

1. Two (2) lengths per track of 1000 kcmil cable with 1000 kcmil lugs seated on the ends of each length will be provided from the bond center taps for supplementary return at interlocking.
2. Cables for return rail bonding within interlocking will be one (1) 1000 kcmil with 1000 kcmil lugs seated on the ends.

G. In block signal territory where one rail is utilized for power and the other is utilized for signal, connections between supplemental negative return cable (or elevated structure) will not exceed 500 feet. Cable utilized for taps will be no less than 500 kcmil.

H. Insulated cable used for any part of the traction power supply (positive and/or negative return, cross-bonding, etc) will conform to the traction power cable specification.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Exothermic Bonds

1. For all exothermic type connections to the rails, the surfaces of the rails where the bond is to be applied will be ground clean with a reinforced grinding wheel, of a type as recommended by the bonding material manufacturer. The use of vitrified grinding wheels will not be allowed. After grinding, the surface will be cleaned with an approved non-toxic solvent to remove all traces of grease and dirt.
2. After the surface has been ground and cleaned, the surface will be heated to drive out any moisture. The cable bond will then be welded by the exothermic process in such a manner as to ensure a thorough mechanical and electrical connection, in accordance with the manufacturer's recommended practices.
3. The welding material will consist of a copper exothermic mixture employing tin in an amount to effectively constitute 4.5 percent to 5.5 percent of the resulting weld metal. The resulting weld metal will be of high electrical conductivity and will have a minimum tensile strength of 39,000 pounds per square inch. The tensile strength will be determined by tensile tests performed on one-half (1/2) inch nominal diameter tensile specimens (without flaws) cast in graphite molds.
4. The casting of the test specimens will be by the direct reduction of the exothermic mixture and the flowing of the weld metal into a graphite mold to form the one-half (1/2) inch diameter specimens.

5. The terminals of the bonds will be applied to the bonding cables in such position that the cable will not be twisted when the terminals are applied to the rail and to the impedance bond.
6. Each cable will be connected to the impedance bond with bronze bolts, washers, and nuts.

B. Arc welded connection

1. Each end of the 300 kcmil rail connection bonds and one end of the 1000 kcmil impedance bond cable will be pressed into a copper or steel sleeve and the sleeve and the copper strands brazed to a steel terminal for welding to the structure by the electric welding process.
2. The terminals of the bonds will be applied to the bonding cables in such positions that the cable will not be twisted when the terminals are applied to the structure.
3. Prior to welding to the structure, the surface where the bond is to be applied will be ground clean with a reinforced grinding wheel to prevent any foreign materials such as scale, grease, rust, and paint, from being fused into the weld. At an ambient temperature of 30 degrees F or less, the surface will be heated with a flame heat source to a temperature between 60 and 100 degrees F.
4. Welds will be made in one continuous pass with voltage settings of 22 to 24 volts and 170 to 200 amps for fast moving single pass flat welds.
5. In cooler temperatures, an insulating blanket will be laid over the weld after it has been made to prevent it from cooling too rapidly.
6. The welding rod used to weld the bonds, where applicable, will comply with all applicable provisions for the American Welding Society for AWS A5.5 E110XX low hydrogen electrodes for manual shielded metal-arc welding.

C. Removal of Existing Connections and Grounds:

1. The Contractor will be responsible for isolation of the double rail track circuits from any grounds and return connections. The contractor will test the rail sections for isolation, and will remove all grounded connections, including any grounded track fasteners, tie fasteners, and tie plates within any rail section that are connected to ground or bonded to ground or another track circuit.

D. All copper bonds that pass under the contact rail will be covered with 1000-volt rubber insulation.

3.02 TESTS

A. Verify that all the negative return bonds including rail to rail bonds, rail to structure bonds, impedance bonds, cross bonds, auxiliary negative bonds, bypass cables, substation negative return bonds, etc. are installed as per the drawings and the CTA's standards.

B. Verify and mechanically test each weld by striking the weld with a mallet. In addition, verify that the resistance of each welded cable at the point of application shall not exceed 40 micro-ohms. The measurement shall be taken from directly across the weld. Perform this test (Ductor test) on 10% of welded cables. Based on the results of the resistance test, CTA will determine if to reduce or increase sampling.

C. Any bond, weld, or connection installed by the contractor which is found to be defective prior to acceptance, will be removed and a new bond will be installed as part of the work.

D. Bolted electrical connections of the impedance bond and negative bus will be tested. After cables are connected, the contractor will test the clamping force of bolted electrical connections with an accurate torque wrench. Bolted electrical connections will be tested for the following torques:

	Minimum Torque	
Bolt Size	Hardware Not Lubricated	Hardware Lubricated
3/8 inch-16	240	170
1/2 inch-13	480	300
3/4 inch-10	840	720

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASURMENT

A. The work of RAIL CONNECTIONS AND RUNNING RAIL BONDING – TRACTION POWER will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the work of RAIL CONNECTIONS AND RUNNING RAIL BONDING – TRACTION POWER must be included in the contract lump sum price as shown in the Schedule of Prices for Traction Power Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Traction Power Work: 340000

END OF SECTION

SECTION 34 42 00

SIGNAL SYSTEM CONSTRUCTION REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Special instructions for removal of existing system infrastructure.
2. Special instructions for the installation of new system infrastructure.

B. Related Sections:

1. Section 34 42 04 – Signal System Drawing Requirements
2. Section 34 42 20 – Audio Frequency Track Circuits
3. Section 34 42 23 – Impedance Bond Layouts
4. Section 34 42 25 – Rail Connections and Running Rail Bonding
5. Section 34 42 38 – Miscellaneous Components and Products
6. Section 34 42 40 – External Cable
7. Section 34 42 41 – Internal Wire and Cable
8. Section 34 42 62 – Junction Boxes
9. Section 34 42 91 – Signal System Tests

1.02 REFERENCES

A. Reference Standards:

This Section incorporates by reference the latest revisions of the following documents:

1. American Railway Engineering and Maintenance-of-Way Association (AREMA).

    a. AREMA Manual for Railway Engineering (MRE).
    b. AREMA Communications & Signals Manual of Recommended Practices (C&S Manual).
    c. AREMA Portfolio of Track Work Plans.

2. City of Chicago:

    a. Municipal Code of Chicago, Title 18 Building Infrastructure, Chapter 18-27, Chicago Electrical Code.

3. National Fire Protection Association (NFPA):

    a. NFPA 70, National Electrical Code.

4. Federal Railroad Administration (FRA):

    a. FRA Rules, Standards and Instructions for Railroad Signal Systems, Part 236.

PART 2 - PRODUCTS

2.01 GENERAL

A. Refer to the Technical Specifications.

PART 3 - EXECUTION

3.01 PROJECT WIDE REMOVAL WORK

A. Wayside signal equipment that interferes with track construction to be removed prior to the start of construction.

1. Equipment that will be reinstalled to be inspected, tested, tagged, and stored in designated area when removed.

    a. The designated storage area to be coordinated with CTA.

        i. The contractor to be responsible for the security and handling of the materials to be reinstalled if the selected storage facility is not a CTA facility.
        ii. The contractor to be responsible for the security and handling of the materials to be reinstalled until such time as it is delivered to a CTA facility and accepted by a CTA employee designated by the Authority.

2. Equipment that will be salvaged to be returned to the Authority.

3. Equipment that will be salvaged to be tagged, catalogued, and stored in a designated area.

    a. Salvaged equipment tags to contain the following information:

        i. Equipment type.
        ii. Identification number.
        iii. Stationing location, including NB or SB track.
        iv. Frequency.
        v. Serial number.

    b. The designated storage area to be coordinated with CTA.

        i. The contractor to be responsible for the security and handling of the salvaged materials until such time as it is delivered to a CTA facility and accepted by a CTA employee designated by the Authority.

3.02 PROJECT WIDE RENEWAL WORK

A. Audio Frequency (AF) Track Circuits

1. Audio frequency track circuits and cab signal loop transmitters to be compatible with existing CTA rail vehicle cab signal systems.
2. Audio frequency track circuits to not interfere with other adjacent existing CTA train detection systems.
3. Equipment may be installed within the gauge of rail where:

    a. The equipment is located within station platform limits, or
    b. Where indicated by the Contract Drawings.

4. Where equipment is installed in the gauge of rail, the equipment to be protected with a steel skid plate with a hot-dipped galvanized coating.

B. Bonding.

1. Bond all standard, non-insulated, running rail joints carrying signal rail current with 3/16-inch signal bonds installed behind angle bars and fastened to rail using exothermic welded connections.
2. Provide one bond on field side of rail and all associated hardware.
3. Develop a negative return system that incorporates the steel inner guard and auxiliary negative rails. Care must be taken to maintain the integrity of the track circuit and broken rail protection.

C. Cable and Wire.

1. Installation:

   a. Open deck Installations:

      i. Express cable to be supported by messenger wire and brackets attached to the outside of the track structure.
      ii. Local cable to be supported by messenger wire attached to theunderside of the track structure.

   b. Junction box wiring to be installed with care and to be neat in appearance.

      i. Pinching of conductors to be avoided.
      ii. Excessive wire bundles to be avoided.
      iii. Manufacturer's recommended bending radii for wire and cable to be maintained.

   c. Point-to-point redundancy of wires for increased current capacity is not permitted.
   d. Sufficient slack to be provided in installed wire and cable to permit wire ends to be easily removed from their terminations and to permit at least three (3) re-terminations.
   e. All spare conductors to be tagged and terminated unless otherwise directed by the Authority or if otherwise specified.
   f. Sufficient slack to be provided in installed in wire and cable to prevent damage to the wires and cables over time due to abrasion.
   g. Exposed wires and cables entering or leaving junction boxes or other wayside enclosures to be protected from abrasion by sharp metallic edges by the installation of approved cable entrance devices.
   h. Empty space in entry ducts to be sealed with a duct seal approved by the Authority.

2. Temporary installations:

   a. HDPE duct may be used for temporary installation of express cable.

      i. HPDE duct may not be used for permanent installation of any express cable.

   b. Belden wire and cable may be used for temporary circuits for a period of up to one year.

      i. Belden wire and cable may not be used for any permanent circuits unless approved in writing by the Authority.

        c. Red jacketed wire to be used for all temporary circuits.

    3. Materials:

        a. Inner duct for signal system fiber optic cable to be black with a yellow stripe.

    4. Single conductor No. 14AWG stranded copper cable to be used for interconnecting signal junction boxes and lamp compartments and other miscellaneous equipment.
    5. Where internal wiring is used in circuits directly connected to rails and/or in circuits with normal working voltages above 600V, DC or AC, the wiring to meet the requirements of the External Signal Cable Section of these specifications.

D. Equipment Platforms

    1. Equipment platforms to be sized to accommodate the proposed equipment and to allow ease of movement on the platform.

        a. Where multiple elements of wayside equipment are located in close proximity, that equipment to be mounted on a single platform unless otherwise directed by the Authority.

E. Junction Boxes

    1. Junction box doors to be hinged on the left to provide maximum sighting of approaching trains.
    2. Track circuit junction boxes to be located within 250 feet of equipment being fed from the junction box.

F. System Configuration

    1. The signal, impedance bond, train stop, and junction box locations are constrained.

        a. Elimination or modification of any of these elements for reasons not related to construction staging is not permitted.

            i. Construction staging modifications to be approved by the Authority prior to the start of work relating to the modifications.

    2. Compatibility of subsystem components from different manufacturers must be demonstrated before final product approval is granted.

G. Signage.

    1. All track marker signs affected by civil construction activities within the project limits to be replaced with new signs.

        a. Track marker signs to have two lines of text:

            i. LP1 or LP2, and;
            ii. Chaining point in 100-foot increments.

H. Testing

1. Adjustment, troubleshooting and testing of all audio frequency track circuit equipment to be performed only by qualified personnel who have been approved under this Contract for that purpose.
2. Validation, troubleshooting and testing of microprocessors to be only performed by qualified personnel who have been approved under this Contract for that purpose.
3. Test all signal equipment to manufacturer recommended settings.

   a. Written approval is required from the Authority for settings outside of manufacturer- and Authority-recommended settings.

4. CTA to provide personnel to witness Contractor adjustment and testing.

   a. CTA personnel to not perform any adjustment and/or testing.

5. The Contractor may request the use of CTA spare materials to support temporary interface to legacy systems.

   a. Any request for CTA spare materials must be approved by the Authority.
   b. Any request for CTA spare materials must be made to the Authority in writing no later than 30 days prior to the need for those materials to be available for installation activities

6. The Contractor to have sufficient materials on-hand to support commissioning of the train control system.

   a. Use of materials designated as CTA spare material is not permitted.

I. Temporary Signal System Requirements

1. The following are minimum operational requirements for revenue service after any modification to the train control system:

   a. Continuous train detection to be maintained.
   b. Normal direction traffic circuits to be permanently energized.
   c. Continuous cab signals to be maintained for normal direct traffic only.
   d. Cab speeds to be validated up to maximum allowable including all intermediate speeds.
   e. Local control panel functions relating to any modifications to be fully tested to the satisfaction of the Authority.
   f. Continuous track circuit indications to be provided to the CTA Control Center.
   g. The event recorder to be fully operational and configured to capture the operation of any modified systems, to the satisfaction of the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 00 - Signal System Construction Requirements shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 00 – Signal System Construction Requirements shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 01

BASIC SIGNAL SYSTEM TECHNICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Description:

1. This Section describes the design concepts and basic requirements for work to be performed by the Contractor to design, furnish, install, and test the equipment, material, hardware, and all necessary appurtenances specified, implied, or required to provide a complete safe operating signal system as described within these Specifications.

B. Drawings Provided by The Authority:

1. Typical construction drawings which illustrate general installation requirements, clearances and materials have been provided for certain elements of the system including equipment mountings, supports and for other purposes.

    a. The contractor is responsible for surveying the locations at which all equipment and materials will be installed and designing detailed installation plans to reflect the varying and unique site conditions at each location.

2. Reference drawings of the existing signal system are also included within the Contract Documents.

    a. Where available, additional reference drawings germane to the work described in the Contract Documents to be made available to the Contractor via a request for specific materials to the Authority.

C. Contractor Designed, Furnished, Installed and Tested:

1. The Contractor to provide the final signal design, based upon the typical drawings and reference drawings shown in the Contract Documents.
2. The Contractor's final design to include, but not be limited to, all the requirements contained within the reference drawings.
3. The Contractor to design, furnish, install, and test all detailed designs as it applies to the Contractor’s and existing equipment including:

    a. All modifications and tie-ins to existing circuits and installations.
    b. Detailed circuits.
    c. Wiring.
    d. Cabling.
    e. Relay, relay contact and relay repeater assignments.
    f. Terminal and wire assignments.
    g. Layouts.
    h. Structural and support systems.
    i. Installation.
    j. Site-specific details.
    k. Communications equipment.
    l. Microprocessor equipment.

        m. Control Panel upgrades.

    4. All apparatus, including but not limited to, the following to be furnished completely wired, installed, and tested.

        a. Wayside cases.
        b. Junction boxes.
        c. Signal and route selector layouts.
        d. Train stop layouts.
        e. Snowmelter layouts.
        f. Impedance bond layouts.
        g. Audio Loop and receive points.
        h. Automatic Vehicle Identification (AVI) sub-system elements.
        i. Worker Ahead control boxes and signals.
        j. Bus holding lighting and station annunciator triggering interfaces.
        k. Vital, Non-vital and Communications Cable Plant.

    5. The work to be completed by the Contractor to include all work from design to installation and testing of all wayside and control office equipment and to be turned over to the Authority ready for train operation, all in accordance with these Specifications.

D. Workmanship and Standards:

    1. The design and workmanship of the apparatus to comply in every respect with the "Rules, Standards and Instructions for the Installation, Inspection, Maintenance and Repair of Automatic Block and Interlocking Systems", as set forth by the Office of Railroad Safety of the Federal Railroad Administration, effective October 01, 2020, and any supplements thereto which to become effective before this Contract is awarded.

E. Site Conditions:

    1. The Authority believes that information in the Contract Documents describing the existing signal and communication facilities pertinent to this Contract is correct insofar as it is shown; however, it does not guarantee or represent that the existing signal and communication facilities conform to the Drawings.
    2. It to be understood that conditions may exist which are contrary to the conditions indicated by the existing signal system drawings.

        a. The Contractor assumes all risks regarding the cost or quantity of work to required to be performed based on site and/or existing condition information provided by the Authority.

F. Bidder Responsibility:

    1. The Bidder to visit the site and satisfy herself/himself/themselves by visual inspection alone, as to existing conditions.

        a. No claim for extra cost will be allowed by the Authority because of the Contractor's unfamiliarity with observable site conditions.

G. Related Sections:

    1. 34 42 04 Signal System Drawing Requirements.

2. 34 42 09 Signal Abbreviations and Definitions.
3. 34 42 90 Technical Support.
4. 34 42 91 Signal System Tests.

1.02 SUBMITTALS

A. Submittals to be as defined throughout the sections of these Specifications.

1.03 QUALITY ASSURANCE

A. Material, equipment, and systems provided for this Contract to be produced under control of a formal Quality Assurance Program to ensure an acceptable level of quality of the equipment provided.

1.04 DELIVERY, STORAGE AND HANDLING

A. All equipment to be protected from damage throughout delivery, storage, and handling.

B. Until the completion of formal handover activites as described in the Contract Documents, security of materials being procured, delivered, stored, and/or installed by the Contractor are the responsibility of the Contractor.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The material and apparatus required for the work to be performed under this Contract is specified within the respective sections of the Specifications.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contractor's design and installation to conform to the requirements as set forth herein and described within the detailed technical sections of these Specifications.

3.02 SYSTEM DESIGN REQUIREMENTS

A. New Design:

1. The Contractor to design and furnish required circuits and wiring plans including modifications to existing circuits for signal tie-ins.

B. Staging Design:

1. The Contractor to design, furnish, and install all temporary staging work and facilities required to maintain scheduled train service during the various stages of construction.

C. Detailed Designs:

1. The Contractor to design all modifications, details, relay, relay contact and relay repeater assignments, terminal and wire assignments, site-specific details, and alternative and additional equipment proposed to provide the detailed design as it applies to the Contractor’s equipment, and the existing equipment in the project area.

D. I/O Ports:

1. The terms “I/O ports” and “I/O port level” to be defined as any point of external interface to the microprocessor-based sub system, including, but not limited to inputs, outputs, serial interfaces and parallel interfaces with external circuits, other systems, or devices.
2. Redundant I/O ports, when provided in conjunction with redundant microprocessor-based systems, to be on separate boards whose removal and maintenance is independent of one another. Independence to be both mechanical and electrical.

E. Fail-Safe Design:

1. Any component or wire becoming grounded, or any combination of such grounds to not cause unsafe conditions.
2. Any amplifier breaking into spurious oscillations to not result in an unsafe condition.
3. Filters used in fail-safe circuits to be designed to prevent undesired signals from passing through the filter at a level that could cause unsafe conditions, even in the event of component failures within the filter.
4. Fail-safe equipment proposed for this Contract to be proven by in-service operation on comparable rapid transit systems or made available for type acceptance testing.

    a. Type acceptance testing of components to consist of bench tests on breadboard or prototype units as directed by the Authority.
    b. Type acceptance testing of systems or subsystems to consist of bench testing of operational systems or subsystems and/or field-testing of same at the discretion of, and as directed by, the Authority.
    c. All expenses incurred during type acceptance testing to be borne by the Contractor.

5. Except where otherwise specified, all control circuits for relays to be energized from an ungrounded DC power supply equipped with ground detectors.

F. System Response Time:

1. Total response times for system functions to not exceed the following maximum allowable values:

    a. Cancellation of an existing route request from a wayside route selector:

        i. Three (3) seconds for a clear signal to change to display a red aspect and for the train stop to return to the normal position, from the time the cancel lever is activated.

    b. Selection of a route from a wayside route selector when all switches are initially unlocked:

        i. Nine (9) seconds for the signal to display a correct clear aspect, including switch movement time, from the time the selector lever is activated.

    c. Selection of a route from a local control panel when all switches are initially unlocked:

        i. Nine (9) seconds for the signal to display a correct clear aspect, including switch movement time, from the time the entrance push button is activated.

    d. Selection of a route from a remote control panel when all switches are initially unlocked:

        i. Ten (10) seconds for the signal to display a correct clear aspect, including switch movement time, from the time the entrance push button is activated.

3.03 SYSTEM DESIGN CRITERIA

A. Signal and Route Selector Requirements

1. Interlocking Home Signal

    a. Interlocking home signals to be absolute signals provided at the entrances to an interlocking to govern the movement of trains through the interlocking.
    b. Interlocking home signals to provide indication that the switches have been properly lined and locked and that conflicting routes have been locked out for routes governed by that signal.
    c. Interlocking home signals to provide routing information for routes governed by that signal.

        i. Multiple routes from a signal to not have the same series of aspects or indication.

            a. Absolute intermediate interlocking signals to be provided within the interlocking to display the additional route indications to avoid duplicate route indications on interlocking home signals for differing routes.
            b. Should conditions not permit the installation of absolute intermediate signals a Theater Indicator to alternatively be provided to display unique route designations.

    d. Interlocking home signals may feature special aspects or indications that require positive action by the train operator, train controller, or both, to display an aspect more favorable than stop under certain conditions.

2. Block Signal

    a. Block signals to be permissive signals provided in non-interlocked areas where greater control of train spacing is required or to match specific site conditions and applications.
    b. Block signals to provide indication that the track ahead is clear.

3. Route Selector

    a. Route selectors to be wayside devices that allow train operators to establish a route at an interlocking.
    b. Route selectors to be located in advance of an interlocked home signal.
    c. Route selectors to be an array of pushbuttons used to initiate routes for turn-back operations, yard access and to re-establish mainline routes.
    d. Route selectors to only be active when the associated interlocking is in Automatic mode.

B. Train Stop Requirements:

1. All signals to be provided with an associated electric train stop mechanism to enforce a ‘STOP’ aspect.

2. Train stops to be electro-mechanical devices that operate in conjunction with the wayside signal to enforce a restrictive condition.
3. Train stops to have a trip arm that when in the tripping position, to engage the side trip emergency mechanism on CTA passenger rail vehicles resulting in a penalty brake application.

    a. The train stop to be de-energized when the wayside signal displays a stop indication, raising the trip arm above the top of the rail (tripping position).
    b. The train stop to be energized when the wayside signal displays a clear indication, lowering the trip arm below the top of rail (clear position).

4. All signals to be equipped with a track trip manual release pushbutton (key-by) mechanism.

C. Train Detection Requirements:

1. Audio Frequency (AF) Track Circuits:

    a. Each AF track circuit to consist of :

        i. One (1) carrier frequency oscillator;

            a. No carrier oscillator to be used for more than one-track circuit.

        ii. One (1) code rate generator;

            a. No code rate generator to be used for more than one-track circuit.

        iii. One (1) modulator;
        iv. One (1) power amplifier;
        v. One (1) line coupling unit;
        vi. One (1) receiver filter;
        vii. One (1) receiver carrier amplifier;
        viii. One (1) code demodulator, and;
        ix. One (1) relay driver.

    b. The AF transmitter and its associated equipment to be capable of operating a track circuit:

        i. At least one-and-a-half times (1.5x) the length of the longest track circuit in the approved block design with a minimum ballast impedance of five ohms (5Ω) per 1,000 feet.
        ii. At least 700 feet in length with a minimum ballast impedance of five ohms (5Ω) per 1,000 feet located a minimum of 3,500 feet from the transmitter utilizing twisted pair No. 14AWG conductors from the impedance bond to the transmitter and receiver.

2. Receive Only Point Requirements:

    a. AF bridging receivers to be provided at locations as shown on the Contract Drawings to allow a shunting definition not exceeding ten (10) feet from the rail connections.
    b. AF bridging receivers to include:

        i. One (1) matching transformer;
        ii. One (1) receiver, and;
        iii. One (1) vital track relay.

c. Connections to the rail to be made without an impedance bond.
d. AF bridging receivers may use current coupling pickup coils in lieu of, or in addition to, the rail connections to provide the required shunting definition.

3. Impedance Bond Requirements:

   a. Impedance bonds to be provided at all AF track circuit boundaries as shown on the Contract Drawings.
   b. Unless otherwise indicated on the Contract Drawings, impedance bonds to be located on the wayside, outside of the gauge of the rails.

      i. Where clearances do not allow mounting outside the gauge of the rails, the impedance bonds may be located between the rails only with the approval of the Authority.

   c. Impedance bonds to be used to:

      i. Act as the interface for train detection track circuit and speed command carrier signals to the rails;
      ii. Receive train detection signals, and;
      iii. For traction negative equalization and substation return.

   d. Where impedance bonds are not being removed and reinstalled, only one (1) style of impedance bond to be furnished.

      i. Impedance bonds to be provided shall match the manufacturer of the existing signal system equipment. Impedance bonds from different manufacturer's shall not be mixed in the same traffic block.
      ii. This style of impedance bond to match the unit being replaced.
      iii. This impedance bond to be tuned to the manufacturer's standard frequencies and to match the unit being replaced.

   e. A terminal board to be provided in the impedance bonds to allow the selection of any of the frequencies to be used for the track circuit transmitting frequency or track circuit receiving frequency.
   f. Impedance bonds to be tuned for the train carrier frequency.

4. Cab Signal Advanced Turn-On Requirements for AF Track Circuits and Loops

   a. Advance turn-on of cab signal to be provided when crossing insulated joints.
   b. For mainline movements leaving interlockings, the advanced turn-on for cab signal to occur when:

      i. The mainline detector track preceding the mainline track beyond the exit signal is occupied for normal route (straight) switch movements.
      ii. Any combination of the island crossing and/or the mainline detector track preceding the mainline track beyond the exit signal is occupied for merging reverse route (crossover) movements.

   c. For movements entering interlockings, the advanced turn-on for the cab loop to occur prior to the train crossing the insulated joint entering the interlocking.
   d. For other movements the advanced turn-on for cab signals to be occur when the train occupies the approach track.

D. Interconnections to Existing Systems:

1. Contractor to provide all temporary and permanent interconnections between new work and the existing signal systems as described in the Summary of Work. The new signal system to include, but not be limited to, the following:

    a. Line Circuits and Control Circuits:

        i. The Contractor to provide all line and control circuits as required to provide a complete and operating wayside system.
        ii. The Contractor to provide the necessary design, plans, materials and engineering supervision required to interconnect these lines to the existing signal systems.

    b. Racine Control Center:

        i. The Contractor to also provide the software and programming to interface with the existing Racine Control Center Supervisory equipment to provide continuous indication of all affected track circuits throughout construction.

E. Miscellaneous Requirements:

1. Current Limiting Resistors:

    a. A dedicated current limiting resistor to be provided for each circuit. Input circuits for the event recorder may use a common current limiting resistor for all the contacts on a single rack.
    b. A minimum of one resistor to be provided for each separate rack recorder power loop.
    c. Input circuits for the non-vital processors may use a common current limiting resistor for all the contacts on a given rack. A minimum of one resistor to be provided for each separate rack non-vital processor input power loop.

2. Power Buss Common Reference:

    a. Common reference terminals for troubleshooting to be provided on every single rack where a contact has energy from a given power supply even when there is no controlled relay or input requiring that reference.
    b. Common reference terminals to be consistently provided in the same relative locations and using the same terminals and approximate geographic rack locations, for ease of troubleshooting.
    c. Power distribution resistors and busses to be consistently provided for each rack throughout the houses.

3. Timer Settings:

    a. All timers to be field settable, excluding loss of shunt timers.
    b. Loss of shunt timers to be fixed at a duration approved by the Authority.

4. Circuit Wiring:

    a. All wiring in relay houses, relay rooms and towers to have a minimum insulation rating of 600 volts.
    b. All AC track circuit wiring to have a minimum insulation rating of 1000 volts.

c. Higher insulation requirements for specific circuits to be as required elsewhere in these Specifications.

5. Circuit Nomenclature:

   a. Circuit nomenclature to follow CTA past practice, the existing nomenclature in the project area, and what is presented in the Contract Drawings.

      i. Where there are conflicts between nomenclature requirements, or where nomenclature is not defined, the Contractor to consult the Authority for the desired nomenclature. The Authority will then provide samples of the nomenclature to the Contractor subsequent to this request.

3.04 MODULAR DESIGN

A. Modular design to be used throughout the systems.

B. Electrical and mechanical components to be organized in plug-in assemblies wherever practicable and to be rack mounted.

C. Interlocking functions to be interconnected in such a fashion that minimizes the impact of a failure of any portion or subsystem.

D. Subsystem Separation:

1. Each subsystem to be completely independent from every other excepting the required communications links.
2. Mixing equipment associated with two (2) or more subsystems in one (1) plug in assembly is not permitted.
3. Each module to be powered from a separate circuit to allow the removal of power to one (1) module without removal of power to all modules.

E. Packaging:

1. Equipment panels to be used to rack mount circuit components such as transformers, meters, relays, fuse holders, and resistors.
2. Cabinets that mount relays without individual dust covers to have transparent panel dust covers of rigid plastic with flexible gaskets, and to be fastened in place with captive quick disconnect fasteners.

   a. Alternatively, the dust cover may be hinged on one edge.

3. All equipment and components mounted on racks to be accessible for testing or replacement without removal of other components except as permitted herein.

   a. If removal of other components or subassemblies is required, the equipment required to be removed to be of the plug-in-type.

F. Heat Dissipation:

1. The design to provide for free air space around all:

        a. Transformers;
        b. Rectifiers;
        c. Reactors;
        d. Track modules;
        e. Power supplies, and;
        f. Other heat generating devices.

G. Wiring Requirements:

    1. Power feeders to be segregated from other wiring when entering and leaving each relay house, relay room, and/or tower.
    2. Power feeders to be terminated on the power racks.
    3. Wires distributing AC and DC power within each relay house, relay room and/or tower to originate from the power rack and terminate on the power distribution panels of the individual racks.
    4. All wiring other than power feeders entering or leaving each relay house, relay room, and/or tower to be connected to terminals located on the entrance racks.
    5. All field equipment wiring to be standardized.

H. Termination Requirements:

    1. Double post terminals with connecting sliding links to be provided on entrance racks to permit the relay house, relay room, and/or tower wiring to be isolated from the field wiring,

I. Adjustments, Test Points, and Visual Indications:

    1. Adjustments:

        a. Adjustable components to be avoided wherever possible by the use of appropriate circuitry, stable components, and high tolerance circuits.
        b. Adjustable components, useful during design development to experimentally determine the correct operational settings to be eliminated in the final design.
        c. Adjustable components, where used after approval of the Authority, to have locking devices or to be self-locking to prevent inadvertent operation and/or drift.
        d. Whenever practical, two or more points of adjustment which are required during the same tune-up operation to be located within 12 inches of each other and in such a way that they can be operated by one person.
        e. Interacting adjustments will not be acceptable.
        f. The replacement of a component or PC card with a spare to not require compensating adjustments to other components or modules.

    2. Test Points:

        a. Test points to be provided for checking essential voltages and waveforms and for injecting test signals.
        b. Test points to permit detection of defective PC boards and equipment modules without the disconnection of wires.
        c. All test points to be clearly labeled.
        d. Test points to be capable of accepting probes and connectors used with standard test equipment such as voltmeters and oscilloscopes.

e. Adjustment and test points to be front accessible and easily obtainable when the equipment is in the normal operating position. Where adjustment and test points locations are not front accessible, extension cards allowing access to be provided for each location.

3. Visual Indicators:

   a. When built in indicators or meters are associated with adjustments, the adjustment point to be sufficiently close to the associated indicator so that the adjustment may be manipulated and the indicator observed, simultaneously, by one person.
   b. Built in indicators or meters to be provided when frequent observation or adjustments are necessary, or when portable test equipment will not provide the necessary information or accuracy.
   c. “Go/No Go” type indicators to be used where feasible.
   d. Light Emitting Diodes (LEDs) to be provided on track modules, supervisory control and indication modules and certain alarm circuits.

3.05 SOLID-STATE EQUIPMENT

A. All solid-state equipment to be provided by the Contractor to fulfill the requirements of this Contract, including but not limited to:

   1. Vital and non-vital microprocessor-based equipment;
   2. Analog and digital train detection and cab signal systems, and;
   3. Control and indication systems .

B. Such equipment provided to be of the most modern design and meet the highest standards of industry and all applicable recommended guidelines of the American Railway Engineering and Maintenance of Way Association (AREMA) Communication and Signal Manual.

C. Design and materials provided by the Contractor to meet the requirements of this Section.

   1. System Compatibility:

      a. All vital processor and vital track circuit products must be proven to interface with the current rail vehicle fleet at CTA.
      b. All vital processor and track circuit products interfaces must have been previously installed at CTA or must be verified by test.
      c. Any new interface not currently installed at CTA must be verified on a smaller scale to be capable of reliable train detection and cab signal transmission to all types of revenue service rail vehicles at CTA. The system compatibility verification test must consist of the following:

         i. The test must utilize the precise interface proposed, ie. the proposed vital processor interfacing with the proposed track circuit product in turn connected to the proposed impedance bond.
         ii. The test must utilize a minimum of two (2) complete adjacent track circuits, with no fewer than three (3) track connections or train detection interfaces.
         iii. The test must demonstrate the successful performance of all specific frequencies and track circuit lengths that are not currently in service.
         iv. A test train of each vehicle type (2600-series, 3200-series, 5000-series, and 7000-series rail vehicles) must be run on the section of track and receive continuous and consistent cab signal.

d. New interfaces requiring system compatibility verification will be defined as below:

   i. Any vital processor not currently in service at CTA.
   ii. Any track circuit product not currently in service at CTA.
   iii. A specific interface of vital processor to track circuit not currently in service at CTA.
   iv. An impedance bond not currently in service at CTA.
   v. An impedance bond interface not currently in service at CTA.
   vi. Any other proposed train detection system not in service at CTA.
   vii. A train detection frequency currently not in service at CTA.
   viii. A track circuit length smaller than any other of the same product currently in service at CTA.
   ix. A track circuit length greater than any other of the same product currently in service at CTA.
   x. An AF track circuit with more than two (2) receive points (bridging receivers) in the track circuit.

2. Isolation and Power Regulation:

   a. The equipment to be provided complete with the necessary isolation and power regulation devices to ensure its performance and reliability upon installation.
   b. The equipment design and fabrication to be such to make it immune to whatever noise and transients may be present.
   c. Lightning and surge protection to be provided.
   d. Solid-state equipment to be immune to electrostatic discharges to all devices and surfaces exposed to human touch during operation or servicing.
   e. All solid-state devices to be equipped with TVSS protection on each incoming power line.
   f. Primary power lines to be provided with TVSS protection.

3. Modular Design:

   a. The equipment to be modular in design to facilitate replacement and upgrades.

4. Temperature Requirements:

   a. Solid-state equipment to meet the basic temperature requirements without heating or cooling enhancements, such as heating strips, fans, etc.
   b. Cab signal equipment and electronic recorder equipment to be capable of operating over a temperature range of -30^{O}C (-22^{O}F) through +60^{O}C (140^{O}F).
   c. Microprocessor equipment to operate over a temperature range of -40^{O}C (-38^{O}F) through +70^{O}C (158^{O}F).
   d. Electronic recorder equipment including but not restricted to data storage devices, interface modems, monitors, and printers to operate over a temperature range of 0^{O}C (32^{O}F) through 50^{O}C (122^{O}F).
   e. Climate control enhancements methods to include, but not be restricted to protective enclosures, fans, and thermostatically controlled flat strip heaters.

      i. These to be independent of relay house or room climate control systems.

   f. All other equipment to operate over a temperature range of -40^{O}C (-38^{O}F) through +60^{O}C (140^{O}F). Equipment to not require special climate control beyond the maintenance of this temperature range.

5. Self-Checking and Diagnostic Features:

   a. The system to incorporate self-checking features and diagnostic tests to ensure that the equipment and program where applicable, are functioning properly.
   b. These checks to be integral parts of both the hardware and software to provide for a secure system.
   c. Vital processors to not allow false information to be transmitted to external devices, which will create a hazardous condition.
   d. Non-vital processors, remote control systems, and/or carrier systems to minimize, to a level acceptable to the Authority, the possibility of false information being transmitted to external devices.
   e. In no case may false information persist long enough to allow an unsafe condition to occur.
   f. Transmission of false information from a non-vital to a vital subsystem to in no way affect the safety of the interlocking.
   g. Visual indications, such as LED lamps, to be used to provide failure and diagnostic indications. Indications to also isolate a failure to a particular function or to the interface between two functions.

6. Parallel Inputs:

   a. Inputs for the equipment to be debounced and to be electrically and physically isolated from one another.
   b. A visual indication, such as an LED lamp, to be provided on the input board for each input to indicate when the input is activated.

7. Parallel Outputs:

   a. Outputs for the equipment to be electrically and physically isolated from one another.

      i. A form "a" contact arrangement rated at 0.25 A at 30V DC minimum to be provided.

   b. A visual indication, such as an LED lamp, to be provided on the output board for each output to indicate when the output is activated.
   c. The use of the output contact for a load in excess off its designed capability is not permitted.

8. I/O Identification:

   a. Labels to be provided by each input and output indication which clearly denote the respective function of each for the ease of maintenance and troubleshooting.

9. I/O Drawings:

   a. Circuit or logic drawings to be furnished to show the functional relationship between inputs and outputs.

10. Equipment Mounting:

    a. Equipment to be mounted complete with necessary accessories in accordance with the applicable Sections of these Specifications.

11. Additional Capacity:

a. Additional spare capacity to be provided in accordance with the applicable Sections of these Specifications.

3.06 TEST

A. Contractor must provide system compatibility conformance verification testing as described in section 3.05C.1.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 01 – Basic Signal System Technical Requirements shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 01 – Basic Signal System Technical Requirements shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 03

EQUIPMENT REMOVAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The work to be done under this Section consists of the removal of existing signal material, equipment, and facilities with instructions for their dispersal, or protection, of such to permit new installation in the surrounding area.

    a. The following instructions apply:

        i. Remove and reinstall.
        ii. Remove and salvage.
        iii. Remove and scrap.
        iv. Protect in place.

B. Related Sections:

1. Reference Plans.
2. Contract Drawings.

1.02 SUBMITTALS

A. Submit the following for approval by the Authority no later than sixty (60) days prior to removal and/or protect in place activities:

1. Remove and reinstall spread sheets and report including the following:

    a. Item identification.
    b. Item serial number, where applicable.
    c. Information identifying the location item is being removed from, such as:

        i. Stationing.
        ii. GPS coordinates.
        iii. Relay house, relay room, or tower.
        iv. Rack number and bay number.
        v. Junction box number.

    d. Itemized condition of the item prior to removal.
    e. Information identifying the location the item being removed is being relocated to prior to replacement, such as:

        i. Stationing.
        ii. GPS coordinates.
        iii. Relay house, relay room, or tower.
        iv. Rack number and bay number.
        v. Junction box number.
        vi. CTA signal maintenance facility.

        vii. Contractor off-site storage facility.

    f. Bench testing and inspection to be completed upon removal and/or prior to replacement.
    g. Packaging procedures.
    h. Contractor area used for storage.
    i. Itemized condition of item upon completion of reinstallation.
    j. Installation, inspection, and operational verification procedure.

2. Remove and salvage spread sheets and report including the following:

    a. Item identification.
    b. Item serial number, where applicable.
    c. Information identifying the location item is being removed from, such as:

        i. Stationing.
        ii. GPS coordinates.
        iii. Relay house, relay room, or tower.
        iv. Rack number and bay number.
        v. Junction box number.

    d. Itemized condition of item prior to removal.
    e. Packaging procedures.
    f. Contractor area used for storage.
    g. CTA facility designated for delivery.
    h. Itemized condition of item when delivered to the Authority.
    i. Authority signature of receipt.

3. Remove and scrap spread sheets and report including the following:

    a. Item identification.
    b. Item serial number, where applicable.
    c. Information identifying the location item is being removed from, such as:

        i. Stationing.
        ii. GPS coordinates.
        iii. Relay house, relay room, or tower.
        iv. Rack number and bay number.
        v. Junction box number.

    d. Contractor Certificate of Dumping Facilities.

4. Protect in Place spread sheets and report including the following:

    a. Item identification.
    b. Item serial number, where applicable.
    c. Information identifying the location item, such as:

        i. Stationing.
        ii. GPS coordinates.
        iii. Relay house, relay room, or tower.
        iv. Rack number and bay number.
        v. Junction box number.

d. Itemized condition of item prior to protect in place activities.
e. Protect in place procedure, including:

    i. Means and methods of protecting item.
    ii. Any operational accommodations required to support the protect in place activity, such as reducing maximum allowable cab speed commands.

f. Expected duration of the protect in place period.
g. Condition of item upon removal of protection.
h. Inspection and operational verification procedure.

1.03 QUALITY ASSURANCE

A. Items removed that are intended for reinstallation or returned to the Authority are to be packaged and treated so as not to cause damage or accentuate any damage that may have been present upon removal.

1.04 DELIIVERY, STORAGE, AND HANDLING

A. Any areas or facilities used by the Contractor for storage of items which are intended to be reinstalled in accordance with this Specification and the Contract Documents or delivered to the Authority are to be outfitted to provide protection from any damage including, but not limited to the weather and humidity.

    1. Relative humidity in any Contractor storage facility designated for the items above to be controlled to not exceed 70 percent, non-condensing.

B. Any damage to items removed with the intent to reinstall, removed for salvage and delivery to the Authority, or protected in place, that is caused after the initial itemized condition assessment has been completed, to be deemed to be the responsibility of the Contractor.

    1. The Contractor will be responsible for any resultant repair or replacement to the satisfaction of the Authority.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor to provide wooden crating, pallets, boxes, cartons, empty cable reels, and light steel strapping or equivalent tying/binding material, all in quantities sufficient for transporting and protecting any items removed with the intent to reinstall or removed for salvage and delivery to the Authority at a CTA store, yard, or shop.

B. The Contractor to provide marking materials including both tape and permanent marking pens to identify units of equipment and components for disposition and material audit purposes.

PART 3 - EXECUTION

3.01 REMOVE AND REINSTALL

A. Any equipment that is to be removed for reinstallation to support the work under this Contract to be fully protected and secured by the Contractor against damage or loss until final reinstallation and acceptance by the Authority.

B. The Contractor to submit condition assessment spread sheets and reports, including photos, prior to removal and after reinstallation, consistent with the requirements of Section 1.02A.

C. Reinstalled items to be inspected for damage and tested in accordance with the approved installation and operating test procedures.

D. Items for removal and replacement include the following:

   1. Impedance bonds.

3.02 REMOVE AND SALVAGE

A. Any equipment that is to be removed for salvage and returned to the Authority to support the work under this Contract to be fully protected and secured by the Contractor against damage or loss until delivery to the designated CTA facility and acceptance by the Authority.

B. The Contractor to submit condition assessment spread sheets and reports, including photos, prior to removal and at the time of delivery, consistent with the requirements of Section 1.02A.

C. Items to be removed intact and without damage.

D. Items for removal and salvage that are to be returned to the Authority include the following:

   1. Junction boxes.
   2. Wayside signal equipment designated for salvage by CTA.

3.03 REMOVE AND SCRAP

A. Any equipment or material that is to be removed for scrap to become the property of the Contractor and to be disposed of away from the project site at the locations designated in the Contractor Certificate of Dumping Facilities in the Contract Proposal.

B. Items for removal and scrap include, but are not limited to, the following:

   1. All wayside signal equipment and foundations and/or mounting bases.
   2. Local and express cable, including messenger and hangers.
   3. Wayside platforms.

3.04 PROTECT IN PLACE

A. Any equipment that is to be protected in place within the area of construction and returned to service to be fully protected by the Contractor against damage until returned to service and acceptance by the Authority.

B. The Contractor to submit condition assessment spread sheets and reports, including photos, prior to applying the means of protection and at the time of return to service, consistent with the requirements of Section 1.02A.

C. Protected items to be inspected for damage and tested in accordance with the approved installation and operating test procedures.

3.05 REPAIRS AFTER REMOVALS

A. Where existing equipment is removed from the right-of-way, the right-of-way to be restored to its normal condition.

  1. For elevated structure locations where existing signals and impedance bonds, etc. are removed, any resultant holes within the walkways to be replaced with a new section of approved walkway.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 03 – Equipment Removal shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 03 – Equipment Removal shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 04

SIGNAL SYSTEM DRAWING REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for final design drawings
2. Requirements for as-built drawings

1.02 SUBMITTALS

A. Submit drawings described in this section for review by the Authority:

1. Before submitting, thoroughly check drawings for both compliance with Contract Documents and presentation. Check the following at a minimum:

    a. Conformance to the Specifications.
    b. Logical grouping and arrangement of subject matter.
    c. Accuracy.
    d. Legibility.
    e. Neatness.
    f. Line quality.
    g. Lettering quality.
    h. Reproduction quality.
    i. Inclusion of Contract specified interfaces with related contracts.

2. Stamp drawings certifying that they have been checked: "This drawing/document has been thoroughly checked and complies with the Contract Documents and field measurements and the item fits with adjoining work except as noted."
3. Drawings submitted without stamp of approval and certification, or which are incomplete, contain numerous errors, have not been checked, or have been checked only superficially will be returned unchecked by the Authority for resubmission by the Contractor.

B. Temporary Drawings:

1. Submit drawings for review.
2. Details of design to be left to Contractor, who is to be responsible for safety and successful construction of Work.

C. Final Design Drawings:

1. Submit as packages of drawings germane to a particular location, subsystem, or family of circuits all at one time.
2. This logical grouping of drawings, sufficient to completely cover the subject concerned, to be known as a Submittal Package.

D. Plan Books:

1. Book of Plans:

a. Assemble drawings into plan books consisting of all design drawings associated with a particular relay house/room or location including the following:

    i. Circuit drawings for all signal system components controlled by that particular house or location.
    ii. Double line location plans up to house limits plus 1000 ft.
    iii. Control line drawings up to house limits.
    iv. Block diagrams for microprocessor and local signal communications systems.
    v. Apparatus tabulation.
    vi. Main Terminal Board and signal rack layouts.
    vii. Signal power distribution and power loop layouts.
    viii. AC Service single line plan.
    ix. Relay house hotel electrical, fire suppression, and intrusion details and circuits.
    x. Drawings from adjacent relay houses/rooms to show non-local portions of traffic and other line circuits appearing in house/room.
    xi. Circuit and layout drawings for field equipment controlled from relay house/room and pertinent location and cable plans.

2. System-Wide Plan Book:

    a. Assemble drawings into a system-wide plan book for the project area and any interfacing areas including the following:

        i. Double-line track plans.
        ii. Single-line track plans.
        iii. Control lines.
        iv. Location plans.
        v. Cable plans.
        vi. Typical drawings.

3. Single-Line Drawings:

    a. Provide a laminated copy of the branch single line drawings.

        i. One (1) in every relay house, relay room, or tower.
        ii. Two (2) to CTA Engineering at 567 W Lake Street.

    b. Provide both the CAD and PDF versions of the drawings to CTA Engineering at 567 W Lake Street in a manner consistent with Section 3.03D.1.
    c. Single line drawings to be completed prior to any signal cutovers.
    d. Necessary revisions to single line drawings to be made and resubmitted before close out.

1.03 CLOSEOUT SUBMITTALS

A. Within thirty (30) days of substantial completion, as-built drawings to be submitted by the Contractor in accordance with the Closeout Procedures.

PART 2 - PRODUCTS

2.01 GENERAL DRAWING REQUIREMENTS

A. The Contractor to be solely responsible for correctness of Contractor-furnished drawings, and for correctness of existing drawings modified by Contractor and included in final design submittals.

B. The Contractor to provide a complete set of drawings including existing drawings containing no modifications.

   1. Drawings to show design, dimensions, connections, and other details necessary to demonstrate that Contract Documents are accurately interpreted.

C. General:

   1. Drawings to adhere to the latest version of CTA CAD Standards currently dated 1. January 2013 Rev 3.
   2. Drawings to establish actual detail of manufactured and fabricated items.
   3. Drawings to indicate proper relation to adjoining work.
   4. Drawings to amplify design details of mechanical and electrical equipment in the physical spaces in structures.
   5. Drawings to incorporate minor changes of design or construction details to suit actual conditions.
   6. Drawings to consist of line drawn graphics.

      a. Image, imported files, reference drawings, attachments, and overlays are not acceptable.
      b. Blocks or cells for individual elements that continue descriptive names are acceptable.

   7. Drawings to position each element type on separate and unique layers such as track, train stop, relay, signal, etc.
   8. Drawings to indicate location, sheet number, and a brief description in the filename.

D. Shop Drawings:

   1. The Contractor to submit detailed drawings as shop drawings.
   2. Shop drawings to show the construction of each part of the Work.
   3. Shop drawings to demonstrate compliance of a product and/or method of installation.
   4. Shop drawings to be as specified in other sections of these Specifications.
   5. Shop drawings to include:

      a. Fabrication details.
      b. Bending schedules for reinforcing steel.
      c. Location and details of construction joints in concrete.
      d. Catalog cuts of equipment or fixtures.
      e. Wiring or piping diagrams.
      f. Data sheets and performance curves for electrical, mechanical, or other equipment.
      g. Other data supplementary to signal system data required by Authority.

E. Coordination:

   1. Where separate sections or trades are involved the Contractor to coordinate drawings.
   2. Where requested by the Authority, the Contractor to submit coordination drawings in composite form, clearly designating which trade will perform which elements of the Work.
   3. Indication or demarcation of "work by others" is not acceptable.

F. Adjoining Work:

1. Drawings to show proper connections with adjoining work in detail.
2. Where adjoining work requires drawings, submit drawings related to adjoined and impacted elements for approval simultaneously to facilitate accurate evaluation and cross-check.

2.02 SUBMITTAL PACKAGES AND PLAN BOOKS

A. The Contractor to furnish books of specific signal system drawings for specified project-wide submittal packages.

B. Signal system drawing books to consist of the following:

1. One (1) protective cover.
2. One (1) protective backing sheet.
3. A device for binding the left hand edges of drawings firmly, in such a manner that drawings may be easily added, removed, or replaced without damage to the drawings.
4. One (1) cover sheet with the following information:

    a. The name of the submittal package.
    b. The location of the plan book.
    c. The phase of the work.
    d. The project name and number.
    e. The submittal package.
    f. The submittal date.
    g. Index sheet(s) of the same size as drawings.
    h. Drawings grouped and assembled in a logical order.

2.03 FORMAT REQUIREMENTS FOR DRAWINGS

A. Unless otherwise specified, drawings to be twenty-four- (24) inches tall by thirty-six- (36) inches wide (ANSI D) using the CTA standard title block.

1. Any other size drawings to require the approval of the Authority.

B. Drawings to not be crowded or cluttered, but to be arranged to be easily readable when reproduced at full-size (ANSI D) or half-size.

1. Half-size to be eleven- (11) inches tall by seventeen- (17) inches wide (ANSI B).

C. Drawings to be arranged to make every attempt to show complete circuits on each sheet with a minimum of circuit continuations to other sheets.

1. Where continuations are used, clear and specific reference to the continuation sheet(s) to be included.
2. Continuations to overlap on both sheets for clarity when reading prints.

D. Local Circuits:

1. Drawings to show relay coils, timers, motors, or other operated devices near the right or left border of the drawing, wherever practical;

    a. The right border is preferred.

2. Drawing to lay out contacts in circuits in geographical succession insofar as possible and practical.

E. Line circuits:

  1. Drawings to arrange line circuits to geographically match the track layout.
  2. Line circuits to only appear on the right and left sides of a drawing.

F. Relay Contacts:

  1. Drawings to have relay contacts aligned vertically and evenly spaced horizontally insofar as possible and practical.

G. Relay Nomenclature:

  1. Drawings to have relay nomenclature shown above each relay coil or contact symbol excepting where relay coils and contacts of the same relay are shown joined vertically by a dashed line.
  2. Relay nomenclature on drawings to be three lines with the following information:

     a. Top: rack and bay location.
     b. Middle: name or identification.
     c. Bottom: functional or working description.

  3. Example:

(4H3)	Rack 4, Row H, Bay 3
9	Signal 9
ASR	Approach Stick Relay

H. Stick Relay Stick Contacts:

  1. Drawings to have the sticking contact of a stick relay coil aligned below the coil of the controlling relay insofar as possible and practical.

I. Track and Signal Plans:

  1. Track and signal plan drawings to show the survey stationing for wayside signal equipment including the following:

     a. Signals.
     b. Train stops.
     c. Auxiliary route selectors.
     d. Points of switch, including:

        i. Power and dual-control switches.
        ii. Hand-throw switches.
        iii. Electric locks.

     e. Track circuit boundaries, including:

        i. Impedance bonds.
        ii. Insulated joints.

            - iii. Receive-only points.

        - f. Worker ahead (WA) system elements, including:

            - i. WA signals.
            - ii. WA control boxes.

        - g. Automatic vehicle identification readers.
        - h. Defect detectors.
        - i. Relay houses.
        - j. Relay cases.
        - k. Local control panel booths.
        - l. Junction boxes.
        - m. Manholes.
        - n. Bumping posts.
        - o. Civil considerations, such as:

            - i. End-of-platform for passenger platforms.
            - ii. Tunnel portals.
            - iii. Bridge abutments.
            - iv. Structure transitions.
            - v. Grade crossings.
            - vi. Point of curve and point of tangent for any horizontal curvature that requires a reduction in the maximum allowable speed.

- J. Circuits:

    1. Circuits to not be drawn as schematics but rather drawn to reflect the actual wiring of circuits.
    2. Circuits to be arranged to minimize the number of crossed or offset lines.
    3. Drawings to have circuit nomenclature to showing "break" numbers to facilitate testing and recording of conditions of individual conductors.
    4. Circuits to be arranged such that no more than two (2) conductors are shown connected to a single terminal or contact pin.

        - a. A uniform method to be used to indicate the location of double wire connections where it is not desirable or practical to show both wires connected at the point of termination.

    5. Circuit drawings to provide sufficient information by means of contact and terminal numbering to enable easy tracing and testing of circuits.
    6. Circuit wiring on drawings to have:

        - a. A minimum distance between lines of 0.40-inch.
        - b. Lettering or printing no smaller than 0.10-inches high.
        - c. Spacing for all elements multiples of tenths of inches (0.10-inch).

- K. Symbols:

    1. Drawings to use American Railway Engineering and Maintenance-of-Way Association (AREMA) standardized symbols and nomenclature where CTA symbols and nomenclature are not available.

- L. Markups During Installation:

1. Where the final installed circuit is not wired as shown on the Contractor's final design drawing, revise the drawing to indicate actual wiring before final as-built drawings are made.

2.04 FINAL DESIGN DRAWING TYPES

A. Control Line Diagrams

1. Description:
    a. Horizontal scale drawings showing the single-line layout and control lines.
2. Horizontal Scale:
    a. 1-inch equals 100 feet.
3. Vertical Scale:
    a. 1-inch equals 30 feet.
4. Included information:
    a. Single-line track representation.
    b. Control lines.
    c. North arrow.
    d. Station equations.
    e. Grade and curve profile including:
        i. Calculated comfort and overturning speed for each curve.
        ii. Chaining limits of curve and grade changes.
    f. Location with track marker chaining of pertinent signal system and other elements such as:
        i. Signals.
        ii. Train stops.
            a. Where located within five (5) feet of an associated signal, a separate track marker is not required.
        iii. Points of switch, including:
            a. Power and dual-control switches.
            b. Hand-throw switches.
            c. Electric locks.
        iv. Track circuit boundaries, including:
            a. Impedance bonds.
            b. Insulated joints.
                i. Where located within five (5) feet of an associated signal, a separate track marker is not required.

        - c. Receive-only points.

    - v. Worker ahead (WA) system elements, including:

        - a. WA signals.
        - b. WA control boxes.

    - vi. Automatic vehicle identification readers.
    - vii. Relay houses.
    - viii. Bumping posts.
    - ix. Civil considerations, such as:

        - a. End-of-platform for passenger platforms.
        - b. Tunnel portals.
        - c. Bridge abutments.
        - d. Structure transitions.
        - e. Grade crossings.

B. Double-Line Track and Signal Plans.

1. Description:

    - a. Horizontal scale drawings showing the arrangement of signal equipment on the wayside.

        - i. Signal system equipment to be overlaid on the Common Track Baseline “1600” Drawings.
        - ii. Signal system wayside equipment, relay houses, and enclosures to be represented to-scale.

2. Horizontal Scale:

    - a. 1-inch equals 40 feet.

3. Vertical Scale:

    - a. 1-inch equals 40 feet.

4. Included information:

    - a. Double-line track representation.
    - b. North arrow.
    - c. Location with track marker chaining of pertinent signal system and other elements such as:

        - i. Signals.
        - ii. Train stops.

            - a. Where located within five (5) feet of an associated signal, a separate track marker is not required.

        - iii. Route selectors.

        a. Where located within five (5) feet of an associated signal, a separate track marker is not required.

    iv. Points of switch, including:

        a. Power and dual-control switches.
        b. Hand-throw switches.
        c. Electric locks.

    v. Track circuit boundaries, including:

        a. Impedance bonds.
        b. Insulated joints.

            i. Where located within five (5) feet of an associated signal, a separate track marker is not required.

        c. Receive-only points.

    vi. Worker ahead (WA) system elements, including:

        a. WA signals.
        b. WA control boxes.

    vii. Automatic vehicle identification readers.
    viii. Relay houses.
    ix. Relay cases.
    x. Switch heater cases.
    xi. Local control panels and orientation.
    xii. Local control panel booths.
    xiii. Manholes.
    xiv. Wayside equipment platforms.
    xv. Switch point lights.
    xvi. Maintainer right-of-way access facilities/furnishings.

C. Single Line Diagram

1. Description:

    a. A condensed drawing or series of drawings showing an entire branch with locations of all signal equipment.

        i. A drawing series should not exceed four (4) pages in length unless approved by the Authority.

    b. This diagram to be used as a quick reference, as necessary.
    c. The limits of the single line diagram to extend no fewer than two (2) full track circuits beyond the limits of the project area, or as otherwise directed by the Authority.
    d. The single line diagram to be sized and printed half-size (ANSI B).

2. Horizontal Scale:

    a. Not required to be drawn to a specific scale.
    b. Relative distances and equipment arrangement to be representative of the field conditions.

3. Vertical Scale:

    a. Not required to be drawn to a specific scale.
    b. Relative distances and equipment arrangement to be representative of the field conditions.

4. Included Information:

    a. Single-line track representation.
    b. North arrow.
    c. Station equations.
    d. Curve information, including.

        i. Calculated comfort and overturning speed for each curve.
        ii. Chaining limits of curve changes.

    e. Signal system operating limits including:

        i. Relay house, relay room, audio house, and tower control limits.
        ii. Interlocking approach and automatic route initiation limits.
        iii. Grade crossing warning control limits.

    f. Right-of-way access and emergency exit locations.
    g. Location with track marker chaining of pertinent signal system and other elements such as:

        i. Cross street names including indication if the crossing is above track level, below track level, or at grade with track level.
        ii. Station platforms including station names.
        iii. Crossovers and turnouts including common name (ie. Belmont Diamond) and turnout numbers (ie. 721, 723).
        iv. Track circuits including:

            a. Track circuit name.
            b. Track circuit maximum speed in the normal direction of traffic.
            c. The frequency and frequency group of for any audio frequency (AF) track circuit.
            d. The length of the track circuit.

        v. Civil considerations, such as:

            a. Tunnel portals.
            b. Bridge abutments.
            c. Structure transitions.

    h. Any other information requested by the Authority.

D. Arrangement Plans.

1. Description:

    a. Drawings showing the arrangement of one (1) or more of the following:

        i. Terminal boards.
        ii. Instruments.
        iii. Components in one or more of the following:

            a. Relay house.
            b. Relay case.
            c. Rack.
            d. Junction box.
            e. Cabinet.
            f. Module.

2. Horizontal Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

3. Vertical Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

4. Included Information:

    a. Equipment installation arrangement and orientation.
    b. Relay information including:

        i. Contact arrangement.
        ii. Identification of working and spare contacts for vital and non-vital relays.
        iii. Cross-references to circuit drawings where working contacts appear in circuit plans.

    c. Terminal arrangements including:

        i. Test links.
        ii. Straps.
        iii. Arrestors.
        iv. Equalizers.
        v. Fuses.
        vi. Resistors.
        vii. High voltage covers (chocolate nuts).
        viii. Identification of working terminals and the number of connected conductors.

E. Relay House, Relay Room, Audio House, or Tower Layout Plans.

1. Description:

    a. Drawings showing the location arrangement of relay racks and other large signal equipment in relay room, relay house, audio house or tower.

2. Horizontal Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

3. Vertical Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

4. Included Information:

    a. Equipment installation arrangement and orientation including, but not limited to:

        i. Equipment racks.
        ii. Entrance racks.
        iii. Cable trays.
        iv. Control panels.
        v. Power distribution equipment.
        vi. Fire suppression equipment.
        vii. Communications equipment.
        viii. Electrical outlets.
        ix. Door swings.
        x. Caged area dividers.
        xi. HVAC equipment.

    b. Critical house, room, tower dimensions.
    c. Critical equipment dimensions.
    d. Critical personnel circulation dimensions.

F. Installation Layout Plans.

1. Description:

    a. Drawings showing the mechanical installation details of signal equipment including, but not limited to, the following:

        i. Signals.
        ii. Route selectors.
        iii. Switch and lock movements.
        iv. Train stops.
        v. Impedance bonds.
        vi. Receive only points.
        vii. Cab signal control loops.
        viii. Snowmelter cases and layouts.
        ix. Switch point lights.
        x. Junction boxes.
        xi. Fiber slack enclosures.
        xii. Inverters.
        xiii. Cable hangers and messenger wire.
        xiv. Relay houses.
        xv. Local control booths.

2. Horizontal Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

3. Vertical Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

4. Included Information:

    a. Equipment installation arrangement and orientation.
    b. All details required to facilitate the complete and accurate installation of the equipment shown on the drawing.

G. Cable Plans.

1. Description:

    a. Horizontal scale drawings showing point-to-point cable runs, cable make up, and conductor size.
    b. Drawings may use the single-line or double-line layout at the discretion of the Contractor and approved by the Authority.

2. Horizontal Scale:

    a. Not required to be drawn to a specific scale.
    b. Relative distances and equipment arrangement to be representative of the field conditions.

3. Vertical Scale:

    a. Not required to be drawn to a specific scale.
    b. Relative distances and equipment arrangement to be representative of the field conditions.

4. Included Information:

    a. Single-line or double-line track representation.
    b. North arrow.
    c. Representations of each unique cable run originating and terminating at any wayside enclosure or signal system element including:

        i. The cable identification.
        ii. The cable make up.

    d. Identification of wayside elements consistent with the requirements of single-line or double-line plans, dependent on the layout selected.

H. Circuit Drawings.

1. Description:

    a. Drawings showing required control, operating, and indication circuits.

2. Horizontal Scale:

    a. Not to scale.

3. Vertical Scale:

    a. Not to scale.

4. Included information:

    a. Drawing title including the identification of particular function(s) performed by circuits shown (ie. Signal Lighting Circuits).
    b. Circuit plans complete with:

        i. Circuit nomenclature.
        ii. Terminal identification.
        iii. Fuse and resistor sizes.
        iv. Relay coils.

            a. Time-element relays to have the designed time setting included below the coil representation.

        v. Relay contacts.

            a. Relay contacts to be identified by number and by coordinates to identify location of relay on instrument rack.
            b. Relay contacts to be shown in the normal operating position be that normally energized, or normally deenergized.

        vi. All other signal system elements that interact with, are connected to, or are controlled by the signal system circuits.

I. Power Distribution Plans.

1. Description:

    a. Schematic drawings of required energy distribution systems or subsystems.

2. Horizontal Scale:

    a. Not to scale.

3. Vertical Scale:

    a. Not to scale.

4. Included information:

    a. Power distribution elements including:

        i. Inverter one-line diagram.
        ii. Distribution panels.
        iii. Power supply configuration and connections.
        iv. UPS configuration and connections.
        v. Power buss.
        vi. Grounding.

        - vii. Circuit and overload protection.
        - viii. Ground detector configuration and connection.

J. Wiring Diagrams.

1. Description:

    a. Drawings showing details of electrical connections for required signal system equipment.

2. Horizontal Scale:

    a. Not to scale.

3. Vertical Scale:

    a. Not to scale.

4. Included information:

    a. Drawing title to include identification of the piece of equipment being detailed.
    b. Schematic representation of the internal wiring of the equipment being detailed.

K. Cable Routing Drawings.

1. Description:

    a. Drawings overlaid on scaled civil and/or shop drawings showing routing of cable, cable make up, conductor size(s), and installation provisions.

2. Horizontal Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

3. Vertical Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

4. Included Information:

    a. Where drawings depict interior cable routing within buildings, relay houses, relay rooms, audio houses or towers, the drawings to include:

        i. Building floor plans showing cable routing.
        ii. Building sections for any vertical cable runs.
        iii. Conduit, duct, and/or raceway locations with identification and size.
        iv. Cable, with identification and size.
        v. Cable routing and bundling details.
        vi. Conduit and raceway fill percentages and/or cross sections.

    b. Where drawings depict exterior locations, the drawings to include:

        i. Right-of-way plan layouts showing cable routing.
        ii. Right-of-way sections showing cable routing:

            a. In or suspended from subway tunnels.
            b. Under or through elevated structures.
            c. Through platform cable chases and risers.
            d. In ductbank.
            e. On trolly poles.

        iii. Conduit, duct, and/or messenger hanger locations with identification and size.
        iv. Cable, with identification and size.
        v. Cable routing and bundling details.
        vi. Conduit and duct fill percentages and/or cross sections.
        vii. Cable bundle cross sections.

L. Input/Output (I/O) Drawings.

1. Description:

    a. Drawings showing assignment of inputs and outputs to microprocessor-based systems.

2. Horizontal Scale:

    a. Not to scale.

3. Vertical Scale:

    a. Not to scale.

4. Included information:

    a. Drawings to include I/O charts summarizing the input and output assignments on each microprocessor unit.
    b. Drawings to include drawings describing I/O assignments at board/card level.

M. Bill of Material Sheets.

1. Description:

    a. Drawings or documentation showing a complete breakdown of material including the following:

        i. Quantity.
        ii. Location.
        iii. Manufacturer.
        iv. Part number information.

N. Product Drawings.

1. Description:

    a. Drawings showing dimensions and internal mechanical and electrical details of each piece of equipment or assembly.

2. Horizontal Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

3. Vertical Scale:

    a. Scale to be determined by the Contractor, while adhering to the legibility and layout requirements of this Specification.

4. Included information:

    a. Drawing title to include identification of the piece of equipment being detailed.
    b. All pertinent mechanical and electrical details of the piece of equipment being detailed..

O. Temporary Plans.

1. Drawing title to include the purpose served.
2. Description:

    a. Drawings showing required temporary work, which will not remain as part of completed work.

3. Horizontal Scale:

    a. Scale to be consistent with the type of drawing being produced for the temporary work and these Specifications.

4. Vertical Scale:

    a. Scale to be consistent with the type of drawing being produced for the temporary work and these Specifications.

5. Included information:

    a. Drawing title to include identification that the work is temporary, and the associated temporary work phase.
    b. Included information to be consistent with the type of drawing produced for the temporary work..

2.05 EXISTING DRAWING REQUIREMENTS

A. Provide CAD and pdf sample version of each drawing type with the Design Validation submittal.

B. Revise and redraw existing drawings modified as a result of work performed under this Contract. The drawing template to match that of the existing plan set.

C. Submit drawings with final design submittals.

D. Submit marked up drawings showing changes to existing circuits and equipment.

   1. Clearly identify changes using “O’s” and “X’s.”
   2. Include on each drawing a legend stating “O-ed line = IN” and “X-ed line = OUT”.

E. Temporary Changes to Existing Drawings:

   1. Submit marked up drawings showing temporary changes to existing circuits and equipment.
   2. Clearly identify changes using “O’s” and “X’s.”
   3. Include on each drawing a legend stating “O-ed line = IN” and “X-ed line = OUT”.

2.06 TEMPORARY DRAWING REQUIREMENTS

A. Drawings to be produced for temporary work and methods of construction including:

   1. Cribs.
   2. Cofferdams.
   3. False work.
   4. Shoring.
   5. Decking.
   6. Protection in place.
   7. Form work.
   8. Other temporary work and methods of construction the Contractor proposes to use.

2.07 AS-BUILT DRAWING REQUIREMENTS

A. Upon completion of the work the Contractor to submit plan books marked “as-installed.”

   1. The plan books and documents to reflect as-built conditions.

B. Include CAD drawings showing conduit routing and site-specific construction details.

C. Include two marked up copies of as-built conditions.

D. As-built drawings should not include staging or temporary notes, references, or markings.

2.08 SOURCE QUALITY CONTROL

A. Factory wiring and testing of factory wired equipment:

   1. Immediately update drawings or documents affected by a change in the circuits or equipment.

PART 3 - EXECUTION

3.01 VERIFICATION OF CONDITIONS

A. Verify dimensions and field conditions and check and coordinate drawings of each Specification section or trade with the requirements of all other sections and trades.

B. Before submitting drawings, coordinate work with adjoining materials or trades as required for proper and complete installation of work.

3.02 MODIFICATIONS TO EXISTING SYSTEMS

A. Submit existing drawings marked up to show temporary changes required during stages of placing portions of the work in service.

3.03 CAD DRAWINGS

A. The Contractor to provide one complete set of the approved type of CAD files of the final as-built drawings prior to final acceptance by the Authority.

   1. These files to include all as-built modifications and approved drawings.
   2. These files, when used in the Authority's CAD system to produce drawings identical to the Contractor's final drawings.

B. All CAD files to conform to the CTA Engineering CAD Standard.

C. Drawing format to be AutoCad (*.dwg) and Adobe Acrobat (*.pdf).

D. Media format for transferring files to be:

   1. USB flash drive with no file compression.

      a. The Contractor to furnish the USB flash drive of sufficient memory to contain all drawings associated with a single location.
      b. Single locations to not be split up among multiple USB flash drives.

E. The file names to correspond to the locations.

   1. Electronic sheets to correspond to the final Drawings.
   2. Each sheet/file name will correspond to the sheet number and a description of what is contained on the sheet. Example: "18T0042_Control Limits (3 of 3).pdf"

3.04 FIELD QUALITY CONTROL

A. On-site installation and testing:

   1. Maintain plan books in each relay house or room.
   2. Immediately update drawings affected by a change in the circuits or equipment.
   3. Maintain a second set of plan books at Contractor's on-site headquarters.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 04 - Signal System Drawing Requirements shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 04 – Signal System Drawing Requirements shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 05

SIGNAL SYSTEM OPERATIONAL DESCRIPTION

PART 1 - GENERAL

1.01 CTA RAIL SYSTEM SUMMARY

A. This document is to be used as a reference and as a baseline for describing the performance and operational features of the completed project elements. It is expected that the project will provide the functionality described within this document.

B. The Project provides for the relocation of existing, and/or installation of new, signal system elements between Tower 18 and Tower 12 to support phasing operations during the reconstruction of, and the final configuration of, the State-Lake replacement station.

C. Trains operate on 600VDC contact rail (3rd rail) power throughout the branch. The running rails are utilized as the primary means of negative return for the propulsion power current. The revenue rail vehicles for this branch are compatible with all other branches and are configured as married pairs which cannot be operated as single units. Married pair units can be operated from either car.

D. The CTA operates a right-hand railroad meaning that the motor cab and all associated wayside signals and selectors are on the right-hand-side of the track. In the Loop, outer loop track LP1 is defined as normal track operating with anti-clockwise circulation when viewed from above. The inner loop track LP2 is defined as normal track operating with clockwise circulation when viewed from above. Reverse running is only allowed during reroutes or when other special circumstances require it and is not part of scheduled service.

E. Service on the lines that utilize the loop are not 24-hour service and have regular shutdowns at night.

1. Brown Line:

	Weekdays	Saturday	Sunday/Holiday
Kimball to Loop	0400am – 0130am	0400am – 0130am	0500am – 0100am
Loop to Kimball	0430am – 0200am	0430am – 0200am	0530am – 0130am

2. Green Line:

	Weekdays	Saturday	Sunday/Holiday
Harlem to Cottage Grove	0400am – 1240am	0500am – 1250am	0500am – 1250am
Cottage Grove to Harlem	0405am – 0100am	0505am – 0100am	0505am – 0100am
Harlem to Ashland/63rd	0410am – 0105am	0515am – 0105am	0515am – 0105am
Ashland/63rd to Harlem	0350am – 1240am	0450am – 1240am	0450am – 1240am

3. Orange Line:

	Weekdays	Saturday	Sunday/Holiday
Midway to Loop	0330am – 0105am	0400am – 0105am	0430am – 0105am
Loop to Midway	0350am – 0125am	0420am – 0125am	0450am – 0125am

4. Purple Line Express to Loop:

	Weekdays	Saturday	Sunday/Holiday
Linden to Loop	0500am – 0915am 1410pm – 1825pm	No Service	No Service
Loop to Linden	0555am – 1010am 1500pm – 1915pm	No Service	No Service

5. Pink Line:

	Weekdays	Saturday	Sunday/Holiday
54th/Cermak to Loop	0400am – 0100am	0500am – 0100am	0500am – 0100am
Loop to 54th/Cermak	0425am – 0125am	0525am – 0125am	0525am – 0125am

F. Two (2) existing interlockings are primarily affected by this project. An interlocking is defined as a crossover, junction, or turn outs with electrically controlled switches and entrance signals with automatic train stops which may be operated from a local control panel. All electric switch machines can also be manually thrown or cranked.

G. The following list summarizes the interlockings within the project:

1. Tower 18 (existing): Located at the northwest junction of the Loop. Two- (2) track by two- (2) track diamond crossover with additional routing for all routes to, from, and on the Loop.
2. Tower 12 (existing): Located at the southeast junction of the Loop. Two- (2) track by two- (2) track diamond crossover with additional routing for all routes to, from, and on the Loop.

H. Wayside train control equipment is installed in houses and rooms located adjacent to the various interlockings. The signal houses or rooms are located within close proximity of the equipment that it controls to assist with maintainability of the signal system. The signal houses/rooms are maintained by Signal Maintainers (see Maintenance Section below) and are secured with Signal Department locks to prevent access by unauthorized personnel. The signal houses/rooms are commonly referred to as “Relay Rooms”, “Relay Houses” or Audio Houses. At locations where space allows, if there is a clear view of the switch machines, the interlocking Local Control Panel is integrated into the signal house with a separate security gate between the train control equipment and the Local Control Panel. At locations where there is not a clear view of the interlocking from the relay house, a separate control panel booth is installed which contains the local control panel. At Berwyn and Argyle Interlockings there are separate control panel booths where the local control panel is installed.

1.02 CAB SIGNAL SYSTEM

All trains operating on the segment are outfitted with an onboard cab signal system which receives permissible cab signal step speeds from wayside audio frequency track circuits and displays a valid cab signal speed and aspect to the operator. The cab signal system is used to enforce civil speed restrictions, provide for rear end collision protection, enforce end of line speed reductions, and diverging switch speed restrictions. The cab signal system also integrates wayside signal aspects and routing into the allowable speed.

A. The permissible cab signal aspects are the following: YELLOW-RESTRICTED SPEED (future; defined as 6MPH), YELLOW-15MPH, YELLOW-25MPH, YELLOW-35MPH, YELLOW-45MPH (future), GREEN-55MPH, GREEN-70MPH. The allowable speed is enforced by the cab signal system with over-speed enforced by a penalty brake of the rail vehicle if the operator does not begin braking within 2.5 seconds. The penalty brake for a train is a full-service brake with full dynamic braking. When a train receives a penalty brake, the operator cannot begin operating the train again until the train reaches zero speed, and the operator places the train in full service brake. When a train does not receive a valid cab signal, the train will receive a zero speed and the operator must bring the train to a stop. After receiving a zero cab signal speed ("steady red"), the operator may only continue to operate the train on rule R6.4 only after bringing the train to zero speed, placing the train in full service brake, receiving permission from the Operations Control Center (OCC), and pushing a cab dashboard R6.4 pushbutton. Trains operating in R6.4 mode may operate to a speed of 15MPH and will no longer provide rear-end protection. The train will continue to operate on R6.4 until it receives a valid cab signal speed from the wayside.

B. The maximum allowable cab speed through this branch is 35MPH. Currently, trains are governed to a maximum speed of 58MPH. The minimum mainline signaled speed is 15MPH. The Restricted Speed (6MPH) command is not used as a normal mainline speed but will specifically be utilized for manually instituted slow-order zones. The Restricted Speed command will be activated through the Track Speed Reduction (TSR) dial. Each track circuit to be capable of being manually reduced to 6MPH through the external TSR dial.

1.03 WAYSIDE SIGNALS

A. In addition to the cab signal system, the train control system employs wayside signals installed directly adjacent to the tracks. There are two types of wayside signals: block signals and interlocked home signals. All block and home signals are placed on the right-hand side of the tracks for the direction of traffic that they govern. All stop aspects are enforced with an automatic mechanical train stop device. The automatic train stop (also referred to as a trip) will actuate the emergency brakes of a train which passes a red signal. Train stops may be physically tied down or "pinned" by stepping on the train stop arm and latching the arm down. All wayside signals are provided with an attached wayside train stop (trip) release pushbutton. The functionality of this pushbutton is described below for block signals and interlocked signals. Operators receive no more than a 15MPH cab signal in approach to a red signal. However, operators to receive a zero cab signal speed if the track circuit block immediately beyond the signal is occupied or when the train stop is driven or pinned down when the signal aspect is at danger. At no time to a signal display a clear (permissive) aspect when a train stop is in the tripping position. Where there are sightlines of less than two hundred feet in approach to a wayside signal, a repeater signal to be installed. Repeater Signals are not enforced signals but simply repeat the aspect of the enforced signal ahead to the operator. Repeater signals are identified by a number plate containing "REP" and do not have an associated train stop. Repeater signals may be installed on the left-hand side of the track it is governing.

B. BLOCK SIGNALS

1. Block signals are only utilized where required as per the block layout. They may be installed for a variety of reasons including to allow trains to be brought closer together safely. Block signals are named after the track stationing where they are located and display a single light aspect. The aspects that may be displayed at a block signal are as follows:

   a. GREEN: Proceed (Approach Cab speed 55MPH or 70MPH).

b. YELLOW: Proceed, expecting red signal ahead (Approach Cab speed 15MPH, 25MPH, 35MPH).
c. RED: Stop (Approach Cab Speed 15MPH or 0MPH).
d. LUNAR (only for entry into yards): Proceed with caution (Approach Cab Speed 15MPH, 6MPH, or 0MPH).

2. Block signals display a normally clear aspect and cycles from restricted to permissive as trains pass. Block signals can be manually by-passed in case of a track circuit failure. An operator, may drive the train stop down by pushing the trip release pushbutton on the signal. The signal aspect to remain at “Red” but the train stop drives to allow a train to pass while operating on sight. The train stops for block signals are automatically driven to be clear when the direction of traffic is flipped from the direction of traffic the block signal is governing.

C. INTERLOCKED HOME SIGNALS

1. An interlocking home signal is provided at the entrance to every defined interlocking at every possible entrance for both normal and reverse direction traffic. Interlocking signals are considered absolute signals which cannot be passed without a permissive aspect or explicit permission from rail supervision. Interlocking signals are typically named based off the specific interlocking and branch they are located on and are always even numbered. Interlocking signals are double light aspects (with three lights illuminated for a call-on only; see below section for elaboration). The aspects that may be displayed at an interlocking signal are as follows:

a. GREEN/RED: Clear (permissive) aspect; proceed on Normal Route (Approach Cab speed 55MPH or 70MPH).
b. YELLOW/RED: Clear (permissive) aspect; proceed on Normal Route (Approach Cab speed 15MPH, 25MPH, 35MPH).
   RED/YELLOW: Clear (permissive) aspect; proceed on Diverging Route (Approach Cab speed 15MPH, 25MPH, 35MPH).
c. RED/RED: Red (Danger) aspect; Stop and Stay (Approach Cab Speed 15MPH or 0MPH).
d. RED/RED/LUNAR: Call-on, stop and then proceed on sight (see below section for elaboration).

2. Interlocking signals normally display a red/red aspect until a route is requested either from a tower operator or from an automatic route initiation. The interlocking signal verifies that the switches are indicating appropriately, are mechanically and electrically locked and that there are no track occupancies ahead. Interlocking signals are provided with a sign indicating the signal number with an “X” symbol to indicate it is an absolute signal and cannot be passed while at danger without supervisory permission.
3. Under normal operations, the diverging routes at the emergency crossover interlockings are not utilized. These interlockings are used only during emergencies or scheduled track access occurrences. The North Branch of the Red Line consists of only a few “active” interlockings which are used daily. Clark Junction is a manned facility. The tower man coordinates the routing of northbound Brown Line trains towards Kimball Terminal and merges the southbound Brown and Purple Line trains. Howard North and Howard South Interlockings are manually controlled from Howard Tower. The Tower controls train movements into and out of the storage yard and as Howard Terminal, coordinates the movements of Red, Yellow and Purple Line within the area.

4. Signals at active interlockings are provided with route selectors for operation when no tower operator is controlling the interlocking (see below section on Route Selectors for more information). Each interlocking has a Route and Aspect chart which provides information on the specific available routes, aspects, and automatic functionality at each particular interlocking.

1.04 ROUTE SELECTORS

A. Some interlocking signals are provided with an associated wayside route selector to allow an operator to select an alternate route where there is more than one normal direction of traffic route available. Wayside route selectors consist of a series of buttons located at train cab window height in front of the signal they are associated with that allow an operator stopped at the signal to depress the selector button from the cab window. Wayside route selectors only function while the interlocking plant is in automatic mode and are disabled when controlled by a tower operator at an LCP or remotely through CTC. The wayside route selector allows an operator to cancel a previously requested route and then select an alternate route. Route selectors provide indicator lights that indicate route availability to select. A route selector cancellation will not cancel a route request from another signal. Route selectors are provided at the following interlocking entrances: track junctions, middle tracks, yard entrances/exits, and terminal interlockings.

1.05 SIGNAL CALL-ONS

A. Interlocking signals may display a call-on aspect. A call-on is considered a permissive signal aspect that is displayed in cases where there may be a track circuit failure and allows trains to proceed, on sight, past the governing signal. The call-on aspect is a Red/Red/Lunar aspect. While an interlocking is in automatic, a call-on will be displayed where a route has been automatically selected, the switches are indicating appropriately and locked for the route, and a minimum of 40 seconds has passed without the signal clearing normally.

B. While an interlocking is being manually controlled, no automatic call-on is issued to the operator. The tower operator, however, is able to issue a call-on signal at any time. The call-on aspect can be issued by the tower operator after entering the route request. After entering the route request from the LCP, if the route does not clear but all switches are properly lined and locked, the tower operator may press a call-on push button associated with the signal to issue a call-on aspect to the operator. The entrance signal on the panel will flash amber to indicate a call-on has been issued.

1.06 DIRECTIONAL TRAFFIC

The Contractor to provide a fully bi-directional signal system throughout the project limits. Traffic is to be capable of being flipped between adjacent interlockings. When a train is operating in a segment of track in the established direction of traffic, the train to receive full permissible cab signal speeds through the segment up to a maximum of 70MPH. The cab signal for only one direction of traffic is provided at a time and a signal may only receive a call-on where the traffic in a segment of track the train is attempting to enter is not aligned properly for the requested route. If a call-on is provided against the set direction of traffic, the cab signal for the originally defined direction of traffic will be disabled.

1.07 LOCAL CONTROL PANELS

Every interlocking is provided with a means to electrically operate the switch machines and enter route requests manually, through the use of a Local Control Panel (LCP). The LCP provides indications of track circuit occupancy, switch position, direction of traffic, and signal aspects to the tower operator.

A. Local control panels are typically physical panels with electro-mechanical switches and pushbuttons. Each interlocking may be controlled from multiple different remote panels but there will be only one Master panel for each interlocking. The master panel utilizes a lever to select between manual control and automatic routing control.

B. To initiate a route, the operator pushes the requested entrance signal pushbutton and the pushes the requested exit signal pushbutton. Once the entrance and exit have been accepted the switches will throw automatically for the requested route.

C. All local control panels are also provided with the ability to issue a call-on to a train when there is track circuit failure. See the section on a call-on above for a description of the call-on functionality. At least one local panel is provided with the ability to conduct emergency switch release and one local panel has the ability to enable track blocking. See the Emergency Switch Release and Track Blocking sections for more information on these features.

1.08 EMERGENCY SWITCH RELEASE

A. Each interlocking to be provided with at least one local control panel with full view of the interlocking switches and provided with Emergency Switch Release buttons. Emergency switch release functionality allows a tower operator to electrically throw switch machines when they are electrically locked due to a failure of an interlocking track circuit. In order to perform an emergency switch release, the tower operator must first remove all routes, wait for any approach timers to complete their cycle and then visually verify there are no trains in the interlocking and all trains in approach are stopped and standing. The tower operator may then move the switch lever to the desired position, push the associated Emergency Switch Release (ESR) button, and then pull the button and hold it in position for at least 30 seconds during which time the associated ESR light will flash. After the time duration, the switch lock light will momentarily darken and allow the switch to electrically throw to the desired position.

B. At specific locations where full view of the switches in the interlocking is not obtainable, a remote wayside emergency switch release button is to be provided. In such circumstances, a two-person emergency switch release operation is required.

1.09 EMERGENCY TRAFFIC RELEASE

A. All local control panels are provided with the ability to change the direction of traffic in an occupied block. The emergency traffic release is used when there is an occupied track between interlockings (possibly a track circuit failure) which prevents the direction of traffic from being changed. An emergency traffic release can be done only after all entrances into a segment of track are cancelled. The tower operator then enters a route into the segment of track in the direction of traffic which is preferred and then must pull and hold the traffic release button for two minutes to flip the traffic.

1.10 WORKER AHEAD SYSTEM

A. The CTA utilizes a Worker Ahead (WA) system to provide a level of supplemental protection to maintenance and construction crews working on or directly adjacent to the right-of-way. The WA system is made up of a number of distinct zones provided at locations with limited visibility. When activated through a switch on the right-of-way by wayside workers, a WA signal in approach to the zone will flash yellow to give warning to operators that workers are present in the section of track ahead. Additionally, an activated WA zone will reduce the cab signal speed for operators traveling through the zone by at least one step speed and provide a maximum cab signal speed of 25MPH to operators while operating in an activated WA zone.

1.11 SNOWMELTERS

A. 600VDC heaters are provided for all switch points, switch operating rods and train stop arms.

B. Switch machines require two switch point heaters located on the outside of each of the stock rails and extending the entire length of the switch from the heel to past the switch point extension. Switch machines also require a ballast heater to be installed which is installed in the tie crib where the throw rod is located and extends across the gauge of rail and under the switch machine. The ballast heaters are installed in a heat sink to distribute the heat evenly in the tie crib and to prevent overheating that can cause fires from debris getting caught in the tie crib. Train Stop heaters are U-shaped heater elements ("hair pin" heaters) and are installed near the train stop pivot point to clear snow and ice preventing the movement of the train stop.

C. Snowmelters are powered locally from a local switch heater case. The switch heater case is located within the geographic vicinity of all the heaters it controls and consists of heat contactors, switch heat fuses, and current monitors. The contactors break the positive 600VDC feed to the heaters and have low voltage controls (and current monitoring feedback indication) back to the local signal house/room. The common wire for the heaters is connected to the negative return rail.

D. Switch heat can be requested and activated at the local control panel, remotely by the Signal Maintainers through a Maintenance Workstation, remotely through CTC, or remotely through the Control Center (independent from the CTC system). Positive indication of the switch heat activation is sent back and indicated to the Control Center and on the Maintenance Workstation.

1.12 SIGNAL MAINTENANCE SUMMARY

A. The maintenance of the train control system is performed by signal maintainers. The Signal Maintainers are assigned to geographical territories of maintenance responsibility. Each territory has an office located within the territory where the maintainers are based. Typically, two maintainers are responsible for all the preventative maintenance within a territory.

B. The territory maintainers are also responsible for all corrective maintenance in the territory during their working hours. Outside of the territory maintainer working hours, a trouble van with two maintainers is assigned to take any trouble calls. Trouble Calls are assigned to the maintainers by the Power Controller after being reported to the Control Center by Rail Operators, Tower Operators, Supervisors, or other personnel. Signal Maintainers are required.

C. The territory maintainers report to a Signal Foreman who is responsible for multiple territories in a geographic area. Each grouping of territories managed by a single foreman is referred to as a Section.

D. Signal Maintainer offices are secured spaces (with Signal Department locks) provided to the territory maintainers for storing work equipment, filling out reports, and for workspace to inspect and prepare parts for installation. Each Maintainer office minimally contains full size (double-wide) lockers for each of the maintainers based at the location to store personal clothing and tools, a knack box for territory-issued tools, a desk and chair for each maintainer based at the location, and a Maintenance Workstation. The Maintenance Workstation provides access to event recorder data, equipment diagnostics, switch heat status, various signal house/room alarms and statuses. While it does not provide the ability to remotely route a train or throw a switch, it will provide the ability to remotely activate the switch heat. It also provides a full graphical layout of the entire North Branch of the Red Line (from Armitage to Howard Terminal) showing track circuit occupancy, switch position, signal aspects, trip indication, interlocking routing, traffic, and all other features shown on a CTC console.

E. Preventative maintenance and inspections are conducted on a periodic basis as per issued procedures based on manufacturer recommendations and CTA specific guidelines.

PART 2 - MEASUREMENT AND PAYMENT

2.01 MEASUREMENT

A. The work of 34 42 05 - Signal System Operational Description shall not be measured for payment.

2.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 05 – Signal System Operational Description shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

2.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 09

SIGNAL ABBREVIATIONS AND DEFINITIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. This section summarizes the abbreviations and definitions required for this Contract.

B. B. Related Sections:

1. Drawings and general provisions of the Contract, including the General and Special Conditions, and sections of Division 1.

1.02 REFERENCES

A. Wherever in the Specifications or Contract Drawings the following terms are used, the intent and meaning to be interpreted as herein defined.

B. Pertinent provisions of the following listed standards to apply to the work of this Specification, except as they may be modified herein, and are hereby made a part of this Specification where the requirements of the following do not conflict with this Section of the Specifications.

1. Association of American Railroads:

    a. Signal Manual Part 1.1.1 Specification of Technical Terms Used in Signaling.

2. Institute of Electrical and Electronic Engineers:

    a. IEEE Standard Dictionary of Electrical and Electronics Terms.

C. In the event of a conflict between definitions, the following order of priority to be followed:

1. Definitions as contained herein.
2. AAR Signal Manual Part 1.1.1
3. IEEE Standard Dictionary.

1.03 DEFINITIONS

AAR: Association of American Railroads.

Alarm Condition: Any abnormal condition which requires the attention of an attendant or operator.

AF: Audio-Frequency or Auxiliary Feeder

API: Applications Interface

AREMA: American Railway Engineering and Maintenance Association.

Audible Alarm: The sounding of a bell, buzzer, or other acoustic device to draw the attention of the Control Operator to an alarm condition.

Audio House: A train control facility that houses ATP and ancillary equipment (such as power supplies, event recording and non-vital processor equipment) only. A facility that does not provide for interlocking control functions.

AWG: American Wire Gauge.

Authority: Chicago Transit Authority.

Automatic Local Control: A mode of system operation in which functions such as route initiation and dispatching is automatically performed by local equipment.

Automatic Routing System: A system to automatically establish route selection at a control point to permit the routing of trains in accordance with a pre-determined schedule or other method of automatic route selection.

Automatic Train Control (ATC): The system for automatically controlling train movement, enforcing train safety, and directing train operations. ATC includes subsystems for Automatic Train Protection, Automatic Train Supervision, and Automatic Train Operation.

Automatic Train Operation (ATO): The subsystem within Automatic Train Control which performs the on train functions of speed regulation, program stopping, and performance adjustment.

Automatic Train Protection (ATP): The subsystem within Automatic Train Control which maintains safe train operation. ATP subsystems include train detection, train separation, interlocking, and speed limit enforcement.

Automatic Train Supervision (ATS): The subsystems within Automatic Train Control which monitors and provides controls necessary to direct the operation of a system of trains in order to maintain intended traffic patterns and minimize the effects of train delays on the operating schedule.

Auxiliary Switch Operation: A manual control which permits operating a switch movement without clearing a signal. This control is performed via an Auxiliary Switch Lever located on a local control or tower panel.

Ballast Impedance: The total inter rail impedance caused by electrical leakage paths of a given section of electrically isolated unoccupied track.

Ballast Resistance: The total inter rail resistance caused by electrical leakage paths of a given section of electrically isolated unoccupied track.

B-Point: Receiver equipment that is installed within the limits of an AF track circuit (bound on both ends by impedance bonds) to create a subzone of train detection within the boundaries of the track circuit. Equipment installed on the wayside picks up the coded train detection signal from the rails via direct wire connections, inductively via wire loops or a combination of both. Receiver equipment includes a means for vitally decoding and verifying the received signal and driving a vital train detection relay.

BCH (BOSE CHAUDHURI HOCQUENGHEM) Code: A class of cyclic error-detecting codes that are particularly effective in the detection and correction of randomly occurring errors in an array of data bits.

Block: A length of track of defined limits, the use of which by trains is governed by block signals.

Bootleg: A protection for track wires where the wires leave the ground near the rail.

Bus: A conductor or a group of conductors that are terminated as a common connection for two or more circuits.

CAD: Computer-Aided Design

Call-On Signal: A proceed wayside signal aspect authorizing a following train movement into an occupied block, with the route lined and locked.

Central Control Office: A location from which the functions of a traffic control system or of interlockings are controlled and indicated.

Channel Bank: A device which samples, quantizes, and codes/decodes voice frequency or data circuits into/from a digital pulse code modulation (PCM) signal.

Circuit, Vital: Any circuit which affects the safety of train operations.

Civil Speed Limit: The maximum speed allowed in a specified section of track as determined by physical limitations of the track structure, train design, and/or passenger comfort.

Communication Based Train Control (CBTC): A railway signaling system that makes use of telecommunications between the train and track equipment for traffic management and infrastructure control.

Control (Supervisory): A coded message from a control console to a field location to change the status of signal equipment for train operation.

Controlled Signal: A block signal located at a control point and capable of being controlled by a control operator.

Control Point: A location so designated where signals, switches, traffic direction and/or other functions of a traffic control system are controlled either locally or from a central control office.

Cross Bond: An electrical connection from one track to another track to distribute traction power return currents.

Crossover: Two turnouts, with track between the frogs, arranged to form a continuous passage between two tracks.

Crosstalk: Undesirable interference created by coupling between one system and another system or from one portion of a system to another portion of the same system.

CRT: Cathode Ray Tube

CTA: Chicago Transit Authority

CTC: Centralized Traffic Control, Automatic Block Signal System - A block signal system where the use of each block is governed by an automatic block signal, cab signal, or both. A roadway signal operated either automatically or manually at the entrance to a block

Data Circuit: A digital signal which conforms to the RS 232 C standard for serial transmission at a baud rate of 9600, or a formatted signal for direct digital input to a channel bank at speeds up to 64 Kb/s.

Data Transmission System (DTS): A bi directional digital communications system between Central Control and field, or between other locations.

Downstream: For a given direction of travel, locations beyond a specified reference point. Used interchangeably with AAR term "in advance of".

Electro Pneumatic Switch: A track switch operated by an electro pneumatic switch and lock movement.

Electro Pneumatic Valve: A valve electrically operated which, when operated, will permit or prevent passage of air.

Entrance-Exit Type Route Control: Automatic route control implemented by defining an entrance point and an exit point. Often referred to in its abbreviated form: eNtrance-eXit or NX.

EP: Electro pneumatic.

EPROM: Erasable programmable read only memory.

Fiber Distribution Panel: A rack mounted device for the connectorized mating of fiber optic pigtails and the mounting of wave division multiplexers (WDM).

Flash Memory: A type of electrically erasable programmable read-only memory (EEPROM).

Fleet: A method of route control in which a route request and establishment is not cancelled by the passage of a train.

FO: Fiber Optic

FRA: Federal Railroad Administration

Hertz (Hz): The unit of frequency in cycles per second.

Indication (Supervisory): A coded message from a field location to a control console to report the status of signal equipment or train operation.

Insulated Joint (IJ): A rail joint in which electrical insulation is provided between adjoining rails.

Interface: The interconnection or inter relationship between two or more systems, subsystems, persons, or contracts, required to ensure continuity and proper operation.

Interlocking: An arrangement of signals and signal appliances operated from an interlocking machine and so interconnected by means of electric locking that their movements must succeed each other in proper sequences, train movements over all routes being governed by signal indication.

Interlocking Limits: The length of track or tracks between opposing wayside signals controlled by an interlocking.

ICEA: Insulated Cable Engineers Association

Joint Electron Device Engineering Council (JEDEC): Cooperative effort of Electronic Industries Association (EIA) and National Electrical Manufacturers Association (NEMA).

Junction: A location where train routes converge of diverge.

LAN: Local Area Network

Local Distribution Frame (LDF): A small or medium sized cross-connect and common termination point for voice frequency and data copper cables, which is subordinate to the main distributing frame (MDF), from which all local voice frequency and data circuits to be accessible.

Local Manual Control: A mode of system operation in which functions such as route initiation and dispatching are controlled manually by local equipment.

Locking: The electrical or mechanical establishment of a condition for a switch, interlocked route, speed limit, or automatic function which cannot be altered except by a prescribed and inviolate sequence of unlocking.

Main Distributing Frame (MDF): A medium or large sized cross-connect and common termination point for voice frequency and data copper cables from which all voice frequency and data circuits to be accessible.

Married Pair: Two rail cars which are semi permanently coupled together and share certain common equipment. This consist is often referred to by CTA Rail Operations as a ‘deuce’ and is assumed to be 96’-6” in length.

Maximum Authorized Speed (MAS): The highest speed limit which is authorized.

Mean Time Between Failures (MTBF): The average time that a piece of equipment will operate without a failure.

Mean Time to Repair (MTTR): The average time required to restore a piece of equipment to operation after the report of a failure. This time is measured from the time troubleshooting and repair work begins until restoration is complete.

Maintenance-of-Way (MOW): Having to do with the installation and maintenance of track and related structures to facilitate the operation of trains.

Multiplexer Demultiplexer (MULDEM): A device for combining several individual low speed digital channels into a common high speed digital bit stream for transmission over digital facilities.

NEMA: National Electrical Manufacturers Association.

Noise, Electrical: Interference brought about by undesirable random voltage or currents.

Outside Plant (OSP): Any device or apparatus intended for permanent installation in a non-protected, exposed environment.

Penalty Brake Application: Automatic brake application at the B3 braking rate.

Pothead: A method of protecting cable ends from the weather and to provide means of disposing of static stresses set up at cable ends.

Power Bond: A conductor of low resistance providing a path for return of propulsion current at non insulated joints, frogs, and switch points.

RAM: Random Access Memory.

Rapid Information Retrieval System: A static informational data bank accessed manually.

Reaction Time: The time used by equipment, operator, or both, that elapses between the moment an action is called for and when the desired result occurs.

Relay Case: A housing, located along the right of way, used to house signal apparatus and/or terminate underground or aerial cable.

Relay House (RH): A large walk-in type housing, sometimes called a bungalow, which is used to house signal equipment and terminate cable at an interlocking or control point.

Relay Room (RR): Room located in tower buildings or at other strategic points to house signal control equipment.

Reliable Power Source: The primary source of power. Also referred to as the normal power source.

Remote Terminal Unit (RTU): The equipment which constitutes the field end of a Data Transmission System.

Reserve Power Source: The secondary power source, used upon failure of the primary source. Also referred to as the emergency source.

Right of Way Hazard: The existence of an abnormal condition on, or near, the tracks which could impair safe train movement.

Roadway Worker: Any employee of or contractor providing work to a railroad, whose duties include inspection, construction, maintenance or repair of railroad track, bridges, roadway, signal and communication systems, electric traction systems, roadway facilities or roadway maintenance machinery on or near track or with the potential of fouling a track, and flagmen and watchmen/lookouts.

Route: A specified succession of contiguous blocks over which trains operate between two controlled interlocked signals.

RP: Receive-only Point. See B-Point.

Service Brake: Retardation produced by the primary train braking system.

Signal: An appliance which conveys information governing train movements, either in a stationary wayside location or in a mobile vehicle-mounted location, responsive to dynamic information based on train position.

Signal Aspect: The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train; the appearance of an automatic speed control cab signal indicator as viewed in the cab.

Signal Bond: A conductor of low resistance providing a path for the signal track circuit current at non-insulated joints.

Signal Indication: The information conveyed by the aspect of a signal.

Snowmelter (SM): An electric, gas, or hot air heater or element used to melt snow and ice at designated locations to allow proper operation of equipment.

Station Distribution Frame: A LDF installed within a station communication room.

Subsystem: A subsystem comprises elements within a system which are interconnected to perform a specific function.

Switch and Lock Movement: A device which performs the sequential functions of unlocking, operating, and locking a track switch.

Switch (Electric): A device be means of which an electric circuit may be opened or closed.

Switch (Track): A pair of switch points with their fastenings and operating rods providing the means for establishing a route from one track to another.

Switch Circuit Controller: A device for opening, closing or shunting electrical circuits, operated by a rod connected to a switch point.

Switch Point: A movable tapered track rail, the point of which is designed to fit against the stock rail.

Switch Test Key/Auxiliary Switch Operation: A device which permits operating a switch movement without clearing a signal.

Thru Routing: A method of entrance exit route selection design whereby intermediate signal calls are automatically initiated between available entrance and intermediate exit points by initiating only initial entrance and final available exit commands.

Track: An assembly of rails, ties, and fastenings over which cars, locomotives, and trains are moved.

Track Circuit: An arrangement of electrical and/or electronic equipment, including a length of the running rails, which permits detection of trains within the limits of the running rails.

Track Transformer: A transformer designed to couple electrical energy to and from the rails of a track circuit.

Traction Supply System or Traction Power System: The substations, feeder cables, contact rails or wires, switch gear and other equipment interfacing with public utilities or other power generation equipment and providing the electrical power for the movement of trains and the operation of their auxiliary systems.

Traffic Circuit: A circuit which controls and maintains the direction in which a signal system will accept and govern train movements.

Traffic Control System: A signal system that permits trains to operate in both directions on the same track governed by cab signal indications.

Trailable Switch Operating Layout: A device which performs the functions of operating a track switch. It can operate the track switch either in a motor driven mode or can be trailed through by a train.

Train Control Facility: A room or equipment house that contains train control system components.

Train Control System: The system for controlling train movement, enforcing train safety, and directing train operations.

Train Detection Equipment: The track circuits and associated equipment used to detect the presence of trains.

Train Identity: The alpha numeric code assigned to each train which contains, as a minimum, the elements of train destination, direction, and train number.

Train Shunt Impedance: The electrical Impedance between running rails when spanned by train wheels and axles.

Train Stop: A track mounted device located at wayside signals which actuates the carborne side trip emergency mechanism, causing an emergency application of the train brakes, when a train passes a signal displaying a STOP indication. Also referred to as trip, track trip, and trip stop.

Turnout: An arrangement of a track switch and frog with closure rails that provides the means for rolling stock to be diverted from one track to another.

Uninterruptible Power System (UPS): An auxiliary power system which provides an uninterrupted AC power source during a normal power source failure.

Unsafe Condition: Any condition which endangers human life or property.

Upstream: For a given direction of travel, locations, which have been passed prior to reaching a specified, reference point. Used interchangeably with AAR term "in approach of."

Voice Frequency (VF): An analog alternating current signal suitable for voice transmission with a bandwidth of 4 kilohertz.

Wayside Equipment: Train control or movement apparatus which is located along the track or wayside as opposed to the control center or other remote location.

Wayside Signal: A signal of fixed location along the track right-of-way.

PART 2 - MEASUREMENT AND PAYMENT

2.01 MEASUREMENT

A. The work of 34 42 09 - Signal Abbreviations and Definitions shall not be measured for payment.

2.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 09 – Signal Abbreviations and Definitions shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

2.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 20

AUDIO FREQUENCY TRACK CIRCUITS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installing the audio frequency track circuits, including:
    - a. Audio frequency double rail track circuits.
    - b. Audio frequency command loops to provide continuous cab signal aspects for trains where audio frequency track circuits will not be installed.
    - c. Receive-only equipment.
2. Furnished audio frequency track circuit equipment to be with the following:
    - a. Cable.
    - b. Conduit.
    - c. All mounting hardware.
    - d. Junction boxes.
    - e. Connections.
    - f. All other equipment and collateral work to complete the installation, ready for operation.

B. Related Sections:

1. 34 42 01 Basic Signal System Technical Requirements.
2. 34 42 04 Signal System Drawing Requirements.
3. 34 42 23 Impedance Bond Layouts.
4. 34 24 30 Traction Power Rail Connections and Running Rail Bonding.
5. 34 42 38 Miscellaneous Components and Products.
6. 34 42 40 External Signal Cable.
7. 34 42 41 Internal Signal Cable.
8. 34 42 62 Junction Boxes.
9. 34 42 90 Technical Support.
10. 34 42 91 Signal System Tests.

1.02 SUBMITTALS

A. The Contractor to submit the following plans and information for approval by the Authority:

1. Mechanical and circuit drawings of the audio frequency track circuits and receive-only points.
2. Mechanical and electrical drawings of the audio frequency loop layouts.
3. Complete performance data of each type of audio frequency track circuit and receive-only point.
4. Complete reliability report for each type of audio frequency track circuit to be utilized.
5. Catalog cuts and descriptive literature for all material as specified herein and as shown on the Contract Documents.
6. Factory test procedures.
7. Installation and field test procedures.
8. Complete electrical schematic drawings and bills of materials for all:

        a. Modules.
        b. Card files.
        c. Synchronizers.
        d. Circuit boards.
        e. Impedance bonds.
        f. Receive only units.
        g. Loop drivers.
        h. Filters.
        i. All other equipment and components associated with the audio frequency track circuit and cab signal system.

    9. Detailed audio loop layout drawings.

1.03 QUALITY ASSURANCE

A. Audio frequency track circuits to be designed, installed, and tested in accordance with the American Railway Engineering and Maintenance-of-Way Association (AREMA) Communications and Signal Manual Parts 8.1.1, 8.2.1, and 8.6.1 where the Manual Parts do not conflict with this Specification.

1.04 DELIVERY, STORAGE AND HANDLING

A. All equipment to be protected from damage throughout delivery, storage, and handling.

PART 2 - PRODUCTS

2.01 GENERAL

A. General requirements for audio frequency track circuits are:

1. All active electronic equipment to be located in Relay Houses, Relay Rooms, Signal Towers, or as specified herein.
2. Plug couplers or terminals to be wired to modules to provide external connection of the speed selection network and other external wiring associated with the module.

    a. No more than one module to be wired to a plug coupler.
    b. All modules to be typically wired to the coupler.

        i. This to include all speed command points, not only those that are connected to the external network.

3. Modules to include a steady, un-coded train carrier setting for maintenance and troubleshooting purposes.
4. Cab signal equipment to include the Manufacturer's latest development to minimize susceptibility to interference from advanced propulsion systems, particularly AC propulsion motors and chopper controls.
5. Sufficient test points or a connected computer display to be provided to allow the viewing of the output waveforms and amplitude modulation rate and levels.
6. Visual indications to be provided for displaying the active commanded speed transmission and go command (speed transmission enabled) status. These indications may alternatively be displayed via a Maintenance Workstation on the signal network or through a light on track circuit module.

7. Equipment to be based on a design that has had successful installation and in-service operation at CTA for a minimum of nine months.
8. The track circuit must provide for broken rail detection of both running rails.
9. The track circuit must be capable of implementing and displaying temporary speed restrictions remotely from any computer connected to the signal network.
10. The transmitter and its associated equipment to be capable of operating a track circuit:

    a. Of at least 1.5 times the length of the longest track circuit in the approved block design with a minimum ballast impedance of five ohms per 1,000 feet.
    b. Of at least 700 feet in length with a minimum ballast impedance of five ohms per 1,000 feet located a minimum of 3500 feet from the transmitter and utilizing twisted pair No. 14 AWG conductors from the impedance bond to the transmitter and receiver.

2.02 MODULES AND COMPONENTS

A. Each audio frequency track circuit module to be capable of generating all speed commands used on the CTA system.

B. Each track circuit module to be furnished with all components necessary to transmit all speed increments from the circuit maximum to 0 mph should the intermediate speeds be selected by the external network or not.

C. Each audio frequency track circuit module to be capable of providing temporary speed restrictions. The Temporary Speed Restriction (TSR) request will be considered non-vital but must be handled VITALLY by the Vital Microprocessor Interlocking System (VMIS) and track circuit product.

1. The VMIS or track circuit must retain memory of the previous state of a temporary speed restriction in the event of power outage or reset.
2. Physical Temporary Speed Restriction Dials:

    a. Adjustment to be from an externally accessible manual selector switch or other approved method.
    b. The TSR switch to be marked "0", “Restricted Speed”, "15", "25", "35", “45”, "55", and "70" to provide visual indication of what maximum speed has been selected.
    c. The TSR switch to be integrated into the cab speed selection through the VMIS System. Interface to be via discrete vital inputs. TSR interface to the code rate generator circuit board to not be allowed.
    d. Speed selection logic to be designed so that the TSR input cannot override a more restrictive command from the control line speed selection logic.
    e. The TSR switch to have the capability of remote control. This functionality to be demonstrated prior to in-service testing and then disabled.
    f. The wiring for each selector switch to be encased in a nonconductive protective cover to guard against false power feeds.

D. The transmitter and its associated equipment to be capable of operating a track circuit of at least 1.5-times the length of the longest track circuit in the approved block design with a minimum ballast impedance of five ohms per 1,000 feet.

1. The minimum current level for the 4550 Hz cab signal in the rail or in a loop to exceed 120 MA for the entering end of the longest track circuit.
2. The transmitter to be able to drive up to 2.0 amperes (minimum) into an impedance-matched loop.

E. Eight (8) different train detection carrier frequencies to be used, with four (4) frequencies dedicated for each track.

F. Frequencies used at tie-in locations to not conflict with the existing train detection carrier frequencies.

G. A minimum of four (4) modulation rates to be required and may be shared by both tracks.

H. Each track circuit to generate its own cab signal and train detection carrier frequency.

I. Each track circuit to be capable of transmitting a cab signal transmission carrier frequency of 4550-Hertz ± 25 Hertz.

J. Each track circuit to have the capability to turn on and shut off, in a failsafe manner, each speed command transmission carrier code rate by closing and opening a circuit or microprocessor vital output external to the track circuit.

K. At no time to a coded speed command transmission be transmitted to the rails during the shut off operation of this circuit.

L. Each track circuit to be capable of transmitting the following cab signal code rates as a square wave signal with equal on time and off time:

    1. 50 codes per minute ± 4% for 6 mph.
    2. 75 codes per minute ± 4% for 15 mph.
    3. 120 codes per minute ± 4% for 25 mph.
    4. 180 codes per minute ± 4% for 35 mph.
    5. 410 codes per minute ± 4% for 45 mph.
    6. 270 codes per minute ± 4% for 55 mph.
    7. 648 codes per minute ± 4% for 70 mph.

M. The cab signal code rate to be used to be selected via the code rate selection circuits, in a failsafe manner, by closing and opening a circuit or vital microprocessor external to the track circuit.

N. The train detection carrier frequency must be modulated at a code rate independent of the cab signal code rate.

    1. The train detection modulation rate will be set through use of a jumper on the module or through track circuit application programming.

O. Separate adjustments to be provided for the power levels of the track and train carrier frequencies.

P. The power level for the working circuit to not be more than eighty percent (80%) of the available power.

Q. The track circuit receiver filter to be a bandpass filter tuned to the train detection frequency.

R. The track circuit receiver filter to have the following characteristics:

    1. At least 20 dB down ± 8% of the train detection carrier frequency.
    2. At least 60 dB down for all train detection and speed command transmission carrier frequencies on the same track, including their harmonics frequencies, and their beat frequencies.

3. At least 45 dB down for all train detection and speed command transmission carrier frequencies on the opposite track, including their harmonics frequencies, and their beat frequencies.

S. The filter to be of failsafe design. The shorting or opening of any element or component within the filter to either:

1. Not change the pass band, non-ringing, and attenuation characteristics of the filter.
2. Attenuate the output of the filter so that the associated track relay will drop or will remain down.

T. The receiver filter to not have adjustable elements.

U. The receiver amplifier gain to be adjustable.

V. All components in receiver section to be designed such that a failure of any component to cause a failsafe condition.

W. Code Demodulators:

1. The code demodulator to demodulate the carrier signal and to remove the code from it.
2. The code demodulator to have no adjustments.
3. For designs utilizing separate demodulation for the train detection, the receiver code rate to be selected by a non-changeable (one-time) set-up switch set to the transmitter modulation rate.

X. The audio frequency track circuit track relay to be a DC biased-neutral relay that meets the requirements for vital relays as specified in the Relays Section of these Specifications.

Y. Drop away time of the track relay to not exceed 1.0 seconds from time of track shunt until back contacts make without a detected failure and shut down of the track circuit and to not exceed 1.8 seconds from time of track shunt until back contacts or the relay make under detected failure mode which will cause the track circuit to be shut down.

Z. Track circuit cables to be as specified in the External Signal Cable Section of these Specifications.

AA. Impedance bonds to be as specified in the Impedance Bond Layouts Section of these Specifications and to be produced by the same manufacturer as the audio frequency equipment manufacturer.

2.03 COMMAND TRANSMISSION LOOPS

A. Command loop transmitters to be in accordance with the track circuit transmitter requirements described within this Section.

B. Loop Turn-on:

1. Audio loops will be turned on in advance of a train entering the loop when a permissive signal aspect governing the track segment of the loop is displayed.

C. Matching Transformers:

1. Loop matching transformers, where required, to be rack mounted type, mounted within the relay house, room or tower and to not be mounted on ties or between the rails.
2. All loop impedance matching transformers, if required, to be identical.

D. Loop Cable:

1. External cable for the command transmission loops to be No. 9 AWG stranded copper insulated conductors in accordance with the External Signal Cable Section of these Specifications.
2. External cable from the house, room, or tower to the loop junction box to be No. 14 AWG.
3. The loop junction box to be in accordance with the Junction Boxes Section of these Specifications.

E. Clips and Fasteners:

1. Retainer clips to fasten the loop cable and hose to the rail to be plated spring steel fasteners with a mild steel strap, Erico Type SBA252S, or approved equal.

F. Conduits:

1. Conduit for protection of the loop cable leads to be FRE conduit in accordance with these Specifications.

2.04 RECEIVE ONLY/B-POINTS

Receivers to be in accordance with the track circuit receiver requirements described within this Section.

A. Multi-conductor Wire Loops:

1. If required by the manufacturer's design, to be enclosed in protective plastic conduit. Loop connector terminals to be enclosed and accessible.
2. Loops to be provided complete with all mounting hardware.

B. Relays:

1. To be DC biased vital type, in accordance with the Relays Section of these Specifications.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Track Circuits:

1. Audio frequency track circuit modules and track relays to be rack mounted in accordance with the approved installation drawings.
2. Track circuits will be adjusted to 0.25Ω shunt sensitivity. The track circuit will be adjusted to de-energize with a 0.25Ω shunt strap placed across the rails within 5 ft. of the rail connections to the receive impedance bond.
3. Adjustment of track circuits to only be conducted under nominal operating conditions with all rail bonds, negative tap connections, and impedance bond rail connections installed and in good condition.

B. Loops:

1. Audio frequency transmission loops to be installed in accordance with the approved installation drawings.

2. The exact layout of the loop or loops through the special trackwork to be determined by the Contractor. Detailed drawings of the loop routing through special trackwork areas must be provided for review and approval in the drawing set.
3. Loops to be transposed to minimize coupling to the track circuits.

    a. Each loop to contain an odd number of transpositions to create an even number of loop sections.

4. Wires and conduit for the loops to be installed straight and parallel between transpositions, and to be firmly secured.
5. All loops to terminate within a loop junction box or wayside case.
6. Wire leads between a loop junction box or wayside case and the relay house or room to be twisted to minimize induction radiation, and to be contained within FRE conduit.

C. As required in specification 34 42 90, Technical Support, all Line Replaceable Units (LRUs) defined as the lowest level of equipment that may be replaced in the field to be barcoded with a unique code.

3.02 TESTS

A. Tests to be performed in accordance with the Signal System Tests Section of these Specifications.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 20 – Audio Frequency Track Circuits shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 20 – Audio Frequency Track Circuits shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 23

IMPEDANCE BOND LAYOUTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Requirements for furnishing and installing impedance bond layouts:

   a. On the elevated structure.
   b. For use with existing ATP modules and system components.
   c. For use with new ATP modules and system components.

B. Related Sections:

1. 34 21 25 Traction Power Cables.
2. 01 11 00 Summary of Work.
3. 34 42 01 Basic Signal System Technical Requirements.
4. 34 42 04 Signal System Drawing Requirements.
5. 34 42 20 Audio Frequency Track Circuits.
6. 34 42 40 External Signal Cable.
7. 34 42 91 Signal System Tests.
8. Division 5 Metals (sections as applicable).

1.02 SUBMITTALS

A. Before ordering, fabricating, or assembling equipment, submit the following for approval by the Authority:

1. Product Data:

   a. Electrical characteristics including the DC rated propulsion current level.
   b. Physical dimensions including mounting bolt sizes, bond J-bar dimensions and lug sizes, and specific weight of impedance bond.
   c. Environmental operating characteristics of the impedance bond including water resistance rating and temperature rating. All temperature effects on operation to be clearly indicated.
   d. Factory test procedure and completed forms including frequency sweep information.
   e. Test results of impedance bond functioning properly with a traction power imbalance current of 400 Amperes between each of the ears of the bond.
   f. Method of separation of dissimilar metals.
   g. Application, Installation, and Maintenance Manuals.

B. Prior to installation, submit details of the following impedance bond layouts to the Authority for approval:

1. Shop Drawings:

   a. Detailed installation for mounting outside of tracks on elevated structures at:

      i. Interlockings.

        - ii. Station Platforms.
        - iii. Along the wayside.
        - iv. Complete scaled details of platform structures, vibration dampening, support hangers, mounting hardware, etc. for use on the above listed elevated structure applications.
        - v. Modifications required to the structure to mount the platforms.

    - b. Detailed installation for mounting inside the gauge of rail on elevated structures (requires prior approval) at:

        - i. Interlockings.
        - ii. Station Platforms.
        - iii. Along the wayside.
        - iv. Complete scaled details of support brackets, vibration dampening, mounting hardware, etc. for use on the above listed closed deck applications.
        - v. Modifications required to the track sturcture to mount the impedance bonds. (requires prior approval).

2. Cable layout drawings detailing cable runs and connections:

    - a. Impedance bond track winding terminals to rails.
    - b. Impedance bond with no center tap connection.
    - c. Impedance bond with center tap connection to Auxiliary Negative Return (ANR) rail.

        - i. For cross bonding and interlocking negative return.

    - d. Impedance bond with center tap connection to bond on opposite track.
    - e. Double impedance bond location adjacent to an insulated joint.

3. The manufacturer’s Quality Conformance Tests performed and results of additional water tightness testing.
4. Product data for the high-conductivity corrosion inhibiting grease including chemical makeup, MSDS, and anti-corrosion and conductivity properties.

C. Prior to safety verification testing submit Factory and Field Installation and Operation Test Procedures.

1.03 QUALITY ASSURANCE

A. Impedance bonds to meet the requirements of the American Railway Engineering and Maintenance-of-Way Association (AREMA) Communications and Signal (C&S) Manual Part 8.4.5 where the requirements of the AREMA C&S Manual do not conflict with any requirement specified within these Specifications.

B. Waterproofing tests may be performed during Factory Acceptance Testing (FAT) to assure that the impedance bond casing is watertight.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Impedance bonds to be properly crated to prevent damage throughout delivery, storage, and handling.

PART 2 - PRODUCTS

2.01 IMPEDANCE BOND GENERAL REQUIREMENTS

A. The track winding of each impedance bond to be rated to carry 2000 amperes per rail continuously. Intermittent rating to be three times the continuous rating.

    1. The impedance bond to function properly with a traction current imbalance of up to at least 20 percent.
    2. The DC resistance of the impedance bond, from track lug to track lug, to not exceed 0.00003 ohms.

B. Two (2) track winding terminal lugs to be provided on each impedance bond.

    1. Each track-winding lug to be designed to accept 1000 kcmil cables.

C. One (1) center tap terminal lug to be provided on each impedance bond.

    1. The center tap lug to be designed to accept up to four 1000 kcmil cables or up to three 2000 kcmil cables.

D. All impedance bonds to be provided with a name plate stamped with the following information with weatherproof labeling:

    1. Manufacturer Name
    2. Part Number
    3. Serial Number
    4. Tuned Operating Frequencies
    5. Nominal Impedance Value at each of the Operating Frequencies
    6. DC Propulsion Current Rating
    7. DC Resistance Rating

E. The center tap on the impedance bond to be required to support termination of any combination of the following:

    1. Cross bonding cables.
    2. A neutral cable to another impedance bond on the same track at insulated joints.
    3. DC negative returns.
    4. A copper extension plate and detailed layout to be provided for each impedance bond center tap requiring more than two (2) negative return cable connections.

        a. Extension plates to be of sufficient size to accommodate all of the terminations required, and for the maximum current that may be encountered.

F. Negative traction power return connections to be included within the block layout design.

G. The size of the impedance bond to be as to permit ballasted mounting, direct fixation to a concrete deck, platform mounting on the elevated structures, and in-gauge installation on elevated structures.

H. The impedance bonds to weigh no more than fifty (50) pounds each.

I. The size of the impedance bonds to not preclude any future relocation of the bonds to the center mounting on the ties at least one-half (1/2) inch below the plane of the top of the rails.

J. A watertight plug connector to be provided at the impedance bond to provide access for the twisted pair cable.

   1. Watertight plug connectors to also be provided for access for cables to the tuning unit, if required.

K. Cables for connections to rails and for cross bonds to be in accordance with the External Cable Section of these Specifications.

L. Impedance bonds to have a watertight cover.

M. Impedance bonds to be designed with four mounting bolts to properly install the bond on a mounting pedestal or bracket.

N. The impedance bond to be arranged for mounting as described below.

   1. On the ballasted area pedestal foundation mounting plates.
   2. On the elevated structure platforms.
   3. In gauge on the elevated structure.
   4. Directly fastened to a concrete deck or vertically mounted on a sound wall in closed deck areas.

O. A one-half- (1/2) inch rubber pad to be installed between the impedance bond and the plate to which bond will be mounted as a means to minimize vibration.

   1. The pad to be sized to cover bottom of impedance bond completely.
   2. Bond mounting bolts and mounting plate fabrication to allow for pad thickness.
   3. Tuning units (if required) to be equipped with the same type of vibration dampening.

2.02 IMPEDANCE BOND LAYOUTS - GENERAL

A. Furnish and install impedance bonds at all locations according to the approved block designs.

B. For impedance bonds located on elevated structure locations, bonds to be installed according to the following conventions:

   1. On steel platforms provided by the Contractor.
   2. Within the gauge of rail at locations where it has been determined that the bond cannot be installed adjacent to the track.

C. Side protection boards as described in the Miscellaneous Components and Products Section of these Specifications to be provided at each location where the impedance bond is on the same side of the tracks as the contact rail.

2.03 IMPEDANCE BOND LAYOUTS – STRUCTURE

A. Impedance bond layouts for installation on platforms to be provided complete with all structure mounting hardware, and hardware and connections for mounting impedance bonds to the structure.

B. Platform construction to conform to the following:

   1. Design to allow the bond to be serviced from either side, parallel to the tracks.

2. The impedance bond to be mounted a minimum of five- (5) feet ten- (10) inches from the centerline of any track.

    a. The tuning unit, where required, to be mounted parallel to the track next to the impedance bond.

3. Platforms to have a minimum of three (3) feet of space adjacent to the left and right sides of the impedance bond and tuning unit parallel to the tracks.
4. Platforms to have a minimum of six (6) inches behind the impedance bond or tuning unit at the point furthest from the tracks.
5. Platforms to have room for a minimum of two (2) maintainers and equipment to service the bond.
6. Platforms to be equipped with railings and kick plates.
7. Installation of the platforms to include installing two- (2) inch by eight- (8) inch treated planking in between the running rails adjacent to the platform and between the closest running rail and the platform grating to form a walkway to the platform.
8. A flashboard to be provided at locations where the platform is adjacent to the third rail.
9. Platform design to be adapted to suit field conditions as required.

    a. Distances from the centerline of track apply to tangent track only; these distances to be increased for platforms located on or near curves to allow for car body overhangs to maintain the minimum clearance.

10. Platforms to be designed to allow full access for the connection and maintenance of the impedance bonds.
11. Platforms to not be installed in the middle third of the span between the bents.

C. Design and installation of the impedance bond platforms is subject to approval by the Authority.

D. Platforms to conform to Division 5 –Metals, of these Specifications.

2.04 IMPEDANCE BOND LAYOUTS – INSIDE RAIL GAUGE (requires Authority approval)

A. Where clearances are tight on both sides of the track or as designated by the Authority, impedance bonds may be installed inside the gauge of rail.

B. All impedance bonds to be recessed between ties and mounted using a steel bracket.

C. All impedance bonds and tuner assemblies (if required) to be protected with a 12-gauge, hot-dipped galvanized, steel skid plate.

D. The impedance bond and skid plate assembly to be no less than one half- (1/2) inch below the top of rail.

E. All materials required for the layout to be provided by the Contractor.

2.05 COMPONENT ASSEMBLIES

A. Compatible metals to be used throughout the assembly of all structures, fixtures and adjoining components including the fasteners.

1. Where contact between two dissimilar metals cannot be avoided, an isolator to be used between the two dissimilar metals thereby circumventing direct contact.

    a. The method of separation to be submitted to the Authority for approval.

2.06 IMPEDANCE BOND LAYOUTS – FOR USE WITH EXISTING ATP EQUIPMENT AND SYSTEMS

A. Impedance bond layouts to function in conjunction with existing ATP systems and components:

    1. Hitachi Rail STS AF-800 ATP system.
    2. Hitachi Rail STS AF-500 ATP system.
    3. Alstom 31049 ATP system, commonly referred to as "GRS-II" or "AFTC2".

B. The impedance bonds to be certified by the OEM of the existing ATP system hardware as being fully compatible and safe for use with their existing equipment.

C. The Authority to not provide impedance bond layouts for these installations.

D. All bonds furnished and installed in conjunction with existing ATP equipment to be newly manufactured units. Installation of "Old-stock" equipment will not be allowed.

E. Impedance bonds to not be of the universal type.

F. Impedance bonds to each be tuned for specific train detection receive, train detection transmit and 4450Hz cab carrier frequencies.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

A. The Contract Documents include plans calling out the intended installation location and type of support means required for each impedance bond layout.

    1. Only those impedance bonds at approved locations to be mounted within the gauge of rail.
    2. Other installations in the gauge of rail are not permitted without written approval from the Authority.

B. All cable connection lugs and impedance bond track terminal winding surfaces to be thoroughly cleaned with emery cloth and immediately thereafter treated with a high-conductivity corrosion-inhibiting grease on all electrical contact surfaces prior to fastening and tightening.

    1. Acceptable high-conductivity corrosion-inhibiting greases are:

        a. Sanchem Industries, Inc. "No-ox-id A-Special".
        b. Approved equal.

C. See the Rail Connection and Running Rail Bonding specification for details on bonding the impedance bond to the rail.

D. In general, the impedance bond to be mounted on the right-hand side of the tracks as viewed from the normal direction of traffic.

E. Provisions to be made for impedance bonds for cross bonding substation return and elevated structure connections at a minimum of every 2000' feet.

F. Adjacent impedance bonds on the same track to not be cross bonded to impedance bonds on the adjacent track or to the structure.

G. As required in the Technical Support specification, all Line Replaceable Units (LRUs) defined as the lowest level of equipment that may be replaced in the field to be barcoded with a unique code.

3.02 INSTALLATION ON ELEVATED STRUCTURES

A. Impedance bond layouts installed in elevated structure territory to be installed on cantilevered steel platforms adjacent to the respective track.

B. Impedance bond to be mounted on a rubber padded base at platform deck height with center tap a minimum of five (5) feet eight (8) inches from the centerline of track.

3.03 CABLE AND WIRE

A. Twisted pair train detection cable between the impedance bond secondary windings and signal houses/rooms or local junction boxes to be provided in accordance with the External Signal Cable Section of these Specifications.

B. Cable connecting to impedance bond track winding and center tap terminals to be in accordance with the Traction Power Cable Section of these Specifications.

3.04 TESTS

A. The Contractor to test the impedance bonds in accordance with the approved installation and operating test procedure.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 23 – Impedance Bond Layouts shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 23 – Impedance Bond Layouts shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 25

RAIL CONNECTIONS AND RUNNING RAIL BONDING SIGNAL

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The work to be done under this Section consists of furnishing and installing rail connections and running rail bonding.

B. Related Sections:

1. 34 42 40 External Signal Cable.
2. 34 42 91 Signal System Tests.

1.02 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA).

1. AREMA Communications and Signals Manual of Recommended Practice (C&S Manual) Part 8.

1.03 SUBMITTALS

A. The Contractor to submit the following plans and information for approval by the Authority:

1. Product Data:

    a. Signal bonds and weld material including material composition, electrical, and mechanical characteristics.
    b. Molds to be used for exothermic welds.
    c. Non-toxic cleaning solvent.
    d. Grinding Disc to be used to grind the rail.
    e. Manufacturer testing certification for conformance with AREMA C&S Manual Parts 8.1.30 and 8.1.34.

2. Shop Drawings:

    a. Drawings showing detailed final design for bonding special track work to assure that all pieces of special track work are properly connected electrically.

3. Procedures:

    a. Field installation procedures for each type of welded connection.
    b. Field inspection and testing procedures for rail bonding.

1.04 QUALITY ASSURANCE

A. The Contractor to install each welded bond in accordance with the manufacturer’s guidelines and the requirements of this Section.

    1. Each welded bond to be inspected and tested in accordance with the submitted inspection and testing procedure.

B. Exothermic welding to only be completed by individuals trained and certified by the bond manufacturer within the past 3-years.

    1. These individuals must provide proof of certification when requested by the Authority.

C. The Authority reserves the right to conduct electrical testing on a random sampling of exothermic bonds.

    1. Failure of these bonds to meet the required electrical properties as defined in AREMA C&S Manual Part 8.1.30, to require the contractor to enlist the services of a testing firm to test all exothermic bonds and to replace any that fail the electrical test.

D. Exothermic Welding Requirements:

    1. Personnel assigned to exothermic welding to be certified by the Authority as described below:

        a. Each certified exothermic welder to weld in the field, under conditions similar to those of the actual work area, not less than three (3) exothermic rail connections for evaluation by the Authority.
        b. Exothermic welders to demonstrate as many additional welds as requested by the Authority to determine the welds are being made satisfactorily.
        c. Exothermic welds to be subject to inspection and test by the Authority.

            i. Certification of the installer to depend on the results of these inspections and tests.

        d. The final approval of the exothermic welders/installers to be at the sole discretion of, and to be solely provided by, the Authority.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Rail bonds to be manufacturer bonds prepared for welding by the exothermic process.

B. Bonds, bonding materials and types of molds being used to be submitted to the Authority for review as described in Section 1.03.

C. Bonds and all associated material required to complete bonding work to be compliant with the requirements of AREMA C&S Manual Parts 8.1.30, 8.1.31 and 8.1.34.

    1. Copper-based exothermic weld material to comply with the requirements of the AREMA C&S Manual Part 8.1.34.
    2. Any non-toxic solvent to be used to remove grease and dirt from the rail after grinding to be submitted for approval by the Authority prior to use.
    3. All welding to be conducted in a dry environment.

        a. Welding during wet weather conditions is not permitted unless the area being welded is fully protected from the elements.

D. Running Rail Track Connections:

1. Material:

    a. Cadmium bronze.

2. Size:

    a. Three-sixteenths- (3/16) inch by seven- (7) inches.

3. Connection:

    a. Exothermic weld to the railhead.

4. Installation:

    a. Install in accordance with AREMA C&S Manual Part 8.1.30.
    b. Install two (2) bonds for each AC track circuit wire:

        i. One (1) track wire.
        ii. One (1) spare.

    c. Install one (1) bond for each end of an AC track circuit jumper cable.

E. Signal Rail Joint Bonds:

1. Material:

    a. Cadmium bronze.

2. Size:

    a. Three-sixteenths- (3/16) inch by seven- (7) inches.

3. Connection:

    a. Exothermic weld to the railhead.

4. Installation:

    a. Install in accordance with AREMA C&S Manual Part 8.1.30.
    b. Install one (1) bond at each rail joint.

F. Fouling Bonds:

1. Material:

    a. Cadmium bronze.

2. Size:

    a. Three-sixteenths- (3/16) inch and as long as required to provide fouling jumper protection inside special trackwork areas.

3. Connection:

   a. Exothermic weld to the railhead.

4. Installation:

   a. Install in accordance with AREMA C&S Manual Part 8.1.30.

G. Switch Heater Element Return Bonds:

1. Material:

   a. Cadmium bronze.

2. Size:

   a. Three-sixteenths- (3/16) inch by seven- (7) inches.

3. Connection:

   a. Exothermic weld to the railhead.

4. Installation:

   a. Install in accordance with AREMA C&S Manual Part 8.1.30.
   b. Install one (1) bond for each heater element return wire.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Exothermic Bonds:

1. For all rail joint and rail head bonds, the surfaces of the rails where the bond is to be applied to be ground clean with a reinforced grinding wheel.

   a. Grinding wheels to be of a type as recommended by the bonding material manufacturer.
   b. Vitrified grinding wheels are not permitted.

2. After grinding, the surface to be cleaned with a manufacturer approved non-toxic solvent to remove all traces of grease and dirt.

B. Fouling Bonds:

1. Fouling bonds to be installed based on the approved signal drawings developed by the Contractor.

C. Removal of Existing Connections and Grounds:

1. The Contractor to be responsible for isolation of the double rail track circuits from any grounds and return connections.

        a. The Contractor to test the rail sections for isolation, and to remove all grounded connections, including any grounded track fasteners, tie fasteners, and tie plates within any rail section that are connected to ground or bonded to ground or another track circuit.

    2. The Contractor to inspect and test track circuits where the existing rail is to remain for other rail connections, and to remove any existing abandoned connections.

        a. Connections between the existing rail and the supplemental return cables to be removed from the rail connection to the supplemental return cable.
        b. Supplemental return cable to be re-taped and insulated for 600 volt DC service.

3.02 TESTS

A. The Contractor to demonstrate that the bonding is in accordance with the requirements of:

    1. This Specification.
    2. The Contract Drawings
    3. The AREMA C&S Manual Parts 8.1.30, Part 8.1.31 and 8.1.34.

B. Any bond, weld, or connection installed by the Contractor which is found to be defective to be removed and a new bond to be installed a minimum of three inches away from the last bond at no additional cost to the Authority.

C. All required inspections and tests are to be included in the field inspection and testing procedures for rail connections and rail bonding submitted to the Authority.

    1. All rail connections and rail bonding must comply with the requirements of these inspection and test procedures.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 25 – Rail Connections and Running Rail Bonding Signal shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 25 – Rail Connections and Running Rail Bonding Signal shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 38

MISCELLANEOUS COMPONENTS AND PRODUCTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installing miscellaneous components and products.

B. Related Sections:

1. 26 05 33 Raceways and Boxes.
2. 34 42 40 External Signal Cable.
3. 34 42 41 Internal Signal Cable.
4. 34 42 62 Junction Boxes.

1.02 REFERENCE STANDARDS

A. Section incorporates by reference the latest revisions of the following documents (unless otherwise noted), or if standard is adopted by the Authority Having Jurisdiction, the latest revision adopted:

B. American Railway Engineering and Maintenance-of-Way Association (AREMA).

1. AREMA Communications & Signals Manual of Recommended Practices (C&S Manual).

C. United States Department of Agriculture, Rural Development (USDA RD).

1. USDA RD Bulletin 345-83 (PE-80), Specification for Gas Tube Surge Arresters.

D. American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE).

1. ANSI/IEEE Standard C.62.41.2 – 2002 Recommended Practice on Characterization of Surges in Low Voltage (1000V and less) AC Power Circuits.

1.03 SUBMITTALS

A. The Contractor to submit the following plans and information for approval by the Authority:

1. A description of material to be furnished under this Contract.
2. Certificates of conformance for all materials provided under this Contract.

B. Product Data:

1. Each type of component or product proposed.

C. Samples:

1. Submit one of each type of proposed solderless terminal.

D. Closeout Submittals

1. Submit a general maintenance manual to permit future direct ordering of miscellaneous components by the Authority.
2. Manual to include catalog cuts, data sheets, and manufacturer's part numbers.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Electrical components:

1. Rated to operate at power, voltage, current, and temperature levels exceeding by 20 percent those that the components will be subject to in service, unless otherwise specified.

2.02 CIRCUIT BREAKERS, FUSES AND FUSE CLIPS

A. Fuses and circuit breakers to be of suitable capacities to protect the various pieces of signal apparatus from the effects of short circuits or overloads.

B. All circuit breakers and fuses required for the equipment and systems to be in accordance with these Specifications.

C. The Contractor to provide fuses for all equipment as required to provide circuit protection as defined within the Contract Documents, and in accordance with the National Electrical Code.

D. Fuses to be controlled time delay, current limiting, non-indicating and non-renewable.

1. Low Voltage Fuses:

   a. To be used for 110 volt circuits, or less, that are not connected to the rails or contained within snowmelter enclosures.

      i. Fuses to be 250V AC, Class RK1 with interrupt ratings of 200kA AC and 20kA DC.
      ii. Fuses to be manufactured by:

         a. Cooper-Bussman, catalog number KWN-R.
         b. Approved equal.

2. High Voltage Fuses:

   a. To be used for protection of snowmelter heaters.

      i. Fuses to be 1000V DC with an interrupt rating of 100kA DC.
      ii. Fuses to be manufactured by:

         a. Ferraz Shawmut, catalog number gRB.
         b. Approved equal.

   b. To be used for AC track circuits, house and room heaters, and other connections to the rails.

    i. Fuses to be 600V AC/DC rated, Class RK1, dual-element, current limiting/time-delay with interrupt ratings of 300kA AC and 100kA DC.
    ii. Fuses to be manufactured by:

        a. Cooper-Bussman, catalog number LPS-RKxSP
        b. Approved equal.

3. In applications where a snowmelter heater's return is bonded to the signal rail of an AC track circuit, the Contractor will coordinate the ratings of both heater branch circuit and AC track circuit (track-side) fuses such that, in the case of a heater fault to signal rail, the heater branch circuit fuse will clear/open prior to clearing of the AC track circuit fuse.

E. AC fuse blocks:

1. AC fuse blocks to be Phenolic base, 2 pole, Class R, center barrier, pressure terminals, rated 250V or 600V AC (based on application), 0-30 amperes.
2. AC fuse blocks to be manufactured by:

    a. Underwriters Safety Device - Cat. No. R25030 - 2 PR.
    b. Approved equal.

F. DC fuse blocks:

1. DC fuse blocks to be Phenolic base, 1 pole, Class R, mainline side barriers, box type terminals, rated 1000V DC. 0 to 30 amperes or 31 to 60 amps, with reinforcing springs.
2. DC fuse blocks to be manufactured by:

    a. Underwriters Safety Device - Cat. No. R60030-1-CR.
    b. Underwriters Safety Device - Cat. No. H60060-1-CR.
    c. Approved equal.

2.03 CONDUIT

A. Galvanized rigid steel conduit:

1. Comply with requirements of the Raceways and Boxes Section of these Specifications.

B. Reinforced Thermosetting Resin Conduit (Type RTRC):

1. Comply with requirements of the Raceways and Boxes Section of these Specifications.

C. Liquidtight flexible metal conduit (Type LFMC):

1. Comply with requirements of the Raceways and Boxes Section of these Specifications.

D. Cable entrance pipes for relay houses, relay rooms, towers, wayside cases, and junction boxes to be four- (4) inch minimum RTRC.

E. Cable entrance pipes to be as furnished complete with one holding device and one bell-end bushing for each such pipe as shown in these Contract Documents.

F. One spare entrance pipe assembly to be furnished for each enclosure.

G. Flexible hose:

    1. Braided Cordura rayon, vari-purpose hose, internal tube neoprene cover.
    2. Aapproved equal.

H. Flexible hose clamps:

    1. Worm-drive stainless steel.

I. Flexible hose fittings:

    1. Compression
    2. Watertight.

2.04 DIODES

A. All diodes to be furnished under this Contract to carry a JEDEC number or to be available from more than one manufacturer and to be used within the published specifications for such number.

B. All diodes to be silicon type, unless otherwise approved by the Authority.

2.05 ENVIRONMENTAL PROTECTION

A. Corrosion prevention compound:

    1. Product must have sufficient body to resist weather and rusting for at least six months.

B. Approved Manufacturer/Product:

    1. Sanchem, Inc.
    2. NO-OX-ID.
    3. Approved equal.

2.06 FIBERGLASS FOOTWALK

A. All footwall, platform grating, railings, and signposts to be fiberglass.

B. The fiberglass to be fabricated with continuous strand roving mat reinforced, thermoset unsaturated polyester electrical insulating laminate produced by the pultrusion process with a UV inhibitor.

C. Fiberglass material to meet the following:

PROPERTIES	TEST	GRATINGS	RAILINGS
FLEX. STRGTH, PSI	ASTM D-790	25,000 MIN	30,000 MIN
FLEX. MOD., PSI	ASTM D-70-	1.0 MIN	2.0 MIN
TENSL. STRGTH., PSI	ASTM D-638	17,000 MIN	30,000 MIN
TENSL. MOD., PSI (10^5)	ASTM D-638	9.0 MIN	8.0 MIN

IMP. STRGTH, FT-LB/IN.	ASTM D-256	25 MIN	
PERP. DIELECT. (VPM)	ASTM D-149	170 MIN	200 MIN
ARC RES. (SEC)	ASTM D-495	180 MIN	120 MIN
WATER ABS. (%)	ASTM D-570	0.2 MAX	0.8 MAX
THERM EXP. (IN/IN/FT)		$7x10^{-6}$ MAX	$5.2x10^{-6}$ MAX
FLAME SPREAD	ASTM E-162	60 MAX	
FLAME RESIST	UL 94	V-O MIN	V-O MIN
TRKING RESIST (MIN)	ASTM D2303	600 @ 2500V	
SPEC. OPTIC. SMOKE DENS.	ASTM E-662	200 MAX	

D. Standard grating panels to be two (2) inches thick, thirty (30) inches wide, with a 50% open surface.

E. Color to be gray.

2.07 HARDWARE

A. All mounting hardware exposed to the elements and used for signal equipment, cases, conduit, hangers, brackets, clamps, etc., to be hot dip galvanized, except as otherwise approved by the Authority.

1. Galvanizing:

    a. The hot dip process of galvanizing to be used.
    b. All parts to be pickled so that all scale and adhering impurities will be removed.
    c. The zinc coating to be of commercially pure zinc, and to be continuous and thorough.
    d. The zinc coating to not scale or blister or be removable by any of the processes of handling or installation.
    e. The finished surface to be free from fine line cracks, holes, or other indications of faulty galvanizing.
    f. The galvanizing to be smooth and free from adhering flux and other impurities.
    g. The edges and ends of parts to be free from lumps and globules.
    h. Parts to be coated with at least two ounces of zinc per square foot of galvanized surface.
    i. Parts to be coated after all bending, cutting, drilling, and final fabrication.
    j. All lock-washers to be cadmium plated to avoid destruction of resilience encountered in the hot dip process of galvanizing,

B. Cadmium Plating

1. All nuts, bolts, and washers used for the mounting of equipment within finished enclosures to be cadmium plated or stainless steel.

    a. The Contractor may submit another type of plating or non-corroding metal for the Authority's approval.

2. Cadmium plating to be an impervious, dense, hard, fine grained, continuous, closely adhering coating of commercially pure cadmium, free from capillaries.
3. Cadmium plating to completely cover the surface of the part in a smooth, bright layer.
4. Cadmium plating on raised or prominent portions to show no evidence of blackness or loose crystalline structure.
5. Cadmium plating to have a minimum thickness of 0.0006 inches and to withstand the salt spray test for at least 1000 hours or an equivalent test approved by the Authority.

2.08 IDENTIIFICATION OF CABLE, WIRE AND EQUIPMENT

A. Permanently identify the following with a tag:

1. Both ends of each cable and each cable wire and all single wires that terminate in:

    a. Relay houses.
    b. Relay rooms.
    c. Towers.
    d. Relay cases.
    e. Junction boxes.
    f. Signals.
    g. Train stops.
    h. Snowmelter cases.
    i. Switch mechanisms.
    j. Control panels.
    k. Route selectors
    l. Any signal system equipment not explicitly noted above.

B. Tags to not obscure connecting links used between terminal binding posts.

C. Tags to be installed such that the tag material is not pressed between layers of the standard AAR hardware schedules.

D. Tags to be installed so that they may be read with a minimum of disturbance of the tags and wiring.

E. Each conductor of the cable to be rung out and identified before applying the tag.

F. The lettering on all tags to be mechanically typed, waterproofed and permanent.

G. The tags to bear the following information in the sequence listed:

1. Wire nomenclature.
2. Cable designation (if applicable).
3. Termination point (rack no., row and contact no., if applicable).
4. Termination point of other end of wire.

H. Tags for wire identification to be waterproof, sleeve type tags.

I. Entrance rack or main terminal board terminals to be tagged with waterproof, flat type tags securely fastened to the front of the board.

1. Provide two (2) fasteners per tag, one (1) to the left and one (1) to the right.
2. Fasteners to be stainless steel brads with ring-shanks or staples.

J. Each cable to be tagged at its point of entry into relay houses, wayside junction boxes and relay cases.

K. Cable tags to be:

1. One and one half (1-1/2) inches in diameter with a one quarter- (1/4) inch hole to accept cable ties.
2. Nomenclature to be mechanically printed on ten (10) mil solid base nylon film material with a yellow base color.
3. Following printing, each tag to be covered with a clear film coating with a thickness of five (5) mils.
4. Font to be Arial, 12 point minimum.

L. Cable tags to include the following information printed from top to bottom:

1. Cable identification number (“CK1,” “C5,” etc.) based on the Contractor’s final design.
2. Cable type including number of conductors and conductor size (e.g. “12C#14”).
3. Destination of cable.

M. The one quarter- (1/4) inch mounting hole for all cable tags to be drilled at the 9 o’clock position.

N. Cable tag text to be printed such that when the tag is lashed to the vertical cable, the text is readable in a top to bottom fashion.

O. Where cables are grouped such that tags on adjacent cables will overlap, offset adjacent cable tags vertically so that all text among adjacent tags is readable and not obscured.

P. Cable tags to be attached to each cable no less than 16” above the interior surface of the relay house, junction box or relay case floor.

Q. Cable tags to be:

1. Twinco Manufacturing P/N 51-003-6-D.
2. Approved equal.

R. Tags to be attached to each cable with a black nylon cable tie of sufficient length to surround the cable jacket perimeter and provide full engagement with the locking head.

1. Following installation, excess cable tie material to be cut back and removed.

2.09 RE-TAGGING OF EXISTING WIRING

A. Where existing internal or external conductors change nomenclature due to repurposing, the Contractor to remove all existing tags from all conductors that are part of the complete circuit. The Contractor to then provide new wire tags for each conductor that is part of the newly configured circuit including all parallel branches.

B. Re-tagging will be required in the following instances:

1. An existing, unused, or spare conductor is assigned with a new, active function.
2. An existing, used conductor is retired and becomes an unused or spare.

3. An existing, used conductor is reused and the existing nomenclature requires modification due to modification of the circuit of which it is part.

C. Where wires and cable conductors require re-tagging, the Contractor to provide new rectangular tags which conform to the following:

1. Seven-eights (7/8) of an inch wide by one and one half (1-1/2) inches tall with a factory-drilled five-sixteenths- (5/16) inch hole provided at the top of the tag.
2. Nomenclature to be mechanically printed on ten (10) mil solid base nylon film material with a white base color.
3. Following printing, each tag to be covered with a clear film coating with a thickness of five (5) mils.
4. Font to be Arial, 12 point minimum.
5. Tags to be printed with the wire/conductor nomenclature as follows:

    a. First Line: Cable ID and conductor numbers (i.e. C110W15).
    b. Second Line: Circuit nomenclature
    c. Third Line: (local) Point where the wire is terminated.
    d. Fourth Line: Point where the remote end of the wire or cable conductor is terminated.
    e. For wires contained within a house, case or room, the information in item "a" above will be omitted and the tag will have only three lines of text.

6. Tags to be:

    a. Twinco Manufacturing RD-style flat tags.
    b. Approved equal.

7. Replacement tags will be affixed to wires and cable conductors using three- (3) inch long black nylon cable ties with a width of 0.09 inches.

    a. Following installation, the excess cable tie to be cut back.

2.10 LIGHTNING ARRESTERS AND EQUALIZERS

A. Lightning arresters to comply with AREMA C&S Manual 11.3.1, Recommended Design Criteria and Functional/Operating Guidelines for Primary Surge Protection of Signal Systems.

B. Lightning arrester bases to be three- (3) post porcelain type, or other approved type.

C. Gas tube arresters for signal circuit to be as follows:

1. Ceramic metal in construction.
2. Provided with ring terminals.
3. Utilize lead insulation.
4. Designed and constructed for mounting on signal terminal blocks.

D. Gas tub arrester for signal circuits to meet or exceed the following:

1. Typical DC breakdown voltage:

    a. 145 V at 500 V/second.

2. Minimum DC breakdown voltage:

    a. 116 V at 500 V/second.

3. Maximum DC breakdown voltage:

    a. 1174 V at 500 V/second.

4. Impulse breakdown:

    a. 500 V @ 100 V/microsecond.

5. Arc Voltage:

    a. 15 V with an arc current of 5 A.

6. Capacitance:

    a. Maximum 1 pF.

7. Surge life:

    a. 1000 minimum at 500 A (10x1000 microseconds).

8. Maximum current surge:

    a. 20 kA (8 x 20 microseconds).

9. Ac current:

    a. 20 A (10 x 1 second at 60 Hz).

10. Ac follow-on current:

    a. 20 A peak (1/2 cycle at 60 Hz).

11. DC holdover voltage:

    a. Typical 90 V per REA PE-80, 0.2A.

E. Transient voltage suppressors for signal circuits to be as follows:

1. Provided with ring terminals.
2. Utilize lead insulation.
3. Designed and constructed for mounting on signal terminal blocks.

F. Transient voltage suppressors for signal circuits to meet or exceed the following:

1. Reverse stand-off voltage:

    a. 16 VDC.

2. Energy handling capacity:

    a. 5 J (5000 W for 1 ms).

3. Voltage range to initiate 5 mA DC conduction:

    a. 17.8 to 19.7 VDC.

4. Maximum peak pulse current:

    a. 192 A (10 x 1000 microsecond waveform).

5. Maximum DC clamping voltage at peak pulse current:

    a. 26 V peak.

6. Line-to-line secondary:

    a. Tertiary level protection for a nominal 12 VDC source.

G. Metal oxide varistors (MOV) for signal circuits to be as follows:

1. Provided with ring terminals.
2. Utilize lead insulation.
3. Designed and constructed for mounting on signal terminal blocks.

H. MOVs for signal circuits to meet or exceed the following:

1. Maximum continuous applied DC voltage:

    a. 30 VDC.

2. Maximum continuous applied ac voltage:

    a. 23 V rms.

3. 1 mA DC conduction voltage range:

    a. 32 to 40 VDC.

4. Peak current handling capacity:

    a. 2000 A (8 x 20 microsecond waveform).

5. Energy handling capacity:

    a. 160 J.

6. Typical capacitance:

    a. 12,000 pF.

7. Maximum clamping voltage:

    a. 63 V peak at a device current of 20 A.

I. Gas tube lightning arresters for data communication systems to be as follows:

1. Two (2) electrode screw-in type.
2. Rated heavy duty.
3. UL listed for use on terminal blocks provided under this Contract.
4. As per USDA RD Bulletin 345-83 (REA PE 80).

2.11 PADLOCKS AND KEYS

A. Switch locks.

1. Switch locks to be Adlake type switch locks.
2. Switch locks to be zinc plated steel locks with brass keys.
3. Switch locks to be:
    a. Adams & Westlake switch locks and keys.

B. Barrel locks:

1. Barrel locks to be Raco-type hexagon spanner locks complete with thirteen and one-half- (13-1/2) inch bronze chain and mounting hardware.

2.12 PAINT AND FINISH

A. Paint and finish to comply with applicable recommendations in AREMA C&S Manual 1.5.10, Recommended Instructions for Painting and Protective Coatings, where AREMA recommendations do not conflict with requirement of these Specifications.

2.13 RESISTORS

A. All resistors, other than those required for electronic circuits, to comply with AREMA Signal Manual Part 14.2.15.

2.14 SEALING COMPOUND

A. Sealing compound to comply with AREMA C&S Manual 15.2.15, Recommended Functional Guidelines for Cold Application Sealing Compound.

2.15 SIDE PROTECTION BOARDS

A. Side protection boards to be fiberglass square tube.

B. Side protection board dimensions to be two- (2) inches by eight- (8) inches.

C. Side protection boards to be:

1. Creative Pultrusions, Inc. Series 1525.
2. Approved equal.

D. Side protection board fastening hardware to be:

1. Stainless steel bolts, nuts, and washers.

   2. Galvanized lag screws.

E. Side protection board supports to be:

   1. One half- (1/2) inch by two- (2) inch galvanized steel bar, bent before galvanizing.

F. Side protection board support anchors to be:

   1. Epoxy type.

2.16 SIGNAL TERMINAL BINDING POSTS

A. Binding posts, other than those required for supervisory control circuits and control panels, to comply with AREMA C&S Manual 14.1.10, Recommended Criteria for Binding Posts.

2.17 SIGNAL TERMINAL BLOCKS

A. Signal terminal blocks to comply with applicable requirements of AREMA C&S Manual 14.1.5, Recommended Criteria for Molded Terminal Blocks, as determined by the Authority.

2.18 TRAIN CONTROL SIGNAGE

A. Train control signage to comply with applicable requirements of Section 34 10 14.

2.19 STAINLESS STEEL CLAMPS

A. Stainless steel clamps for clamping hose at each end to be:

   1. Worm-drive type
   2. Stainless steel.

2.20 TERMINAL POST INSULATORS

A. Terminal post insulators to be provided as a protective insulator for terminal posts having fifty (50) volts or more on the terminal and located on terminal boards in relay houses, relay rooms, relay cases, junction boxes, and/or wayside equipment:

B. Terminal post insulators to be an individual insulated sleeve and nut for each terminal post.

      a. This insulated nut is in addition to the double nut requirement.

C. Terminal post insulators to be fire resistant.

D. Terminal post insulator sleeves to be cut to fit around the protrusions of the solderless terminals.

2.21 TERMINALS FOR WIRES AND CABLES

A. Solder terminals.

   1. Solder terminals to comply with AREMA C&S Manual 10.4.1, Recommended Instructions for Wire and Cable Installation and Maintenance, and manufacturer's recommendations.

B. Solderless terminals.

        a. Solderless terminals to comply with AREMA C&S Manual 14.1.1, Recommended Design Criteria and Functional/Operating Guidelines for Solderless Crimp-Type Wire Terminals for Use in Wiring Signal Apparatus, unless otherwise specified.

    2. Solderless terminals to be crimp-on type, designed such that flexibility of conductor is not destroyed and possibility of breakage at terminal is reduced to a minimum.
    3. Solderless terminals to be insulated ring-type.

        a. The Contractor to be responsible for furnishing and installing solderless terminals that are compatible with the actual terminal stud sizes used.
        b. Solderless terminals to feature barrel insulation.
        c. Barrel insulation to be a stepped nylon material whose diameter increases to accommodate expanded conductor insulation.

            i. Conductor insulation to extend into the mouth of the terminal insulation.

    4. Solderless terminal barrel to include internal serrations.
    5. Solderless terminal palm to be of a thickness not less than nine thirty-seconds (9/32) of an inch.
    6. Samples of each type of solderless terminal to be submitted to the Authority for approval no less than thirty (30) days prior to bulk procurement/supply of any of solderless connector to be used as part of the Work.
    7. Solderless terminals to be:

        a. For stranded insulated wires 22-18 AWG:

            i. Panduit Heavy-Duty Ring Terminals, Nylon Insulated, P/N PN18-56HDR.
            ii. Approved equal.

        b. For stranded insulated wires 16-14 AWG:

            i. Panduit Heavy-Duty Ring Terminals, Nylon Insulated, P/N PN14-56HDR.
            ii. Approved equal.

        c. For stranded insulated wires 16-12 AWG:

            i. Panduit Heavy-Duty Ring Terminals, Nylon Insulated, P/N PN12-56HDRX.
            ii. Approved equal.

        d. For stranded Insulated wires 12-10 AWG:

            i. Panduit Heavy-Duty Ring Terminals, Nylon Insulated, P/N PN10-56HDRX.
            ii. Approved equal.

C. Solderless terminal compression tools.

    1. Solderless terminal compression tools to be manufactured by terminal manufacturer for the purpose of properly and permanently installing solderless terminals on appropriately-sized cable.
    2. Solderless terminal compression tools to be equipped with ratchet device that will not release until proper indentation of the solderless terminal is complete.

3. Two (2) solderless terminal compression tools to be provided to the Authority as part of the Work.

    a. Where more than one (1) type of solderless compression tool is required to terminate each type of solderless terminal used, two (2) of each required type of solderless terminal compression tool will be provided.

        i. Where a solderless compression tool uses different inserts or dies to service different solderless terminals, sets of dies may be provided alongside two (2) solderless compression tool bodies.

PART 3 - EXECUTION

3.01 TYPE INSTALLATION REQUIREMENTS

A. Conduit.

1. Conduit installed under ballast, outdoors, to be RTRC.
2. Conduit installed under track to be RTRC encased in reinforced concrete.
3. Conduit carrying 600 VDC positive and/or negative cables to be RTRC.
4. Conduit Installed in trackway to be RTRC.
5. Conduit installed between switch and lock movements and terminal cases to be FNMC.
6. Conduit cable entrances to be RTRC, 4” (minimum).

B. Padlocks and keys.

1. Switch and lock movements:

    a. Barrel locks to be provided for cast lids to circuit controller and main crank compartments, as well as any other compartment that is capable of being locked.
    b. Two (2) padlocks to be provided for each switch machine.
    c. One (1) padlock to be provided for each hand throw pedal stand.

2. Work ahead control boxes:

    a. One (1) Adlake type switch locks to be provided for each worker ahead control box.

3. Worker ahead signal and color light signal lamp compartments:

    a. One (1) barrel lock to be provided for each lamp compartment cover.

4. Train stop mechanisms:

    a. One (1) barrel lock to be provided for each train stop mechanism compartment cover.

5. Wayside junction boxes:

    a. One (1) barrel lock to be provided for each junction box three- (3) point door latch.

6. Relay Houses:

    a. One (1) Adlake type switch lock to be provided for the main door leading to the local control panel (LCP)/anteroom.
    b. One (1) barrel lock to be provided for each other door and access opening leading to portions of the relay houses that require access by signal maintenance personnel only, such as those in the rear of entrance racks or those that provide access to the signal system equipment.

  7. Relay cases:

    a. One (1) barrel lock to be provided for each three- (3) point door latch.

  8. Other signal apparatus containing hinged or removable doors:

    a. One (1) barrel lock to be provide barrel for each hinged or removable door, and latch.

C. Terminals for wire and cable.

  1. Solder terminals are permitted only where recommended by relay manufacturer for vital relay connections.
  2. Solderless terminals to be used where stranded wires terminate on terminal binding posts.
  3. Solderless compression connectors to be used where terminating heavy wire or signal power wire.

D. Surge protection.

  1. Where line circuits connect a tunnel location to a location outside the tunnel surge protection to be installed on the line circuits.

3.02 INSTALLATION

A. Materials, components, and products specified in this section to be installed in accordance with details of respective technical sections of these Specifications and in accordance with Contractor's approved installation drawings.

B. Flexible hose.

  1. Flexible hose to be clamped at both ends with stainless steel clamps.

    a. After tightening clamps, excess strap material to be cut off one-half- (1/2) inch from the worm drive housing.
    b. After cutting, strap material tail corners to be chamfered or "dog ear" the corners at one-eighth (1/8) of an inch.
    c. Clamps are not required for track wire risers.

C. Cable entrance.

  1. Each RTRC conduit to be provided complete with:

    a. One (1) holding device.
    b. One (1) bell end bushing.

  2. Each enclosure to be provided one (1) spare entrance conduit assembly.

3. Each cable entrance to be sealed with approved sealing compound.
4. Cables which are weatherized utilizing gels, grease compounds, or otherwise known to propagate flames to be housed in a metallic conduit to within three (3) inches of the final termination point.

    a. EMT or flexible conduits to be submitted for approval.
    b. Cables meeting these criteria to not have slack stored within the signal house/room.

        i. Fiber optic and telephone cables are included in this requirement.

D. Environmental protection.

1. Machined/finished surfaces, threaded rods, nuts, and other parts that are susceptible to rusting with to be protected with approved corrosion prevention compound.

3.03 INSTALLATION OF IDENTIFICATION

A. Wire and cable.

1. Wire and cable to be permanently identified at both ends of each cable, each cable wire, and each single wire that terminate in signal cases, junction boxes, signals, switch mechanisms, and control panels.
2. Each conductor to be rung out and identified before applying the identifying tag.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 38 – Miscellaneous Components and Products shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 38 – Miscellaneous Components and Products shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 40

EXTERNAL SIGNAL CABLE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installing single and multi-conductor insulated and jacketed wire and cable required for signal circuits and signal power system wiring external to wayside relay houses, relay rooms, cases, junction boxes, wayside signal appliances, impedance bonds, and buildings.
2. Types of cable include signal and power cable / train detection and annunciator cable that is:

    i. Suited for direct burial in duct banks in ballasted track.
    ii. Suited for applications along barrier walls or on the elevated structure (UV-protected).
    iii. Suited for duct bank and aerial applications in tunnels and subways (low-smoke, low-toxicity, zero-halogen).

B. Related sections:

1. 34 42 38 Miscellaneous Components and Products.
2. 34 42 62 Junction Boxes.
3. 34 42 91 Signal System Tests.

1.02 REFERENCES

A. Reference Standards

1. Section incorporates by reference the latest revisions of the following documents (unless otherwise noted), or if standard is adopted by the Authority Having Jurisdiction, the latest revision adopted:

    a. American Railway Engineering and Maintenance-of-Way Association (AREMA).

        i. AREMA Communications & Signals Manual of Recommended Practices (C&S Manual).

    b. ASTM International (ASTM):

        i. ASTM B3, Standard Specification for Soft or Annealed Copper Wire.
        ii. ASTM B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
        iii. ASTM B33, Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
        iv. ASTM D257, Standard Test Methods for DC Resistance or Conductance of Insulating Materials.
        v. ASTM D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.
        vi. ASTM D470 - 05 Standard Test Methods for Crosslinked Insulations and Jackets for Wire and Cable.

        - vii. ASTM D471, Standard Test Method for Rubber Property—Effect of Liquids.
        - viii. ASTM D573, Standard Test Method for Rubber—Deterioration in an Air Oven.
        - ix. ASTM D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
        - x. ASTM D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
        - xi. ASTM D2240, Standard Test Method for Rubber Property – Durometer Hardness.
        - xii. ASTM D2863, Standard Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index).
        - xiii. ASTM E662, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.

    - c. Code of Federal Regulations (CFR):

        - i. 10 CFR Part 50, Domestic Licensing of Production and Utilization.

    - d. Institute of Electrical and Electronics Engineers (IEEE):

        - i. IEEE 383, Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations.

    - e. Insulated Cable Engineer’s Association, Inc. (ICEA):

        - i. ICEA S-19-81/NEMA WC3, Rubber-Insulated Wire and Cable.
        - ii. ICEA S-56-434, Polyolefin Insulated Communication Cables for Outdoor Use.
        - iii. ICEA S-68-516, Standard Test Method for Chlorinated Polyethylene Jacket.
        - iv. ICEA S-95-658/NEMA WC70, Nonshielded 0-2kV Cables.

    - f. Military Standards (MIL):

        - i. MIL-DTL-24643, Detail Specification: Cables, Electric, Low Smoke Halogen-Free, for Shipboard Use General Specification for.

    - g. Ministry of Defense, (UK) Naval Engineering Standards (NES):

        - i. NES 711, Determination of the Smoke Index of the Products of Combustion from Small Specimens of Materials.
        - ii. NES 713, Determination of the Toxicity Index of the Products of Combustion from Small Specimens of Materials.

    - h. National Fire Protection Association (NFPA):

        - i. NFPA 70, National Electrical Code

1.03 QUALITY ASSURANCE

A. Qualifications:

1. Cable manufacturers supplying cable for this Contract must be qualified by the Authority prior to the manufacture of cable.
2. Cable manufacturer qualifications to be based on the following past performance criteria:

a. Past performance and experience:

    i. Cable manufacturer to have a minimum fifteen (15) years reliable experience on circuit signal cables of the type being provided that is described by these Specifications.
    ii. Cable manufacturer to have at least five (5) Class 1 railroads or rapid transit properties where similar cable from the manufacturer has been installed and is in service.
    iii. Cable manufacturer to have a minimum 2 million cable-feet installed.
    iv. Cable manufacturer to demonstrate previous successful experience supplying cable to railway or transit industry for signal control.

b. Quality assurance program:

    i. Cable manufacturer to demonstrate compliance with an ISO 9001 quality assurance program that ensures a thoroughly tested cable with long service life.
    ii. Cable manufacturer quality assurance program to focus on formal assurance that cable failure cannot be attributed to actions or lack of actions by manufacturer.
    iii. Cable manufacturer quality assurance program to demonstrate compliance with requirements of this Specification for each specified cable type proposed.
    iv. Cable manufacturer quality assurance program to incorporate performance of demonstration tests required by the Authority.

c. Traceability:

    i. Each finished wire and cable to be traceable to the test data on file for each step in its manufacturing process.
    ii. Cable manufacturer to formulate, prepare, and apply conductor insulating materials and cable outer coverings in its own facility/facilities.

        a. Where a cable manufacturer does not normally prepare insulating materials in its own facility/facilities, it is acceptable for manufacturer to have its proprietary formulations compounded at another non-owned facility.
        b. Where an outside facility is used, submit a notarized copy of attached quality assurance program form completed by the outside facility prior to award of contract.

            i. Non-owned facilities to be subject to the same quality assurance procedures and systems the manufacturer uses in its own facilities.
            ii. Non-owned facilities to be subject to audit by the Authority under the requirements of 10 CFR Part 50, Appendix B.

    iii. Cable manufacturer to perform conductor insulating, cable assembly, and testing in its own facility/facilities.

d. Quality assurance plan:

    i. Quality assurance plan to include procedures for implementing all requirements of these Specifications.
    ii. Quality assurance plan to cover all stages of manufacture, including the following:

        a. Receipt of incoming materials.
        b. Assembly.
        c. Calibration of test equipment.

        d. Final test.
        e. Shipment.

    iii. Quality assurance plan to provide for written documentation of tests and inspections made under the plan.

        a. Such documentation to be made available at the cable manufacturer's facility/facilities for inspection by the Authority.

    iv. Revisions to the quality assurance plan to be submitted to the Authority for approval.

        a. Provide data required for evaluation by the Authority and make arrangements for demonstrations and tests, if requested.

3. Annual audits:

    a. Cable manufacturer to satisfactorily pass the annual audits conducted as called for in 10 CFR Part 50 and AAR-M-1003.

1.04 SUBMITTALS

A. Submit the following for review by the Authority:

1. Before ordering, fabricating, or assembling cable, submit the following product data:

    a. Full technical data for each type of cable proposed.
    b. Certification that each cable supplied complies with the requirements of these Specifications.
    c. Cable lubricant.
    d. Weatherproof coating.

2. Past performance experience:

    a. Provide data as required by this Specification for the Authority’s CTA evaluation.

3. Quality assurance program:

    a. Quality Assurance Program and Provide data as required by this Specification for the Authority’s evaluation.

4. Quality assurance plan:

    a. Provide Quality Assurance Plan and data required by this Specification for the Authority’s evaluation.

5. Samples:

    a. If requested by the Authority, submit samples of each cable type cable proposed.

        i. Samples to be equal to the proposed cable in construction, assembly and material.
        ii. Samples to be four (4) feet in length.
        iii. Samples to be complete with specified identification.

        - b. Requested samples to be delivered prior to cable submittal.
        - c. Samples will remain the property of the Authority.

- B. Prior to shipment of cable, submit the following for review by the Authority:
    - 1. Certified Factory Test Reports, including the following:
        - a. Report number.
        - b. Date and location of test.
        - c. Description of test and test conditions, including:
            - i. Complete cable and/or wire description.
            - ii. Lot, batch, and reel identification number.
            - iii. Quantitative test results.
            - iv. Summary/disposition of test results.
            - v. Information on components of cable tested including:
                - a. Batch numbers.
                - b. Physical properties.
                - c. Electrical properties.
            - vi. Completed, signed, and notarized standard Wire and Cable Test Report Sheet as part of each cable test report.
    - 2. Test reports for all demonstration tests required by the Authority.
- C. Prior to installation, submit the following:
    - 1. Shop Drawings:
        - a. Proposed temporary aerial cable attachment details.
    - 2. Installation Plans:
        - a. Detailed plans of each cable raceway installation showing hardware to be used.
        - b. Methods of attachment.
        - c. Cable routing through junctions.
    - 3. Field installation inspection and test procedure.
    - 4. Calculations:
        - a. Structural.
        - b. Messenger loading of cable used.
        - c. Manufacturer-recommended maximum pulling tensions for each cable type.
        - d. Cable pulling tensions for each individual cable pull.
- D. Following installation, submit the following for review by the Authority:
    - 1. Cable pull report showing measured pulling tensions for each cable pull.
    - 2. Field Installation Inspection and Test Reports.

1.05 DELIVERY, STORAGE AND HANDLING

A. Protection:

   1. After passing factory tests, effectively seal cable against the entrance of moisture.
   2. Protect both ends of each length of cable by wrappings of rubber tape and plastic tape, an effective boot taped or sealed into place, or other suitable means approved by the Authority.

      a. Friction tape to not be used, except as an external mechanical protection over an adequate rubber or plastic tape.

   3. Cable end protection to be adequate to protect the cable in shipment and prolonged external storage in the weather if not immediately employed, regardless of the position of the reel.

B. Cable to be shipped on reels:

   1. Each length of cable to be wound on a separate reel.
   2. Cable to be closely and tightly wound, in a uniform manner.
   3. Inner end of the cable to be secured and accessible but protected from injury.
   4. If the inner end of the cable projects through the flange of the reel, the inner end to be protected by a suitable cover of metal having rounded ends and sides and securely fastened in place to protect the cable end.
   5. Secure in place both ends of cable on reel, to prevent cable from becoming loose in transit or handling of reel.
   6. Protect cable from damage in shipment by heavy wrapping or wood lagging. The external protective wrapping on reels to be secured by at least two steel bands to ensure damage free shipment.

C. Reels:

   1. Reels to be substantial to withstand handling.
   2. The diameter of the reel drum to be at least fourteen (14) times the cable diameter to prevent damage to the cable during reeling.
   3. The maximum width of reel to not exceed forty-eight (48) inches unless otherwise specified.
   4. The arbor hole to admit a spindle two and one half (2-1/2) inches in diameter without binding.
   5. The reels to be designated and constructed as non-returnable when drum size and cable weight and volume permit.
   6. An arrow to be painted on one head of each reel pointing the opposite direction from the outer end of the cable with the words "Roll This Way" in letters not less than three-quarters (3/4) of an inch high and an arrow not less than six (6) inches long and one half (1/2) inch wide.

D. Identification:

   1. Each reel to contain a weatherproof tag, firmly attached to the reel, showing the following:

      a. Size of conductor.
      b. Type of conductor.
      c. Number of feet.
      d. Gross weight.
      e. Type of jacketing.
      f. Name of manufacturer.
      g. Date of manufacture.
      h. Other necessary information.

E. Contractor to be responsible for a change in the shape of the cable occurring in normal shipping that results in an increase in the maximum diameter beyond that specified.

1.06 WARRANTY - CABLE

A. Contractor to certify compliance with the following warranty before selection of the cable manufacturer:

1. Manufacturer warrants that design, material, and workmanship incorporated into cable to be of the highest grade and consistent with established standards for aerial and underground cable for railroad signal, power circuit, train detection and annunciator applications.
2. Manufacturer warrants that each item and component complies with this Specification.

B. Contractor to provide warranty from cable manufacturer that cable provided is free from defects in material and workmanship and agrees to replace cable that is unsuitable for operation or fails in operation during normal and proper use.

1. Warranty for signal and power cable to be for a period of forty (40) years from date of acceptance of cable, and to apply whether the defect is patent or latent.
2. Warranty for train detection and annunciator cable to be for a period of three (3) years from date of acceptance of cable, and to apply whether the defect is patent or latent.

C. The warranty covering any length of cable that to be replaced by the Manufacturer to be replaced for a period of forty years effective as of the day said replacement is effective.

D. These warranties are in addition to and do not limit other warranties or other requirements in the Contract or law.

PART 2 - PRODUCTS

2.01 GENERAL CABLE REQUIREMENTS

A. Types of cable includes:

1. Direct burial – for underground applications in ductbank or in ballasted track.
2. Aerial cable on elevated track structures or on pole line. (UV protected)

B. Cables to be suitable for use in environment to be encountered on a transit signal system.

C. Insulation to cross or ground: Minimum 1 Mega-ohm.

2.02 CABLE APPLICATION

A. Application of cable includes:

1. Main cables.
    a. Cables (express) that run between relay houses/rooms, cases, junction boxes, and buildings, or those cables containing conductors for more than one system function.
2. Local distribution cables.

        a. Cables that run between a housing or junction box and an individual unit of equipment.

    3. Audio frequency train detection cables.

        a. Single twisted pair (local) and multiple twisted pair (express) cables that are used for the detection of trains, the transmission of cab signals or other signal related circuits.

    4. Annunciator / supervisory cables.

        a. Multiple twisted pair (express) cables that run between relay houses/rooms and communication rooms/houses or stations used to transmit train operations statuses and information such as next train arrival PA triggering, bus holding light control, etc..

B. Cable sizing and use:

    1. The Contractor to be responsible for sizing all conductors and cable makeup if greater than specified due to application of this design.

        a. Increase in conductor size to be approved by the Authority and to have no effect on the value of the Project.

    2. Multi-conductor main (express) cable for audio track circuits, annunciators and supervisory.

        a. These are main (express) cables, comprised of twisted pairs, provided along the right-of-way between relay houses/rooms, and terminating in each track circuit junction box.
        b. The number of conductors to be determined by the Contractor, and to meet the following:

            i. Cables to be one (1) size, with the same number of conductors in each segment between relay houses/rooms.

                a. Different sized cable for each segment are not permitted.

            ii. Twenty percent (20%) minimum spare conductor pairs to be provided in each segment for each track.
            iii. Cable to not have less than twelve (12) pairs.

        c. Based on the requirements of Section 2.02B.2.b, the Contractor to:

            i. Determine the number of working pairs required in each section and for each track between relay houses/rooms.
            ii. Determine the maximum of these values.
            iii. Multiply the maximum by two (2) to determine the minimum number of spares to be provided for audio train detection and supervisory express cable for the entire length of the project.

    3. Main (express) cable for line circuits.

        a. These are main (express) cables provided along the right-of-way between relay houses/rooms for line circuits.
        b. These cables to be terminated in track circuit junction boxes along the express run at an interval no greater than 1500 feet.
        c. The number of conductors to be determined by the Contractor, and to meet the following:

        i. Cables to be one (1) size, with the same number of conductors in each segment between relay houses/rooms.

            a. Different sized cable for each segment are not permitted.

        ii. Twenty percent (20%) minimum spare conductor pairs to be provided in each segment.
        iii. The cable size to be a standard signal cable size of nineteen (19), twenty-one (21), twenty-seven (27), or thirty-seven (37) conductor cable.

            a. Use of cable with fewer than nineteen (19) conductors will not be allowed.

    d. Based on the requirements of 2.02B.3.c, the Contractor to:

        i. Determine the number of working conductor pairs required in each section and for each track between relay houses/rooms.
        ii. Determine the maximum of these values.
        iii. Multiply the maximum by two (2) to determine the minimum number of spares and round up to nineteen (19), twenty-one (21), twenty-seven (27), or thirty-seven (37) to determine the number of conductors to be provided for line circuit cable for the entire length of the project.

            a. Where the required number of conductors exceeds thirty-seven (37), multiple cables to be provided.

4. Main (express) cable for traffic line circuits.

    a. These are main (express) cables provided along the right-of-way between relay houses/rooms for line circuits.
    b. These cables to be terminated in track circuit junction boxes along the express run at an interval no greater than 1500 feet.
    c. The minimum cable provided to be:

        i. Twelve (12) conductor No. 9 AWG, or larger as required, for two (2) tracks.

            a. No. 9 AWG used to prevent voltage drop from inhibiting operation.

    d. The Authority’s standard traffic circuitry design requires ten (10) working conductors with two (2) spare conductors.

        i. If the Contractor’s design differs in the number of conductors, the two (2) multiplier as used for above spare cable requirements to be used.

5. AF track circuit connection cable:

    a. Cables provided for installation between track circuit junction box and impedance bond or tuning unit if one is required, to be a single twisted pair No. 14 AWG.

6. AC track circuit connections:

    a. Cables provided for installation between relay houses/rooms and the rails to be two (2) separate twisted single No. 9 AWG conductors.

        i. The two conductors to be twisted at a rate of one (1) turn per foot.

7. AF loop connections:

    a. Cables provided for installation between relay houses/rooms and the loop junction boxes to be a single twisted pair No. 14 AWG.

        i. The cable for loops to be a single No. 9 AWG transposed every fifty (50) feet or less with a minimum of one (1) transposition per loop.

8. Color light signal cable:

    a. Cables provided for installation between relay houses/rooms and color light signals to be a twelve (12) conductor No. 14 AWG.

9. Electric train stop cable:

    a. Cables provided for installation between relay houses/rooms and electric train stops to be a twelve (12) conductor No. 14 AWG.

10. Route selector cable:

    a. Cables provided for installation between relay houses/rooms and route selectors to be a twelve (12) conductor No. 14 AWG.

11. Electric switch-and-lock movements:

    a. Cables provided for installation between relay houses/rooms and the switch junction boxes to consist of a five (5) conductor No. 9 AWG, and a twelve (12) conductor No. 14 AWG composite cable that includes both may be submitted to the Authority for consideration.

        i. The Contractor to perform voltage drop calculations for the No. 9 AWG conductors, and to provide larger conductors if required.

12. Electric Switch Light:

    a. Cables provided for installation between relay houses/rooms and electric switch lights to be a two (2) conductor No. 9 AWG.

13. Electric locks and circuit controllers:

    a. Cables provided for installation between relay houses/rooms and junction boxes to be a seven (7) conductor No. 14 AWG.

14. Worker Ahead signals:

    a. Cables provided for installation between relay houses/rooms and Worker Ahead junction boxes or control boxes to be a twelve (12) conductor No. 14 AWG.
    b. The signal lighting cables provided for installation between the Worker Ahead control boxes and the signals to be a three (3) conductor No. 14 AWG.

15. Snow melter control cases:

   a. Cables provided for installation between the relay houses/rooms and snow melter control cases to be a seven (7) conductor No. 14 AWG.

16. Snow melter power tap:

   a. Cables provided for installation between the contact rails and the snow melter control cases to be a one (1) conductor No. 6 AWG, rated for 1000 volts DC.

17. Snow melter elements:

   a. Cables provided for installation between the snow melter control case and the positive end of each heating element to be a one (1) conductor No. 9 AWG cable rated at 1000 volts DC.
   b. Cable provided for installation from the negative end of the element to the negative running rail or impedance bond neutral to be a one (1) conductor No. 9 AWG cable with both ends rated at 1000 volts DC.

18. Automatic Vehicle Identification (AVI):

   a. Cable provided for installation between the AVI RFID readers back to the signal house/room to be a four (4) twisted pair No. 20 AWG plus one (1) No. 22 AWG conductor shielded cable.

19. Ground wire:

   a. Ground wires case/house/room grounding to be No. 6 AWG stranded copper with green ethylene propylene rubber (EPR) insulation.
   b. Wayside equipment grounding wire to be single conductor No. 6 AWG stranded bare copper.
   c. Grounding wires for bonding equipment to the structure to be single conductor No. 6 AWG stranded bare copper.

20. Source signal power distribution:

   a. The cables provided for installation between the commercial utility source(s) and the relay houses/rooms to provide the 120/240-volt single-phase signal power distribution to be three (3) single conductor, stranded copper cables with a conductor size determined by the Contractor, insulated in accordance with ICEA Standard Publication S-19-81.
   b. The cables provided for installation between the traction power inverter and the contact rail/impedance bond to be two (2) single conductor, stranded copper, No. 4/0 AWG insulated cables.
   c. The Contractor to perform voltage drop calculations on all above cables, and to provide larger conductors if required.
   d. All above cables to be rated for 1000 volts DC.

21. Annunciator / bus holding cables:

   a. Cables provided for installation between signal houses/rooms and communication houses and station platform rooms to be six (6) pair, No. 18 AWG.

C. Local and express cable plans are shown on Contract Drawings.

2.03 SIGNAL CABLE – DIRECT BURIAL / IN DUCT AND AERIAL ON ELEVATED SATRUCTURES

A. Conductor:

1. Soft or annealed copper, tinned or lead alloy coated, conforming to ASTM B33 or ASTM B189 respectively.
2. Stranded in accordance with ASTM B8.
    a. Seven- (7) or nineteen- (19) strand, unless otherwise specified or indicated.
3. DC resistance conforming to ICEA S-95-658/NEMA WC70.

B. Insulation:

1. Material:
    a. EPR compound meeting the following dimensional, electrical, and physical properties:
        i. At a minimum, physical and electrical performance requirements of AREMA C&S Manual Part 3.19, Recommended Design Criteria for Ethylene Propylene Rubber Insulation for Wire and Cable.
        ii. In accordance with Table 8 and Table 9, where these requirements exceed requirements of AREMA C&S Manual Part 3.19.
2. Apply conductor insulation directly to surface of conductor such that it adheres tightly but is free stripping so as to leave conductor clean.
3. Installation Temperature Rating:
    a. -40^{O}C (-40^{O}F) with no cracking.
4. Rating:
    a. 1000 V continuous operation at 75^{O}C (167 ^{O}F) in wet or dry locations.

C. Individual Conductors of Multi-Conductor Signal Cable:

1. Insulation thickness:
    a. Direct burial or in ducts:
        i. In accordance with Table 3, AREMA Class A.
    b. Above grade or aerial:
        i. In accordance with Table 3, AREMA Class B.
2. Identification:
    a. a. Uniquely identify each individual conductor with numbers:
        i. Print directly on conductor insulation.

        ii. Write number and spell out numbers, starting with "1-one" and continuing in sequence, without repetition, until all conductors are identified (i.e. 1-one, 2-two, 3-three, etc.).

    b. Color:

        i. Dark brown or black insulated wire to have identification printed in white ink.
        ii. Orange insulated wire to have identification printed in black ink.
        iii. Light red insulated wire to have identification printed in black Ink.

    c. Configuration:

        i. Print identification in two (2) parallel lines 180 degrees apart, with one (1) line reversed in direction relative to the other.

    d. Spacing:

        i. Repeat a minimum of every six (6) inches for entire length of cable.

D. Multi-Conductor Cable Assembly – Direct Burial / In Duct

1. Cabling:

    a. Multi-conductor cable to use individual conductors meeting the requirements of this Specification.
    b. Multi-conductor cable to be constructed with helical windings of individual conductors, with adjacent layers wound in opposite directions.

2. Fillers:

    a. Where necessary with cabled conductors to assemble cable into a tight cylindrical core, fillers to be flame and moisture resistant.

3. Cushion layer:

    a. Cushion layer to be moisture resistant, shock-absorbing, cushioning tape or elastomeric material that covers the cable core.

        i. Cushioning tape:

            a. Compound filled, compatible with conductor insulation.
            b. Applied helically to a 10-mil minimum thickness, with a minimum five percent (5%) overlap.

        ii. Elastomeric material thickness:

            a. In accordance with Table 4.

4. Outer jacket:

    a. Outer jacket to be black, extruded, low density, high molecular weight, polyethylene meeting ASTM D 1248, material Type I, Class C, Grade E5.
    b. Thickness:

        i. In accordance with Table 5.

    c. Physical characteristics:

        i. In accordance with Table 10.

E. Multi-Conductor Cable Assembly – Aerial on Elevated Structures

1. Cabling:

    a. Multi-conductor cable to use individual conductors meeting the requirements of this Specification.
    b. Multi-conductor cable to be constructed with helical windings of individual conductors, with adjacent layers wound in opposite directions.

2. Fillers:

    a. Where necessary with cabled conductors to assemble cable into a tight cylindrical core, fillers to be flame and moisture resistant.

3. Tape covering:

    a. Tape covering to be moisture resistant and to provide complete overall coverage.

4. Outer jacket:

    a. Chlorinated polyethylene (CPE), conforming at a minimum to requirements of AREMA C&S Manual Part 3.20, Recommended Design Criteria for Chlorinated Polyethylene Jacketing for Wire and Cable.
    b. Thickness:

        i. In accordance with Table 6.

    c. Physical characteristics:

        i. In accordance with Table 11, where these requirements exceed requirements of AREMA C&S Manual Part 3.20.

F. Single Conductor Cable – Direct Burial / In Duct

1. Insulation thickness:

    a. In accordance with Table 7.

2. Outer jacket:

    a. Same requirements as for multi-conductor cable assembly for underground direct burial and duct cables.

G. Identification – Multi-conductor Cable and Single Conductor Cable:

1. Permanently identify each length of cable:

    a. Multi-conductor cable:

        i. Moisture resistant marker tape under jacket, parallel to longitudinal axis of cable, with bold, easily read, permanent characters; or
        ii. Information indelibly embossed or printed on jacket.

    b. Single-conductor cable:

        i. Information indelibly embossed or printed on jacket.

    c. Required information:

        i. Name of manufacturer.
        ii. Year manufactured.
        iii. Size and type of cable (i.e. 27c#14, 12c#14, etc.)
        iv. Relative footage marker number incremented based on the interval of spacing of identification marks such that the difference between two (2) footage markers to be able to be used to accurately calculate length of cable segment.

    d. Spacing:

        i. Minimum every three (3) feet.

2.04 MULTI-TWISTED PAIR SIGNAL AUDIO FREQUENCY TRAIN DETECTION

A. General Requirements:

1. Train Detection, annunciator and supervisory control cables intended for installation in ducts, open air, or buried in earth to be rated to withstand a maximum rated circuit voltage of 1000 volts DC and to be rated for 75^{O}C (167 ^{O}F) continuous.
2. All pairs to be guaranteed for end-to-end continuity and to be free of such manufacturing defects as short circuits, crosses, or opens.

B. Material Requirements:

1. Where characteristics are not specifically defined by the following, the ICEA S-1.56-434 and ICEA S-95-658/NEMA WC70 to apply and govern.
2. Conductors:

    a. Soft, annealed copper, No. 14 AWG.
    b. Seven- (7) strand, stranded in accordance with ASTM B8.
    c. Meet ASTM B3 requirements for elongation and resistivity before insulating.

C. Conductor Insulation:

1. Polyethylene (PE)-Polyvinyl Chloride (PVC).

    a. Each conductor will have a duplex type of covering with the first layer over the copper being PE and the exterior layer or jacket being PVC.
    b. The overall thickness of the combination to be not less than thirty (30) mils.
    c. The nominal polyethylene thickness to not be less than twenty (20) mils.
    d. And the PVC covering to be nominally not less than ten (10) mils.

2. PE insulation to be in accordance with AREMA C&S Manual Part 3.16.E, Type III for polyethylene insulated conductors.
3. PE insulation to comply with or exceed the applicable requirements of the latest revision of ASTM D1351.
4. PVC insulation to be in accordance with AREMA C&S Manual Part 2.23.
5. PVC insulation to be colored and to comply with Paragraph 7 and/or 8 of IPCEA-NEMA Standards Publication Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy (ICEA Pub. No. S-61-402; NEMA Pub. No. WC5).

D. Pairs

1. Two (2) conductors are assembled with a random length twist to form a twisted pair.
2. Pairs to be formed from consecutively numbered odd then even conductors.

E. Identification of cable pairs/conductors:

1. Each pair to consist of one (1) black conductor and one (1) white conductor.
2. Black conductors to use white ink for numbering.
3. White conductors to use black ink for numbering.
4. Black conductors to have odd numbers, identified as “1-ONE”, “3-THREE”, “5-FIVE”, etc.
5. The matching pair for each black conductor to be a white conductor stamped with the next even number: “2-TWO”, “4-FOUR”, “6-SIX”, etc.
6. Alternate identification of conductors to be as follows, subject to approval:

    a. Each pair to consist of one (1) solid-color conductor and one (1) white conductor with a color tracer stripe that matches the color of the solid-color paired conductor
    b. Colors to not be duplicated amongst the pairs in the cable.
    c. The colors to be in sequence and comply with ICEA Method 5, which shows colors and tracer colors.

F. Cylindrical core:

1. Conductors to be twisted into pairs and arranged in layers to in accordance with ICEA S-56-434, Section II-9.
2. The core to be completely covered with one or more layers of moisture-resistant material to provide separation between the core and inner jacket.

G. Outer jacket:

1. Jacket (sheath) to be in accordance with AREMA C&S Manual Part 3.16.G, Type II for polyethylene jackets.
2. Outer jacket to provide protection against mechanical damage and entrance of moisture, earth acids, and alkalis into cable.
3. Outer jacket to conform to Table 2.

    a. Outer jacket to not adhere to the color requirements of insulated conductors of multiple-conductor cables.

4. Outer jacket to be applied by continuous tube method, without joints.
5. Outer jacket average thickness of sheath compound for multi-conductor cables to be not less than values specified in Table 1.
6. Average mutual capacitance of all pairs in a reel:

   a. Maximum 0.083mF per mile in accordance with ICEA S-56-434 Section II-20.

7. Output-to-output, far end crosstalk loss:

   a. Comply with ICEA S-56-434 Section II-14.20.

8. Provide name of manufacturer and year manufactured in bold, easily read, permanent characters. This information may be embossed on the jacket or imprinted on a tape inserted within the cable.

2.05 BUS HOLDING AND TRAIN ARRIVAL ANNUCIATOR CABLE 05

A. General Requirements:

1. Cable to be No. 18 AWG, six- (6) pair, seven- (7) strand bare copper with polyvinylchloride and nylon insulation, unshielded with an overall PVC jacket, 600V control tray cable, approved for use in sunlight-resistant direct-burial and oil-resistant 90^{O}C (194^{O}F) applications.
2. All pairs to be guaranteed for end-to-end continuity and to be free of such manufacturing defects as short circuits, crosses, or opens.

B. Material Requirements:

1. Conductor:

   a. No. 18 AWG, seven- (7) strand, Class B.
   b. Annealed bare copper.
   c. Pair count to be six (6) pairs.

2. Insulation:

   a. Material to be PVC and nylon.
   b. Wall thickness to be 0.015” PVC and 0.005” nylon.
   c. Color code to be black and white numbered pairs.

3. Assembly:

   a. Pair/cable lay length to be per UL Standard 1277.

4. Jacket:

   a. Material to be PVC.
   b. Wall thickness to be 0.060” minimum.
   c. Diameter to be 0.545” minimum.
   d. Color to be black.
   e. Ripcord to be provided.
   f. Cold bending rating to be -40^{O}C (-40^{O}F).

5. Markings:

   a. Cable to be permanently identified via surface inkjet print.
   b. Required information:

        i. Manufacturer name.
        ii. Cable identification part number.
        iii. Lot number.
        iv. Standard manufacturer cable properties identifications for type and all ratings.

    c. Provide footage markers.

6. Standards:

    a. Cable to be suitable for use in Class I Division II hazardous locations.
    b. UL Listing to be Type TC-ER per UL Standard 1277 for tray cables.
    c. UL-approved for direct burial (DIR BUR), sunlight (SUN) and oil (OIL) resistant applications.
    d. Flame test for individual conductors pass UL VW-1, rated THHN/THWN/VW-1.
    e. Meet UL 1581 and 1202 (FT-4) 70,000 BTU/HR and ICEA T-29-520 210,000 BTU/HR requirements
    f. Meet ICEA S-73-532, where applicable.
    g. Refer to NEC (NFPA 70) for supplemental installation guidelines.

7. All materials used in manufacture of this cable are RoHS compliant.

2.06 MESSENGER CABLE SUPPORT

A. Messenger Materials:

1. High-tensile strength, seven- (7) strand, copper clad, thirty percent (30%) HS-7W messenger.
2. Size:

    a. Determine diameter of messenger required for proposed cables.
    b. Five-sixteenths (5/16) of an inch minimum diameter.

3. Messenger brackets and hardware to be galvanized.
4. Suspension clamps to be galvanized steel, three- (3) bolt type.
5. Messenger hangers to be galvanized steel.
6. Pole line hardware and messenger brackets for concrete pole line to be galvanized steel.
7. Acceptable manufacturers/products.

    a. Suspension clamps:

        i. Maclean Power Systems J-931.
        ii. Approved equal.

    b. Messenger hangers:

        i. Maclean Senior Industries J1070.
        ii. Approved equal.

    c. Cable straps for cables:

        i. Thomas & Betts TY54407X.
        ii. Approved equal.

        d. J-hooks for cables with integrated messengers:

            i. Maclean Power Systems J-2235.
            ii. Approved equal.

        e. Automatic guy splices:

            i. Hubbel Power Systems GLS500x or GLS504x-series (EHS).
            ii. Approved equal.

B. Messenger Design:

    1. Provide structural calculations completed by a Structural Engineer licensed in the state of Illinois for support system components and messenger loading.
    2. Base loadings upon a heavy loading district per the National Electrical Safety Code.

2.07 MISCELLANEOUS PRODUCTS

A. Wire and Cable Tags:

    1. See Section 34 42 38, Miscellaneous Components and Products.

B. Sealing Compound:

    1. See Section 34 42 38, Miscellaneous Components and Products.

C. Cable Lubricant:

    1. Glycerized liquid or other approved lubricant, non-injurious to cable insulation, as recommended by manufacturer.

D. Weatherproof Coating:

    1. 3M™ Scotchkote™ Electrical Coating.
    2. Approved equal.

2.08 SOURCE AND QUALITY CONTROL

A. Testing Notification:

    1. Notify the Authority in writing a minimum of thirty (30) days in advance of final testing, so that the Authority may witness tests if it so elects.

B. Contractor Inspection:

    1. Monitor wire and cable manufacturer to ensure that approved Quality Assurance Program is closely followed by cable manufacturer and that wire and cable is manufactured in accordance with this Specification and approved submittals.

C. Authority Inspection and Testing:

1. The Authority or its authorized representative to have the right to make such inspection and tests as necessary to determine if cable meets requirements of this Specification.
2. The Authority to have the right to reject cable that it deems to be defective or not meet the Specifications.

D. Design Tests:

1. Test insulated conductors to demonstrate that they meet the following requirements:

    a. At a minimum, signal cable for use above ground or underground, and aerial conductors to meet physical and electrical performance requirements of AREMA C&S Manual Part 3.19, Recommended Design Criteria for Ethylene Propylene Rubber Insulation for Wire and Cable.
    b. Conductors to be in accordance with Table 8 and Table 9 where these requirements exceed requirements of AREMA C&S Manual, Part 3.19.
    c. Jacket material to be in accordance with Table 9 or Table 10, depending on jacket type.
    d. List actual values of the tests performed.

E. Production Tests:

1. Physical Tests:

    a. Select samples at random at place of production.
    b. Take each test sample from accessible end of different reels.
    c. Identify each reel selected and corresponding sample.
    d. Number and lengths of samples to be as specified under individual tests.
    e. Perform all applicable tests for cable materials and cable construction specified.

2. Manufacturer to provide, at the point of production, apparatus, and labor for making any or all of the following tests under supervision of the Authority’s inspector:

    a. Conductor size and physical characteristics.
    b. Insulation HV and IR tests.
    c. Physical dimension tests.
    d. Special tests on materials in coverings.
    e. Final HV, IR, and conductor resistance tests on shipping reels.

3. Single conductor tests:

    a. Dry "spark" test:

        i. Pass single insulated conductors through high voltage test electrodes energized with a minimum of 10 kV, 60Hz, AC to insure detection of damage to conductor insulation.

    b. AC test (wet tank):

        i. Before assembly into cable, randomly wind each insulated conductor on reels, submerge in water for minimum twenty-four (24) hours.
        ii. Subject to five (5) minutes of 60Hz AC test voltage, in accordance with Table 3.

    c. Insulation resistance tests:

    i. Perform test immediately after AC test, while conductor is still submerged.
    ii. Perform on each length of conductor.
    iii. The insulation on resistance constant, "K", in the following formula, when corrected to 6^{O}C (60^{O}F), to not be less than 35,000 megohms per 1000 feet.

        a. $R = K\log 10(\frac{D}{d})$, where:

            i. R = Insulation resistance in megohms per 1000 feet at 6 degrees C (60 degrees F)
            ii. K = 35,000 megohms constant, 1000-foot unit
            iii. D = Diameter over conductor insulation.
            iv. d = Diameter under conductor insulation.

d. DC test:

    i. Perform test immediately after insulation resistance test, while conductor is still submerged.
    ii. Subject each coil or reel length of insulated conductor to DC test voltage in accordance with Table 3, for 10 minutes.
    iii. Conductor to withstand test.

4. Assembled cable tests:

    a. Dry "spark" test:

        i. During process of cabling, and before applying overall coverings, pass cable through high voltage test electrodes energized with a minimum of 10 kV, 60Hzm AC to insure detection of damage to conductor insulation.

5. Finished cable tests:

    a. Signal cable for use above ground or underground, and aerial conductors:

        i. Conductor resistance test:

            a. Verify cable conforms to ICEA S-95-658/NEMA WC70.

        ii. Insulation resistance test:

            a. Perform using the 60 Hz AC test voltage or DC test voltage in accordance with Table 3.
            b. Test from conductors to ground obtained by water immersion of non-metallic shielded cables and between each conductor and every other conductor with which it comes into contact in the cable.

6. Communication and supervisory control cable tests:

    a. Factory tests:

        i. Cable to meet or exceed requirements of ICEA S-56-434, Section II-20.
        ii. Complete tests specified in Table 2.

        iii. Each completed cable to pass the IEEE 383 70,000 BTU/hour Vertical Tray Flammability Test.

7. Test reports:
    a. Submit certified electrical and physical test reports for finished multiple conductor cables no later than time of shipment.
    b. Each test document to include the following:
        i. Test results.
        ii. Date tests were performed.
        iii. Signature of Manufacturer's authorized representative.

PART 3 - EXECUTION

3.01 GENERAL CABLE INSTALLATION REQUIREMENTS

A. Authority to be given notice in writing of cable installation activities no less than forty-eight (48) hours before installing cables.

B. Wire and cable to be installed in accordance with AREMA C&S Manual Part 4.1, Recommended Instructions for Wire and Cable Installation and Maintenance, except as specified otherwise in this Section.

C. Cable runs to be continuous without splices between cable terminating locations.

    1. No splices to be made in vital, non-vital or train detection signal cables.

D. Provide end bells to prevent damage to cable at transitions from conduit to messenger or tray as specified in these Specifications.

E. Separation:

    1. Cable carrying 480 volt, or greater, potential to not be installed in the same trench or conduit as signal or communication cable, except as otherwise specified.

F. Cable installed in conduit:

    1. Cable fill, in conduit, to not exceed forty percent 40%, unless otherwise allowed by the Authority.
    2. Install all cables to be placed in one duct simultaneously.
    3. Approved cable lubricant to be used when pulling cables into conduit, pipe, or duct bank.
    4. Cables to be pulled into conduit or pipe without crossing one with another.
    5. Conductors to not be pulled tight or kinked in conduit fittings or boxes.
    6. Extreme care to be exercised when installing cables to avoid twisting, kinking, or injuring cable or its sheath.
    7. Pulling cords to be provided in each conduit.
    8. Spare conduit not to be used without approval from the Authority.

G. Cable bend radius:

1. Cable bend radius to be no less than ten (10) times the diameter of cable, during installation and as finally installed.

H. Cable slack:

   1. Sufficient slack to be provided in conductors at terminating posts for three (3) re-terminations of conductor due to broken eyelets without re-servicing or re-potheading cable.
   2. Where cable is subject to equipment vibration slack to be provided for flexibility.

I. Special Protection:

   1. Special protection to be provided for cable in areas where unavoidably exposed to hazardous conditions such as vibration or sharp corners on equipment.
   2. Cable to be laid on tarps so as not to contact any surfaces between reel and duct or hanger when pulling and hanging cables.
   3. Cable that is damaged before acceptance as a result of Contractor's failure to provide protection to be replaced, at no additional cost to the Authority.

J. Termination:

   1. Multiple conductor cables to be terminated by:

      a. Careful removal of the outer sheath of cable to point of cable entrance.
      b. Application of two (2) layers of plastic electrical tape at end of cable sheath or covering.

   2. Conductors to be terminated in conductor order.
   3. Spare conductors to be terminated.

K. Sealing openings:

   1. Openings in equipment enclosures and junction boxes to be sealed with either a compression type fitting or pliable sealing compound after cable is in place.
   2. The area around cable where cable emerges from the end of a conduit, pipe, or duct bank to be sealed using sealing compound.
   3. Spare, empty, and abandoned conduits to each be sealed or plugged in an approved manner.

L. Identification:

   1. Each cable to have a cable tag.

      a. Cable tags to have cable identifier, destination, and number of conductors in cable marked or stenciled on the tag.

M. Conductors:

   1. Individual conductors at each cable termination to be identified with wire tags.
   2. Spare conductors at each cable termination to be identified with wire tags.

N. Cable entry and routing:

   1. Cable outer jackets to be stripped back within 3" of the entrance to the junction box, house or case.

2. Cables to enter the enclosure through the conduit or opening closest to the terminals to minimize crossing other cables or interfering with access to other terminals.
3. Cable wire loom to be brought up the top of the enclosure and supported from the top with a cable grip.
4. Cables to be “treed” down to the appropriate terminal post(s) in a neat and professional manner.

3.02 DIRECTIONAL BORING

A. Start and end pits for guided borings to be hand dug, unless otherwise approved by the Authority.

B. Boring depth to be a minimum of forty-eight (48) inches to clear existing underground signal cables.

C. All waste materials created during the boring operations and any subsequent reaming operations to be removed from the site by the Contractor.

D. The Contractor to carry out all excavations for entry, exit, recovery pits, slurry sump pits, or any other excavations associated with the directional boring process.

   1. Sump pits to be required to contain drilling fluids if vacuum devices are not utilized throughout the drilling process.

E. Within forty-eight (48) hours of completing installation of the boring materials, the worksite to be cleaned of all excess slurry and spoils.

F. Any removal of any materials installed in a failed bore path to be at no additional costs to the Authority.

   1. The Contractor to promptly fill all voids by injecting all taken out of service products that have any annular space with excavatable flowable fill.

G. The approved method of locating and tracking the drill head during the pilot bore to be used.

   1. As a minimum, the locating and tracking system to provide clock and pitch information, depth, transmitter temperature, battery status, “x, y” information, and azimuth information where direct overhead readings are not possible.

H. Take and record alignment readings or plot points such that elevations on top of and offset dimensions from the center of the bore to a permanent fixed feature are provided.

   1. The permanent feature to be approved by the Authority prior to commencement of boring operations.
   2. The Contractor to provide elevations and dimensions at all bore alignment corrections, and at a minimum of every 100-foot segments.

      a. A minimum of three (3) elevations and plot points to be provided for each cable run to determine the installed horizontal and vertical alignment.

   3. Final readings to be used by the Contractor in his preparation of as-built drawings to show the vertical and horizontal alignments of all conduits installed by the directional boring process.

   a. The as-built drawings to also contain all "failed path" and "obstruction encountered" boring locations.

I. The Contractor to minimize the potential damage from soil displacement and settlement by limiting the ratio of the bore hole to the installed conduit diameter. The size of the back reamer bit or pilot bit, if no back reaming is required, to be limited to the conduit diameter as follows:

Nominal Inside Conduit	Bit Diameter
2 inches	4 inches
3 inches	6 inches
4 inches	8 inches
6 inches	10 inches

J. Drilling fluid for lubrication and soil stabilization to be a mixture of bentonite clay or other approved stabilizing agent and potable water.

   1. Use of other chemical agents will require approval of the Authority and will require certification by the Contractor that the materials used are environmentally safe and not harmful to the facilities.
   2. The Contractor to ensure that all drilling fluids are disposed or recycled in a manner acceptable to the appropriate local, state, and federal regulatory agencies.

K. The Contractor to match the boring equipment to be used with the size of conduit to be installed. The Contractor to ensure that the drill rod meets the bend radius required for the installation.

L. The Contractor to ensure adequate removal of soil cuttings and stability of the bore hole by monitoring the drilling fluids such as the pumping rate, pressures, viscosity and density during the pilot bore, back reaming, and conduit installation.

   1. Location of relief holes to relieve excess pressure down hole to be approved by the Authority.

M. Pull back rates to be monitored to minimize heaving.

N. Recommended pull back rates for the size conduit installed to not be exceeded.

O. The Contractor to also contain excess drilling fluids at the entry and exit points until they can be removed from the site.

P. The Contractor to ensure that the entry and exit pits are of sufficient size to contain the expected return of the drilling fluids and soil cuttings.

3.03 OUTDOOR LOCATIONS UNDERGROUND BURIED INSTALLATION

A. Cables to be installed in concrete encased RTRC conduit along the right of way.

   1. Cables to not be installed in metallic conduit of any type.

B. Local cable within ballasted areas to be buried to a uniform minimum depth of thirty-six (36) inches below finished grade.

C. Restoration of backfill and ballast to be in accordance with the construction methods outlined in the Backfill Section of these Specifications.

D. Where cable leaves the ground at other than buildings or in foundations, it to be protected by a bootleg or other covering extending above the ground line.

   1. Top of such protective coverings to be filled with a sealing compound.

E. Where buried cables enter a concrete foundation, junction box, or cases, a five- (5) foot slack coil in each cable to be left in a trench below the foundation or pedestal.

   1. Cable marker tape to be installed over the slack coil.
   2. Slack coils to not be used for cables carrying solid state track circuit frequencies.

F. The potheading of buried cables to be applied whenever cable is terminated in signal equipment and such termination is within two (2) feet of the grade level.

   1. This chlorinated polyethylene end seal pothead to be installed in accordance with the manufacturer's instructions.

3.04 INSTALLATION OF CABLE IN DUCT BANK

A. Duct bank preparation:

   1. Water to be pumped out of manholes, handholes, and pull chambers before installing cable.
   2. Manholes, handholes, and pull chambers to be maintained in a dry condition while the cables are being pulled.

B. Conduit preparation:

   1. Blow or swab dry conduit to be used.
   2. Each conduit to be rodded and mandreled.
   3. Pulling cords to be provided in each conduit.

C. Cable pulling:

   1. An approved wire cable grip extending not less than eighteen (18 inches) back from the end of the cable to be provided.
   2. Cables to be lubricated with approved lubricant.
   3. Cable to be placed in duct bank according to the Contract Drawings.

      a. Where more cables are used than the typical, cables to be placed in lowest available duct.

   4. Cable slack to be provided in handholes and manholes in lengths of one (1) turn around the inside perimeter of the handhole from the cable entrance to the cable exit.

D. Cable puller:

   1. Clutch to eb set to slip at fifty percent (50%) of cable weight per 1000 feet.
   2. Equip with calibrated dynamometer that indicates pulling force in pounds.
   3. Contractor to verify pulling tensions do not exceed manufacturers recommended pulling tension for cable.

      a. Contractor to provide intermediate pulling access points.

4. Glycerized liquid lubricant or other approved lubricant to be applied to the cable as approved by the Authority when installing cables in ducts.

E. After cable pull:

1. Ends of cable to be sealed immediately after pulling until time for terminating.
2. All conduits entering manholes or housings to be sealed with sealing compound.
3. Cables in manholes to be constrained and fastened to the walls of the manhole in accordance with the Approved installation drawings.

3.05 NON-BURIED INSTALLATION

A. Installation in trays or troughs:

1. Cable installed in trays or troughs to be laid therein and not pulled in place.

    a. Where the location of the tray does not allow laying of the cables, suitable rollers or other pulling devices designed for cable trays may be allowed with the approval of the Authority at each location.

2. Cables installed in trays and troughs to have a minimum amount of crossover and to not be pulled tightly around bends.
3. Cables installed in troughs integrated into a concrete deck to be suspended from a messenger wire attached to the wall of the trough at six (6) foot intervals.

B. Installation in conduit or pipe:

1. Cables to not cross one another when they are pulled into a conduit or pipe and care to be taken not to have the conductors pulled tight or kinked in conduit fittings or boxes.
2. End bells to be installed on all conduits where cables transition from the conduit to messenger.
3. All cables entering conduits to be supported and guided.
4. Multiple cables occupying a conduit to be simultaneously pulled.
5. The use of any lubricating medium for pulling cable through any conduits to be minimized.

    a. Excess lubricating medium to be cleaned up prior to enclosing conduit runs.
    b. Lubricant to be suitable for the application and non-injurious to the cable jacket.

3.06 INSTALLATION OF AERIAL CABLE

A. Installation of messenger brackets:

1. Existing aerial messenger and cable brackets to not be reused.
2. Brackets and dead-ends for installation of aerial cables to be designed, furnished, and installed by the Contractor.
3. Messenger brackets to be provided to support messengers along stringers, from each bent on elevated structure, and along walls.
4. Additional brackets to be provided where needed to redirect messenger to clear platform supports, abutments, and other obstructions along structure or walls.
5. Bracket design to allow minimum clearance of two (2) inches from cables to structure or wall at all points along messenger.
6. Spacing:

        a. Fastened to walls:
            i. Tangent track: Minimum every twenty-five (25) feet.
            ii. Curved runs: Minimum every twelve (12) feet six (6) inches.
        b. Fastened to elevated structure:
            i. Tangent runs: Minimum every fifty (50) feet or every bent, whichever is closer.
            ii. Curved runs: Minimum every twenty-five (25) feet.

    7. Attachment:
        a. Walls:
            i. Brackets to be attached with epoxy-type anchors.
        b. Structure:
            i. Brackets to be securely attached with bolted connections.
            ii. Brackets to not be welded to structure.
            iii. Bolt holes to be drilled, and not burned or punched through.
            iv. Bolts to be treated with thread locking compound after final installation to prevent loosening from vibration.
                a. Thread locking compound to be as manufactured by:
                    i. Henkel Loctite.
                    ii. Approved equal.

B. Installation of precast concrete or fabricated metal poles.
    1. Poles to be installed at maximum fifty (50) foot intervals.
    2. Poles to be installed at each side of a viaduct.
    3. Poles to be reinforced with guy wires as required to prevent undue stress on the pole.

C. Installation of messenger:
    1. Messenger to be installed loosely in the clamps until dead-ended at both ends.
    2. After dead-ending all clamps to be tightened to provide uniform tension in each span.
    3. Where sagging tension is applied from the ground by means of a coffing hoist or block and tackle hoist, the pulling point to be located minimum seventy-five (75) feet beyond the last pulley, and in direction of the line.
    4. Tensions during installation of messenger to be continuously checked by means of one or more dynamometers.
    5. Final tension to not exceed twenty-five percent (25%) of the rated breaking strength of the messenger at 15.6^{O}C (60^{O}F) after initial stretch and cable installation.

D. Installation of cables on messenger:
    1. Maximum cable bundle supported by a single messenger to be five (5) inches in diameter.
    2. Where multiple cables are installed on one (1) messenger, care to be taken to prevent twisting or spiraling of cables.

    a. Cables to be dressed in a neat, parallel fashion.

3. The following steps to be taken when installing cables on messenger:

    a. Cables to be tied to messenger with temporary marline or rope ties close enough together to hold cable without undue sagging or slack.
    b. Cables to then be permanently tied to messenger with cable straps placed on maximum fifteen (15) centers.

4. Supplemental wire ties consisting of individual strands of No. 9 AWG wire to be furnished and installed at:

    a. All messenger brackets.
    b. Mid-spans between messenger brackets.
    c. Transitions to other messengers or cross-runs.
    d. Transitions to or from conduits.
    e. Transitions to or from junction boxes.

5. Supplemental wire ties consisting of individual strands of No. 9 AWG wire to be installed with sufficient turns to neatly bind cables and messenger and to fully support the cables in the event of a complete failure of cable straps.
6. At points where cables leave suspension strand messenger to enter housings or conduit, cables to be securely fastened and anchored to messenger with sufficient wrappings of nylon filament rope to prevent cables from slipping or sagging.
7. Cable bundles and runs to be secured at transition points when cable runs or portions of cable runs change direction or branch off.
8. All cable straps and lashings to secure the entire bundle to the messenger or hanger.
9. Where additional cables are installed on an existing cable/messenger run:

    a. Existing straps to be removed where cables are added to existing bundles.
    b. New straps to be furnished and installed and the entire bundle to be re-dressed.
    c. Partial securing of additional cables to existing bundles without re-securing and redressing the entire bundle is prohibited.

10. New cable straps and ties for both new messenger runs as well as for securing cables to existing bundles or messenger runs to be furnished and installed.
11. Cables routed to relay housings or rooms, junction boxes, relay cases or making vertical runs to be secured with cable clamps properly sized that firmly support the cable.

    a. The use of one clamp to secure multiple cables to not be permitted except as approved by the Authority.
    b. The use of tie-wraps as permanent support or securing of cables is not permitted.

12. Where messenger is exposed a weatherproof coating to be applied.
13. Cables and cable bundles to be installed such that no contact will be made between the bundle, messenger, or cable and any other fixed or hanging object other than hangers, clamps and fittings intended to secure those specific cables and runs.

    a. A minimum of two (2) inches clearance to be provided between cable bundles/messenger and any other object, structure, wall or equipment, taking into account wind loads, other objects or equipment moving, variations in cable sag due to temperature and tension changes.

    b. Where this clearance cannot be maintained by any other method, bracket or hanger, the installation to be modified to secure and protect the cables from damage, subject to approval by the Authority.

14. The Contractor to provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions such as vibration or sharp corners on equipment.

    a. The Contractor to be responsible for replacing, at no additional cost to the Authority, any cable he has installed which is subsequently damaged prior to acceptance as a result of his failure to provide such special protection.

3.07 TESTS

A. Inspection:

1. After installing, inspect each cable installation in accordance with requirements of Contractor's approved Field Installation Inspection and Test Procedure.
2. Correct noted deficiencies to the satisfaction of the Authority.

B. Test cable in accordance with the Signal System Tests Section of these Specifications.

3.08 EXTERNAL CABLE TABLES

TABLE 1

SUPERVISORY CONTROL CABLE

INNER AND OUTER JACKET THICKNESS

DIAMETER OF CORE IN INCHES	THICKNESS OF SHEATH IN 64TH OF AN INCH MULTIPLE CONDUCTOR
0 to 0.425	5
0.426 to 0.700	6
0.701 to 1.050	7
0.0501 to 1.500	8
1.501 to 2.000	10
2.001 to 3.000	12
3.000 and Larger	14

NOTE: Minimum thickness of sheath compound at each point to not be less than 90 percent of specified thickness.

TABLE 2

PROPERTIES OF POLYETHELYNE SHEAT FOR TRAIN DETECTION CABLE INSULATION

	PROPERTY	TEST METHOD	VALUE
Original	Tensile Str. PSI Elongation %	ASTM D412 ASTM D412	1400 Min. 350 Min.
Air Oven Aged	48 hours @ 100C Tensile Str. % Original Elongation % Original	ASTM D573 ASTM D573	80 Min. 80 Min.
Low Temp. Flex.	Pass °C	ICEA S-19-81	-55C
Air Oven Aged	168 hours @ 100C Tensile Str. % Original Elongation % Original	ASTM D573 ASTM D573	75 Min. 75 Min.
Water Absorption	168 hours @ 70C mg/in^2	ASTM D470	5.0 Max
Environmental Stress Aging	100% Igepal CO-630 @ 50C for 48 hours, Failures		None

TABLE 3

INSULATION THICKNESS, CONDUCTORS IN MULTI-CONDUCTOR CABLES

			TEST VOLTAGES	
AREMA CLASS	CONDUCTOR SIZE, AWG	CONDUCTOR INSULATION	AC-60Hz 5-MINUTES	DC 10-MINUTES
A	16 to 8	79 mils	10,000	30,000
	6 to 2	94 mils	11,000	33,000
B	16 to 8	62 mils	8,000	25,000
	6 to 2	78 mils	10,000	30,000

NOTE: The insulation thickness specified in Table 3, at the thinnest part of any cross-section of insulated wire, to not be less than 90% of the specified thickness. The average thickness to be no less than the specified value.

TABLE 4

CUSHION LAYER – ELASTOMERIC MATERIAL THICKNESS

UNDERGROUND DIRECT BURIAL OR DUCT CABLES

CALCULATED CORE DIAMETER – INCHES	AVERAGE CUSION LAYER THICKNESS
0 to 1.500	47 mils
1.501 to Layer	62 mils

TABLE 5

OUTER JACKET THICKNESS

AERIAL (ABOVE GROUND) CABLE

CALCULATED CORE DIAMETER – INCHES	AVERAGE JACKET THICKNESS
Up to 0.425	65 mils
0.426 to 0.700	80 mils
0.701 to 1.050	95 mils
1.051 to 1.500	100 mils
1.501 to 2.000	140 mils

TABLE 7

INSULATION AND OUTER JACKET THICKNESS, TANK TEST

SINGLE-CONDUCTOR UNDERGROUND CABLE

CONDUCTOR SIZE AWG	INSULATION THICKNESS	POLYETHELENE JACKET THICKNESS	TANK TEST Kv AC 5-MINUTES
6	94 mils	62 mils	7.5
8	78 mils	62 mils	6.0
9	78 mils	62 mils	6.0

TABLE 8

INSULATION PHYSICAL CHARACTERISTICS

SIGNAL CABLE

1. PHYSICAL PROPERTIES		
Original Requirements		
Tensile Strength		
Tensile Strength at 200% Elongation	Minimum psi	1000
Elongation at Rupture	Minimum psi	60
Aging Requirements	Minimum Percent	300
After 168-Hour Oxygen Pressure at 80^{O}C (176^{O}F) 300 psi		
Tensile Strength	Minimum Percent of Original	90
Elongation at Rupture	Minimum Percent of Original	85
After 20-Hour Air Pressure Heat at 127^{O}C (260^{O}F) 80 psi		
Tensile Strength	Minimum Percent of Original	90
Elongation at Rupture	Minimum Percent of Original	85
After 168-Hour Air Oven Aging at 121^{O}C (249.8^{O}F)		
Tensile Strength	Minimum Percent of Original	90
Elongation at Rupture	Minimum Percent of Original	85
2. MECHANICAL WATER ABSORBTION		
7 Days, 70^{O}C (158^{O}F)	Maximum mg/square inch	8
3. OZONE RESISTANT TEST		
7 Days at 250ppm concentration	Inspection	No Cracks

TABLE 9

INSULATION ELECTRICAL REQUIREMENTS

1. INSULATION RESISTANCE CONSTANT		
1000 feet at 15.6^{O}C (60^{O}F)	Minimum Megohms	35,000
2. ELECTRICAL STABILITY IN WATER		
1000 cycles at 50^{O}C (122^{O}F)		
Dielectric Constant 1-Day Immersion	Maximum	3.0
Increase in Dielectric Constant		
1-14 Days	Maximum Percent	1.0
7-14 Days	Maximum Percent	0.5
3. ACCELERATED ELECTRIC STABILITY IN WATER		
80 Volts/mil Measurement Stress		
60 Cycles at 90^{O}C (194^{O}F)		
Dielectric Constant 1-Day Immersion	Maximum	3.0
Increase in Dielectric Constant		
1-14 Days	Maximum Percent	1.0
7-14 Days	Maximum Percent	0.5
1-90 Days	Maximum Percent	1.0

Power Factor		
14-Days	Maximum Percent	1.0
90-Days Immersion	Maximum Percent	1.0
4. ACCELERATED INSULATION RESISTANCE STABILITY TEST		
90°C (194°F) Megohms – 1000 Feet		
1-Day Immersion	Minimum	1000
90-Days Immersion	Minimum	1000

5. ACCELERATED VOLTAGE STABILITY	
Immerse 10-foot single conductor minimum No. 14 AWG with minimum 80 mils insulation in room-temperature water. Continuously energize without covering over insulation.	
AC Voltage, V/mil	Time, Mos.
325	2 or
280	3 or
240	4 or
200	6

TABLE 10

POLYETHYLENE PHYSICAL CHARACTERISTICS

When tested in accordance with methods described in ICEA S-95-658, the polyethylene compound to conform with the requirements in this table.		
1. PHYSICAL PROPERTIES		
Original Requirements		
Tensile Strength	Minimum psi	1400
Elongation at Rupture	Minimum Percent	350
Aging Requirements: After 48-Hour Air Oven at 100OC (212OF)		
Tensile Strength	Maximum	3.0
Elongation at Rupture		
Oil Immersion Aging: After 4 Hours at 70^{O}C (158^{O}F), ASTM No. 2 Oil		
Tensile Strength	Maximum Percent	1.0
Elongation at Rupture	Maximum Percent	0.5
Mechanical Water Absorption: After 7 Days at 70^{O}C (158^{O}F)		
mg/Sq. In.	Maximum	5
Shrinkback: 24 Hours at 100^{O}C (212^{O}F)		
	Minimum Percent	5
2. COLD BEND		
Mandrel Size	0-0.80	8-Times Outside Diameter of Cable
	0.80 and Over	10-Times Outside Diameter of Cable
1 Hour at -35^{O}C (31^{O}F) Bend 180^{O} Around Mandrel	Inspection	No Cracks
3. HEAT DISTORTION		
1 Hour in Air Oven at 90^{O}C (194^{O}F)		
Distortion	Maximum Percent	25
4. ABSORPTION COEFFICIENT		
Reciprocal Function of Light Transmission		
	Minimum	3200
5. ENVIORNMENTAL STRESS CRACKING REQUIREMENT REAGENT IGEPAL CO-630		
48 Hour at 50^{O}C (122^{O}F)	Inspection	No Cracks
6. IMPACT		
4 Hours at 9.4^{O}C (49^{O}F), Strike with 1-inch Diameter Steel Rod on a Flat Surface with 3ft/lb Force		
	Visual Inspection	No Cracks

TABLE 11

PHYSICAL AND ELECTRICAL CHARACTERISTICS OF THE CPE JACKET

When tested in accordance with methods described in ICEA S-68-516 and UL requirements, the thermosetting chlorinated polyethylene jacket to conform to the requirements in this table.		
1. PHYSICAL PROPERTIES		
Physical Requirements – Unaged		
Tensile Strength	Minimum psi (N/mm)	2000 (13.8)
Elongation at Rupture	Minimum Percent	300
Tensile Strength at 200% Elogation	Minimum psi (N/mm)	1400 (9.6)
Set	Minimum Percent	50
Aging Requirements: After 168-Hour Air Oven at 121^{O}C (250^{O}F)		
Tensile Strength	Minimum Percent of Unaged Value	85
Elongation	Minimum Percent of Unaged Value	70
Oil Immersion: After 18 Hours at 121^{O}C (250^{O}F), IRM 902		
Tensile Strength	Minimum Percent of Unaged Value	85
Elongation	Minimum Percent of Unaged Value	70
Aging Requirements: After 168-Hour Air Oven at 100^{O}C (212^{O}F)		
Tensile Strength	Minimum Percent of Unaged Value	85
Elongation	Minimum Percent of Unaged Value	65
2. OZONE RESISTANCE		
24 Hours at 0.015%	Inspection	No Cracks
3. COLD BEND		
1 Hour at -35^{O}C (-31^{O}F) – Minimum	Inspection	No Cracks
4. GRAVIMETRIC WATER ABSORPTION		
7 Days at 70^{O}C (158^{O}F)	Maximum mg/in^{2} (mg/cm^{2})	20 (3.08)
5. TEAR STRENGTH		
7 Days at 70^{O}C (158^{O}F)	Maximum lbs/in (kg/cm^{2})	35 (6.25)
6. FLAME TEST		
VW-1 Flame Test	Pass/Fail	Pass
IEEE-383-1974 Vertical Tray Test, Completed Cable	Inspection	No Propagation
Oxygen Index	Maximum Percent	30
8. ELECTRICAL REQUIREMENTS		
Specific Surface Resistivity	Minimum megohms	200,000

TABLE 12

POLYVINYL CHLORIDE COMPOUND PHYSICAL CHARACTERISTICS

When tested in accordance with methods described in ICEA S-95-658, the polyvinyl chloride compound to conform to the requirements in this table.		
1. PHYSICAL PROPERTIES		
Original Requirements:		
Tensile Strength	Minimum psi	2000
Elongation at Rupture	Minimum Percent	150
Aging Requirements: After 168-Hour Air Oven at 136^{O}C (276.8^{O}F)		
Tensile Strength	Minimum Percent of Unaged Value	75
Elongation	Minimum Percent of Unaged Value	45
Oil Immersion: After 40 Days at 75^{O}C (176^{O}F), IRM 902, ASTM No. 2 Oil		
Tensile Strength	Minimum Percent of Unaged Value	65
Elongation	Minimum Percent of Unaged Value	65
Mechanical Water Absorption: After 7 Days at 82^{O}C (179.6^{O}F)		
mg/Sq. In.	Maximum	20
Shrinkback: After 24 Hours at 100^{O}C (212^{O}F)		
	Minimum percent	5
2. COLD BEND		
Mandrel Size	0-0.80	8-Times Outside Diameter of Cable
	0.80 and Over	10-Times Outside Diameter of Cable
1 Hour at -35^{O}C (31^{O}F), Bend 180^{O} Around Mandrel	Inspection	No Cracks
3. HEAT DISTORTION		
1 Hour in Air Oven at 90^{O}C (194^{O}F)		
Distortion	Maximum Percent	50
4. ABSORPTION COEFFICIENT		
Reciprocal Function of Light Transmission		
	Minimum	3200
5. FLAME TEST		
Vertical, per UL 1581	Pass/Fail	Pass
6. INSULATION RESISTANCE		
Resistance in 75^{O}C (176^{O}F) Water per UL 83	Pass/Fail	Pass
7. IMPACT		
4 Hours at 9.4^{O}C (49^{O}F), Strike with 1-inch Diameter Steel Rod on a Flat Surface with 3ft/lb Force		
	Visual Inspection	No Cracks

TABLE 13

PROPERTIES OF CROSS-LINKED POLYOLEFIN SHEATH

1. PHYSICAL PROPERTIES		
Original Requirements:		
Tensile Strength	Minimum psi	1700
Elongation	Minimum Percent	150
Aging Requirements: After 168-Hour Air Oven at 100^{O}C (212^{O}F)		
Tensile Strength	Minimum Percent of Unaged Value	100
Elongation	Minimum Percent of Unaged Value	75
Aging Requirements: After 168-Hour Air Oven at 125^{O}C (257^{O}F)		
Tensile Strength	Minimum Percent of Unaged Value	75
Elongation	Minimum Percent of Unaged Value	60
Aging Requirements: After 168-Hour Air Oven at 150^{O}C (302^{O}F)		
Tensile Strength	Minimum Percent of Unaged Value	60
Elongation	Minimum Percent of Unaged Value	60
Oil Immersion Aging: After 22 Hours at 125^{O}C (257^{O}F), IRM 902, ASTM No. 2 Oil		
Tensile Strength	Minimum Percent of Unaged Value	50
Elongation at Rupture	Minimum Percent of Unaged Value	50
2. DUROMETER		
	Shore A (ASTM D2240)	85 +/- 5
3. LOW TEMPERATURE FLEX		
	Pass EC (ICEA S-19-81)	-40
4. MECHANICAL WATER ABSORPTION		
168 Hours at 70^{O}C (158^{O}F)	Maximum mg/in^2	30
5. OXYGEN INDEX		
Percent of Oxygen	Minimum Percent	35
6. SMOKE GENERATION		
Flaming Average after 4 Minutes	Maximum Optical Density	150
Flaming Average	Maximum Optical Density	250
Non-Flaming Average after 4 Minutes	Maximum Optical Density	150
Non-Flaming Average	Maximum Optical Density	300
7. OZONE		
	Pass/Fail	Pass

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 40 – External Signal Cable shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 40 – External Signal Cable shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 41

INTERNAL SIGNAL CABLE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installing single and multi-conductor insulated and jacketed wire and cable required for signal circuits and signal power system wiring internal to wayside relay houses, relay rooms, cases, junction boxes, wayside signal appliances, and buildings.

B. Related sections:

1. 34 42 38 Miscellaneous Components and Products.
2. 34 42 40 External Signal Cable.
3. 34 42 62 Junction Boxes.
4. 34 42 91 Signal System Tests.

1.02 REFERENCES

A. Reference Standards

1. Section incorporates by reference the latest revisions of the following documents (unless otherwise noted), or if standard is adopted by the Authority Having Jurisdiction, the latest revision adopted:

   a. American Railway Engineering and Maintenance-of-Way Association (AREMA).

      i. AREMA Communications & Signals Manual of Recommended Practices (C&S Manual).

   b. ASTM International (ASTM):

      i. ASTM B3, Standard Specification for Soft or Annealed Copper Wire.
      ii. ASTM B33, Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
      iii. ASTM B189, Standard Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes.
      iv. D3032 Standard Test Methods For Hookup Wire Insulation.

   c. Institute of Electrical and Electronics Engineers (IEEE):

      i. IEEE 383, Standard for Qualifying Class 1E Electric Cables and Field Splices for Nuclear Power Generating Stations.

   d. Insulated Cable Engineer’s Association, Inc. (ICEA):

      i. ICEA S-95-658/NEMA WC 70, Non-Shielded power cables Rated 2000 V or Less.

   e. Military Standards (MIL):

            - i. MIL-W-81822, General Specification for Wire, Electrical, Solderless Wrap, Insulated and Uninsulated.
            - ii. MIL-W-22759/ SAE-AS22759, Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy.
            - iii. MIL-W-81044 Wire, Electrical, Crosslinked Polyalkene, Crosslinked Alkane-Imidepolymer, or Polyarlyene Insulated, Copper or Copper Alloy.
            - iv. MIL-W-81381 Wire, Electric Polyimide Insulated, Copper And Copper Alloy.

f. National Fire Protection Association (NFPA):

- i. NFPA 70, National Electrical Code.

g. National Electrical Manufacturers Association (NEMA):

- i. NEMA HP 100, High Temperature Instrumentation and Control Cables.
- ii. NEMA HP 100.2, High Temperature Instrumentation and Control Cables Insulated and Jacketed with ETFE Fluoropolymers.

h. Society of Automotive Engineers International (SAE).

- i. SAE AS22759, Wire, Electrical, Fluoropolymer-Insulated, Copper or Copper Alloy (supersedes MIL-W-22759, even though MIL-W-22759 is still widely referenced).

1.03 QUALITY ASSURANCE

A. Quality assurance provisions to follow applicable standards in the manufacture of wire and cable covered by this Section.

B. All other work covered by this section to be performed in compliance with a Quality Assurance Program that meets the intent of ISO 9001:2015 and ISO/TS 22163:2017.

1.04 SUBMITTALS

A. Submit the following for review by the Authority:

1. Product Data.

    a. Complete technical data verifying the proposed internal wire and cable complies with the requirements of this Section.

2. Procedures.

    a. Field Installation, Inspection and Test Procedures.

3. Reports.

    a. Certified reports of qualification tests.
    b. Certified test reports of breakdown tests conducted on finished cable.
    c. Certified test reports of flame tests conducted on finished cable.
    d. Field Installation, Inspection and Test Report.

4. Samples.

        a. Qualification samples for each wire and cable proposed.

1.05 DELIVERY, STORAGE AND HANDLING

A. Wire and cable to be properly crated at the manufacturer's point of shipment.

B. Wire and cable to be protected from damage throughout delivery, storage, and handling.

C. Material damaged in transit or by mishandling or improper storage to be replaced by the Contractor at no additional cost to the Authority.

PART 2 - PRODUCTS

2.01 STRANDED WIRE

A. General requirements.

1. The requirements for wire specified in this Section to consist of this Section and SAE AS22759 or NEMA HP100 and NEMA HP 100.2.
2. Where there is a discrepancy between this Specification and the requirements of the applicable standard, the requirements of this Specification to govern.
3. The requirements of this Specification to also be used where the standard refers to “the detail specification.”

B. Internal stranded wire.

1. Internal stranded wire to have soft annealed copper conductors per ASTM B3.
2. Internal stranded wire to have tin or lead coating per ASTM B33 or ASTM B189.
3. Internal stranded wire to have ethylene-tetrafluoroethylene (ETFE) insulation per SAE AS22759 or NEMA HP 100.2.
4. Internal stranded wire to be constructed per Table A.
5. Internal stranded wire to have performance meeting or exceeding Table C.
6. Internal stranded wire additional requirements to be as per Table F.

C. Identification.

1. Each stranded wire to be marked with the following information:

    a. Manufacturer name.
    b. Year of manufacture.
    c. Size of conductor.
    d. Type of insulation.

2. Identifying markings to be permanent, legible, and understandable.
3. Stranded wires used in multiconductor cable to be numbered or color-coded in addition to the basic four- (4) part identification.

2.02 MULTICONDUCTOR CABLE

A. Multiconductor cable to have a thermoplastic rubber (TPR) outer jacked in accordance with IEEE 383, stabilized for outdoor exposure.

B. Multiconductor cable to have an outer sheath with a nominal thickness in accordance with ICEA S-95-658/NEMA WC70.

C. Multiconductor cable barrier tape to be 0.005-inch thick with a minimum twenty-five (25%) percent overlap.

D. Individual conductors of multiconductor cables to be

   1. Sized to meet 150 percent of the load requirements.
   2. Minimum No.16 AWG.

      a. Excepting of control panel internal wiring, which is to be no smaller than No.20 AWG.

E. Multiconductor cables to be made by assembling individual or twisted pairs of insulated wires into a tight, cylindrical form.

   1. Individual or twisted pairs to be assembled helically and with adjacent layers wound in opposite directions.

F. Multiconductor cables specified in this Section will not exceed thirty-seven (37) conductors for vital circuits.

G. Multiconductor cables specified in this Section will not exceed fifty (50) conductors for non-vital circuits.

H. Multiconductor cables to have spare conductors as indicated in these specifications.

   1. Reduction in the number of spare conductors is not permitted unless otherwise directed by the Authority in writing.

I. Identification.

   1. Each multiconductor cable to be marked on the outer sheath with the following information, repeated at intervals no greater than thirty-six (36) inches:

      a. Manufacturer’s name.
      b. Year of cable manufacture.
      c. Number and size of conductors.
      d. Type of insulation in wires.
      e. Type of outer sheath insulation.
      f. Voltage rating.

   2. Identifying markings to be permanent, legible, and understandable

2.03 SOLID WIRE FOR WIRE WRAP APPLICATION

A. General requirements.

   1. The requirements for solid wire used in wire wrap application in this Section to consist of this Section and MIL-W-81822.
   2. Where there is a discrepancy between this Specification and the requirements of the applicable standard, the requirements of this Specification to govern.

3. The requirements of this Specification will also be used where the standard refers to "the requirements of the applicable military specification sheet."

B. Solid wire.

1. Solid wire to have soft annealed copper conductors per ASTM B3 (Type A only).
2. Solid wire to have a tin coating with continuity and adherence per ASTM B33.
3. Solid wire to have ethylene tetrafluoroethylene (ETFE), or polyvinylidene fluoride (PVF2) insulation.
4. Solid wire to be constructed per Table D.
5. Solid wire to have performance meeting or exceeding Table E.

C. Identification.

1. Each solid wire to be marked with the following information, repeated at intervals no greater than twenty-four (24) inches:

   a. Manufacturer name.
   b. Type of insulation.

2. Identifying markings to be permanent, legible, and understandable.

2.04 SOURCE QUALITY CONTROL

A. Contractor inspection.

1. Test reports of each required qualification test to be submitted to the Authority prior to the release of the associated cable for shipment.
2. The Contractor to provide monitoring of the manufacturer's conformance to the quality assurance requirements.

B. Authority inspection and testing.

1. Shipment specific testing may be witnessed by the Authority.
2. The Authority reserves the right to audit conformance to specified witnessing and testing.

C. Multi-conductor cable tests.

1. Test individual conductors per the specified requirements for Stranded Wire for General Use, before cable assembly.
2. Place finished cables in water at room temperature.
3. After 48 hours immersion and while still immersed, test all conductors for breakdown at 2,500 V (rms) for 5 minutes.
4. From each batch of cable outer-sheath material, flame-test samples of finished cable per IEEE Standard 383.

D. Stranded wire tests:

1. Flame Spread Test: UL 1581.
2. Vertical Flame Test: IEEE 383.
3. Dynamic Cut-Through Test: ASTM D3032.

a. Perform at room temperature using tensile testing machine equipped with recorder suitable for recording force in pounds necessary to force a tungsten carbide cutting tool through insulation of a finished wire specimen.
b. Cutting tool will have a cutting edge of 0.005-inch radius of curvature on a 90-degree wedge.
c. Testing machine will also be equipped with a 12-volt detection circuit designed to stop testing machine when the cutting edge cuts through the wire insulation and contacts conductor.
d. Remove 1 inch of insulation from one end of an 18-inch finished-wire specimen.
e. Place specimen on a hard, flat surface and orient cutting edge perpendicularly to axis of wire specimen.
f. Force cutting edge through insulation at a constant rate of 0.2 inch per minute until contact with the conductor occurs.
g. Record force measured at time of contact with conductor.
h. Perform four tests on each specimen with specimen being moved forward 1-inch minimum and rotated clockwise 90 degrees between each test.
i. Cut-through resistance to be average of four test result values.

2.05 MISCELLANEOUS PRODUCTS

A. Wire and cable tags:

1. See the Miscellaneous Components and Products Section in these Specifications.

2.06 TEMPORARY HOUSE WIRE

A. General requirements.

1. Temporary wire is standalone, and the requirements outlined in other Sections of this Specification do not apply.
2. Temporary wire to not be installed for any permanent applications.

B. Temporary wire.

1. Temporary wire to be either No.14 AWG or No.16 AWG.
2. Temporary wire to have stranded copper conductor(s).
3. Temporary wire to have a tin coating.
4. Temporary wire to have extruded ethylene tetrafluoroethylene (ETFE)/Tefzel insulation.
5. Temporary wire to be rated for 600V.

C. Identification.

1. Temporary wire to be surface printed with the following information:

   a. MIL part number.
   b. Manufacturer CAGE Code (FSCM number).

PART 3 - PART 3 - EXECUTION

3.01 WIRE AND CABLE SIZE REQUIREMENTS

A. Single conductor No.14 AWG stranded to be used for interconnecting signal junction boxes and lamp compartments and other miscellaneous equipment.

3.02 GENERAL WIRE AND CABLE REQUIREMENTS

A. Installation.

1. Internal wire and cable to be installed in accordance with applicable recommended instructions of AREMA C&S Manual Part 10.4.1, Recommended Instructions for Wire and Cable Installation and Maintenance, and as specified.
2. Internal wire and cable to be installed in a neat, workmanlike manner.
3. Point-to-point redundancy of wires allowed for increased current capacity is not permitted.

B. Termination.

1. Sufficient slack to be left in wire and cable to permit wire ends to be easily removed from the device or terminal and re-terminated.
2. All spare conductors to be terminated unless otherwise directed by the Authority in writing or otherwise specified.

3.03 INSTALLATION IN TRAYS AND TROUGHS

A. Internal wire and cable to be laid in trays or troughs.

1. Pulling internal wire and cable into trays or troughs is not permitted.

B. Internal wire and cable to be installed with minimal crossovers and without pulling cable tightly around bends.

C. Sufficient slack to be left in wire and cable at transitions and other locations to prevent damage to the wires and cables over time due to abrasion.

D. Exposed wires and cables entering or leaving equipment racks or housings to be protected from abrasion by sharp metallic edges.

3.04 BUNDLING AND CABLING

A. Nylon straps to be provided for bundling cabling conductors where two (2) or more single conductors are exposed in internal rack bundles, cable trays, cable troughs, or whenever wires are bundled.

1. Use of tape for this purpose is not permitted.

B. Straps to be installed a minimum of every five (5) feet along a cable run.

C. Wires of multi-conductor cables exposed for termination by stripping cable jacket to be trained in a neat, workmanlike manner and tied approximately every three (3) inches with nylon straps.

3.05 MODULE WIRING

A. Unless otherwise approved by the Authority in writing:

1. Module wiring terminations to be made using solderless connections.
2. Solid wire to be used for wire wrap connections.
3. Stranded wire to be used for crimped connections for module and display panel wiring.

B. Module wiring minimum wire size to be:

1. No.20 AWG for stranded wire.
2. No.24 AWG for solid wire.

3.06 RACK WIRING

A. Vital and non-vital rack wiring termination to be made using approved solderless connections.

B. Vital and non-vital rack wiring minimum side to be No.16 AWG stranded wire or multiconductor cable unless otherwise directed by the Authority in writing.

C. Vital and non-vital rack wiring to be neatly tied to the rack in compact bundles.

1. Main bundles and branches to be secured to the racks.
2. Physical damage due to pressure or abrasion to be prevented.
3. Wire weight to not be supported by wire terminations, connections, or plug connections.
4. Wire bundles and cables to not interfere with visual inspection, troubleshooting, or repair of rack mounted equipment.

3.07 RACK-TO-RACK WIRING

A. Rack-to-rack wiring to be routed via overhead cable trays with 1 foot of slack between cable tray and each rack to which cable or wire is connected.

B. Rack-to-rack wiring minimum wire size to be No.16 AWG.

C. Vital racks.

1. In factory wired housings and relay rooms rack-to-rack wiring to use single conductors tied into bundles to form unjacketed multi-conductor cables, unless otherwise approved by the Authority in writing.
2. Maximum tie spacing to be six (6) inches.

D. Non-vital racks:

1. Single conductor cables and solderless terminals to be used for non-vital rack-to-rack wiring, unless otherwise approved in writing by the Authority.

    a. Non-vital panels within the relay rooms and towers may have a plug connector panel to terminate wiring from rack.

2. Non-vital racks within the relay houses to be wired point-to-point without the use of plug connectors.

E. Non-vital racks to vital racks:

1. Wiring from non-vital racks to vital racks, or vice versa, to be single conductors tied into bundles for wiring between non-vital and vital rack connection points, unless otherwise approved in writing by the Authority.

    a. Wiring between relay room and tower racks may have a plug connector panel to terminate the wiring between racks.
    b. Racks within relay houses to be wired point-to-point without using plug connectors.

2. Maximum tie spacing to be six (6) inches.

F. Rack to local control panel (LCP) wiring.

1. Rack to LCP wiring to be made-up cables and multi-conductor cables from vital and non-vital instrument racks to solderless terminals installed on Local Control Panel.
2. Made-up cables.

    a. Made-up cables to be assembled from single conductors.
    b. Made-up cable conductors to be stranded.
    c. Made-up cable conductors to be minimum No.16 AWG.
    d. Maximum tie spacing to be six (6) inches.

3. Control panel wiring:

    a. Control panel wiring to use single conductor wires and solderless terminals, unless otherwise approved in writing by Authority.
    b. Control panel wiring minimum wire size to be No.20 AWG.

G. Entrance rack to instrument rack wiring.

1. Entrance rack to instrument rack wiring to be stranded wire.
2. Entrance rack to instrument rack wiring minimum wire size to be No. 16 AWG, as approved by the Authority.

H. High-voltage wiring.

1. Where internal wire and cable is used in circuits directly connected to the rails or carrying above 600 V, the internal wire will meet requirements of the External Signal Cable Section of these Specifications.

I. Energy distribution wiring.

1. Energy distribution wiring to be single conductor, stranded wire, unless otherwise approved by the Authority in writing.
2. Energy distribution wiring conductors to be sized per NFPA 70.

    a. Conductors to not be smaller than any minimum specified conductor sizes defined in these Specifications.

3. Energy distribution wiring in racks.

    a. Energy distribution wiring in racks to use solderless connections.
    b. Energy distribution wiring minimum wire size when installed in racks to be:

        i. No.14 AWG for AC power.
        ii. No.16 AWG for DC power.

4. Energy distribution rack-to-rack wiring.
    a. Energy distribution rack-to-rack wiring to use solderless connections.
    b. Energy distribution rack-to-rack wiring minimum wire size when installed in racks to be No.10 AWG.

J. Identification.

1. Cables to have a cable tag for each cable.
    a. Cable tags to be letter tags with cable destination and number of conductors in cable.
2. Individual conductors to be identified at each cable termination with wire tags.
3. Each spare conductor in each cable to be identified with a wire tag.

3.08 FIELD QUALITY CONTROL

A. Inspection.

1. After installing, each wire and cable installation to be inspected in accordance with requirements of Contractor’s approved Field Installation, Inspection and Test Procedure.
2. Noted deficiencies to be corrected to the satisfaction of the Authority.

B. Cable to be tested in accordance with the Signal System Tests Section of these Specifications and the approved Field Installation Inspection and Test Procedure.

3.09 INTERNAL WIRE AND CABLE TABLES

Wire Size (AWG)	Conductor Stranding (Strands x Size)	Max. Diameter Stranded Conductor (Inches)	Conductor Resistance Max. at 20^{o}C (Ω/1000ft)
20	19x32	0.041	9.88
16	19x29	0.058	4.81
14	19x27	0.073	3.06
12	37x28	0.090	2.02
10	37x26	0.114	1.26
8	133x29	0.173	0.701
6	133x27	0.204	0.433

Table A - Construction Details

Abrasion Resistance (Procedure 11)				
Wire Size (AWG)	Min. Resistance (In. of Tape)	Weight Support Bracket	Weight (lbs)	Tension Load (lbf)
20	26	A	1.0	1.0
16	28	A	1.0	2.0
14	19	B	3.0	2.0
12	29	B	3.0	2.0
10	36	B	3.0	3.0
8	35	B	3.0	3.0

Table B - Performance Details

Bend Testing				
Wire Size (AWG)	Mandrel Diameter Life Cycle	Cold Bend (In. Max.)	Test Load Life Cycle	Cold Bend (lbs)
20	3/4	1	2.0	4.0
16	1	1-1/4	2.0	5.0
14	1-1/4	2	2.0	5.0
12	2	2	2.0	5.0
10	3	3	2.0	5.0
8	3	4	3.0	6.0

Table C - Performance Details

Wire Size (AWG)	Finished Wire Diameter (In)	Load in Grams for		Insulation Pull-Off Cold (lbs)
		Cut Through	Flow	
24	0.034 ± 0.0015	1050	800	1 to 4
22	0.039 ±.0.002	1100	850	1 to 6
20	0.046 ± 0.002	1200	950	1 to 6

Table D – Construction and Performance Details

Wire Size (AWG)	Bend Mandrel Diameter (In)		Testing Tension Load Cold Bend (lbs)
	Heat Resistance	Cold Bend	
24	7/64	1.0	0.50
22	1/8	1.0	0.75
20	9/64	1.0	0.75

Table E - Construction and Performance Details

Type of Insulation	ETFE	Polyarylene	Polyimide File Tape
Military Specification	MIL-W-22759	MIL-W-81044	MIL-W-81381
Nominal Wall Thickness Size 20-14 AWG	15 mils	10 mils	10 mils*
Nominal Wall Thickness Size 12-8 AWG	17 mils	12.5 mils	12.4 mils*
Nominal Wall Thickness Size 6 AWG	20 mils	12.5 mils	12.4 mils*
Temperature Rating	150^{o}C	150^{o}C	150^{o}C
Blocking (Qualification Only)	200^{o}C	200^{o}C	200^{o}C
Color	Contractor Option		
Flammability**	Pass	Pass	Pass
Identification	30-inch intervals (max.)		
Identification, Striping, or Printing Durability	125 cycles (250 strokes) (min.) with 500 gram weight		

Life Cycle Dielectric Test	Oven temp. 200°C for 168hrs. 2200V RMS, 60Hz		
Accelerated Aging	7hrs at 210°C (Quality Conformance Test, Group II; Procedure as in Life Cycle Test)		
Physical Properties of Insulation			
Tensile Strength, PSI (min.)	5000	12000	24000
Elongation Percent (min.)	125	50	40
Chemical Resistance	Test not required.		
Shrinkage at 200°C ± 2°C, inches (max.)	0.125	0.125	0.303
Smoke	200°C	200°C	200°C***
Thermal Shock	Test not required.		
Cold Bend	-65°C	-65°C	-65°C
Wrap Test (Size 20 AWG Wire)	2hrs at 200°C No Cracks	Mandrel dia. 0.125in No Cracks	
Dynamic Cut Through, pounds (min.) at 23°C with Size 20 AWG**	61.7*****	90	90
Wicking	Test not required.		
Lamination Sealing	N/A	N/A	230°C
Polyimide Cure Test	N/A	N/A	48hrs required.
Resin Coating Durability	N/A	N/A	****
Humidity Resistance	IR after exposure will meet initial requirements.		
Voltage Rating	600V RMS	600V RMS	600V RMS
Impulse Dielectric Test (100%)	8kV peak	8kV peak	8kV peak
Insulation Resistance	See Table H		
Spark Test	Test not required.		
Surface Resistance, megohms/inch (min.), Initial and Final	500	500	500
Wet Dielectric Test Volts RMS	2500	2500	2500
* Nominal wall thickness for Polyimide film will eb achieved by the following combinations of 50% overlapped tape wraps plus an outer 1 mil coating of modified aromatic Polyimide resin: First wrap 1 / 2 / 0.5 Second wrap 0.5 / 1 / 0.5 Third wrap (size 12-8 AWG only) 0.1 / 1 / 0.1			
** As required by this specification			
*** Test per MIL-W-22759			
**** 250 cycles (500 strokes) (min.) with one pound load			
***** Average value with standard deviation of 11.7lbs			

Table F - Additional Requirements for Stranded Wire

Temperature Rating	200^{o}C maximum conductor temperature
Voltage Rating	300V RMS
Insulation Tensile Strength (min.)	2500 PSI
Insulation Elongation (min.)	50%
Color	Black
Spark Test	3000V RMS
Insulation DC Resistance (min.)	2500 megohms/1000ft
Wet Dielectric Test	2000V RMS, 60Hz
Cold Bend Conditioning	4hrs at -65^{o}C ± 2^{o}C
Dielectric Test for Cut-Through and Cold Flow	500V RMS, 60Hz
Insulation Heat Resistance (max.)	Conditioning, 120hrs at ± 2^{o}C shrinkage, 0.062in
Dielectric Constant (max.)	2.30 at 1MHz
Power Factor (max.)	0.0005 at 1MHz
Resistance to Fluids	Test not required.
Flammability (max.)	30sec after-flame 3.0in flame travel No flaming of tissue paper
Surface Resistance (min.)	5000 megohms

Table G - Additional Requirements for Solid Wire

Wire Size (AWG)	Insulation Resistance (megohms/1000ft)
22	15051
20	12636
18	10543
16	9594
14	8035
12	8294
10	6842
8	5034
6	4065

Table H - Insulation Resistance

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 41 – Internal Signal Cable shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 41 – Internal Signal Cable shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 62

JUNCTION BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installing junction boxes for terminating:

    a. Signal and signal power cables.
    b. Track circuit cables.
    c. Express signal cables.
    d. Switch-and-lock-movement layout cables
    e. Train stop cables.
    f. Route selector cables.
    g. Worker ahead wayside element cables.

2. Cable cord connectors.

B. Related Sections:

1. 34 42 20 Audio Frequency Track Circuits.
2. 34 42 38 Miscellaneous Components and Products.
3. 34 42 40 External Signal Cable.

1.02 SUBMITTALS

A. Before ordering, fabricating, or assembling equipment, the following to be submitted for approval by the Authority:

1. Product Data:

    a. Product data for each type and size of junction box, including components furnished with each.
    b. Product data for each paint and protective coating proposed for junction box identification.

2. Shop Drawings:

    a. Shop drawings of each type of junction box including:

        i. Terminal boards.
        ii. Signal terminal binding posts.
        iii. Wiring.
        iv. Mounting details.
        v. All other integral parts.

    b. Shop drawings to show the location of each junction box.
    c. Shop drawings to show the design of the support system and the method of installation for each junction box.

   d. Where a junction box forms part of layout, the junction box shop drawing submittal may be made as part of total layout shop drawing submittal.

3. Procedures:

   a. Factory test procedure, including verification of the required NEMA 4X rating.
   b. Installation, inspection and field test procedure.

PART 2 - PRODUCTS

2.01 JUNCTION BOX GENERAL REQUIREMENTS

A. Junction boxes to be sized to accommodate specified signal terminal binding posts, terminal boards, cable, wire identification, termination of spare wires, and other associated apparatus along with required expansion space.

   1. The junction box size to be 25% larger than what is required to house the as designed equipment and cabling.
   2. The junction box to have a minimum of 10% spare terminals included.
   3. The junction box to be of sufficient size to provide ample space to accommodate the minimum bending radii of the cables and wires in the junction box.

B. Junction boxes to be provided with gaskets to prevent the entrance of moisture and dust in accordance with the American Railway Engineering and Maintenance-of-Way Association (AREMA) Communications and Signals Manual Part 15.2.10 - Recommended Functional Guidelines for Gasket Material Suitable for Circuit Controllers, Signal Cases, and Other Signal Apparatus Housings.

C. Junction boxes to be NEMA 4X-rated enclosures.

D. Junction boxes to have a print pocket capable of holding twenty-four- (24) inch by thirty-six- (36) inch (ANSI D) folded plans.

E. Finish and Painting.

   1. Exterior:

      a. The exterior of stainless-steel junction boxes to not be painted unless otherwise directed by the manufacturer and approved by the Authority.
      b. The exterior of cast junction boxes to be painted in accordance with the Miscellaneous Components and Products Section of these Specifications, excepting:

         i. The exterior of cast junction boxes for switch-and-lock movement layouts to be painted black.
         ii. The exterior of cast junction boxes for signals and communications to be painted gray.

   2. Interior:

      a. The interior of stainless-steel junction boxes to not be painted unless otherwise directed by the manufacturer and approved by the Authority.
      b. The interior of cast junction boxes to be to the manufacturer’s standard practice.

F. Security.

1. Junction boxes to be provided with a locking device and a split half- (1/2) inch, hex, Raco-style barrel lock with a brass chain.
    a. The brass chain to be fastened to the side of the box with enough slack to allow for insertion and locking of the barrel lock in the locking hasp.
    b. Fastening hardware to be of a material that does not promote galvanic corrosion of the junction box due to contact of dissimilar metals.

2.02 TRACK CIRCUIT, AUDIO FREQUENCY (AF) LOOP, ROUTE SELECTOR, AND LOCAL CABLE JUNCTION BOXES (CAST ALUMINIUM)

A. Material:

1. Cast aluminum.

B. Hinge and Hasp Fittings:

1. Aluminum.

C. General:

1. Junction boxes to be sized to fit under the platform edge and to not extend into the train clearance envelope.
2. Junction boxes to be provided with the number of accesses required for the designed volume of cable and conduit.
3. Junction boxes to be provided with signal double-post terminal binding posts as specified in the Miscellaneous Components and Products Section of these Specifications.

D. Acceptable Manufacturers:

1. Alstom.
2. Hitachi Rail STS.
3. Approved equal.

2.03 SWITCH-AND-LOCK-MOVEMENT JUNCTION BOXES (CAST IRON)

A. Material:

1. Cast-iron.

B. Hinge and Hasp Fittings.

1. Bronze

C. General:

1. Junction boxes to be provided with the number of accesses required for the designed volume of cable and conduit.
2. Junction boxes to be provided with signal double-post terminal binding posts as specified in the Miscellaneous Components and Products Section of these Specifications.

    3. Junction boxes to be provide with a means of attaching a padlock to prevent access.

- D. Acceptable Manufacturers:

    1. Alstom.
    2. Hitachi Rail STS.
    3. Siemens.
    4. Approved equal.

2.04 ROOM-TO-ROOM AND EXPRESS CABLE JUNCTION BOXES (STAINLESS STEEL)

- A. Material:

    1. 316L stainless steel.
    2. 12-gauge, minimum.

- B. Hing and Hasp Fittings:

    1. Hinges and all attached accessories:

        a. 316L stainless steel.
        b. 12-gauge, minimum.

    2. Hasp and/or door latching mechanism:

        a. 316L stainless steel.
        b. 10-gauge.
        c. Constructed of U-channel bracket with rollers.

- C. General:

    1. Junction boxes to be provided with the number of accesses required for the designed volume of cable and conduit.
    2. Junction boxes to be provided with signal double-post terminal binding posts as specified in the Miscellaneous Components and Products Section of these Specifications.

        a. All cable conductors brought into the junction box to be terminated on signal terminal binding posts mounted to stainless steel support rails.
        b. A minimum of six (6) inches of spacing to be maintained between vertical rows of terminal blocks.
        c. A minimum of eight (8) inches of spacing to be maintained between the inner walls of the junction box and any terminal block.

    3. Junction box hinges to be the full length of the door and welded to the enclosure.

        a. The enclosure design to include complete hinge concealment when the door is closed.
        b. The door to be capable of opening through a 180-degree swing.
        c. The door to be equipped with a removable stop to prevent it from closing or opening further when at the 90-degree and 170-degree positions.

    4. Junction box doors to be constructed of the same stainless-steel material as the main junction box enclosure.

    a. The door to have rolled edges.
    b. The door design construction to be tamperproof.
    c. Where a junction box door surface area is greater than 400 square inches, the door construction to incorporate stainless steel bracing to prevent buckling or warping.

5. Junction box mounting brackets to be welded to the outside of the junction box.

    a. Riveting, bolting, and any other method requiring piercing of the box is not permitted.

6. Junction boxes to have a half- (1/2) inch breather drain installed at the bottom of the junction box.

    a. The breather to maintain the NEMA 4X rating of the enclosure.
    b. The breather drain to be constructed of the same stainless-steel alloy as the main junction box.

7. Junction box doors to have a stainless steel three- (3) point locking mechanism for padlocking the enclosure.

    a. The locking mechanism latch to have a five-eighths- (5/8) inch diameter opening for accepting a CTA lock shackle.
    b. Stainless steel reinforcing pads to be provided where the locking mechanism is attached.

8. Junction boxes to each have a stainless-steel drip shield installed to protect the door hardware from dripping water, ice/snow buildups, and settling dust.

    a. The drip shield to be welded to the main box.

2.05 MISCELLANEOUS PRODUCTS

A. Cable cord connectors to be a water- and oil-tight type.

PART 3 - EXECUTION

3.01 REQUIRED JUCTION BOXES

A. Junction boxes to be provided at each block location between interlockings shown on the Contract Drawings and in the approved design for terminating the following cables:

    1. Local track circuit cables.
    2. Track circuit express cables.
    3. Line circuit express cables.

B. Junction boxes to be provided for local track circuits and audio loops to terminate cables, as required by the final design.

C. Junction boxes to be provided for route selector layouts to terminate cables.

    1. Route selector junction boxes are defined as the terminal cases contained within the split-base junction boxes that are part of the respective mounting and support assemblies.

D. Junction boxes to be provided for switch-and-lock-movement layouts to terminate cables.

    1. Switch and lock movement junction boxes are defined as cast steel terminal cases.

E. Junction boxes to be provided for signal and worker ahead layouts to terminate cables.

    1. Signal and worker ahead junction boxes are defined as the terminal cases contained within the split-base junction boxes that are part of the respective mounting and support assemblies.

3.02 JUNCTION BOX INSTALLATION

A. Junction boxes to be provided complete with all required mounting hardware.

B. Cable junction boxes to be mast mounted in outdoor areas.

C. Ballasted areas:

    1. Foundations or mounting bases, and attachment hardware for mounting cable junction boxes to be provided.

D. Closed deck or subway:

    1. Support systems for installation in closed deck areas to be designed and submitted to the Authority for approval before fabrication.

E. Platform areas:

    1. Locations of junction boxes under platform areas are subject to approval by the Authority.

3.03 CABLE TERMINATION

A. Express signal cables to be terminated in each junction box at each block location.

B. Conduit connectors to firmly support terminated conduit end.

    1. Where conduit is used as ground connection, grounding-type connections for the conduit termination to be provided.

3.04 PAINTING

A. Following completion of installation and testing, paint cast junction boxes in accordance with the Miscellaneous Components and Products Section of these Specifications.

3.05 IDENTIFICATION

A. Black powder coated stainless steel lettering to be welded onto the outside of the junction box door indicating the approved name designation of the junction box.

    1. Lettering to be of two- (2) inches in height.
    2. All lettering to be level with the top of the junction box door.

B. The top of each terminal strip to be clearly labeled.

    1. Labeling to be black and one- (1) inch tall.
    2. Labeling may be stenciled onto the mounting board after it is painted.

    a. Labelling to be protected after stenciling with a coat of clear exterior grade varnish, acrylic, or equal transparent protective covering, compatible with paint used for stenciling.

C. All wires terminating in the junction box to be tagged in accordance with the Miscellaneous Components and Products Section of these Specifications.

3.06 FIELD QUALITY CONTROL

A. Inspection:

1. After installation and wiring, each junction box to be inspected in accordance with requirements of Contractor's approved installation inspection and field test procedure.
    a. Any deficiencies to be noted and corrected to the satisfaction of the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 62 – Junction Boxes shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 62 – Junction Boxes shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTAION 34 42 90

TECHNICAL SUPPORT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The work to be performed under this Section consists of furnishing the following technical support and material:
    a. Maintenance and trouble-shooting manuals.
    b. Certain items of maintenance equipment designated as GROUP 1 EQUIPMENT, as herein specified.

B. Related Sections:

1. 34 42 01 Basic Signal System Technical Requirements.
2. 34 42 20 Audio Frequency Track Circuits.
3. 34 42 23 Impedance Bond Layouts.
4. 34 42 38 Miscellaneous Components and Products.

1.02 QUALITY ASSURANCE

A. Other than test equipment, all materials to be identical in quality to the components or assemblies furnished and installed under the respective Specification Section covering the item.

B. All Line Replaceable Units (LRUs) defined as the lowest level of equipment that may be replaced in the field to be barcoded with a unique code.

1. Fuses and resistors are exempt from the requirement for unique barcodes.

C. Factory tests to be equal to those as specified within the applicable sections of these Specifications.

1.03 SUBMITTALS

A. EQUIPMENT AND SUPPORT MATERIAL LISTS: To include Contractor’s intended material, apparatus tabulation number, Manufacturer’s reference number, part number, quantities, unit price and costs. Include the Contractor’s, estimate of the number of crates, packages, with packing lists as a submittal to be submitted to the CTA Signal Engineer for approval prior to shipment. Upon approval of the CTA Signal Engineer, the Contractor to ship the material to a location designated by the CTA Signal Engineer.

1. EQUIPMENT TABULATION: The Contractor to provide a spreadsheet listing for all equipment provided and the location of the equipment as installed on the system. A barcoding plan to also be included. A template for the specific formatting of the listing of equipment to be provided to the Contractor by CTA. The sheet to list all assets down to every Line Replacement Unit as agreed to by CTA. spreadsheet template to at minimum include the following columns with data filled out. Apparatus Tabulation Number Supplier Reference Number
2. Equipment Type
3. Manufacturer

4. Manufacturer Model Number
5. OEM Manual Name/Number
6. Serial Number
7. Barcode UPC
8. Installation Date
9. Warranty expiration date
10. Nomenclature of Equipment
11. Location of Equipment (Interlocking or Relay House name)
12. Chaining Point (Stationing) of Wayside Equipment (where applicable)
13. Track Number wayside equipment is installed on (where applicable)
14. Associated installation drawing name
15. Picture of Equipment as Installed (if applicable)
16. GPS coordinate locations
17. Supplemental Information (Frequency/Code Rate for AF Equipment, Layout information for switch machines, etc.)

B. Track Circuit Tabulation: The Contractor to additionally provide a comprehensive spreadsheet listing all track circuits provided on the project. The precise template for this spreadsheet to be provided to the Contractor by CTA. The following columns to be provided at a minimum:

1. Track Circuit name
2. Track Circuit Type (Power Frequency or Audio Frequency)
3. Direction (NB or SB)
4. Maximum Allowable Cab Signal Speed
5. Train Detection Frequency
6. Train Detection Code Rate
7. Track Circuit Length
8. Receive Bond Stationing
9. Transmit Bond Stationing

C. In addition to the submittal of the supplemental list of recommended support items referenced herein, pamphlet and comprehensive product descriptions to be submitted for each item thereon that has not previously been submitted as a requirement of the technical sections of these specifications.

PART 2 - PRODUCTS

2.01 TECHNICAL AND MAINTENANCE MANUALS

A. Two (2) manuals of types shown to be furnished to the CTA.

1. Impedance Bonds:

    a. Installation, operation, and maintenance manuals.

B. One (1) electronic version of all manuals and technical information to be furnished to the CTA on a USB flash-drive.

2.02 GROUP 1 EQUIPMENT

A. The following identifies the names of the separate locations that to be used for purposes of determining material and equipment to be furnished under this Section:

1. Tower 18.
2. Tower 12.

B. The following items of equipment to be furnished not later than thirty days prior to the Contractor's field-testing of the train control system:

1. Two (2) of each type of biased-neutral relay, non-vital relay, timer, and timer unit/module for each location.
2. One (1) for every ten (10), or portion thereof, of each type of impedance bond provided.
3. One (1) for every ten (10) sets, or portion thereof, of each type of impedance bond cable connectors.
4. One (1) for every ten (10), or portion thereof, of each type of impedance bond mounting hardware.
5. Two (2) complete sets of track shunts for adjusting, testing and calibrating track circuits.

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. All equipment provided under this Section to be packaged to preclude deterioration of the product.

B. The number of crates and packages and packing lists to be submitted to the CTA for approval prior to shipment.

C. The Contractor to ship all approved support material equipment to the area designated by the CTA, not less than 60 days prior to the time that the first part of the system is scheduled to be placed in service.

D. Any items having a limited shelf life to be clearly identified on the storage container with the expiration date.

E. The Contractor to obtain a signed receipt for all materials, and promptly post such receipts as an issue on the project web site.

F. With the exception of storage card files, material to not be delivered directly to the field locations identified in this section.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 90 – Technical Support shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 90 – Technical Support shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 42 91

SIGNAL SYSTEM TESTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. The work to be done under this Section consists of the tests and inspections that are to be performed to demonstrate that signal components and designs comply with the specifications and that the wayside train control system is functionally and safely integrated into the carborne ATP system, the communications backbone system, the Control Office RSMS (QuickTrack) system and the traction power negative return system including, but not limited to:
    a. Systems.
    b. Subsystems.
    c. Assemblies.
    d. Subassemblies.
    e. Components supplied under this Contract.

2. Tests and inspections to be made both during the progress of this Contract and after completing the installation of equipment to consist of, but not be limited to:
    a. Factory tests.
    b. Circuit breakdown tests.
    c. Wiring verification tests.
    d. Continuity tests.
    e. Resistance tests.
    f. Voltage and current tests.
    g. Time tests.
    h. Operating tests.
    i. Simulation tests.
    j. Other electrical and mechanical tests and inspections.

3. The work to include the costs of the Contractor's personnel and any special equipment and assistance required to conduct all tests and complete the required documentation.
4. Where the system does not meet the Specification requirements, necessary corrections are to be made and any and all tests or re-tests to prove compliance are to be included in the work, without any additional cost to this Contract. The Authority to be made aware of any failures at the time of their occurrence, along with preliminary measures to correct them, and the final measures presented in writing through the RFI process.
5. The work to include all necessary disconnecting and reconnecting required to support testing and return-to-service activities.
6. Test work specified elsewhere in these Specifications to be construed as related to and inclusive with the testing described herein.

B. Standards and regulations.

1. Standards:

        a. American Railway Engineering and Maintenance-of-Way Association (AREMA), Communications and Signal Manual, Part 2.4.1 "Instructions for Inspection and Test of Signal Installations before Placing in Service."

    2. Regulations:

        a. Federal Railroad Administration (FRA), Rules, Standards and Instructions for Railroad Signal Systems, Part 236.

1.02 SUBMITTALS:

A. Within ninety (90) days of receipt of Notice to Proceed, the following to be submitted to the Authority for approval:

    1. An outline of the tests to be performed on each type of component or unit, together with sample forms of test record forms and cards as hereinafter specified.
    2. The numbers of each type of component or unit to be tested to demonstrate the adequacy of design and quality control.
    3. A line diagram showing the grouping and sequencing of system and subsystem tests showing both factory and field tests.
    4. Any additional tests required by the Contractor to ensure the safe operation of the system to be submitted.

B. No fewer than sixty (60) days prior to the scheduled performance of each test, a detailed test procedure, for tests as described herein, to be submitted to the Authority for approval.

C. Within ten (10) days of the completion of a test, the completed results of each test as herein specified to be recorded and the test result documentation to be furnished to the Authority.

    1. Certified test results to also be furnished for tests performed by any subcontractors when such tests are required within this Specification.
    2. Discrepancy forms to accompany each test.

        i. All discrepancies and corrective actions to be listed on these forms.
        ii. Tests to not be considered complete until all discrepancies, if any, have been resolved to the satisfaction of the Authority.

    3. All test reports to be checked and approved by the Contractor prior to submittal.
    4. Test reports to document the calibration date of each instrument used during the test.

        a. The calibration of each instrument to be certified by a recognized testing facility.
        b. Recertification to be conducted every ninety (90) days or as stated by the manufacturer’s recommended calibration period. Out of date instruments to be considered non-certified.
        c. Tests conducted with non-certified instruments to be rejected.

    5. Upon completion of all tests specified herein, the Contractor to submit a letter signed by an authorized representative, certifying that all tests have been performed.

1.03 QUALITY ASSURANCE

A. All test procedures and inspection procedures to be subject to the approval of the Authority and to comply with all FRA and AREMA rules and regulations, including AREMA Manual Part 2.4.1 "Inspection and Test of Signal Installation before Placing in Service."

B. Test equipment of the proper type, capacity, range, and accuracy to be supplied by the Contractor to perform the required tests and inspections.

   1. Test equipment to be in good working order and properly calibrated at the time the tests or inspections are conducted.

C. Each component and unit of the wayside signal and train control system to have an inspection performed at its point of manufacture and evidence of this inspection and acceptability to be indicated on the item where practicable.

D. Authority factory inspection.

   1. The Authority reserves the right to witness any or all tests and inspections in the Contractor's plants or other manufacturing facilities.

      a. The Authority to be advised a minimum of ten (10) weeks in advance of each factory test event.
      b. When tests are to be conducted continuously as in a production line routine, the Authority to be advised six (6) weeks in advance of the start of such tests.

         i. Such notice to indicate the duration period in which such tests to be conducted.

   2. Travel to be required by the Authority to the Contractor's factory as follows:

      a. First trip for a design conference/prototype inspection.
      b. Following trips to witness factory/operational test for each location.

   3. The following conditions must be satisfied before factory testing can be scheduled:

      a. All signal circuits and programs to be approved by the Authority.
      b. The circuitry, including all panels, to be wired so that operation of all house/room equipment can be observed during simulation tests.

   4. The number of trips to not be limited.

      a. Should problems develop, or if the manufacturer's scheduling does not permit completion of tests within one visit, additional trips may be necessary to complete the objectives of this Contract.
      b. When technical information is desired, it may be such that the information can be brought to the Authority representatives instead of the Authority representatives traveling to the factory. In such case the Contractor to have the option of bringing qualified personnel to the Chicago area to accomplish the needed solution in lieu of providing for travel for the Authority.

E. All approved system and subsystem tests to demonstrate that the installation meets these Specifications and design requirements to be completed prior to any operational testing of systems or subsystems.

F. The Authority to have the right to witness any or all field tests conducted.

  1. The Authority to be notified in writing at least seven (7) days prior to each field test.
  2. No part of the signal system to be placed in service without an authorized representative of the Authority being present and witnessing the in-service tests.

G. The work to include all tests required to ensure the proper and safe operation of all systems and subsystems and to prove the adequacy and acceptability of the total installation specified herein.

H. The tests to be performed to cause each system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions to prove that the installation complies with all specified fail-safe requirements.

PART 2 - PRODUCTS

2.01 SITE TEST EQUIPMENT AND MATERIALS

A. All test instruments and equipment necessary to conduct the tests specified herein to be available, ready-for-use not less than one week in advance of test need.

  1. Ready-for-use to mean:

    a. Properly matched for test parameters.
    b. Properly calibrated.
    c. Sufficiently supplied with:

      i. Leads.
      ii. Probes.
      iii. Adapters.
      iv. Stands.
      v. Other materials necessary to conduct the particular test in a completely professional manner.

B. All temporary or interim test-related equipment to be furnished and available including, but not limited to:

  1. Materials.
  2. Special tools.
  3. Connections.
  4. Jumpers.
  5. Etc.

PART 3 - EXECUTION

3.01 FACTORY TEST PROCEDURES

A. Confirmation to be provided by the Contractor that all factory tests have been performed.

B. Factory tests required under this Contract are those of:

  1. Systems.
  2. Subsystems.

3. Assemblies.
4. Subassemblies.
5. Components.

C. The above tests to verify design and name plate ratings and adequate and proper performance.

D. When test results are not recorded on a test data plate affixed to the equipment or unit, certified test reports to be furnished for each item at the time of delivery in a form and format suitable for regular office file record keeping.

E. Each component and unit to be inspected at its point of manufacture and evidence of this inspection and acceptability to be indicated on the item where practicable.

F. All systems, subsystems, and equipment to be 100 percent inspected and tested.

G. All components, other than those related to fail safe circuits, may be tested on a sampling basis.

1. A number of randomly-selected components or units from the manufacturing process to be tested to ensure the adequacy and acceptability of all components and units produced.

    a. The number of randomly-selected components or units to be approved by the Authority.

3.02 FACTORY TESTS AND INSPECTIONS

A. Relay houses, relay rooms, and relay cases.

1. Each relay house and relay case to be completely wired at the point of assembly, with all equipment installed.
2. Each relay room relay house and instrument rack to be completely wired at the point of assembly and interconnected with all equipment installed.
3. An operational and wiring verification test to be made in accordance with the approved circuit plans.
4. Functions external to the housing to be simulated using test panels where required.

B. Vital relay tests.

1. All DC vital relays to be factory tested and inspected in accordance with AREMA Signal Manual Part 6.4.1.

C. Microprocessor tests.

1. These tests to be performed at the factory by the Contractor using a test panel to simulate all field connections.
2. The test panel to consist of independent indicator lights for each system output and separate two-pole switches for each input.

    a. Indicator lights to determine polarity of biased inputs.
    b. Test switches for switch repeater inputs to also establish input polarity.

3. The test panel to interface with the microprocessor system via the main terminal board racks and the control panel.

4. The system to be configured to allow full functional testing using the test panel, control panel and the microprocessor system operating.
5. Complete breakdown and operational testing to also be performed at each location when the system is delivered and connected to the field equipment prior to placing the system in service.
6. Detailed breakdown and test procedures to be provided to the Authority and approved prior to testing.
7. The Authority to verify the operational check at the factory and in the field as specified within these Specifications.

D. Energy distribution tests.

1. Energy distribution tests to be completed with all fuses removed.
2. Energy distribution tests to include, but not be limited to, the following:

    a. Circuit breaker sizes to be verified against those shown on the approved circuit plans.
    b. All energy distribution to be checked, using resistance test instrument acceptable to the Authority, to verify agreement with the approved plans.
    c. Wire gauge to be verified against the gauge called for on the approved circuit drawings.
    d. Each energy bus to be tested to all energy buses to ensure that no crosses exist.

3. Any discrepancies found to be corrected.

E. Wiring verification test.

1. Wiring verification tests may be done with energy on or off.
2. Wiring verification test to include, but not be limited to, the following:

    a. All circuitry to be checked for accuracy against the approved circuit drawings.
    b. All point-to-point wiring to be checked for accuracy against the approved circuit drawings.
    c. Wire count on each terminal, relay contact, etc. to be taken to ensure that only the number of wires called for on the approved circuit plans is present at each terminal, relay contact, etc.
    d. Tags and nomenclature to be verified, where applicable.
    e. All components, relays, resistors, etc. to be verified against those called for on the approved circuit drawings for correct element and installation and location, position, and/or orientation.

3. Any discrepancies found to be corrected.

F. Vital circuit tests.

1. Vital circuit tests to be conducted with energy on during simulation testing.
2. All vital circuits to be tested to ensure that the opening of each contact in a control circuit cuts off the control current under the conditions shown on the approved plans following through all multiple circuits and cut arounds.
3. Where a circuit is broken by a relay contact twice or when it is broken by some other relay contact, whose coil circuit is opened by opening the relay, the wires in the circuit to be disconnected in addition to opening the relay.
4. Any discrepancies found to be corrected.

G. Interlocking tests.

1. After conducting the vital circuit tests, all operating conditions to be simulated to ensure that each circuit function is in accordance with the specifications.
2. Functions tested to include, but not be limited to, the following:

    a. Approach and time locking.
    b. Route locking.
    c. Detector locking.
    d. Traffic locking.
    e. Verification of time release settings.
    f. Route setting and cancellation in both the automatic and manual modes of operation.
    g. Proper polarity of energy that is to interconnect with the existing and/or new circuitry outside the housing, room, or case tested.

3. Adjustments and corrections of defects in the wiring to be made as necessary to obtain proper operation.
4. All design changes found necessary to obtain proper operation to be submitted to the Authority for approval.

H. Instrument racks.

1. All instrument racks and equipment germane to a singular installation to be wired at the point of assembly, with all equipment installed.
2. Instrument racks to be interconnected in accordance with the approved drawings.
3. All functions of the system to be simulated to determine that each function of the system operates as required.
4. Adjustments and correction of defects in the instrument rack wiring to be made as necessary to obtain proper operation.
5. All design changes found necessary to obtain proper operation to be submitted to the Authority for approval.

I. Control panels.

1. All operating functions and indications of the control panels required by these Specifications to be tested to determine that each function to perform as required.
2. This test to be performed in conjunction with the associated instrument rack and microprocessor system tests as specified herein.
3. Adjustments and correction of defects in the control panel and equipment wiring that are necessary to obtain proper operation to be made.

J. Supervisory control system factory test

1. Prior to initial shipment of the supervisory control system, a system functional test to be conducted.
2. The supervisory control system test to include the assembly and interconnection of all supervisory control apparatus, data transmission equipment, and field apparatus for each of the field station control points to be controlled under this Contract.
3. Where simulation or test fixture equipment is required to perform this factory test, such equipment to be provided by the Contractor at no additional cost to the Authority.
4. Functions to be tested to include all control manipulations and indications between central control and all field locations to verify the supervisory control and data transmission system operation.

        a. Simulated data streams to be injected into the system at all input points at a rate twice the calculated normal through put.

5. The supervisory control system factory test to also include all control manipulations and indications corresponding to the system design.
6. No shipment to be accepted at the site if the supervisory control factory test results have not been approved to the Authority.

K. Operation recorder

1. Indication to the proper input location on the operation recorder and all subsystem interfaces into the recorder to be verified.

L. Other factory tests.

1. Factory tests and inspections of other components, products, and subsystems to be completed may be found in the respective technical sections of these Specifications.

3.03 FIELD TEST PROCEDURES

A. The field tests performed to cause each installed system and subsystem to be sequenced through its required operations, including the imposition of simulated conditions, to demonstrate that the installation complies with all specified fail-safe design requirements and operational functions.

B. The quality of the installation to be demonstrated by field tests for:

1. Continuity.
2. Insulation resistance.
3. Resistance of ground connections.
4. Circuit breakdown.
5. Visual inspection.
6. Any other tests required by this Specification.

C. These above installation quality tests to be performed prior to any operational testing of systems or subsystems.

D. The Contractor test procedures to include a narrative for each test. The narrative to at minimum include:

1. Purpose of test.
2. Pre-requisites.
3. Test equipment required to perform tests.
4. Testing method and procedure.

E. The Contractor test procedures to consist of pre-printed data sheets or inspection sheets for each test.

1. When completed by the field test personnel and checked for accuracy and completeness, the sheet to be submitted as the test report.

F. When tests require specific meter or test instrument readings, the pre-printed data sheet to show the allowable range of values, for each part of the test.

G. The test report to also contain:

1. A check off system for each action and a blank space adjacent to the expected value in which to record the test readings.
2. A final discrepancy sheet on which the Contractor to record discrepancies found and action taken. This documentation to be furnished to the Authority.
3. Space for the printed name and signature of the responsible employee of the Contractor or subcontractor, and the witnessing inspector.

H. All test reports to be dated and signed by the responsible employee of the Contractor or subcontractor on the day the test is performed.

I. The report to show the specific test instruments used on each test, with the instruments identified by name, type, serial number, and calibration due date.

J. Should an error be discovered during field testing due to field wiring and connections that do not agree with the approved circuit plans, the Contractor may correct such errors without prior approval of the Authority.

1. The Contractor to not make any changes that effect the safety of operation of the approved circuit(s), as-designed, without prior written approval of the Authority.

K. The Authority to make all final determinations as to whether only a partial or whole test to be rerun when any specific field test does not meet the requirements specified for the test.

L. Any changes made after completion of test procedure to be retested in accordance with the applicable test procedure.

3.04 GENERAL FIELD TESTING AND INSPECTION

A. General field tests to include, but not be limited to the following:

1. Test to ascertain removal of all negative rail connections from the signal rail for single rail track circuits, and removal of negative rail connections from both rails for AF track circuits.
2. Ground verification test.
3. Vital relay calibration inspection.
4. Inverter and commercial power operation and transfer tests.
5. Power racks, energy distribution system and failure alarm checks.
6. Breakdown test of all vital circuitry.
7. Wiring verification of all non-vital circuitry.
8. Line circuit verification between wayside relay houses/rooms.
9. Vital function tests.
10. Operating tests.
11. Dynamic and safe braking tests with a derated train
12. All applicable tests prescribed by AREMA Signal Manual Part 2.4.1, where the AREMA inspections and tests do not conflict with the requirements of these specifications.
13. Ancillary signal house/room equipment, alarm, and HVAC system tests.

3.05 SPECIFIC FIELD TESTS

A. Resistance of ground connections.

1. All grounding connections to be tested to determine that the ground resistance is not greater than 15 ohms using the ratio ground resistance test method.

B. Insulation resistance tests.

1. The test procedure for testing of insulation resistance to include tests to verify the following:
    a. All wire and cable installed along the right of way and all wire and cable entering or leaving wayside relay houses, rooms, towers, and cases to be tested after installation to ensure that the insulation of wires and cable, and connected equipment, meet the specified resistance value.
        i. A direct reading instrument, having a 0 megohm to 200 megohm scale range and a self-contained DC power supply rated 500 volts minimum to 1000 volts maximum, to be used to measure the insulation resistance.
        ii. Resistance between conductors and ground to not be less than that specified in the Federal Railroad Administration Rules, Standards, and Instructions for Railroad Signal Systems, Part 236.108.
    b. The insulation resistance of each conductor to ground and between each conductor and all other conductors in each multi conductor cable to be tested.
        i. Power source made grounds and connections to the rails to be disconnected from the circuits during testing.
    c. The point used as ground to be the most convenient ground available.
    d. Insulation resistance test values to be recorded on approved Insulation Resistance Record Forms and submitted to the Authority upon Authority acceptance of the completion of this test requirement.

C. Negative return rail bonding in single rail track circuits.

1. Electrical tests of negative rail bonding to be performed only if directed by the Authority.
2. Extreme care to be exercised during these tests due to the potential presence of return currents in the rail.
3. Electrical tests of negative return rail bonding, cross bonds and negative return traction feeder cable to be conducted and recorded as herein described using a Biddle Portable Kelvin Bridge, Catalog No. 72 439 or an equivalent test instrument with corresponding range and accuracy.
4. Tests to only be performed when no traction power energy is in the rails.
5. Approval of any power removal to be obtained from the Authority prior to testing.
6. Resistance of Welded Connections
    a. The installed resistance of each welded negative return bond to be tested to verify that it does not exceed 0.000080 ohms.
    b. The null-balance method of testing to be employed utilizing the four- (4) terminal arrangement, two (2) potential and two (2) current terminals.
        i. The C1 and C2 current leads to be attached to the rail approximately six (6) inches outside of welds being tested.
        ii. The P1 and P2 leads to then be attached to the rail one (1) inch from either end of the bond being tested.
        iii. The meter dials to then be manipulated to achieve a balanced condition of the meter.

c. This procedure to be followed for each welded bond attached to the rail.

7. Cross bonding:

   a. The installed resistance of each 1000 kcmil cross bond cable to not exceed 0.000160 ohms plus 0.000011 ohms for each foot of cable installed.
   b. The null balance method of testing as described in 3.05C.6.b of this Specification to be employed.

8. Mechanical tests:

   a. All welds to be struck with a hammer in the presence of the Authority to ensure proper bonding of the materials.

      i. Tests to be performed on the structure welds prior to repainting.

D. Vital Relays

1. All DC vital relays to be tested for pick up and drop away values.

   a. These values to be in accordance with field requirement values stated in Table I of AREMA Signal Manual Part 6.4.1.

2. These measured values to be recorded on the approved Relay Record forms and subnmitted to the Authority upon Authority acceptance of the completion of this test requirement.
3. These tests to be performed at the field locations after the housing has been set, or the room construction has been completed.

E. Inverter operation and signal and commercial power distribution.

1. Pre-power up verification testing to be completed with inverter and commercial power off, fuses removed, and disconnects open.
2. Pre-power up verification testing to include, but not be limited to, the following:

   a. All fuses and disconnect sizes to be verified as in accordance with the approved plans.
   b. All point-to-point wiring in both the inverter and commercial/signal power racks to be verified as in agreement with the approved plans.
   c. All wiring run and gauges to be verified as in agreement with the approved plans.
   d. Transformers are to be verified as wired in agreement with the approved plans.
   e. Inverter rack and equipment mounted upon the inverter rack to be verified as not within six (6) feet of any potentially grounded object(s).
   f. Ground tests to be performed on the inverter and commercial/signal power racks to verify:

      i. Inverter rack and equipment mounted upon the inverter rack are isolated from any earth ground.
      ii. Inverter rack and equipment mounted upon the inverter rack are grounded to the negative running rails as shown on the approved plans.
      iii. Signal/commercial power rack and equipment mounted upon the signal/commercial power rack are earth grounded and pass the minimum ground resistance requirement called for by these Specifications.

   g. Equipment and wire tags to be verified for proper type and nomenclature.

        h. Operation of the 600VDC manual transfer switch to be verified.

3. Power on verification testing to follow the completion of pre-power up testing.
4. Power on verification testing to be completed with inverter and commercial power connected and on, fuses installed, and disconnects closed.
5. With the transfer switch set to inverter power, power on verification testing to include, but not be limited to, the following:

    i. Load and Line voltages to be verified as within five percent of those called for on the approved plans.
    ii. Commercial and signal power to be verified as being delivered in accordance with approved plans.

        a. Signal and commercial power voltages present in the signal house/room to be measured and recorded.
        b. Voltages to be within five (5) percent of those called for on plans.

    iii. Inverter indication data to be verified and recorded.
    iv. Operation of the 600VDC manual transfer switch to be verified.

  b. With the transfer switch set to commercial power, power on verification testing to include, but not be limited to, the following:

    i. Commercial and signal power to be verified as being delivered in accordance with approved plans.

        a. Signal and commercial power voltages present in the signal house/room to be measured and recorded.
        b. Voltages to be within five (5) percent of those called for on plans.

    ii. Inverter indication data to be verified and recorded.

F. Energy distribution.

1. Energy off tests:

    a. Energy off tests to be completed with all power to wayside relay house/room or case off and all fuses removed.
    b. Energy off tests to include, but not be limited to, the following:

        i. Circuit breaker sizes to be verified against those shown on the approved circuit plans.
        ii. All energy distribution to be checked using resistance test instrument acceptable to the Authority, to verify agreement with the approved plans.
        iii. Wire gauges to compared with those called for on the approved circuit drawings.

            a. All discrepancies in wire sizes to be corrected by replacing the erroneous wire with the proper size wire.

        iv. Wire counts on each terminal, relay contact, etc. to be taken to ensure that only the number of wires called for on the approved circuit plans is present at each terminal, relay contact, etc.

        a. Any discrepancies found to be corrected and additional wires, if found, to be removed.

      v. Tags to be verified for proper nomenclature and terminal location.
      vi. Each energy bus to be tested to all other energy buses to ensure that no crosses exist.

2. Energy on tests:

    a. Energy on tests to follow the completion of energy off tests.
    b. Energy on tests to be completed with the power on and the fuses for the power supply feeds installed.
    c. Energy on tests to include, but not be limited to, the following:

        i. Fuses for power supply feeds to be verified for proper size according to the approved circuit drawings.
        ii. Energy feeds to be turned on the operation of power transfer to be tested for proper operation.
        iii. Each AC voltage input to be measured and recorded.
        iv. Each power supply output voltage to be measured and recorded.
        v. Verification that the proper voltage is present at all distribution points to be completed.
        vi. Circuit power failure alarms and all other alarms that indicate to remote control points to be tested.

G. Circuit continuity tests:

1. All wire and cable installed by the Contractor to be tested to verify the continuity of each conductor and that each conductor is connected to the proper terminal as shown on the approved drawings.

    a. Where parallel circuits exist, each parallel path to be tested independently to verify the continuity of each path.

H. Vital and non-vital circuit breakdown.

1. All circuits to be broken down to be checked for accuracy against the approved circuit drawings.
2. Breakdown tests may be done with energy on or off.
3. Breakdown tests include, but are not limited to, the following:

    a. Point-to-point wiring between the field device or adjacent location and the first relay or input/output terminal in the house to be verified.

        i. Where wiring changes have been made to the wiring internal to the house after the completion of the factory test, the point-to-point test to verify all elements of the modified circuit.

    b. A wire count of all field installed wires to be made for each terminal, relay contact, etc. to ensure that only the number of wires called for on the approved circuit plans is present at each terminal, relay contact, etc.
    c. Tags and nomenclature to be verified, where applicable.
    d. All components, relays, resistors, etc. to be verified as the same as called for on the approved circuit drawings and located in proper positions.

4. Any discrepancies found to be corrected.

I. Breakdown of control circuits

1. All circuits to be tested in their entirety for the correct operation of and response to each contact on each circuit element, such as relays and contactors.
2. Where parallel paths exist, the tests are to validate each path.
    a. Circuits to be opened when required to ensure the proper test.
3. Each circuit to be tested by simulating all operating conditions to verify that the circuit operates in accordance with the Specifications and approved plans.

J. Power frequency (AC) track circuit tests.

1. Each track AC circuit to be tested in accordance with the Contractor's approved test procedure and these specifications to ensure that the 60 hertz track circuits are properly designed, installed, and adjusted.
    a. Where a discrepancy exists between the approved Contractor test procedure and these Specifications, these Specifications to take precedence.
2. Each AC track circuit test to include, but not be limited to, the following:
    a. Each AC track circuit to be tested for defective insulated joint protection.
    b. Each AC track circuit to be tested for shunting sensitivity.
        i. Shunting sensitivity to be tested by:
            a. Connecting an ammeter in series with the track coil of the track relay, and;
            b. Placing a 0.25-Ohm shunting strap across the rails at the track transformer feed point.
            c. The value of current required to pick up the track relay to be recorded.
        ii. Acceptable shunting sensitivity to have the effective value of any current so measured to be less than seventy-five (75) percent of the drop-away current of the track relay.
        iii. Shunting sensitivity to be tested after the final track circuit adjustment has been made.

K. Audio frequency track circuits.

1. Audio frequency track circuit components to be tested to ensure that the comply with the manufacturer's specifications and these Specifications.
    a. Where a discrepancy exists between the manufacturer specifications and these Specifications, these Specifications to take precedence.
2. Audio frequency track circuit tests to include, but not be limited to, the following:
    a. Code rate periods to be checked with a frequency counter and recorded.
    b. Track and train carrier frequencies to be checked and recorded for proper frequency and to be within tolerance limits.

c. Tuning units to be checked to verify that they are tuned to proper frequency and the results to be recorded.
d. The resistance of line wire feed to the trackside-tuning unit to be verified.
e. The following information to be recorded and submitted to the Authority for each transmitter:

   i. Power level settings for track and train carrier frequencies.
   ii. Line voltage levels for track and train carrier frequencies.
   iii. Current readings in milli-amps for each train carrier frequency.

f. The following information to be recorded for each receiver:

   i. Receiver input voltage value, both shunted and non-shunted.
   ii. Pick up voltage of the associated receiver track relay.

3. After all the audio frequency track circuits are set up and operating, each track to be shunted to verify that only the proper track relay drops with a 0.25 Ohm shunt applied to the track circuit.
4. A selected group of track circuits to be tested to determine that each is properly immune to interference.

   a. Interference immunity to be tested by:

      i. Disabling the track circuit transmitter without disconnecting it from the rails, and;
      ii. Connecting and oscilloscope to the receiver detector at a point before the signal is digitalized or limited.

   b. The oscilloscope waveform to be observed for:

      i. Harmonic interference from adjacent transmitters.
      ii. Traction power noise.
      iii. Noise from moving trains.
      iv. Other undesirable sources of noise.

   c. Acceptable interference immunity to be such that the effective voltage level of any signal so observed is less than seventy-five (75) percent of the minimum voltage level, at that point, required to hold the track relay in an operated state with the receiver set to maximum sensitivity.
   d. At a minimum, one track circuit for each combination of frequencies and modulation rates to be tested.

5. A select group of track circuits to be tested to determine that speed commands cannot be received by a train behind the train for which they are intended.

   a. Speed command isolation testing to be performed by:

      i. Causing the transmitter to transmit a speed command;
      ii. Placing three 0.25-Ohm shunting straps across the rails, ten (10) feet from the transmitter bond;
      iii. Connecting an oscilloscope to a train receiver detector at a point before the signal is digitalized or limited;
      iv. Advancing the train such that its front end is ten (10) feet in approach to the impedance bond on the track circuit entering end.

        b. Acceptable speed command isolation to be such that the effective voltage level of the signal to be less than seventy-five (75) percent of the minimum voltage level, at that point, required to hold any frequency detector relay or any code detector relay energized with the transmitter set to produce normal operating current in the rails and the train receiver set for maximum sensitivity.
        c. At a minimum, one track circuit for each combination of frequencies and modulation rates to be tested.

    6. Each track circuit to be tested for shunting sensitivity.

        a. Shunting sensitivity to be tested by:

            i. Connecting an oscilloscope to the track circuit receiver detector at a point before the signal is digitalized or limited, and;
            ii. Placing a 0.25-Ohm shunting strap to be across the rails ten feet from the transmitting bond.

        b. Acceptable shunting sensitivity to be such that the effective voltage level of signal to be less than seventy-five (75) percent of the minimum voltage level, at that point, required to hold the track relay in an operated state.
        c. Shunting sensitivity to be tested after the final track circuit adjustment has been made.

L. Interlocking loop circuits.

    1. Interlocking loop circuits to be tested to verify that only the proper train carrier frequency transmitters are turned on for the route initiated.
    2. Interlocking loop circuits tests to also verify that all other loop circuits have sufficiently low signal levels to prevent a false speed command from being received on a train overrunning an interlocking signal indicating stop.
    3. Interlocking loop circuits to be tested by:

        a. Initiating all possible routes;
        b. Simulating train movements by use of shunts, and;
        c. Measuring current levels of train frequency carriers at all entering points for each track circuit in each route.

    4. All train frequency current levels to be recorded and submitted to the Authority.

M. Speed command loops.

    1. Speed command loops to be tested to ensure that only the proper inductively coupled ATP speed commands in AC track circuit areas meet the manufacturer-recommended levels and are turned on for the route initiated.
    2. Speed command loops to be tested by:

        a. Initiating train movement by use of shunts, and;
        b. Measuring current levels of train frequency current in each route.

    3. All train frequency current levels to be recorded and submitted to the Authority.

N. Receive-point loops.

1. Receive-point loops to be tested to ensure that the proper shunting of the high-definition receive-point loops and ATP speed commands meet the manufacturer-recommended criteria.
2. Receive-point loops to be tested by use of shunts to simulate train movement.
3. All track frequency levels to be recorded and submitted to the Authority.

O. Wayside train detection and protection circuit tests.

1. Each track circuit to be tested to determine that the speed commands transmitted by that track circuit conform to the speed commands shown on the approved drawings.

    a. An Authority-provided train to be used to test all cab signals for each track circuit.
    b. All control lines for the approved block layout to be tested, including all modified control lines for existing tie-in track circuits.

2. Wayside train detection and protection circuits to be tested by:

    a. Advancing the train to the track circuit being tested, and;
    b. Placing shunting straps on other track circuits required to provide the required speed commands as shown on the approved drawings.

        i. The track circuits ahead of the track circuit under test to be shunted in a way to simulate the movement of a maximum length train and a minimum length train.

            a. If an interlocking signal is in the control line for the track circuit under test, the test to be performed with the interlocking signal indicating stop and with the interlocking signal giving an indication other than stop.
            b. If a facing point switch is in the control line of the track circuit test, the test to be performed with the switch in both positions.

3. Acceptable wayside train detection and protection to be such that the cab signal displayed within the test train to conveys all individual speed commands shown by the control line for the track circuit under test.

P. Switch-and-lock movement.

1. All electric switch-and-lock movements to be tested to verify proper installation and operation.
2. Switch-and-lock movement tests to include, but are not limited to, the following:

    a. Field wires to switch-and-lock movements to be continuity checked to verify proper nomenclature in junction boxes and switch circuit controllers.
    b. Throw bar to be adjusted such that proper tension is placed on switch points in both directions.
    c. Lock rods and point detector rods to be adjusted after manually crank/lever switch machine to the far switch point such as to allow the switch machine to lock up with no obstruction.

        i. The above to be repeated for the same switch machine cranked/levered to the near switch point.

    d. Switch machine correspondence to be verified by turning on switch machine power and calling the switch machine normal to observe in the field that switch machine corresponds to position called and that in wayside instrument housing the proper switch correspondence relay is picked up.

e. Gaps on circuit controller contacts to be verified to see that the gaps meet equipment specifications with the switch machine operated to both the normal and reverse positions.

f. Each contact in switch circuit controller to be broken down to observe that the proper switch correspondence relay drops for both positions of the switch.

g. Clutch adjustment and overload to be confirmed by placing an ammeter in series with motor control energy and adjusting the clutch such that it causes overload relay to pick up in less than ten seconds with a quarter- (1/4) inch obstruction in switch point.

    i. Current readings to be recorded.
    ii. Clutch adjustment and overload to be verified in both positions.

h. The crank cut-out operation to be confirmed by inserting the hand crank and observing that the switch mechanism cannot be operated by power. That switch mechanism can be powered is to be subsequently verified by removing the cranks , restoring the latch and operating the machine under power.

i. Locking and indication tests for the normal and reverse points to be performed using a three-eighths- (3/8) inch and quarter- (1/4) inch obstruction gauges.

Q. Train stop layouts.

1. Train stop layout tests to include, but not be limited to, the following:

    a. Mechanical distance and arrangements to be checked against the approved installation drawings.
    b. The train stop indication contacts to be adjusted so that the NVP to be de-energized when the trip arm is lowered one quarter (1/4) inch below the full normal position.
    c. The train stop indication contacts to be adjusted so that the RVP to be energized when the trip arm is within one half (1/2) inch of the full reverse position.
    d. Contact closure and pressures to be checked to be in agreement with the manufacturer requirements.
    e. Checks to be made to ensure that the installed electric train stops operate at the manufacturer-recommended current requirements.

        i. The hold down circuit to be verified for proper functionality wherein it reduces the motor current.

R. Signal layouts.

1. Signal layout tests to include, but not be limited to, the following:

    a. Field wires to be checked for continuity.
    b. Field wires to have all nomenclature verified.
    c. All voltages to be adjusted to the nominal array rating.

        i. Energy to be applied to the signal lighting circuits to support this adjustment.

    d. Signal clearing relay contacts to be broken down to observe that proper signal aspects are displayed.
    e. Trip release to be operated to verify proper operation.
    f. Signals to be sighted for maximum visibility from the vantage point of a rail vehicle operator.

S. Route selector layouts

1. Route selector layout tests to include, but not be limited to, the following:

    a. Field wires to be checked for continuity.
    b. Field wires to have all nomenclature verified.
    c. Lighted indicators to be verified as corresponding with available routes.
    d. Route requests and cancel via the wayside selectors to be confirmed as inhibited unless location is in automatic mode of operation and track circuit directly in approach to signal is occupied.

T. Line circuits.

1. Line circuit tests to include, but not be limited to, the following:

    a. All conductors to be checked for continuity.
    b. All conductors to have all nomenclature verified.
    c. Proper response of the relay at the other end of the circuit to be verified by opening and closing the controlling relay contacts of the line.

U. Traffic locking.

1. Traffic locking tests to include, but not be limited to, the following:

    a. Traffic direction to be tested by first establishing each direction of traffic and then sequentially dropping each individual track circuit from headlock to headlock and observing that traffic cannot be reversed.
    b. Once traffic is established an attempt to be made to clear all possible conflicting routes and ascertaining that neither the conflicting route can be cleared nor can the established direction of traffic be affected.
    c. Each block repeater relay to be tested to determine that it follows all the proper track relays dropped in wayside instrument housings.
    d. With an established direction of traffic, the controlled signal governing entrance to that particular route to be put to stop when approach track circuit is occupied.

        i. Establishing traffic in the opposite direction to not be possible until a predetermined time has passed.
        ii. This predetermined time to be as indicated on the approved plans. It to be ascertained that approach or time locking is effective for this test.

    e. Both the normal and reverse directions to be tested in accordance with the above.

V. Interlocking and control point tests.

1. A detailed list of the tests and complete test procedures to be submitted for the approval of the Authority to establish safe and proper operation of interlockings.
2. The test sequence to be designed to test each function for correct performance in accordance with these Specifications and the approved plans. Furthermore, the test sequence to include simulated unusual conditions to determine that the interlocking circuits to respond in a safe and desirable way.
3. The functions to be tested to include, but not be limited to, the following:

    a. Approach locking.
    b. Time locking.

        c. Route locking.
        d. Verification of timing of time releases.
        e. Detector locking.
        f. Signal operation in accordance with route and aspect charts.

            i. Initiation and cancellation of routes in the automatic and manual modes of operation.

        g. Interconnection with existing signal systems.
        h. Interconnection with existing interlockings.

    4. Time tests to be as follows:

        a. Loss of shunt.
        b. Approach and time locking.
        c. Emergency traffic release and track locking.
        d. Emergency switch release.

    5. Overrun protection to be tested to ensure that with a route lined and the accepting train shunting the first interlocking detector track circuit downstream of the controlled signal governing the lined route, the cab signal train control energy being transmitted to the track to be shut off when another train overruns an interlocking signal protecting a conflicting route.

W. Route security locking.

    1. Each route to be tested for route security by establishing the routes and falsely picking the route check relay for each opposing or conflicting signal while observing that the associated signals stay at STOP and the associated signal clearing relays remain de-energized.

        a. Route security test procedures within microprocessor systems to be submitted by the Contractor and tested in accordance with the approved procedures.

X. Snowmelter layouts.

    1. Snowmelter layout tests to include, but not be limited to, the following:

        a. Field wires to be checked for continuity.
        b. Field wires to have all nomenclature verified.
        c. Control relay operation to be verified by applying energy to the control relay and observing that it picks up.
        d. Turn on controls to verify that the heating elements are operating and indicating operation properly.

            i. Proper contactor operation of applying and removing power from the heating element to be confirmed.
            ii. Removal and application of power by the designated fused to be confirmed by removal and installation of the designated fuse.
            iii. Door indicator LED light operation to be verified with all contactors closed and dark with any individual contactor open.

        e. All current sensors to be verified for proper operation and individual faults under the following conditions:

            - i. Break in heater element feed or return connection cables.
            - ii. Open 10A feed end fuse to any heater feed.
            - iii. Failure of contactor to close.
            - iv. Open 5A low voltage fuses.

        - f. All safety devices included in the snowmelter layout to be tested, including:

            - i. Door switch.
            - ii. Test switch.

        - g. Local control on/off to be tested.
        - h. Remote control on/off to be tested.
        - i. Location to location cascade of on/off control to be tested.

Y. Control office and maintainer workstation(s) to wayside interface.

1. Upon completion of the wayside tests, a simulated system test to be performed to ensure continuity of operation of wayside equipment from the supervisory control system.

    a. This test to consist of controlling all office wayside functions from a simulated supervisory control console and the transmission back to the simulated console of all indications from the field stations.

Z. Worker ahead (WA) warning system tests.

1. The worker ahead warning system tests to consist of checking the operation of:

    a. Control box switches (in every combination of switch positions).
    b. Indication lighting.
    c. WA lights.
    d. Verification of cab signal system speed downgrade when system is activated.

AA. Automatic vehicle identification (AVI) system tests.

1. The AVI system to be tested to verify the following:

    a. Verification that the equipment is installed and wired in accordance with the approved design and manufacturers recommendations.
    b. Proper routes are registered in the interlocking system logic when a transponder passes over the wayside reader within the set design and manufacturers parameters.
    c. The wayside reader is sufficient distance from the interlocking to allow signal clearing without cab signal degradation.
    d. AVI route requests are stored when interlocking is in the manual mode of operation.
    e. AVI requested routes are acted upon in the correct sequence when the interlocking is in the automatic mode of operation.

BB. Emergency control and indication panel tests.

1. The emergency control and indication panel tests to consist of controlling the wayside functions from the local or remote panel.
2. All controls and indications on the respective panel to be checked.

CC. System tests.

1. Tests to be conducted to verify the integrity of the installed signal and interlocking system. These tests to also include all tie in interface signal control and approach locking circuitry for all signaled tracks approaching and abutting the limits of this Contract.

    a. For interlockings, this test to be performed using the local control panel.
    b. Other system tests to include, but not be limited to, the following:

        i. With traffic lined normal, all possible routes to be lined. A 0.25-Ohm shunt to be placed sequentially on each track circuit in the route to simulate train movement. The Contractor to verify that all wayside signals are displaying the proper signal aspects as indicated on the approved plans.
        ii. All aspects observed during the progression of this test to be recorded.
        iii. Traffic to be established in the reverse direction, for each route between adjacent interlockings, and the system to be tested in a similar manner as described for normal direction operation.
        iv. Verification that cab signal energy code rates are in agreement with wayside signal aspects to also be made, and results recorded, for all routes shown on the approved plans.
        v. All design changes found necessary to obtain proper operation to be submitted to the Authority for approval.

DD. Operation recorders.

1. Operation recorders to be tested in accordance with the manufacturer-recommended test procedures and the approved field test procedures.
2. Operation recorder tests to include, but not be limited to, the following:

    a. Verification of indication wires for the proper input locations.
    b. Verification of the proper printed output for each input.
    c. Clarity of printed outputs.

EE. Power tests.

1. The following power tests to be made and recorded:

    a. The voltage of the main power feeders to be measured and recorded.
    b. A check of all fuses to be made for correct size and type.
    c. All power supplies to be checked for correct setting and quantities.
    d. Buss to buss checks to be made to determine that no shorts, crosses or grounds exist.

FF. Ground detector tests.

1. All ground detectors to be made operational (free from grounds) prior to performing this test.
2. The following ground detector tests to be completed and results recorded:

    a. A ground condition to be simulated on both the positive and negative sides of each power supply provided with a ground detector and verify:

        i. As the simulated ground is introduced the ground detector is tripped and alarm sounds.

    - ii. When simulated ground is removed the ground detector to reset and remain set and the alarm silent.

  - b. Test to be repeated for each power supply/ground detector combination.

GG. Transfer switch.

1. The following to be tested, and results recorded:

   - a. Both normal (inverter) and reserve (commercial power) sources available. Check indications and affected circuits.
   - b. Open normal source and verify transfer. Check indications and affected circuits.
   - c. Close normal and verify transfer back to normal.
   - d. Open reserve source and verify indications.
   - e. Open normal source and verify total power loss.
   - f. Close reserve source and verify transfer to reserve.
   - g. Close normal source and verify transfer back to normal.

HH. Dynamic braking tests.

1. The Contractor to perform dynamic braking tests for each speed command for each control line for the approved block layout.

   - a. Tests to be performed on the control lines for the new track circuits and for all commands for the existing tie-in track circuits.
   - b. Every speed command for every control line within the project limits to be tested.

2. A derated train and train crew to be provided by the Authority for the dynamic tests. Scheduling and arrangements of the tests, including coordination with the concurrent contracts, to be by the Contractor.

   - a. The Contractor to provide the Authority a minimum of four (4) weeks advance notice to allow the Authority to prepare the derated train.

3. All field personnel and equipment required to place shunts, measure speeds and distances, record results, and the supervision to perform the tests to be by the Contractor. The Authority may be present to observe the testing.
4. Prior to the tests, the Contractor to submit a detailed, step-by-step test procedure to be followed. Submittal of the test procedure to be sufficiently in advance of the test date to allow Authority review and comments to be incorporated.
5. Tests to be conducted for the normal and reverse directions. Tests to be conducted for all diverging and non-diverging routes. Where routings are combined, each routing to be tested. Use of data from a similar run, or extrapolation of data for similar runs to not be allowed.
6. Each block to be shunted at the entering end of the block for the direction being tested. The test train to be located at a point to allow the test speed to be obtained. With the train approaching the shunted block at maximum speed, the speed and location of the train when tripped to be recorded. The location where the train stops, and the distance to the shunt, to be recorded. Successive tests to be performed for the same shunted block at all speed commands less than the maximum speed.
7. Should any block layout modifications be required due to the results of the dynamic tests, the modified blocks to be retested by the Contractor at no additional cost to the Authority. The costs for train crews and preparation costs for any retests to be borne by the Contractor.

II. Ancillary signal house/room equipment, alarms, and HVAC system tests.

1. House/room intrusion and fire alarms to be tested in accordance with the approved design, manufacturer's recommended test procedures and the approved field test procedures. Tests to demonstrate and document results of the following:

    a. a. Activation and de-activation of the intrusion alarm.
    b. b. Activation of the fire alarm system and at what point the fire repellant would be released.

2. The house/room heating, ventilation, and air conditioning system to be tested in accordance with Manufacturer and Contractor provided procedures submitted to and approved by the Authority.

    a. Testing to demonstrate interoperability of all components in satisfying all requirements of the HVAC system stated within these specifications.

3.06 DISCREPANCIES

A. The Contractor to prepare Discrepancy Sheets to accompany each factory test section and each field installation and test section. These forms to be located at the end of each test section. All discrepancies found during testing to be noted on these forms.

1. There to be one (1) discrepancy sheet for each discrepancy uncovered within a test section. The sheet to contain the following minimum information:

    a. Test section and subsection.
    b. Detailed description of discrepancy.
    c. Detailed description of corrective action taken to rectify discrepancy.
    d. Printed name and signature of individual that uncovered discrepancy and date.
    e. Printed name and signature of individual that corrected discrepancy and date.
    f. Printed name and signature of individual witnessing corrective action and date.

2. If no discrepancies are found during a test, a single form should be included at the end of the test section with notation that no discrepancies had occurred. The sheet should then be dated and notarized with printed name and signature of the test person in charge and Authority’s witness to the tests.

B. In addition to discrepancy forms accompanying tests, the Contractor to maintain a separate up-to-date Master Discrepancy Logbook for each location.

1. This separate discrepancy log for each location to contain a copy of all discrepancy sheets as would be found in the field.
2. The log to be maintained in the order of testing.
3. A single “quick look” overview sheet to be maintained at the beginning of each log showing each test section along with the number of discrepancies and status of each.
4. Each locations discrepancy log to be submitted for review by the Authority on a weekly basis and a copy available for review within 24 hours of request.

C. No tests to be considered complete until all discrepancies have been resolved to the satisfaction of the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The work of 34 42 91 – Signal System Tests shall not be measured for payment.

4.02 PAYMENT

A. No separate payment shall be made for the work covered in this section. Payment for the work of 34 42 91 – Signal System Tests shall be included in the contract lump sum price as shown in the Schedule of Prices for Signal and Train Control Work.

4.03 PAY ITEM ACCOUNT NUMBER

A. Signal and Train Control Work: 344200.

END OF SECTION

SECTION 34 71 24

ROADWAY SIGNING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This work shall consist of the fabrication, furnishing, and mounting of signs and sign poles of various sizes and lengths to the project locations as per the Contract Drawings and as directed by the Commissioner. Standard traffic signs designated by letters and numbers must be according to the MUTCD. Standard traffic signs must be according to the Standard Highway Signs, except where otherwise specified by the Commissioner. Non-standard signs must be according to the Chicago Sign Manual and Detailed Drawings included in the Plans. Pole installation shall be either by dig method or drill method as shown on the Contract Drawings. The poles installed using dig method shall be 10 feet and 8 inches in length and the poles installed using drill method shall be 9 feet and 8 inches in length. The cost of wedges, sleeves, pole bases and all other required hardware to install poles is included in the cost of these items. As part of the work under this item, the Contractor must supply and install all hardware required for a complete installation including horizontal bracing channels, bands, bolts, washers and nuts.

1.03 RELATED SECTIONS

A. Work under these items shall be performed in accordance with the requirements of Section 720 of the Standard Specifications, the latest version of the City of Chicago Department of Transportation Field Manual For Sign Installation, and the Illinois Department of Transportation Manual on Uniform Traffic Control Devices (MUTCD), latest edition; except as herein modified.

B. Except as modified herein, the work must be performed in accordance with the requirements of Section 108.2 of Special Conditions for Transportation Construction, and applicable Additional Special conditions, as well as the requirements of the General Conditions, Division 1, and this Section.

1.04 REFERENCES

A. Standard Specifications for Road and Bridge Construction, Illinois Department of Transportation (IDOT), latest edition.

PART 2 - PRODUCTS

2.01 MATERIALS – SIGN PANELS

A. Sign Base - Flat Aluminum Base: Flat aluminum sign base material must be Type 5052 H38/Mill flat sheet and shall meet the requirements of Article 1090.01 of Standard Specifications. Mill certification sheets must be submitted with each order of fabricated signs. The sign panel thickness must be according to Article 1090.02 of the Standard Specifications.

B. All sign-bases used for non-reflective signs shall be powder coated. The sign base material must withstand exposure to temperatures up to 350 degrees Fahrenheit (as experienced during a powder coating process) and maintain all inherent physical characteristics. No warpage or other deformation must result from exposure to said temperature, and the bowing, when laid on a true flat surface must not exceed 1/16 inch per foot in length or width.

C. Sign Base Coating - Powder Coat Finish: Powder coatings of aluminum sign blanks must be used as the substrate for applying a reflective sheet of either heat applied or pressure sensitive adhesive, to be followed by direct application of message inks, pastes or baked enamel paints either by printing or silk screening processes and then receive a protective overlay film.

D. Electrostatically apply powder coat of selected color and bake in controlled high temperature oven to assure a smooth, hard satin finish.

E. Powder coating must be applied to both sides of sign blanks, including the back of one sided signs. Powder coating type must be a TGIC-Polyester. The powder coat color must be the same as the sign background color, as defined in the MUTCD.

  1. The powder coating process must include a negative electrical charge administered to the sign blanks, a five (5) stage washing process, an oven dry process, a cooling period, a spray application of polyester coating, which has been given a positive electrical charge to strengthen the bonding, a baking process as recommended by the paint vendor, at a temperature no higher than 350° and a cool down period.

     a. Coated surface must be free of visual defects such as orange peel, craters, dust, discoloration, etc.

  2. Application: Electrostatic Spray, cold.

     a. Substrate: 0.08 inch sheet aluminum, alloy 5032 H38.
     b. Pretreatment: Chromium chromate, Alodine as recommended by the coating.
     c. Manufacturer.
     d. Cure Schedule: As recommended by the coating manufacturer.
     e. Film Thickness: 2.0-2.5 Mils, or as required to cover.

  3. Colors: Safety Yellow, Red, Brown or White. The color of the powder discoloration, etc. coating must match the color of the sign background.

F. Powder coating must be tested and certified for the following properties:

TEST	METHOD	COATING PROPERTIES
*ASTM D3451 (18.3)	Specific Gravity	3.30±0.06
Theoretical Coverage		147±4 ft,°/lb/mil
*ASTM D3451 (13)	Volatile Content During Cure	<.5%
Maximum Storage Temp.		75°F
ASTM D623	Gloss at 80°	85+
Visual Comparison	PCI Power Smoothness	7
*ASTM D2454	Overbake Resistance, Time	100%
ASTM D3383	Pencil Hardness	H-2H
ASTM D2794 (modified)	Dir/Rev Impact, Gardner	40/10 in/lbs
ASTM D3359B	Adhesion, Cross Hatch	5B Pass
ASTM D522	Flexibility, Mandrel	1/8 In. dia. no fracture
ASTM D117 Salt Spray 1,000 hrs	1,000 hrs ASTM 04585	Humidity

*Above properties are typical, and vary with the product used.

G. Sign Face Materials

1. Non-reflective signs: The non-reflective material must conform with Section 1091.01 and 1091.02 of the Standard Specifications.
2. Reflective Signs: The reflective material must be Type A (glass spherical lens) as specified in Sections 1091.01 and 1091.02 of the Standard Specifications or Type AZ (Prismatic Retroreflective Sheeting) as specified herein. In accordance with the warranty requirements defined hereinafter, between the end of seven and ten years after installation, the coefficient of retroreflection must be greater than or equal to the percentages shown below for .2o and .5o observation and -4o and +30o entrance angles.

   a. Type A Sheeting: Initial requirements, for Type A sheeting, are as shown in Table 1091-2 of the Standard Specifications. For screen printed transparent colored areas or transparent colored overlay films on white sheeting, the coefficients of retroreflectivity must be greater than or equal to the values for the corresponding color shown in the table below.

Sheeting Color	Min.Coefficient of Retroreflectivity After Seven Years (% of Initial Requirements)	Min. Coefficient of Retroreflectivity After Ten Years (% of Initial Requirements)
White	85%	80%
Yellow	85%	80%
Green	84%	80%
Red	84%	80%
Blue	85%	80%
Brown	83%	80%

H. Silk Screen Inks: The silk screen inks must meet the recommendations of the manufacturer of the sign background material and be applied according to the ink manufacturer’s recommendations. Inks must be suitable for exterior applications with proven weather resistant and color retention properties. Ink types must include opaque, semi-transparent and transparent. The Contractor must provide specific types as required for type of applications indicated, as selected by Owner's Representative and as shown on approved shop drawings. The Contractor has the option to use vinyl graphic marking film, 3M Scotchcal in lieu of silkscreen inks. The Contractor must provide certification that the material meets or exceeds the requirements specified for silkscreen inks, including warranty requirements, and is compatible with sign materials. The color of the graphic marking film must be the same as specified for silkscreen inks.

I. Type AZ Sheeting

1. Type AZ sheeting shall consist of a flexible, colored, cube corner prismatic retroflective material having a smooth outer surface. It shall have a protective liner that is easily removed and a pre-coated pressure sensitive adhesive (Type 1) capable of being applied to the aluminum base without additional adhesive coats on the reflective sheeting or substrate material.
2. The sheeting shall be uniform in color and devoid of streaks throughout the length of each roll. It shall conform to the latest appropriate standard color tolerance chart issued by the U.S. Department of Transportation, Federal Highway Administration or through instrumental color testing. The diffuse day color of the reflective material shall conform to the following tables.
3. Transparent colors screened on white sheeting shall have initial `R' values not less the 50 percent for yellow and red, and 70 percent for green, blue and brown of the 0.2° observation angle/-4.0° entrance angle values shown in Table II for the color being screened.
4. Nighttime reflected colors shall be uniform, devoid of streaks, and appear substantially the same as daytime colors throughout the warranted service life.
5. Sheeting used for side by side overlay applications will require closer day/night color tolerances.

Color Specifications Limits (Daytime) Type AZ

Reflectance

Color	1		2		3		4		Limit Y (%)	
	X	Y	X	Y	X	Y	X	Y	Min.	Max.
White	0.305	0.305	0.355	0.355	0.335	0.375	0.285	0.325	40	-
Yellow	0.487	0.423	0.545	0.454	0.465	0.534	0.427	0.483	24	45
Orange*	0.583	0.416	0.523	0.397	0.560	0.360	0.631	0.369	30	-
Red	0.690	0.310	0.595	0.315	0.569	0.341	0.655	0.345	3	15
Blue	0.078	0.171	0.150	0.220	0.210	0.160	0.137	0.038	1	10
Green	0.030	0.398	0.166	0.364	0.286	0.446	0.201	0.794	3	9
Yellow/* Green	0.387	0.610	0.460	0.540	0.421	0.486	0.368	0.539	60	-
Yellow*	0.521	0.424	0.557	0.442	0.479	0.520	0.454	0.491	40	-

* FLOURESCENT COLOR

6. The four pairs of chromatically coordinates determine the acceptable color in terms of the CIE 1931 standard calorimetric system measured with standard illuminate D65.

7. The reflective intensity shall be determined by the procedures described in ASTME 810 except that values shall be met at both 0° and 90° or the 45° rotation angles without averaging.
8. Minimum Coefficient of Retroreflection
9. Average Candelas/Lux/sq m (candelas/foot candle/sq ft) of Material

Type AZ
(0 degree Rotation Angle)

Observation Angle 0.2 Observation Angle 0.5
Entrance Angle Entrance Angle Color -4
+30 -4 +30
White 430 235 250 170 Yellow 350 140 200
140 Yellow* 240 150 165 75

Yellow/ Green*	325	200	235	105
Green	45	24	25	19
Blue	20	11	10	7

* Fluorescent Colors

10. The sheeting surface shall exhibit a 85° gloss-meter rating of not less than 50 when tested in accordance with ASTM D 523.
11. Processed and applied in accordance with recommended procedures, the sheeting shall be weather resistant. Following cleaning, the applied sheeting shall show no appreciable discoloration, cracking, streaking, crazing, blistering, or dimensional change and shall exhibit not less than 80 percent of the brightness values shown in Tables II and III when exposed to 1,000 hours of accelerated weathering.
12. The test specimens shall be cleaned by immersing in 5% hydrochloric acid solution for 45 seconds, then rinsing with water and blotted dry with a soft clean cloth. The cycle used shall consist of 8 hours of light at 60° C followed by 4 hours of condensation at 40° C.
13. When tested according to ASTM D 4956, the sheeting shall not shrink in any dimension more than 1/32 inches in 10 minutes and not more than 1/8 inches in 24 hours.
14. After conditioning for 24 hours at 22± 4°C at 50± 5% relative humidity, with the protective liner removed, the sheeting shall show no cracking when tested by bending over a 1/8in mandrel in one second (adhesive coated with talcum power to prevent sticking to the mandrel).

15. A single roll shall not contain more than 4 splices per 50yd length. The sheeting shall be overlapped not less than 3/16".
16. The sheeting shall form a durable bond to smooth corrosion and weather-resistant surface and adhere securely at temperatures of -35° to 70°C. The pre-coated adhesive, 48 hours after application, shall be elastic enough to resist shocking off when struck at -23°C and strong enough to resist appreciable peeling. The bond shall be sufficient to support a 1.75lb weight attached to the free end of a specimen and allowed to hang free from an angle of 90° to the panel surface for 5 minutes without peeling more than 2" as outlined in the test for adhesive backing in Federal Specification LS-300.
17. Sheeting, with Type I adhesive, used for manufacturing cut-out legends and borders shall provide sufficient position ability during the fabrication process to permit removal and re-application without damage to either the legend or sign background and shall

have a plastic liner suitable for use on bed cutting machines. Thereinafter, all other adhesive and bond requirements contained in the specification shall apply.

18. The thickness of the sheeting without protective liner shall not be more than 0.025”.
19. The sheeting shall permit cutting and color processing in accordance with the sheeting manufacture’s recommendations at temperatures of 15° to 38°C and relative humidity of 20% to 80%. The sheeting shall be heat resistant and permit forced curing without staining of applied or unapplied sheeting at temperatures recommended by the manufacturer. The sheeting shall be solvent resistant and capable of being cleaned with VM & P naphtha, mineral spirits, and turpentine.
20. Stored under normal conditions and temperatures, the sheeting as supplied shall be suitable for use for a period of at least two years. With the exception of the mandrel test values specified, the sheeting shall continue to be pliable and workable.
21. The sheeting shall have a distinctive overall pattern in the sheeting unique to the individual manufacturer. If material orientation is required for optimum retroreflectivity, permanent marks indicating direction of orientation shall be incorporated into the face of the sheeting throughout the roll length. They shall be readily visible to the sign fabricator. Neither the overall pattern nor the orientation marks shall interfere with the reflectivity of the sheeting.
22. Documentation for roll materials shall contain a written declaration from the sheeting manufacturer stating that material storage conditions, fabrication and application processes, completed sign storage facilities, and packaging and shipping methods at the Department’s Sign Shop facilities are acceptable and comply with applicable material warranty conditions.
23. Rolls of the widths and lengths specified on the purchase order shall be supplied on a 3 inch I.D. fiber core the same width as the sheeting. The rolls shall be packed snugly in individual corrugated fiberboard boxes in such a manner that no damage or defacement will occur to the reflective sheeting during shipment or storage. Rolls of 12 inches or less in width may be multiply packaged. Both ends of each box shall be clearly labeled as to type, color, adhesive, manufacturer’s lot number, date of manufacture, and vendor’s name.
24. The vendor shall provide, at no cost to the user, the following incidental items for fabrication, packaging and installation of Type AZ roll good material. Quantities will be requested by the user and will not exceed those appropriate for use of the Types AZ material purchased.

    a. Opaque Silk Screen Ink - Black (Single Component, Low odor).
    b. Transparent Silk Screen Ink - All colors (Single Component, Low Odor, Clear Coat not required, 8 Hour Maximum Dry Time).
    c. Ink Thinner.
    d. Slip Sheeting (Perforated) 24in, 30in, 36in, and 48in widths by 100yd rolls.
    e. Nylon Protective Mounting Washer 1/16in Thick by 3/8in ID by 7/8in OD.
    f. Packing paper 24in, 30in, 36in, and 48in widths by 100yd rolls.

J. Type AZ sheeting used for permanent traffic control signs shall be guaranteed by the manufacturer to comply with the following:

1. Typed AZ sheeting processed and applied to new or refurbished aluminum sign blank material shall perform effectively and maintain a uniform day/night color for a period of ten (10) years after erection.
2. The sheeting shall be considered unsatisfactory when it has deteriorated due to natural causes to the extent that any of the following conditions exist:

a. The sign has been determined by the purchaser to be ineffective when viewed from a moving vehicle under normal day or night driving conditions.
b. Permanent streaking, cracking, or color variations (either day or night) develop on the sign surface.
c. The reflective value of a sign(s) at the 0.2° observation angle/-4.0° entrance angle is below the value shown in the following table. The reflective value shall be determined by averaging random reflective measurements * in accordance with the following criteria.

Sign Size (Square Feet)	1-50	51-200	over 200
Min. Random Measurement/Sign (Ea.)	5	9	15
Max. Readings Below Table II (Ea.)	1	2	3

K. Reflective Measurements will be made with a calibrated hand held retroreflectometer after wiping with a soft dry cloth to remove any dust, lent, or road film from the area to be measured.

L. The purchaser will date all signs by month and year when they are fabricated.

1. This guarantee will be prorated accordingly for signs erected more than one year after fabrication.

M. Warranty Criteria

1. Minimum Coefficient of Retroreflection
2. Candelas per Lux per Square Meter of Material
3. Observation Angle 0.2 Degree - Entrance Angle -4.0 Degrees

Type AZ

	Initial	(1-7yrs)	(8-	10yrs) Initial (1-7yrs) (8-10yrs)		
White	370.0	295.0		260.0 N/A	N/A	N/A
Yellow 100.0	300.0	240.0		210.0 175.0	140.0	
Green 16.0	45.0	36.0		31.0 31.0	22.0	
Blue 10.0	22.0	17.0		15.0 14.0	12.0	
	325.0	260.0		190.0 N/A	N/A	N/A
Yellow/Green*						
Yellow*	240.0	192.0	165.0 120.0	96.0	80.0	
Red	98.0	78.0	68.0 68.0	57.0	51.0	

*Fluorescent Color **
(1-3yrs)

N. When Type AZ sheeting does not perform in accordance with the guarantee, the manufacturer shall provide replacement signs during the first seven years after the sign is erected.

2.02 MATERIALS – SIGN POSTS

A. Materials: The material for the poles furnished must be hollow steel tubes, 2 - 3/8 inches outside diameter, conforming to ASTM A500 Grade B and coated for resistance to corrosion and outdoor weathering. Nominal wall thickness of the pole must be 0.08". The sign pole must be formed to the size and type specified in the Contract Drawings. Holes must be drilled prior to coating to prevent indentations and dimples in the poles.

B. Finish: The poles must be galvanized, straight and have a smooth, black, uniform powder coating finish as specified below. The interior of the sign poles must be coated with a minimum of an 81% zinc rich primer. The exterior of the poles must be galvanized with material conforming to AASHTO M 120 with a minimum weight of 1.00 ounce per square foot. The weight of the exterior galvanizing may be reduced to 0.65 ounces per square foot of High Grade material conforming to AASHTO M120 if applied with a chromate conversion coating and a clear high performance organic polymer coating. Powder coating of the poles and extensions must meet the following requirements:

1. Color: Vulcan Black Polyester
2. Product No.: PFB-401-S6
3. Cure: 400F-18 minutes PMT
4. Resin type: Polyester
5. Gloss: Medium

C. Pretreatment Process:

1. Cleaning: All parts must be cleaned utilizing spray washers and an alkaline cleaner to remove any remaining grease, dirt, or other contaminants.
2. Rinsing: All parts must be spray rinsed in a continuously overflowing rinse stage to remove any remaining cleaning solution.
3. Phosphating: All parts must be spray phosphated with a heated phosphate solution to provide a transition coating between metal and powder.
4. Rinse: All parts must be spray rinsed in a continuously overflowing rinse stage to remove any remaining phosphate / sealant solution.

D. Powder Coating Process:

1. Drying: All parts must be preheated to totally eliminate moisture and prevent off gassing of casting.
2. Powder Coating: A premium TGIC polyester powder must be Electrostatically applied to provide a uniform coating to a thickness of 1-3 mils (1 mil minimum). To achieve proper mil thickness, the powder must be applied with one application. The manufacturer must be responsible for ensuring proper adhesion to the metal surface.
3. Curing: All parts must be heated to the exact time and temperature requirements, recommended by the powder coat material manufacturer, in precisely controlled gas ovens.

E. Sleeve and Locking Wedge

1. Pole sleeve (pipe socket): Material must be hollow steel tubes conforming to ASTM A500 Grade B or ASTM A501, and galvanized according to AASHTO M111, nominal wall thickness of 0.109", 2- 5/8 inch inside diameter that allows for a minimum of 13-1/4 " of sign pole to nest inside the sleeve. The overall length of pole sleeve must be 27". A drawing detail as shown in the Appendix I shall govern.
2. Locking wedge: Material shall be 11 gauge steel tube conforming to ASTM A500 Grade B or ASTM A501 and galvanized according to AASHTO M111. The locking wedge shall be contoured to fit between the steel pole and the 27-inch sleeve. A drawing detail as shown in Appendix I shall govern.

F. Sign Pole Base

1. The sign pole base furnished under this contract includes a carriage bolt, tamperresistant nuts, and anchor bolts with nuts. The finished casting must be free from burrs, cracks, voids, or other defects.
2. Support base: Twelve-inch diameter, aluminum -zinc alloy casting per ASTM A197. The casting must have the words "City of Chicago" cast in relief as shown in the drawings provided in the Appendix I of these specifications.
3. Bolt washers and nut: Stainless steel as specified in Article 1006.31a of the Standard Specifications. Include a ½" x 4-1/2"carriage bolt with two 1"flat washers and a ½"13 full height hex nylon locknut.
4. Anchor Bolt: Galvanized steel expansion anchors conforming to Article 1006.09 of the Standard Specifications. Red Head #1236 (½"x 3-3/4"). Furnish three (3) per each sign base provided.
5. Finish: Powder coat to minimum 1 mil thickness with satin black polyester finish.

2.03 MATERIALS – SIGN PANEL MOUNTING

A. The sign mounting hardware for the signs furnished under this contract includes brackets, holders, bands, bolts, nuts, washers, screws and all other necessary devices to connect sign assemblies and to mount signs to new posts, existing light or traffic signal posts, or adjacent structures. Bolts and nuts must be tamper-resistant.

B. Sign Hardware for center mount on sign poles and light poles: Stainless steel sign bracket, 5/16"x 5/8" stainless steel hex head flanged bolt, and 3/8"x 3/4"x 1/16" stainless steel washers. 5/16"x 3.5" stainless steel socket head screw with 1-1/2"x1-1/4" sign bracket, two flat washers and nylon locknut per fastener assembly as per the installation detail in the Appendix I. Mounting detail for back-to-back sign mount on light pole is provided in Appendix I.

C. Sign Hardware for flag or center mount, banded to light poles: Two 0.75 inch x 0.020 inch stainless steel band fasteners.

D. Sign hardware for center mounting: One stainless steel button head socket head screw with two flat washers and nylon locknut per mounting bracket, to attach mounting bracket to pole. Two button head socket head screws with four flat washers and nylon locknut per mounting bracket to attach sign to the sign bracket.

E. Sign Hardware for flag mount on light pole or sign pole: Cast aluminum brackets per the drawing in the Appendix I. The sign mounting brackets must be an aluminum-zinc alloy. The casting must be tenzaloy with a multi-curve back design. The sign brackets must be powder coated with a satin black finish, Product 311 B, with Cure 400F - 18 minutes PMT, TGIC polyester. A drawing of this bracket is included in the Appendix I. Mount the brackets to a sign pole with a 3" x 5/16" stainless steel bolt and nylon lock nut.

F. Mount the bracket to a light pole by banding with 0.75 inch x 0.020 inch stainless steel banding. Attach the sign to each bracket with two 1-1/4" x 1/4" stainless steel bolts and nylon locknut.

G. Miscellaneous: All stainless steel screws, bolts, washers and nuts must conform to the requirements of Section 1006.29(d) of the Standard Specifications. All bolts and nuts must have National Coarse Thread.

2.04 MATERIALS SAFETY-SIGN PANELS

A. All suppliers for roll material shall furnish at no cost, any product information, Material Safety Data Sheets, bulletins, technical service required to use the sheeting, and the name(s) and telephone number(s) of qualified service personnel that may be contacted during normal working hours to address any product related problems.

B. Additional Sign Face Materials Requirement: Contractor must certify that all materials used in the fabrication of signs (substrate material, inks, films, overlays) are compatible with one another under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience, and that the materials comply with these specifications.

C. City of Chicago Identifier: In addition to the above requirements, signs must have "CITY OF CHICAGO XX" logo screened at the bottom center or top right corner of the sign where XX represents the last two digits of the year of sign manufacture.

2.05 SUBMITTALS/MATERIAL ACCEPTANCE – SIGN PANELS

A. Shop drawings: Fabrication shop drawings showing full size sign layout, color, message (including "City of Chicago" logo and date of sign fabrication), graphics and proposed materials for each sign assembly, including poles, bases and hardware must be submitted for approval prior to start of fabrication. Similar sign types that have the same sizes, colors, symbols and text layout must be submitted using one full size sign layout. Note: The message “City of Chicago XX”, where XX represents the last two digits of the calendar year of sign manufacture, must be screened on all signs furnished under this contract. For stock items, submit manufacture's catalog sheets for approval before shipping the order. B. Materials:

1. Aluminum: Mill Certifications, Samples
2. Powder coating: Test Data; Sample; Manufacturer's Certification that material complies with the required specifications.
3. Sign Face Material: Test Data; Samples; Manufacturer's Certification that material complies with the required specifications. Test Data must be gathered by an independent agency, such as AASHTO’s National Transportation Product Evaluation Program (NTPEP). Test data must cover retroreflective sheeting and process inks and/or overlay films manufactured by the sheeting manufacturer in standard traffic colors.

C. Samples: Submit one sample for each sign type.

D. Certifications: The manufacturer must submit written certification for material's compliance with these specifications.

E. Maintenance Instructions: Submit manufacturer’s printed instructions for maintenance of each product, coating and film, including precautions for use of cleaning materials and solvents for paint removal which could damage specified materials. F. Warranty:

1. Non-Reflective Signs: The manufacturer’s warranty period is five (5) years. Failures under warranty include, but are not limited to: coating degradation or failure, chalking, fading, structural or material failure, delamination of applied graphics and adhesive failure. The final punch list completion and acceptance constitutes the start of the warranty period.
2. Reflective Signs: The manufacturer’s warranty period will be for seven (7) years. The warranty will cover the cost of replacement signs. Failure under warranty includes, but is not limited to: loss of retroreflectivity below the minimum specified under sign face materials above, deterioration of retroreflectivity sheeting to the extent that the sign is ineffective for its intended purpose when viewed from a moving vehicle under normal day and night driving conditions, coating degradation or failure, chalking, fading, structural or material failure, delamination of applied graphics and adhesive failure.

G. The final punch list completion and acceptance date constitutes the start of the warranty period.

2.06 SUBMITTALS/MATERIAL ACCEPTANCE – SIGN POLES

A. Shop Drawings: Fabrication shop drawings showing the full size layout, color, and proposed materials for poles, bases, and hardware must be submitted for approval prior to start of fabrication.

B. Poles: Mill certification, samples of each size of finished pole and extension.

C. Locking wedge and sleeve: Samples of each item.

D. Cast aluminum base: Mill Certifications.

E. Powder coating: Test Data; Sample; Manufacturer's Certification that material complies with the required specifications.

F. Galvanizing: Manufacturer's Certification for compliance with these specifications.

G. Stainless steel bolts and nuts, anchor bolts: sample, product data sheet.

H. Installation: All installation shall be performed in accordance with Article 720.04 of the Standard Specifications.

1. Dig Method: To install a sign pole by dig method, the Contractor will first drive a base sleeve to a level with the top of the sleeve near flush to the ground. The sign pole will then be inserted into the sleeve and raised to a level with the bottom of the pole 10 to 12 inches below the ground. The sign pole will then be locked in place by driving a locking wedge between the sign pole and the base sleeve. Note: Pipe sleeve and wedge shall not be bolted together. The holes at the top of the sign pole will be properly aligned such that the sign to be installed will properly face the flow of traffic.

2. Drill Method: The base will be secured to the concrete surface by steel expansion anchors and must be leveled by using stainless steel washers as shims at the anchor bolt locations and under the base castings. The sign pole will be installed into the cast iron base and locked in place with a carriage bolt with two flat washers and a nylon lock nut as shown in the Appendix I. The holes at the top of the sign pole must be aligned such that the sign to be installed will properly face the flow of traffic. Sign poles will be installed 18" from back of curb unless otherwise specified. Poles for transportation stops, e.g. bus, taxi, tour bus, or tour boat stops, must be installed 24" from the back of the curb unless otherwise noted.

I. Warranty: Manufacturer's warranties shall be 5 (five) years. The final punch list completion and acceptance date constitutes the start of the warranty period.

2.07 SUBMITTALS/MATERIAL ACCEPTANCE – SIGN POLES

A. Submit materials data, catalog sheets, certifications and samples, for each type of hardware specified, for the City's approval prior to the start of work.

B. Installation: All signs must be installed at locations and with mounting type as specified on Contract Drawings. Sign panels must be installed according to Article 720.04 of the Standard Specifications and as specified herein. Sketches showing 30° and 90° mounting details of signs are provided in the Appendix I. Sign panels will be installed on newly supplied sign poles and on existing light poles or traffic signal poles. Installation will include provision of all necessary support brackets, flanges, banding material, and hardware to provide a complete installation. On light poles or traffic signal poles, sign panels will be installed by the banding method. Guide signs and flag mounted signs will be installed on brackets banded to the light/signal pole. Two (2) stainless steel bands will be required for signs up to six (6) feet high. Three (3) bands will be required for signs over six (6) feet high.

C. Warranty: Manufacturer's warranty shall be 5 (five) years. The final punch list and acceptance date constitutes the start of the warranty period.

PART 3 - EXECUTION (see PART 2 above)

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of ROADWAY SIGNING will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of ROADWAY SIGNING will be included in the contract lump sum price as shown in the Schedule of Prices for CIVIL WORK.

4.03 PAY ITEM ACCOUNT NUMBER

A. CIVIL WORK: 020000

END OF SECTION 34 71 24

SECTION 34 72 00

PARKING SIGN RELOCATION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Book 1 Terms and Conditions for Construction, Book 2 Instructions and Execution Documents, Additional Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. This work shall consist of reimbursing the owner of the InterPark LLC Theater District Parking Garage, 181 North Dearborn Avenue, Chicago for the purpose of relocating to the west the cantilevered sign over the Lake Street entrance. The property owner will hire a contractor independently of the City's contract.

PART 2 - PRODUCTS – none

PART 3 – EXECUTION

3.01 SUMMARY

A. The contractor must pay the owner's contractor in advance of the relocation. This work is estimated as $60,000 in cost.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. The Work of PARKING SIGN RELOCATION will not be measured for payment.

4.02 PAYMENT

A. No separate payment will be made for the work covered in this section. Payment for the Work of PARKING SIGN RELOCATION will be included in the contract lump sum price as shown in the Schedule of Prices for STRUCTURAL WORK.

B. If the final cost invoiced by the parking garage owner's contractor is more or less than $60,000, the contract lump sum price for STRUCTURAL WORK will be adjusted up or down the same amount.

4.03 PAY ITEM ACCOUNT NUMBER

A. STRUCTURAL WORK: 030000

END OF SECTION 34 72 00

APPENDIX A

STRUCTURAL GEOTECHNICAL REPORT
REPLACEMENT OF THE STATE/LAKE LOOP ELEVATED CTA STATION

Structural Geotechnical Report

Replacement of the State/Lake Loop Elevated CTA Station
Chicago, Illinois

Prepared for

CDOT
CHICAGO DEPARTMENT
OF TRANSPORTATION

Prime Consultant:

Transystems Corporation

Prepared by

GSG CONSULTANTS, INC.
Engineers. Scientists. Construction Managers
735 Remington Road, Schaumburg IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

December 3, 2021

GSG CONSULTANTS, INC.

735 Remington Road
Schaumburg, IL 60173
Tel: 630.994.2600
www.gsg-consultants.com

December 3, 2021

Mr. Will Colletti, P.E., S.E.
Transystems
222 South Riverside Plaza, Suite 610
Chicago, IL 60606

Structural Geotechnical Report
Replacement of the State/Lake Loop Elevated CTA Station
Chicago, Illinois

Dear Mr. Colletti:

Attached is a copy of the Structural Geotechnical Report for the above referenced project. The report provides a description of the site investigation, site conditions and foundation and construction recommendations for the Replacement of the State/Lake Loop Elevated CTA Station in Chicago. The site investigation for the foundation design and construction included advancing nine (9) soil borings to depths ranging from 121 to 133 feet, including cores of the bedrock.

Should you have any questions or require additional information, please call us at 630-994-2600.

Sincerely,

Min Zhang, Ph.D., P.E.
Project Engineer

Ala E Sassila, Ph.D., P.E.
Principal

Executive Summary
Structural Geotechnical Report
Replacement of the State/Lake Loop Elevated CTA Station
Chicago, Illinois

GSG completed a geotechnical investigation for the proposed replacement of the State/Lake Loop Elevated CTA Station in Chicago, IL. The geotechnical investigation included advancing a total of nine (9) soil borings across the site. Four bedrock cores were also collected from four (4) boring locations. GSG also completed vane shear tests at five (5) soil boring locations. Below is a summary table of the borings completed at the site.

Soil Boring Summary Table

Boring ID	Depth (feet)	Existing Ground Elevation CCD(1)	Summary of Bedrock Coring			
			Depth (ft)	Recovery (%)	RQD (%)	RQD Classification
B-01(3)	122.5	14.0	NA			
B-02	133.0(2)	13.7	123.0	98.3	76.7	Good
B-03	123.5	14.0	NA			
B-04	120.5	13.6				
B-05(3)	121.0	14.0	NA			
B-06	131.0(2)	14.4	121.0	100	85.4	Good
B-08(3)	119.0	14.5	NA			
B-09(3)	131.0(2)	15.0	121.0	98.8	97.3	Excellent
B-10(3)	127.5(2)	14.1	117.5	99.4	66.7	Fair

(1) City of Chicago Datum
(2) Completed with 10-foot Bedrock Core
(3) Vane Shear Testing completed

Project Information

GSG understands that the proposed project will include the replacement of the existing elevated CTA station platform, including an eight-car platform with fare collection area, new elevators to the new platform and below ground station, two escalators and a new canopy. The existing State/Lake platform will be demolished using phased construction.

Foundation Recommendation

Based on the subsurface soil conditions and anticipated loads, GSG recommends supporting the platform bents upon drilled shaft foundations, bearing upon the hard to very hard silty clay encountered at depths approximately 90.0 (-76 CCD) feet below existing street grade. The recommended maximum net allowable soil bearing capacity of the hard to very hard silt clay is 18 kips per square foot (ksf). The maximum net allowable bearing capacity is that pressure that can be transmitted to the soils in excess of the final overburden pressure.

Alternatively, the drilled shaft foundations could extend to the top of the solid dolomite bedrock, which was encountered below approximately 3 feet of fracture bedrock at a depth between of 120 to 123 feet below the street level (-106.0 to -109.0 CCD). For drilled shaft cored or socketed one (1) foot into the solid bedrock, the maximum net allowable bearing capacity of the bedrock is 200 kips per square foot (ksf) per Table 1806.2 of the City of Chicago Building Code. This value may be increased by 40 ksf for each additional foot that the drilled shaft is socketed into the bedrock, to a maximum of 400 ksf. The minimum recommended shaft diameter is 4 feet based on the anticipated drilled shaft depths.

Construction Consideration

Based on the vane shear test results, the ratio of overburden pressure divided by the undrained shear strength of the soft clay exceeds the limited value at depths ranging from 20 to 55 feet. Therefore, a protective casing will be required from the top of the drilled shafts to a maximum depth of 55 feet. A summary of the squeeze potential analysis is attached in **Appendix F**.

TABLE OF CONTENTS

Appendices

1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) completed a geotechnical investigation for the proposed Replacement of the State/Lake Loop Elevated CTA Station in Chicago, Illinois. The purpose of the investigation was to explore the subsurface conditions, to determine engineering properties of the subsurface soil, and develop design and construction recommendations for the proposed station replacement.

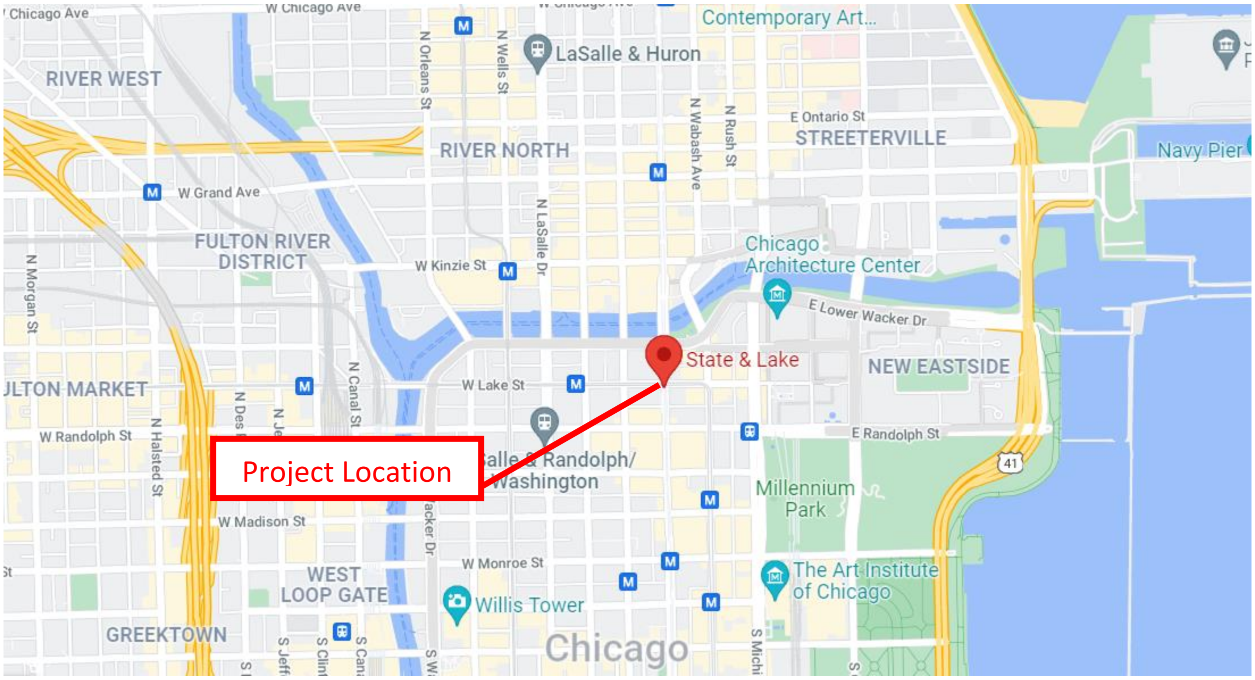

Exhibit 1: Project Location Map

1.1 Proposed Project Information

Based on detailed specifications provided by Transystem, the general scope of this project includes construction of an elevated rapid transit station on the Loop Elevated Line at State Street and Lake Street as well as accessibility improvements at the Lake Red Line Subway Station. The work is anticipated to include the following:

- Phased demolition of the existing State/Lake Station.
- Foundation construction including micropiles, earth retention, and excavation.
- An eight-car platform with fare collection area including four elevators, two escalators and a canopy.
- Utility connections, utility relocation, vaulted sidewalk modifications, pavement

reconstruction, sidewalks, signaling and streetscaping.
- Track Structure modifications and replacements.
- Phased partial demolition of the existing Lake/Randolph subway mezzanine.
- Renovation of the existing Lake/Randolph subway mezzanine and platform to add two elevators.

GSG’s scope of work is to provide geotechnical investigations to determine the nature and conditions of subsurface soil conditions and provide recommendation regarding foundation type, allowable bearing capacity, estimated settlements, seismic site classification, lateral foundation design parameters for the proposed structures as shown in **Appendix A** and other engineering parameters required during construction activities; and describe any potential difficulties that may encountered during the site development activities in the vicinity of the proposed improvement.

1.2 Regional Geology

GSG reviewed several published documents to determine the regional geological setting in the area. The subject area is in the eastern portion of Cook County, Illinois. The surficial geologic deposits in this area are typically glacial drift deposited during the Wisconsin Glacial Age. The geology of the subject area consists of lake deposits; largely silt with sand facies near shorelines, extending from the surface to approximately 80 feet deep. Deposits are primarily from the Carmi Member of the Equality Formation, which, consists of deposits of largely quiet-water lake sediments; dominantly well-bedded silt, locally laminated and containing thin beds of clay; local lenses of sand and sandy gravel along beaches. This formation overlies the Silurian System Dolomite (undifferentiated) which varies from extremely argillaceous, silty and cherty to exceptionally pure with an average depth of generally 100 to 120 feet below ground surface in the subject area, consistent with the boring logs.

2.0 SUBSURFACE EXPLORATION PROGRAM

This section describes the subsurface exploration program and laboratory testing program completed as part of this project. The subsurface exploration program was performed in accordance with applicable AREMA and IDOT geotechnical manuals and procedures.

2.1 Subsurface Exploration Program

GSG conducted a subsurface exploration between November 2 and 13, 2021. The investigation included advancing nine (9) borings to the top of bedrock, between depths of 121 and 133 feet. The locations of the soil borings were proposed by Transystem and adjusted based on OUC review and field accessibility to avoid underground utility conflicts. After completion of the Existing Facility Protection process through the City of Chicago Office of Underground Coordination (OUC), the borings were staked at the approved locations on site for the public DIGGER utility locate. Elevations, referenced to Chicago City Datum, and as-drilled locations for the borings were based on the topographic survey provided by Transystem. The as-drilled locations of the soil borings are shown on the Soil Boring Location Plan & Subsurface Profiles **(Appendix B)**. **Table 1** present a summary of the borings completed for the improvements. One proposed boring location (B-07) could not be completed as planned due to the utility conflicts and underground concrete obstructions.

Table 1 – Summary of Subsurface Exploration Borings

Boring	Northing	Easting	Existing Ground Surface Elevation CCD**	Depth (ft)
B-01	1901758.80	1176024.60	14.0	122.5
B-02	1901724.37	1176047.64	13.7	133.0*
B-03	1901759.66	1176167.96	14.0	123.5
B-04	1901724.14	1176228.52	13.6	120.5
B-05	1901759.94	1176214.96	14.0	121.0
B-06	1901708.56	1176378.69	14.4	131.0*
B-08	1901730.29	1176576.25	14.5	119.0
B-09	1901782.88	1176568.45	15.0	131.0*
B-10	1901510.79	1176297.95	14.1	127.5*

* Depth includes Bedrock Core (10 feet)

**Chicago City Datum with 0 CCD at 579.88 feet

Pavement cores were collected at the marked boring locations. The upper 10 feet at each location was hydro-vacuumed as requested by the Office of Underground Coordination (OUC's) permit due to the presence of multiple underground utilities within the close of proximity of the soil borings.

The soil borings were drilled using a truck mounted Diedrich D-50 TM, Diedrich D-50 ATV and CME-75 drill rigs, equipped with 3¼-inch I.D. hollow stem augers and an automatic hammer. Soil sampling was performed according to AASHTO T 206, "Penetration Test and Split Barrel Sampling of Soils." Soil samples were obtained at 2.5-foot intervals to a depth of 30 feet, then at 5-foot intervals to the boring termination depths where practical auger and split spoon refusal on bedrock was encountered. Water level measurements were made in each boring when evidence of free groundwater was detected on the drill rods or in the samples. The boreholes were also checked for free water immediately after auger removal, and before filling the open boreholes with soil cuttings and surface patching with concrete where necessary to match the existing pavement or concrete.

GSG also collected rock core samples at boringsB-02, B-06, B-09 and B-10 with the use of a ten-foot diamond bit, NX-5 split core barrel during the investigation. The collected bedrock cores were evaluated in the field for texture, physical condition, recovery percentage, and Rock Quality Designation (RQD). The extracted samples were visually inspected and classified, and the Rock Quality Designation (RQD) was determined according to ASTM D 6032, “Standard Test Method for Determining Rock Quality Designation (RQD) of Rock Core” by totaling all sections with a length in excess of four (4) inches and dividing it by the total length of the core run. The RQD is given a classification based upon the numeric value as indicated in **Table 2**.

Table 2 – Rock Quality Designation Summary

Rock Quality Designation (RQD)	Descriptions
< 25%	Very Poor
25 – 50%	Poor
51 – 75%	Fair
76 – 90%	Good
91 – 100%	Excellent

2.2 In-Situ Vane Shear Test

GSG performed in-situ vane shear testing during the field investigation activities. The vane shear tests were performed in five of the borings in accordance with ASTM D 2573 and were completed in conjunction with soil boring drilling activities. The vane shear test consisted of advancing a four-bladed vane into undistributed cohesive soil at the bottom of a bore hole and applying a measured torque at a constant rate until the material fails in shear along a cylindrical surface. Test results can be affected by the presence of gravel or sand layers. The torque measured at failure provides the undrained shear strength of the soil. A second test run immediately after the soil has failed at the same depth provides the remolded strength of the soil and, thus, information on soil sensitivity can be obtained. The soil sensitivity (St = intact vane shear strength/remolded vane shear strength) is normally described as follows:

Table 3 – Vane Shear Descriptions

Sensitivity	Descriptive Term
0-1	Insensitive
1-2	Low Sensitivity
2-4	Medium Sensitivity
4-8	Sensitive
8-16	Extra Sensitive
>16	Quick

A summary of the vane shear test results and the sensitivity of the soft clay layer in each of the borings tested is presented in **Table 4**.

Table 4 - Vane Shear Test Results

Boring ID	Depth (ft)	Shear Strength (tsf)	Remolded Shear Strength (tsf)	Sensitivity
B-01	27.5	0.58	0.36	1.6
	37.5	0.78	0.58	1.3
	47.5	0.78	0.52	1.5
B-05	25.0	0.36	0.17	2.2
	32.0	0.78	0.31	2.5
	42.0	0.78	0.34	2.3
B-08	25.0	0.58	0.22	2.6
	32.0	0.43	0.25	1.7
	42.0	0.39	0.21	1.9
B-09	25.0	0.41	0.17	2.5
	32.0	0.39	0.18	2.1
	42.0	0.43	0.22	1.9
B-10	25.0	0.78	0.45	1.7
	32.0	0.62	0.43	1.5
	42.0	0.45	0.34	1.3

The vane shear tests revealed undrained shear strengths ranging from approximately 0.39 to 0.78 tons per square foot (tsf) for undisturbed samples, and from approximately 0.17 to 0.58 tsf for the remolded samples. The clay sensitivity ranged from 1.3 to 2.6, which is considered to have low to medium sensitivity. The vane shear test results are shown on the attached boring logs.

2.3 Laboratory Testing Program

All samples were inspected in the laboratory to verify the field classifications. A laboratory testing program was undertaken to characterize and determine engineering properties of the subsurface soils encountered in the area of the proposed bridge. The following laboratory tests were performed on representative soil samples:

- Moisture content ASTM D2216 / AASHTO T-265
- Atterberg Limits ASTM D 4318 / AASHTO T-89 / AASHTO T-90
- Dry Unit Weight ASTM D7263
- Particle Size Distribution ASTM 6913 / AASHTO T11/T27
- Hydrometer Analysis ASTM D422
- Unconfined Compressive Strength on Rock ASTM D2938

The laboratory tests were performed in accordance with test procedures outlined in the IDOT Geotechnical Manual (2020), and per ASTM and AASHTO requirements. Based on the laboratory test results, the soils encountered were classified according to the Unified Soil Classification System. The results of the laboratory testing program are included in the Laboratory Test Results **(Appendix D)** and are also shown in the Soil Boring Logs **(Appendix C)**.

2.4 Existing Pavement Conditions

Table 5 provides a summary of the existing pavement thicknesses from the pavement cores collected at each of the boring locations. The photographs of the pavement cores are included in the **Pavement Core Exhibits (Appendix E)**.

Table 5 – Pavement Core Summary

Pavement Core ID	Asphalt Thickness / Overlay (inches)	Concrete Thickness (inches)	Granite Paver Thickness (inches)	Total Thickness (inches)
B-01	8.0	-	4.0	12.0
B-02	3.0	14.0	-	17.0
B-03	5.5	6.0	-	11.5
B-04	4.0	9.5	-	13.5
B-05	8.5	8.5	-	17.0
B-06	-	9.0	-	9.0
B-07	11.0	-	6.0	17.0
B-08	10.5	-	6.5	17.0
B-09	-	6.5	-	6.5
B-10	-	11.0	-	11.0

2.5 Subsurface Conditions

This section provides a brief description of the soils encountered in the borings performed in the vicinity of the proposed improvement. Variations in the general subsurface soil profile were noted during the drilling activities. Detailed descriptions of the subsurface soils are provided in the soil boring logs and are shown graphically in the **Boring Location Plan & Subsurface Profiles** (**Appendix B**). The soil boring logs provide specific conditions encountered at each boring location and include soil descriptions, stratifications, penetration resistance, elevations, location of the samples, and laboratory test data. Unless otherwise noted, soil descriptions indicated on boring logs are visual identifications. The stratifications shown on the boring logs represent the conditions only at the actual boring locations and represent the approximate boundary between subsurface materials; however, the actual transition may be gradual.

2.5.1 Existing Fill

The surface elevation of borings ranged from 13.6 to 15.0 CCD. Under the pavement sections, the top 10 feet of soil was hydro vacuumed excavated, and no samples were obtained for visual classification. At a depth of 10 feet below grade, all the borings encountered a miscellaneous fill layer, including sand, silt, clay, gravel, and wood to elevations 1.5 to -2.4 CCD.

The standards penetration test (SPN) values of the fill layer were between 6 and 29 blows per foot (bpf), with most values less than 10 bpf and a moisture content ranging between 10 to 24%. These fill materials are not considered expansive.

2.5.2 Native Soil

Under the fill, the borings usually encountered a crust layer of medium stiff to very stiff gray silty clay layer to elevations of -1.0 to -8.1 CCD, followed by very soft to medium stiff silty clay to elevations of -35 to -46 CCD, stiff to hard gray silty clay to elevations of -63 to -75 CCD, and very stiff to hard gray silty clay with sand and gravel to elevations of -103.5 to -108.5 CCD where bedrock was encountered. Borings B-01, B-08, and B-10 also encountered clayey gravel under the silty clay layer to the top of the bedrock at -101.4 to - 107.5 CCD. Borings B-04 and B-05 encountered around 6 feet of limestone fragments under the silty clay layer to the top of the bedrock at -105.0 CCD. Sand and gravel seams were observed throughout the clay deposits. Upon encountering bedrock, a zone of highly weathered limestone, approximately 2 to 5 feet thick, was encountered in several borings before terminating with auger refusal and initiating the rock cores.

The unconfined compressive strength values of the crust layer generally ranged between 0.5 and 3.1 tsf with moisture contents between 16 and 31%. The unconfined compressive strength values of the very soft to medium stiff silty clay generally ranged between 0.1 and 0.5 tsf with moisture contents between 18 and 44%, and most values over 25%. The unconfined compressive strength of the stiff to hard silty clay generally ranged between 1.0 and 3.8 tsf with moisture contents between 13 to 28% and most values below 25%. The unconfined compressive strength of the hard silty clay with sand and gravel generally ranged between 1.5 and 5.0 tsf with moisture contents between 7 to 22% and most values below 15%.

Rock core samples were collected at Borings B-2, B-6, B-9 and B-10. The bedrock cores generally consisted of gray limestone, with slight weathering, some fracturing and occasional vugs. **Table 6** provides the RQD values and unconfined compression strength values of the rock cores extracted during the site investigation. Photographs of the cores are included with each boring log in **Appendix C**.

Table 6 – Rock Core Summary and Classification

Boring Number	Core Run	Core Depth (feet)	Type of Rock	RQD (%)	RQD Classification	Depth (ft)/ Unconfined Compression Strength (psi)
B-02	1	123.0-133.0	Limestone	76.7	Good	124.2-124.9/10,570 129.0-129.8/11,104
B-06	1	121.0-131.0	Limestone	85.4	Good	123.0-123.7/7,819 127.6-128.2/7,082
B-09	1	121.0-131.0	Limestone	97.3	Excellent	121.0-122.0/13,016 129.0-130.0/7,827
B-10	1	117.5-127.5	Limestone	66.7	Fair	122.1-123.1/9,350 125.5-126.5/8,589

2.6 Groundwater Conditions

Water levels were checked in each boring to determine the general groundwater conditions present at the site and were measured while drilling and after each boring was completed. Water was not encountered in any of the borings, while drilling or after the completion of drilling.

Based on the color change from brown to gray and the proximity to the Chicago River and Lake Michigan, it is anticipated that the long-term groundwater level could range between elevations 1.5 to -2.4 CCD. Perched water may be encountered within the existing fill materials. Water level readings were made in the boreholes at times and under conditions shown on the boring logs and stated in the text of this report. Long term observations in cased borings or piezometers would be necessary to evaluate the long-term groundwater conditions at the site. However, it should be noted that fluctuations in groundwater level may occur due to variations in rainfall, other climatic conditions, or other factors not evident at the time measurements were made and reported herein.

3.0 GEOTECHNICAL ANALYSES

This section provides GSG's geotechnical analysis and recommendations for the design of the proposed improvements based on the results of the field exploration, and laboratory testing.

3.1 Derivation of Soil Parameters for Design

GSG determined the geotechnical parameters to be used for the project design based on the results of field and laboratory test data on individual boring logs as well as our experience. Unit weights, friction angles and shear strength parameters were estimated using corrected standard penetration test (SPT) using published correlations for N values results for the fill and cohesionless soils and in-situ and laboratory test results for cohesive soils. The SPT values were corrected for hammer efficiency. The hammer efficiency correction factor considers the use of a safety hammer/rope/cat-head system, generally estimated to be 60% efficient. Thus, correlations should be based upon what is currently termed as N_{60} data. The efficiency of the automatic hammer used for this exploration was estimated to be approximately 94% for the Diedrich D-50 TM, Diedrich D-50 ATV and CME-75 truck mounted rig based on previous efficiency testing of the drill rigs. The correction for hammer efficiency is a direct ratio of relative efficiencies as follows:

N_{60} = N * (96/60): Diedrich D-50 TM
N_{60} = N * (98/60): Diedrich D-50 ATV
N_{60} = N * (91/60): CME-75 TM
*Where the N value is the field recorded blow counts.

Based on the field investigation data collected, generalized soil parameters for the soils for use in design are presented in **Table 7**.

Table 7 – Summary of Soil Parameters

Depth Range (Elevation CCD, feet)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained	
			Cohesion c (psf)	Friction Angle ϕ (°)	Cohesion c (psf)	Friction Angle ϕ (°)
	New Engineered Clay Fill	125	1,000	0	100	25
	New Engineered Granular Fill	125	0	30	0	30
0-14 (14 - 0)	Sand and Gravel Fill	132	0	30	0	30
Long term ground water table						
14-19 (0 - (-5))	Gray Medium Stiff to Very Stiff Silty Clay	133	1,300	0	130	28
19-53 ((-5) - (-39))	Gray Very Soft to Soft Silty Clay	113	250	0	25	26
53-83 ((-39) - (-69))	Gray Stiff to Hard Silty Clay	138	2,200	0	220	28
83-114 ((-69) - (-105))	Gray Hard Silty Clay with Sand and Gravel	138	4,300	0	430	34
114-121 [1] ((-100) - (-107))	Gray Extremely Clayey Gravel	137	0	42	0	42
119 (-105) and below	Gray Limestone	165	NA			

1. Layer only noted in Borings BSB-01, BSB-08 and BSB-10

3.2 Seismic Parameters

The seismic hazard for the site was evaluated per the AREMA 2019 Manual, Seismic Design for Railway Structures (Chapter 9). The manual specifies that the seismic hazard potential should be evaluated for both the peak ground, short and long period acceleration, using the coefficients obtained from the United States Geologic Survey (USGS) website. A three-level ground motion and performance criteria approach was employed. The Site Class for the soils encountered was generally found to be Site Class E. The Short Period and Long Period Spectral Acceleration and Peak Ground Acceleration (PGA) have been provided for 100 years (40% in 50 years), 475 years (10% in 50 years), and 2475 years (2% in 50 years) return periods for the project location (Latitude 41.885674, Longitude -87.627822) in **Table 8**.

Table 8 – Seismic Design Parameters

Railroad Response Level	Ground Motion Level	Performance Criteria Limit State	Return Period	Peak Ground Acceleration (PGA)	0.2 Second Spectral Response Acceleration (S_S)	1.0 Second Spectral Response Acceleration (S_1)
II	1	Serviceability	100 year (40% in 50 year)	0.0065 g	0.0144 g	0.0056 g
III	2	Ultimate	475 year (10% in 50 year)	0.0215 g	0.0438 g	0.0216 g
III	3	Survivability	2475 year (2% in 50 year)	0.0568 g	0.1088 g	0.0535 g

4.0 GEOTECHNICAL STRUCTURAL DESIGN RECOMMENDATIONS

This section provides the design parameters, foundation type, bearing capacity, settlement, and lateral earth pressure for the proposed structures. Foundation design recommendations presented within this section were completed per the AREMA 2019 Manual.

Below is a summary of the anticipated structure elements of the project:

- Bents for the new platform along Lake Street – the maximum vertical load of 990 kips, shear in north-south of 170 kips and shear in east-west of 180 kips at Bents 447 N&S
- Elevator 1
- Expanded corridor 1
- Elevator 2

The final foundation type is normally selected based on the nature of subsurface soils, anticipated loading, and site condition considerations. The foundation design recommendations are highly dependent upon anticipated structural loads, nature of subsurface soils, and construction considerations. Below is a brief discussion of each anticipated foundation system.

4.1 New Platform Deep Foundation Design Recommendation

4.1.2 Drilled Shaft Foundations

The new platform for the elevated tracks is anticipated to be supported on 23 bents, which could be supported upon drilled shaft foundations extending to hard silty clay at a depth of 90 feet or to the solid bedrock at depths between 121 and 123 feet below the existing street level. The recommended net allowable bearing capacity that could be used for the design of the drilled shaft foundations bearing on these materials is shown in **Table 10**. The net allowable bearing capacity is the pressure that can be transmitted to the soils/rock in excess of the final overburden pressure.

Table 10: Drilled Shaft Parameters

Approximate Bearing Depth (ft)*	Estimated Shaft Length (ft)	Strat Description	Net Allowable Bearing Capacity (ksf)**
90.0	90.0	Hard Silty Clay with Sand and Gravel	20.0
123.0	123.0	Solid Dolomite bedrock	200.0

*Depth below current sidewalk/street level

**Net allowable bearing capacity values are calculated based on a factor of safety of 3.0 and limited by 2019 Chicago Building Code.

The allowable bearing capacity may be increased by 1/3 for intermittent loads such as wind.

Based on the bedrock core recovery (>95%) and RQD (>70%) of the bedrock in B-02, B-06 and B-09, a maximum net allowable bearing capacity of 200 kips per square foot (ksf) could be used for drilled shaft socketed one (1) foot into the solid bedrock based on Table 1806.2 of the City of Chicago Building Code. This value may be increased by 40 ksf for each additional foot the drilled shaft is socketed into the bedrock, to a maximum of 400 ksf. , The solid bedrock is presnet at a depth of 2-4 feet below the fractured bedrock. The minimum recommended shaft diameter is 4 feet based on the anticipated drilled shaft depths.

For a single drilled shaft bearing on the hard silty clay layer, the anticipated settlement from the soil layer below the tip of the shaft is approximately 0.3 inches considering a maximum bearing pressure of 20 ksf. For drilled shafts bearing on fair to very good bedrock, elastic settlement can be assumed to be less than 0.25 inches. The maximum differential settlement between drilled shafts will be on the order of ½ of the total settlement. These settlement values are for the soil compression only, and the elastic compression of the drilled shaft concrete should be added to these values.

Side resistance would not be built up on the drilled shafts and is not included in the overall bearing capacity. Group effects for drilled shafts founded on hard silty clay should be considered. Settlement of drilled shafts founded on rock is usually very small and group effects for considering axial capacity are not usually significant. As it can be expected that the shafts will penetrate through or into the hard clay soils, very dense silt or bedrock, the contractor should be prepared for hard drilling and be prepared with techniques to properly clean the bottom of the shaft before any concrete is placed.

Concerns for drilled shaft construction include (1) the top 15 feet of granular fill could cave into the drilled holes; (2) the very soft clay at depths ranging from 15.0 to 55.0 feet below existing street grade with high water content could squeeze into the drilled shaft shafts. Squeeze potential of the very soft clay was analyzed based on the vane shear test results and the results are included in **Appendix F**. The ratio of overburden pressure divided by the undrained shear strength of the soft clay at depths ranging from 20 to 55 feet is above the limited values. Therefore, protective casing will be required to avoid squeezing into drilled shaft. Construction of drilled shaft should follow the recommendations in Section 5.2. GSG understands that the drilled shafts will be placed adjacent to nearby buildings and underground utilities and tunnels during construction. The City of Chicago will require the installation of a permanent casing to maintain the sides of the drilled shaft excavation through the upper fill materials and soft clays.

4.1.2 Micropile Foundations

As an alternative option, micropile foundations can be used to support some bents. Micropiles are normally designed and built by a specialty contractor and are installed with the use of equipment similar to that used for anchoring and grouting. Micropiles typically develop their capacity using side friction. Often, due to their small size and construction methods, end bearing is neglected. Micropiles typically have a relatively small diameter, between 6 and 12 inches, and are drilled to the bearing depth and grouted. The presence of fill materials at the site may cause the micropile to cave in during installation; therefore, provisions should be made to case the micropile during installation.

The loads applied at the top of the micropile are normally resisted through the bond zone. The micropiles should be designed and installed in accordance with AREMA requirements and should be verified through the performance of load tests. The micropiles should be extended to the bond zone, which typically consists of suitable soils or bedrock. The bond zone is anticipated between depths of (-75 CCD) and (-105 CCD) where hard silty clay was encountered or between depths of (-105 CCD) and (-110 CCD), where fractured bedrock was encountered in the borings. The fractured bedrock depth varied between 4 and 5 feet, which was followed by sound bedrock at estimated elevations of (-110 CCD) to (-120 CCD).

For micropiles designed to provide total design capacity primarily through side resistance, the allowable grout to ground bond strength values should be used to calculate the available resistance for various materials in a particular bond zone. Assuming that the pressure grouting method will be used for the construction of the micropiles, **Table 11** shows the typical ultimate grout to ground bond strengths for the soils encountered.

Table 11 – Typical Ultimate Grout-to-Ground Bond Strengths for Micropile Design (Table C10.9.3.5.2-1, AASHTO)

Elevation CCD	Soil Description	Grout-to-Ground Allowable Strengths (psi)
(-75)- (-105)	Stiff to Hard Silty Clay	10
(-105) – (-108)	Highly Weathered Limestone	17
(-108) - (-115)	Limestone/ Dolomite Bedrock	150

We recommend performing static load test to verify the presumptive grout to ground bond nominal resistances assumed for micropile design and the geotechnical resistance of the micropile. The City of Chicago Building Code allows a maximum axial load of 30 kips (15 tons) without load test.

The City of Chicago may require extending the micropiles to the top of the bedrock. An allowable bearing capacity of 200 ksf could be used for the design of the micropiles socketed into bedrock. It should be noted that for micropiles bearing on bedrock, the structural capacity of the micropile itself normally controls the total available design capacity, as the capacity of the rock will be much higher. The micropiles may need to be socketed into the bedrock a minimum of 5 or 10 feet, to ensure that the pile is bearing on high quality rock.

For micropiles bearing on fair to very good bedrock, elastic settlement can be assumed to be less than 0.25 inch. The maximum differential settlement between micropiles will be on the order of ½ of the total settlement.

4.2 Elevator 1 – Deep Foundation Design Recommendations

Based on information provided by Transystems, the base of the proposed Elevator 1 will be located at a depth of approximately 25 feet below the existing sidewalk level, where soft to medium stiff silty clay was encountered. GSG does not recommend supporting the elevator pit upon the soft clay materials as it will likely experience excessive settlement based on the subsurface soil data. Deep foundations consisting of micropiles could be used to support Elevator 1. Recommendations for Micropiles can refer to Section 4.1.2.

4.3 Lateral load Resistance for Deep Foundations

It is understood that deep foundations will be designed for the lateral loads and moments anticipated for the proposed structures. Lateral loadings applied to deep foundations are typically resisted by battering selected piles, the soil/structure interaction, pile flexure, or a combination of these factors. Section 3.10.1.10 of the 2012 IDOT Manual requires performing detailed structure interaction analysis if the factored lateral loading per pile exceeds 3 kips. The analysis shall determine actual pile moment and deflection to determine the selected pile adequacy for the existing loadings. **Table 12** provides recommended lateral soil modulus and soil strain parameters that can be used for laterally loaded pile analysis via the p-y curve method based on the encountered subsurface conditions.

Table 12 – Lateral Load Resistance Soil Parameters

Depth Range (Elevation CCD, feet)	Soil Description	Long-term/Drained			Parameters for p-y Curve Method	
		Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	At-Rest Earth Pressure Coefficient (K_o)	Coefficient of Subgrade Modulus** (k_{py}, pci)	Horizontal Strain Factor ε_{50}
	New Engineered Clay Fill	0.41	2.46	0.58	500	0.01
	New Engineered Granular Fill	0.33	3.00	0.50	90	NA
0-14 (14 - 0)	Sand and Gravel Fill	0.33	3.00	0.50	60	NA
14-19 (0 - (-5))	Gray Medium Stiff to Very Stiff Silty Clay	0.36	2.77	0.53	500	0.007
19-53 ((-5) - (-39))	Gray Very Soft to Soft Silty Clay	0.39	2.56	0.56	30	0.02
53-83 ((-39) - (-69))	Gray Stiff to Hard Silty Clay	0.36	2.77	0.53	1,000	0.005
83-114 ((-69) - (-105))	Gray Hard Silty Clay with Sand and Gravel	0.28	3.54	0.44	2,000	0.004
114-121[1] ((-100) - (-107))	Gray Extremely Clayey Gravel	0.20	5.04	0.33	125	NA

* Layers only noted in Borings BSB-01, BSB-08 and BSB-10

** The initial p-y modulus, E_{py} , varies linearly with depth. To obtain E_{py} use the equation $E_{py} = k_{py} * z$, where k_{py} is the Coefficient of Subgrade Modulus given in the table and z is the distance from the surface to the center point of the layer in inches.

4.4 Elevator 1 - Expanded Pedestrian Corridor

Based on the preliminary drawings from Transystems, an expanded pedestrian corridor will be constructed adjacent to Elevator 1. The bottom elevation of the corridor is anticipated at approximately 18 feet below the existing sidewalk level, where soft to medium stiff silty clay was encountered. GSG recommends the floor slabs be supported by a minimum of 24 inches of self-compacting stone such as IDOT CA-7 or CA-1 to provide a stable base above the soft clay at the bottom of the floor slab. It is recommended that geotextile fabric to be placed on the top of the soft clay prior to placement of the stone to separate the fine and coarse materials. The floor slab should be designed using a vertical subgrade reaction modulus of 50 pounds per cubic inch (pci).

4.5 Elevator 2 - Foundation Design Parameters

Based on information provided by Transystems, the proposed Elevator 2 shaft will bear at a depth of approximately 52 to 56 feet below the current sidewalk level near the depth of the existing subway platform. At this depth, stiff gray silty clay was encountered. GSG recommends supporting the elevator pit upon 1 foot of granular stone such as CA-1 or CA-7. The Elevator 2 shaft could then be designed using a net allowable bearing capacity of 2,000 psf. The Elevator 2 shaft should be designed using undrained and at-rest soil pressures because it would not be practical to place a drainage layer along the elevator shaft.

4.6 Below Grade Walls - Shallow Foundation Design Recommendation

Based on the provided information, there will be continuous below grade walls bearing approximately 20 feet below existing grade, which could be supported on continuous strip footings. Soft to medium stiff gray silty clay was encountered at this depth. It is not recommended to bear foundations directly on these soils due to the low strength values and potential for large settlement. The proposed shallow foundations should bear as high as possible at the top of the stiff to very stiff silty clay layer at a depth of 15 feet below grade. If the bearing elevation for the continuous strip footings will be placed 20 feet below grade, GSG recommends removing the soft to medium stiff gray silty clay soils to a minimum depth of two times the footing width below the foundation and replacing with new engineered granular fill. The continuous strip footings, with a minimum width of 2 feet, bearing on new engineered fill may then be designed using a net allowable bearing capacity of 1,000 psf and would result in a total settlement of less than 1 inch and differential settlement less than 0.5 inches. Exhibit 2 illustrates the structural fill placement below the footings.

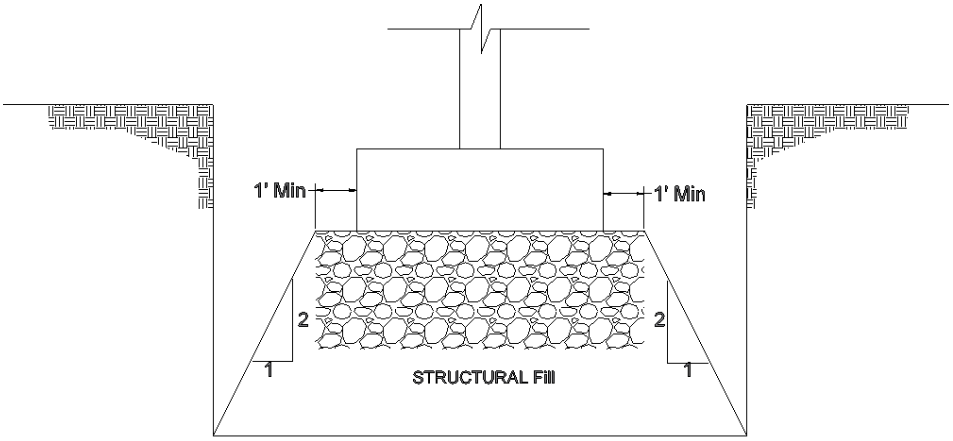

Exhibit 2: Structural Fill Placement below Footing

As an alternate to the structural fill where a smaller excavation trench is desirable, Controlled Low Strength Material (CLSM) may be used to backfill foundation over-excavations in lieu of structural fill. The over-excavation for the CLSM placement will be limited due to vertical trench with no sloping. The trench excavation shall extend laterally a minimum 6 inches beyond the footing width. The CLSM shall not be placed upon uncontrolled fill, soft materials, or below the water table. The ultimate compressive strength of the CLSM shall be no less than 200 pounds per square inch (psi) when tested on the 28th day per ASTM D4832.

4.7 CLSM Backfill for Subway Construction

Based on the provided information, CLSM backfill will be used for the subway construction areas. The anticipated density of the CLSM is 115 pcf with a compressive strength of 100 pci. Initial lateral pressure during placement of CLSM can be calculated using an equivalent fluid pressure of 115 pcf. After CLSM curing is completed, the lateral pressure could be estimated using an equivalent fluid pressure of 35 pcf.

CLSM should be placed by any method which preserves the quality of the material in terms of compressive strength and density. Lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, should be limited to the lesser of 4 feet or calculated lift heights based on the structure stability which CLSM placed against. Another lift of CLSM should not be placed until the last lift of CLSM has set and gained sufficient strength to prevent lateral load due to the weight of the next lift of CLSM.

5.0 CONSTRUCTION CONSIDERATIONS

All work performed for the proposed project should conform to the requirements in the AREMA 2019 Manual, IDOT Standard Specifications for Road and Bridge Construction (SSRBC) and IDOT Construction manual 2021. Any deviation from the requirements in the manuals above should be approved by the design engineer.

5.1 Existing Utilities

Based on the existing site conditions, significant utilities exist throughout the project area that will interfere with construction. Before proceeding with construction, where possible all existing underground utility lines that will interfere with construction should be completely relocated. Where possible, existing utility lines that are to be abandoned in place should be removed and/or plugged with a minimum of 2 feet of cement grout. All excavations resulting from underground utilities removal activities should be cleaned of loose and disturbed materials, including all previously placed backfill, and backfilled with suitable fill materials in accordance with the requirements of this section. During the clearing and stripping operations, positive surface drainage should be maintained to prevent the accumulation of water.

5.2 Site Excavations

The contractor will be responsible to provide a safe excavation during the construction activities of the project. All excavations should be conducted in accordance with applicable federal, state, and local safety regulations, including, but not limited to the Occupational Safety and Health Administration (OSHA) excavation safety standards. Excavation stability and soil pressures on temporary shoring are dependent on soil conditions, depth of excavations, installation procedures, and the magnitude of any surcharge loads on the ground surface adjacent to the excavation. Excavation near existing structures and underground utilities should be performed with extreme care to avoid undermining existing structures. Excavations should not extend below the level of adjacent existing foundations or utilities unless underpinning or other support is installed. It is the responsibility of the contractor for field determinations of applicable conditions and providing adequate shoring for all excavation activities.

5.3 Borrow Material and Compaction Requirements

If borrow material is to be used for onsite construction, it should conform to the requirements of the applicable sections of the 2019 AREMA Manual of recommended practice, or as a minimum Section 204 “Borrow and Furnish Excavations” of the IDOT Construction Manual (2021). Earth-moving operations should be avoided during excessively cold or wet weather to avoid freezing or softening subgrade soils. The fill material should be free of organic matter and debris and should be placed in lifts and compacted according to Section 5.5, Design of Backfill (AREMA 2019).

All backfill materials must be pre-approved by the site engineer. Backfill materials for undercut areas should be placed in 8 inches loose lifts and should be compacted to 95% of the maximum dry density as determined by AASTHO T-180, Modified Proctor Method.

GSG recommends that subgrade preparation, and structural fill placement and compaction be inspected by a GSG geotechnical engineer to verify the type and strength of soil materials present at the site and their conformance with the geotechnical recommendations in this report.

5.4 Groundwater Management

It is anticipated that the long-term water table is at approximately 1.5 to -2.4 CCD. Perched water should be anticipated within the upper granular fill materials. GSG does not anticipate groundwater related issues during construction activity due to the proposed improvements. If rainwater run-off or groundwater is accumulated at the base of excavations, the contractor should remove accumulated water using conventional sump pit and pump procedures and maintain a dry and stable excavation. The location of the sump should be determined by the contractor based on field conditions. During earthmoving activities at the site, grading should be performed to ensure that drainage is maintained throughout the construction period. Water should not be allowed to accumulate in the foundation area either during or after construction. Undercut and excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater or surface run-off. Grades should be sloped away from the excavations to minimize runoff from entering.

It is anticipated that temporary shoring will be necessary for the below grade excavations. If steel sheeting is planned to be installed around the entire perimeter of the proposed excavation, the sheeting will extend well into the clay soils and serve as a cutoff wall to prevent perched water from entering the site. Some water may still seep through the interlocks of the steel sheeting, but it is anticipated this could be removed by normal sump pump operations. No well points or other sophisticated dewatering is warranted for this site.

If water seepage occurs during excavations or where wet conditions are encountered such that the water cannot be removed with conventional sumping, we recommend placing open grade stone similar to IDOT CA-7 to stabilize the bottom of the excavation below the water table. The CA-7 stone should be placed to 12 inches above the water table, in 12-inch lifts, and should be compacted with the use of a heavy smooth drum roller or heavy vibratory plate compactor until stable. The remaining portion of the excavation beneath the footings should be backfilled using approved structural fill.

5.5 Drilled Shaft Construction

Any drilled shaft construction should be completed in accordance with Section 24.3 in AREMA 2019 and Section 516, Drilled Shafts, in the IDOT SSRBC. Permanent casing will likely be required to extend to the bottom of the upper stiff to hard silty clay layer encountered in the soil borings. Water should be removed from the base of the drilled shaft base prior to placing any concrete. The placement method of concrete for the drilled shaft foundation should be based on the amount of water present at the base of the shaft just prior to placing the concrete. Concrete may be placed using the free fall method, provided less than 2 inches of water is present at the base of the shaft at the time the concrete is being placed. If more than 2 inches of water is present, a tremie should be used to displace the water to the surface for removal.

GSG recommends that the drilled shaft concrete be ready on site as the drilled shaft excavation is completed, so that the concrete can be placed immediately after completing the excavation. This will reduce the potential of water accumulation in the bottom of the shaft. Bottom cleanliness of the drilled shaft excavation should be observed from the ground surface with the use of flood light or down-hole camera. When direct observation of the bottom is not possible, sounding the bottom with a weighted tape or rock probe is necessary. Workers should not enter the shaft to manually clean the base of the shaft due to safety reasons.

To confirm the quality of construction of drilled shafts, Non-Destructive Testing (NDT) can be utilized to confirm the integrity of the shaft. The most common test is cross-hole sonic logging (ASTM D6760), according to IDOT Construction Manual (2021).

5.6 Temporary Sheeting, Soil Retention and Stage Construction

A temporary soil retention system (TSRS) will be necessary during all construction excavation in excess of 4 feet due to the subsurface soil conditions and the presence of underground utilities and foundations of the existing elevated tracks and other structures. This would require the installation of a temporary earth retention system to support the site excavation and to act as cut-off wall for the groundwater. The design of the temporary soil retention system (TSRS) is normally the responsibility of the contractor. The retention system shall be designed by an Illinois licensed structural engineer in accordance with the AREMA, Part 28, and the City of Chicago requirements. The contractor should submit the TSRS plans to the structural design team for review prior to commencing construction of the TSRS.

Table 13 provides a summary of adhesion and friction values that may be used in addition to the soil properties from **Table 7** for TSRS design. It is recommended that sheet piles be installed around the entire perimeter of the proposed to provide a groundwater cutoff during construction.

Table 13 – Adhesion and Friction Factors for Steel Sheet Pile

Depth Range (Elevation CCD) feet	Soil Description	Active Earth Pressure Coefficient (K_a)	Nominal Adhesion (psf)	Nominal Friction Factor (Friction Angle)
0-14 (14 - 0)	Sand and Gravel Fill	0.33	n/a	0.30 (17°)
14-19 (0 - (-5))	Gray Medium Stiff to Very Stiff Silty Clay	0.36	500	n/a
19-53 ((-5) - (-39))	Gray Very Soft to Soft Silty Clay	0.39	250	n/a
53-83 ((-39) - (-69))	Gray Stiff to Hard Silty Clay	0.36	950	n/a

5.7 Potential Effect of Excavation on Existing Structures and Utilities

Excavations adjacent to existing structures and utilities will reduce support to the foundation of these structures and utilities. Excavations should not extend below the level of adjacent existing foundations or utilities unless underpinning or other support is installed. It is the responsibility of the contractor for field determinations of applicable conditions and providing adequate shoring for all excavation activities.

Existing structures, vaulted sidewalks, tunnels, and significant utilities are located throughout the project site; therefore, earth retention system or foundation underpinning will be required for all foundation excavations. The City of Chicago requires that all drilled shaft excavations within 15 feet of an existing open tunnel, bridge, other structure foundations, and utilities mains to be permanently cased with heavy wall casing from 5 feet above the crown of the foundation to a minimum 10 feet below the invert/bottom of the foundation. Therefore, permanent steel casing will be required to a depth of 10 feet of the existing tunnel along Lake Street. Also, the drilled shafts should be drilled at a minimum distance of 5 feet from the wall of the existing tunnel.

5.8 Building Condition Survey and Construction Monitoring

Existing structures around the site could be impacted by construction activities such as ground vibration during foundation installation, subway excavations or ground vibration due to operation of heavy construction equipment. GSG recommends completing a pre-construction and post-construction condition survey for all structures located around the site to document the existing conditions of the structures. The survey should include documentation of cracks, opening of joints, and other defects and deficiencies.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of Chicago Department if Transportation and its Design Section Engineer (DSE) Transystems. The recommendations provided in the report are specific to the project described herein and are based on the information obtained from the soil borings located within the project limits. The analyses performed and the recommendations provided in this report are based on subsurface conditions determined at the location of the borings. This report does not reflect all variations that may occur between boring locations or at some other time, the nature and extent of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations presented herein.

APPENDIX A

FOUNDATION PLAN AND SECTIONS

1 FOUNDATION LAYOUT PLAN

1" = 20'-0"

NOTES:

1. DIMENSIONS OF FOOTINGS, NUMBER OF MICROPILES, AND DEPTH OF FOUNDATIONS TO BE DETERMINED DURING FINAL DESIGN.
2. ALL FOUNDATIONS WILL BE REMOVED TO 3' BELOW GROUND AND BURIED.
3. PROPOSED FOUNDATION AND COLUMN LOCATIONS SHOW ARE SUBJECT TO ONGOING UTILITY COORDINATION.

DESIGN BY:	WJC									
DRAWN BY:	WJC									
CHECKED BY:	MDS									
APPROVED BY:	MDS			60% SUBMITTAL						
CDOT/APPROVED BY:		NO.	DATE	REVISIONS	DES.	DRW.	CHK.	DCCO	CDOT	

TranSystems
TRANSYSTEMS
222 SOUTH RIVERSIDE PLAZA SUITE 610
CHICAGO, ILLINOIS 60606

SOM
SKIDMORE, OWINGS & MERRILL LLP
224 SOUTH MICHIGAN AVENUE, SUITE 1000
CHICAGO, ILLINOIS 60604

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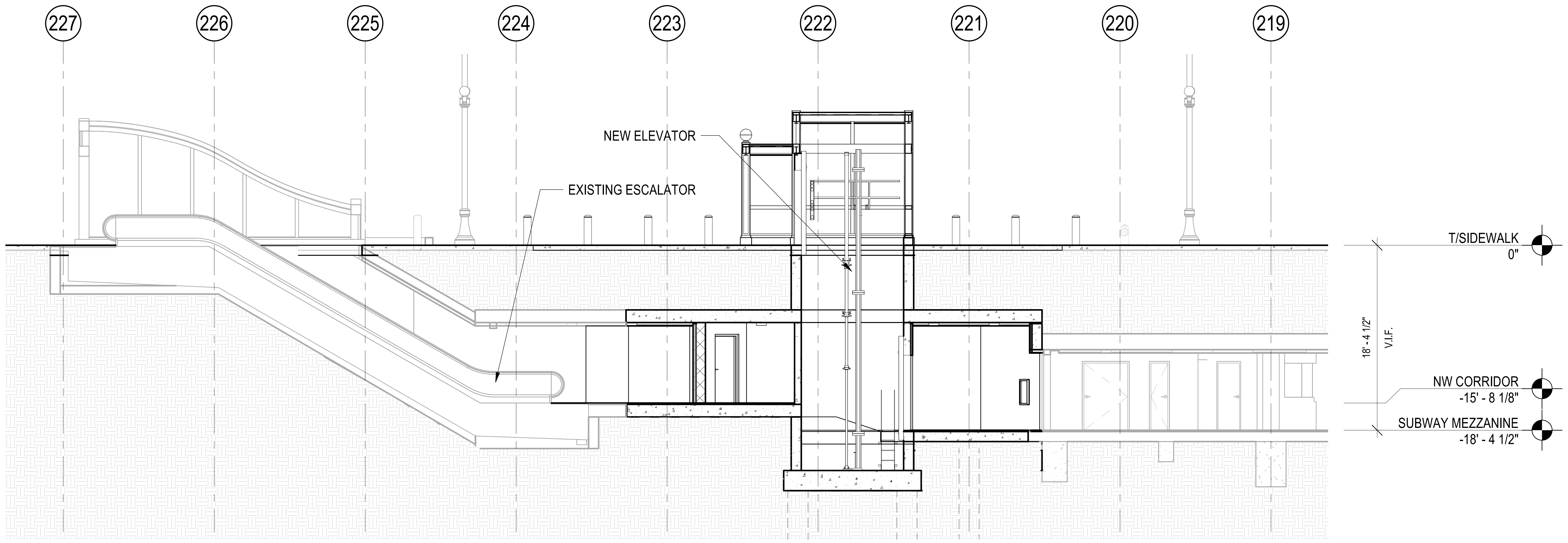
CHICAGO DEPARTMENT
OF TRANSPORTATION
DIVISION OF ENGINEERING

STATE / LAKE LOOP ELEVATED STATION
SPEC. NO.

OVERALL PLAN - GROUND LEVEL
DRAWING NO.
S-101

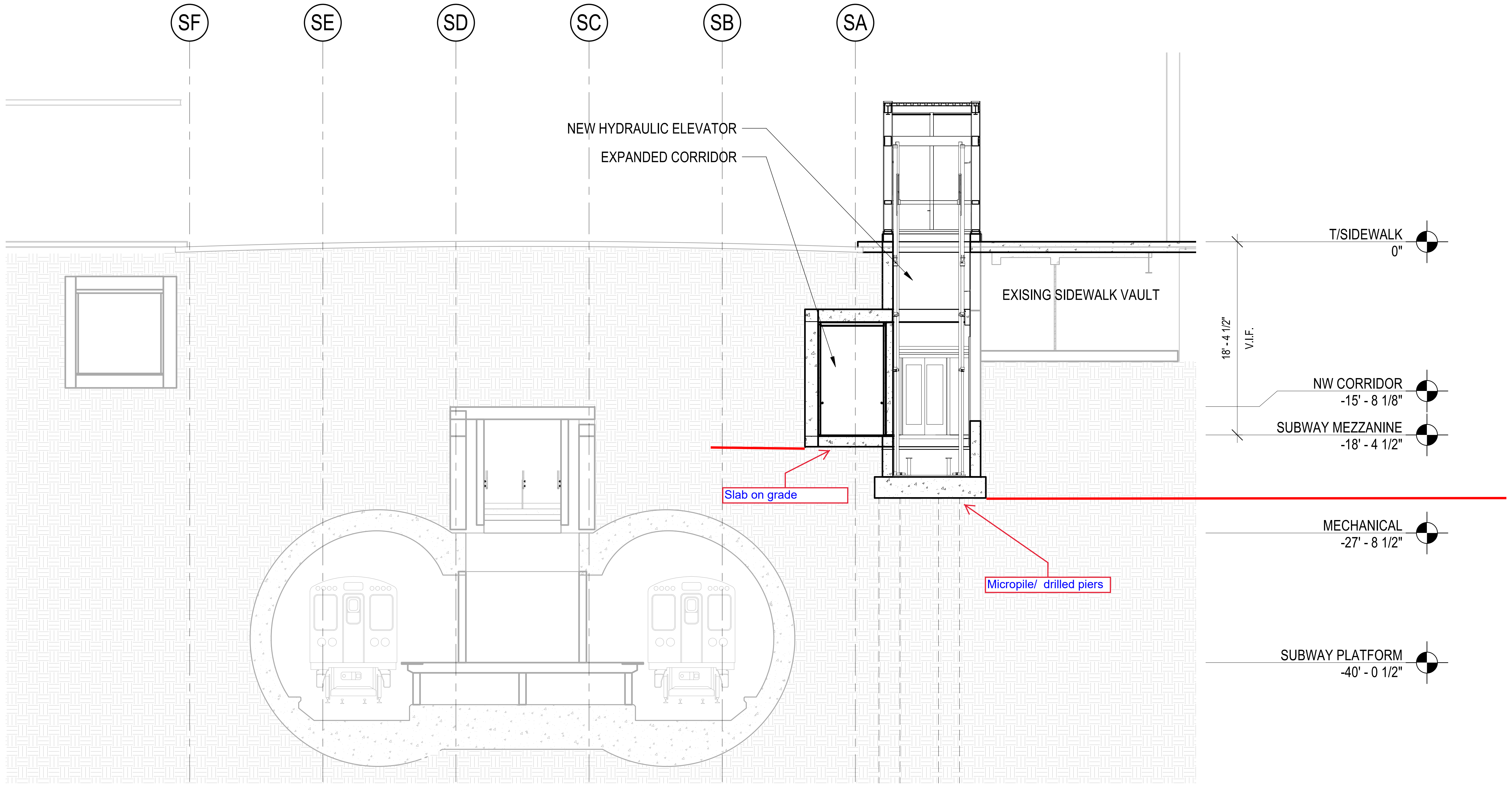
CDOT PROJECT D-1-209
DATE: 07/01/2021
REVISION NO.

GENERAL NOTES:
1. ELEVATION 0' = ELEVATION 14.375' (CHICAGO DATUM)



1 ELEVATOR 1 N-S SECTION

1/8" = 1'-0"



2 ELEVATOR 1 E-W SECTION

1/8" = 1'-0"

A B C D E F G H J K

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

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APPROVED BY:			60% SUBMITTAL	KP	KP	NL		
CDOT/APPROVED BY:	NO.	DATE	REVISIONS	DES.	DRW.	CHK.	DCCO	CDOT

TranSystems

TRANSYSTEMS
222 SOUTH RIVERSIDE PLAZA SUITE 610
CHICAGO, ILLINOIS 60606

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DIVISION OF ENGINEERING

STATE / LAKE LOOP ELEVATED STATION

SECTIONS

CDOT PROJECT D-1-209

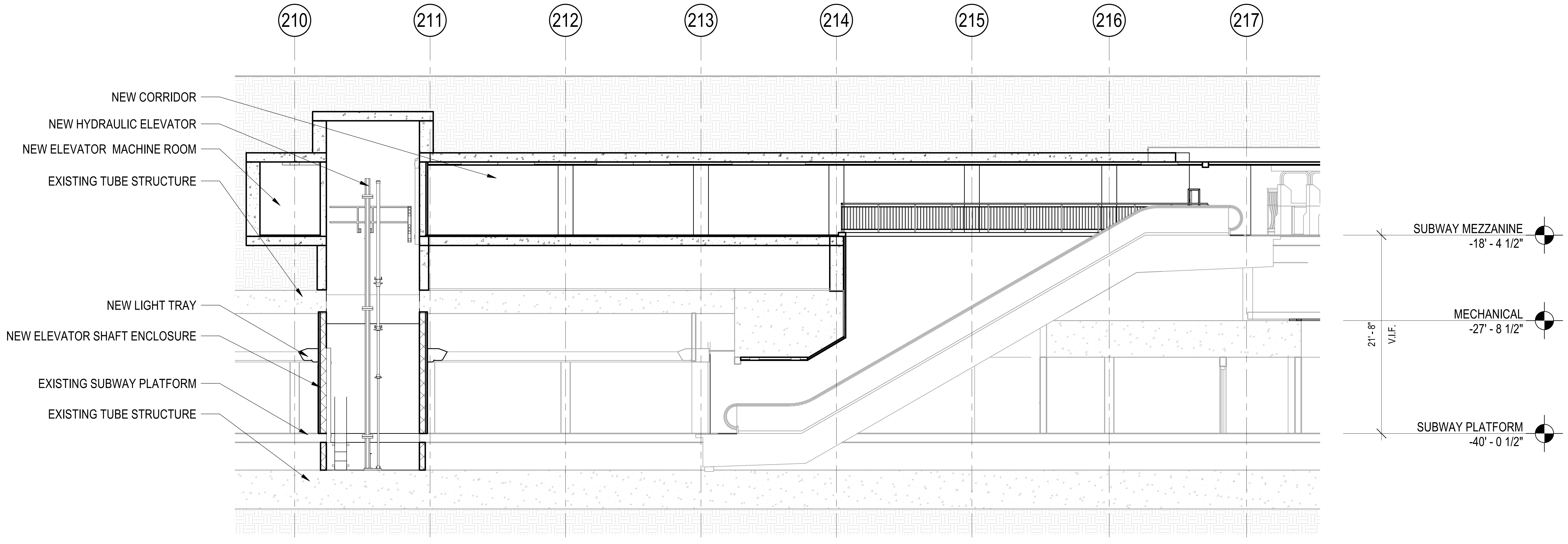
DATE: 07/01/2021

SPEC. NO.

DRAWING NO.
AS-301

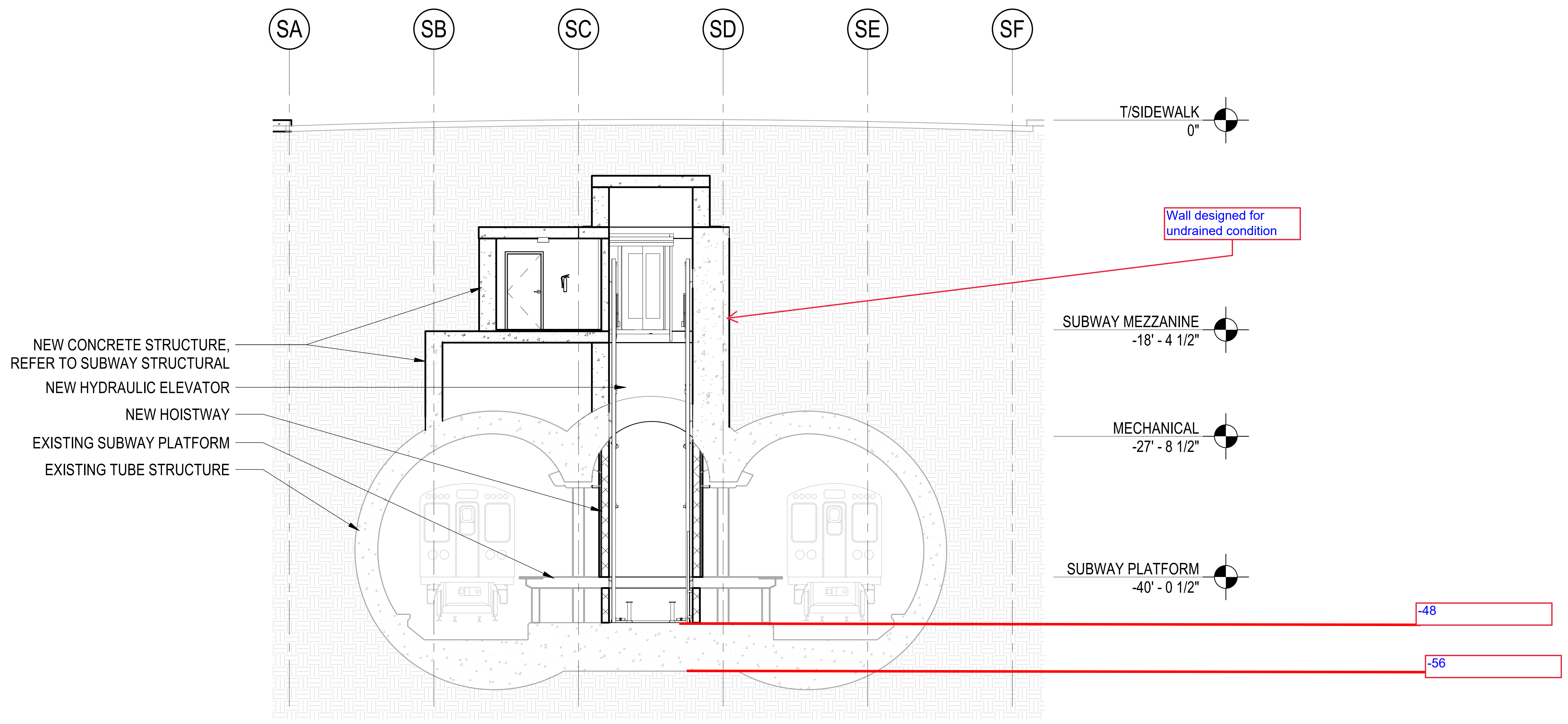
REVISION NO.

GENERAL NOTES:
1. ELEVATION 0' = ELEVATION 14.375' (CHICAGO DATUM)



1 ELEVATOR 2 N-S SECTION

1/8" = 1'-0"



2 ELEVATOR 2 E-W SECTION

1/8" = 1'-0"

DESIGN BY:
DRAWN BY:
CHECKED BY:
APPROVED BY:
CDOT/APPROVED BY:

NO.	DATE	REVISIONS	DES.	DRW.	CHK.	DCCO	CDOT
		60% SUBMITTAL	KP	KP	NL		

TranSystems
TRANSYSTEMS
222 SOUTH RIVERSIDE PLAZA SUITE 610
CHICAGO, ILLINOIS 60606

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STATE / LAKE LOOP ELEVATED STATION

SECTIONS

CDOT PROJECT D-1-209

DATE: 07/01/2021

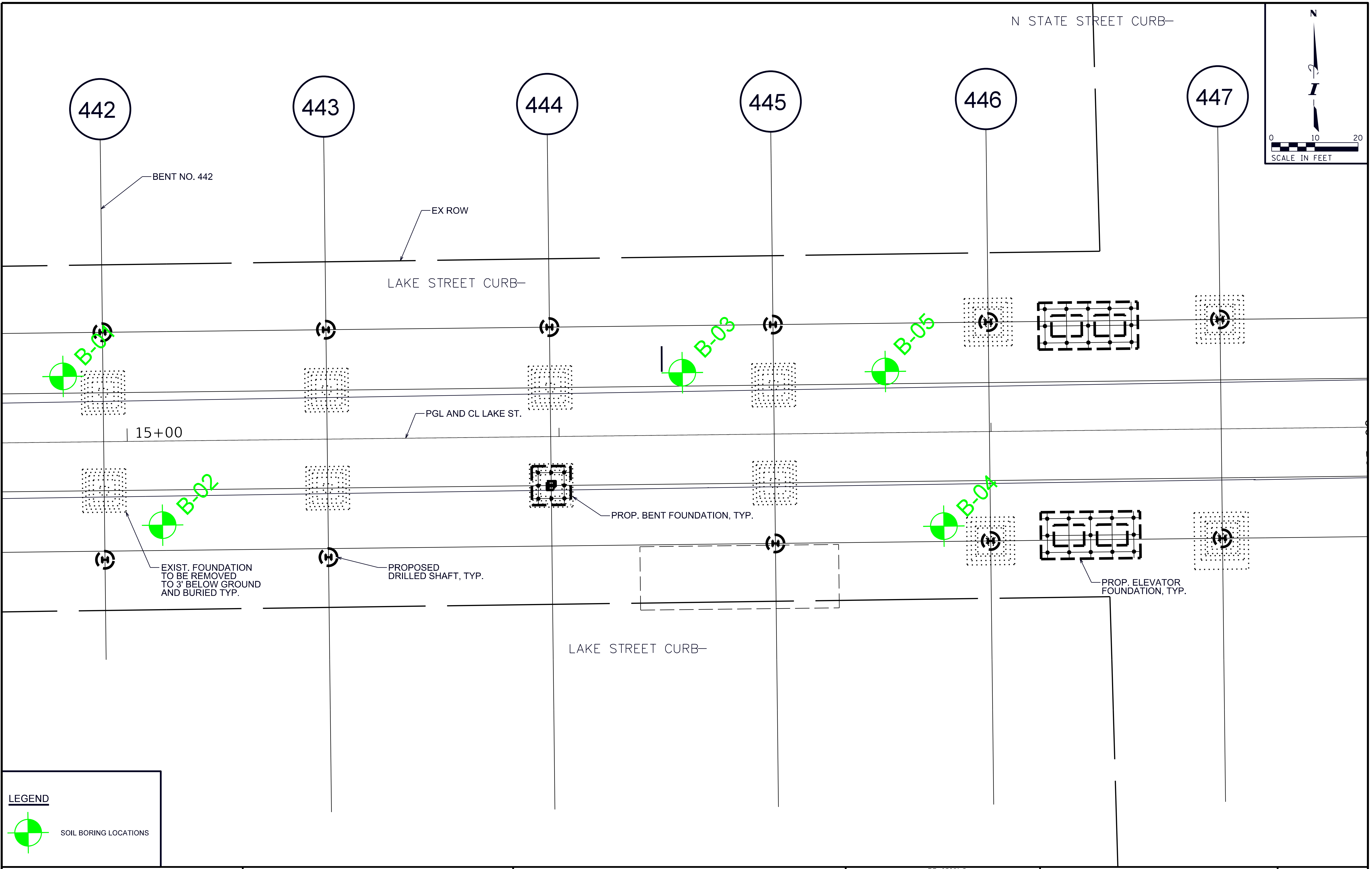
SPEC. NO.

DRAWING NO.
AS-302

REVISION NO.

APPENDIX B

SOIL BORING LOCATION PLAN AND SUBSURFACE PROFILE



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PLOT DATE = 12/2/2021
USER NAME = anieves

DRAWN BY AN DATE 09/16/2021
CHECKED BY MZ DATE 09/16/2021

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

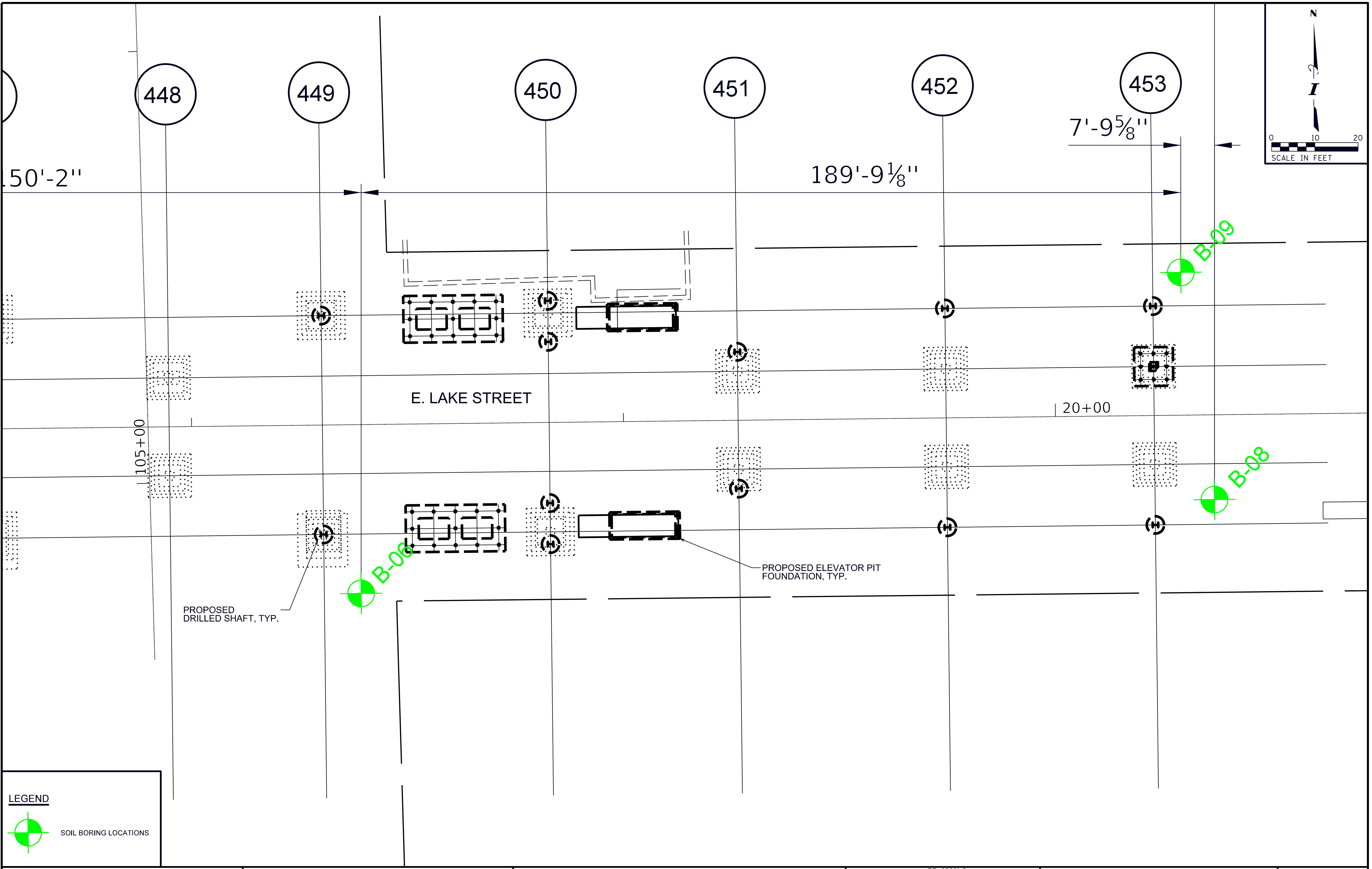
CDOT
CHICAGO DEPARTMENT OF TRANSPORTATION

REVISIONS		
NO.	DATE	DESCRIPTION

BORING LOCATION PLAN

REPLACEMENT OF THE STATE/LAKE LOOP ELEVATED CTA STATION

SHT NO. 1
DRAWING NO. 1 OF 3



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USER NAME = oneves

DRAWN BY AN	DATE 09/16/2021		
CHECKED BY MZ	DATE 09/16/2021		

CHICAGO DEPARTMENT OF TRANSPORTATION

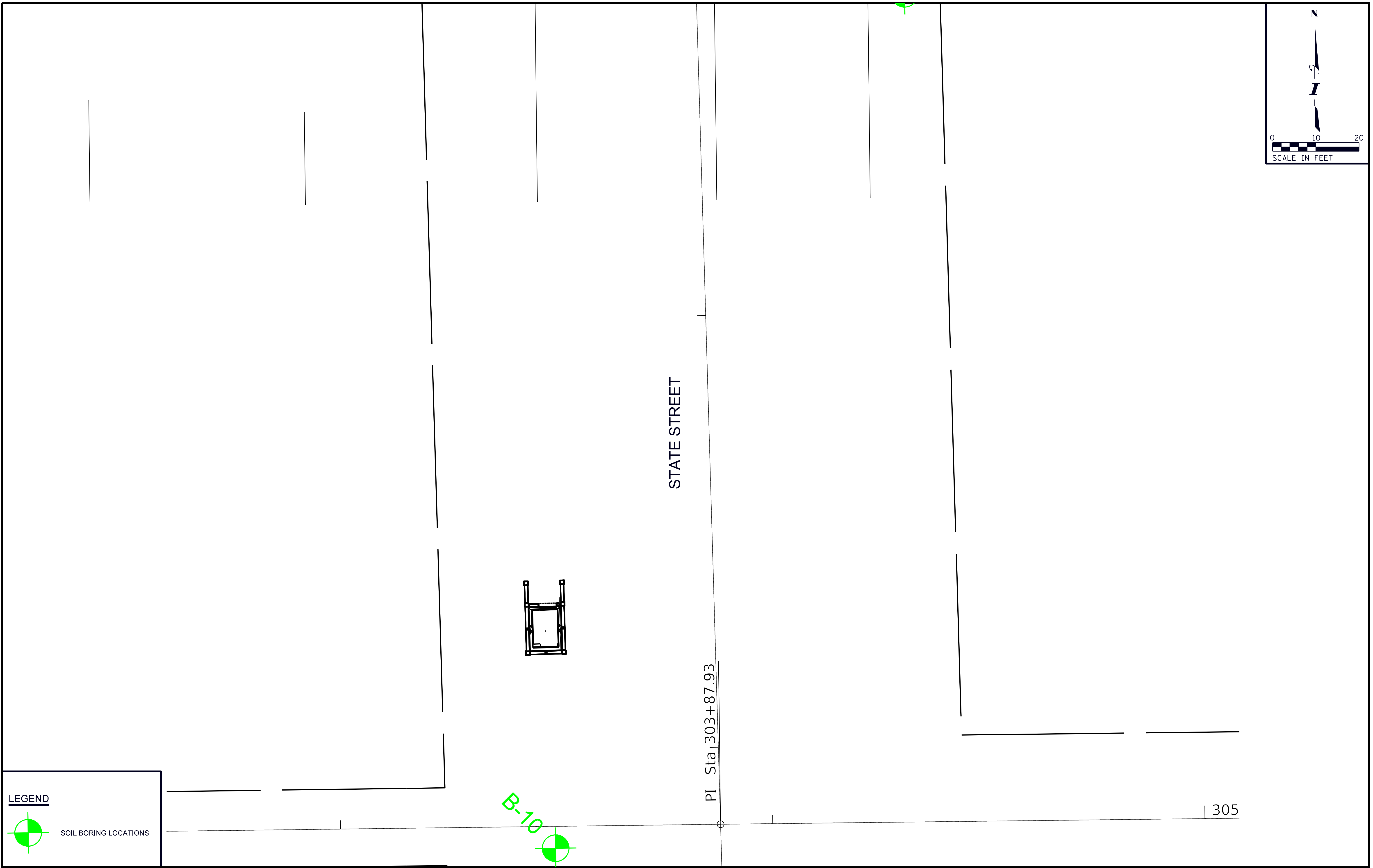
REVISIONS		
NO.	DATE	DESCRIPTION

BORING LOCATION PLAN

REPLACEMENT OF THE STATE/LAKE LOOP ELEVATED CTA STATION

SHT NO. 2

DRAWING NO. 2 OF 3



LEGEND

🟩 SOIL BORING LOCATIONS

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PLOT DATE = 12/2/2021
USER NAME = anieves

DRAWN BY	AN	DATE	09/16/2021
CHECKED BY	MZ	DATE	09/16/2021

CHICAGO DEPARTMENT OF TRANSPORTATION

REVISIONS

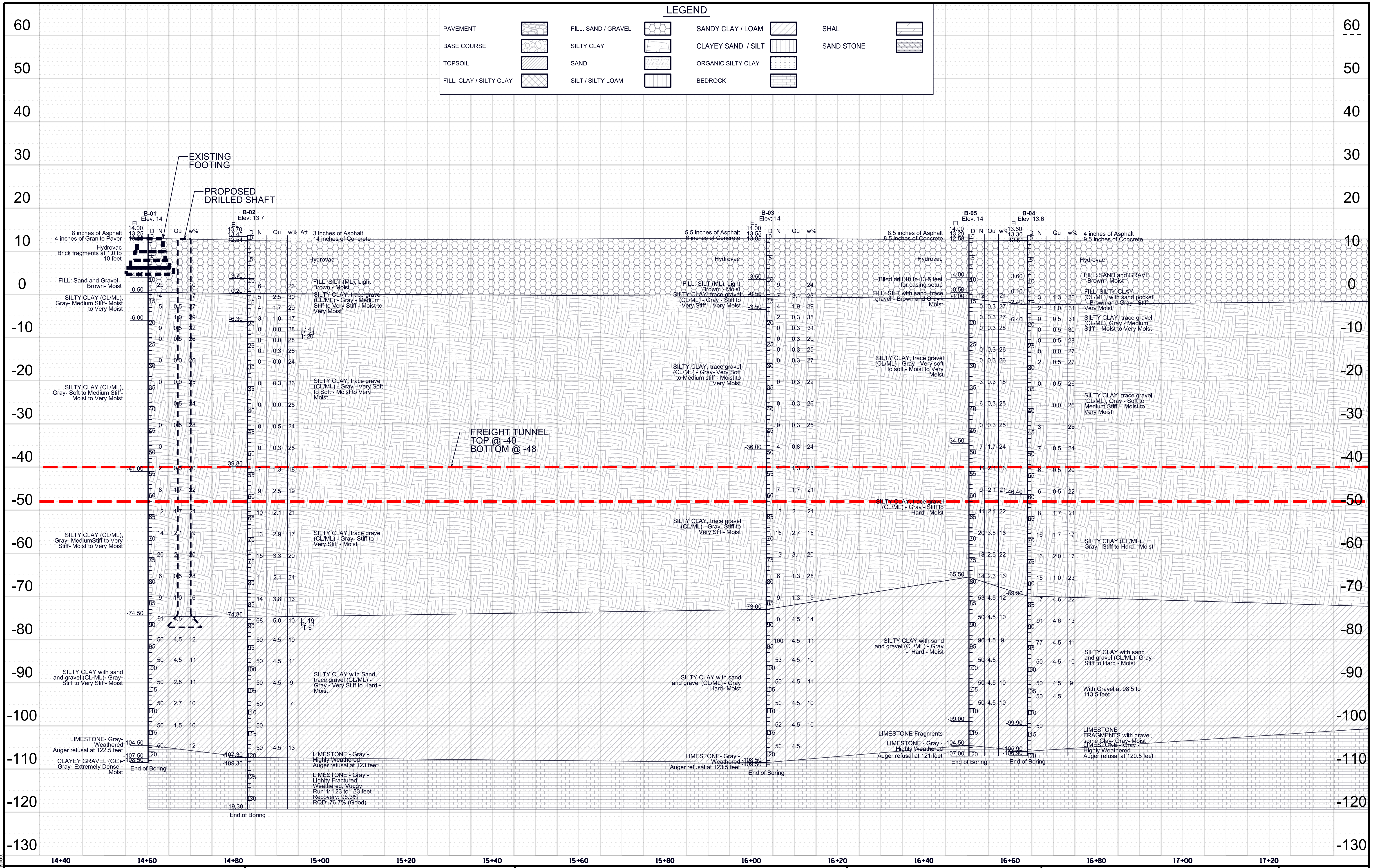
NO.	DATE	DESCRIPTION

BORING LOCATION PLAN

LAKE & STATE CTA STATION UPGRADES GEOTECHNICAL WORK

SHT NO. 3

DRAWING NO. 3 OF 3



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PLOT DATE = 12/3/2021
USER NAME = jscott

DRAWN BY	AN	DATE	11/22/2021
CHECKED BY	MZ	DATE	11/22/2021

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735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

CDOT CHICAGO DEPARTMENT OF TRANSPORTATION

CHICAGO DEPARTMENT OF TRANSPORTATION

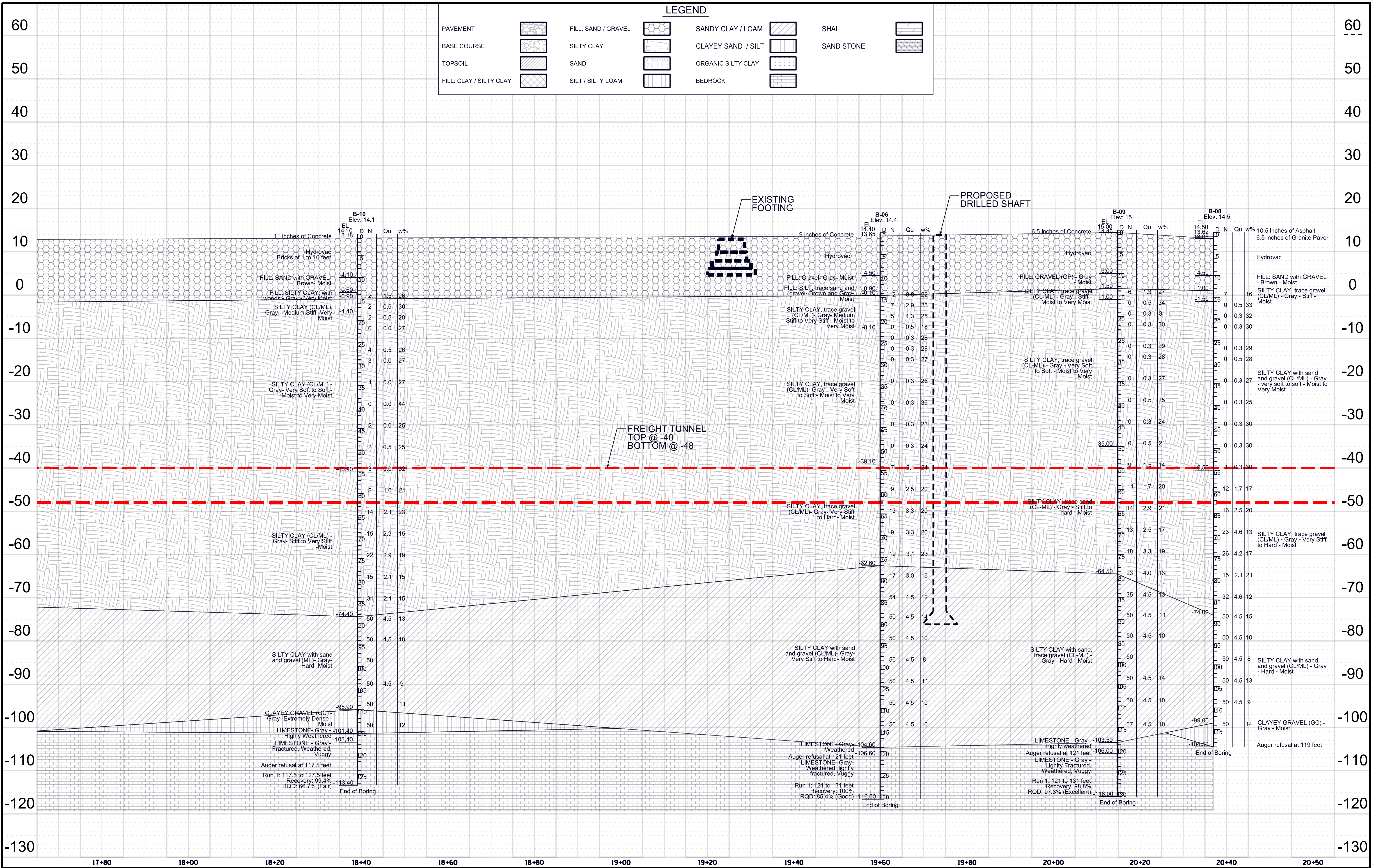
NO.	DATE	DESCRIPTION

SOIL BORING PROFILE

REPLACEMENT OF THE STATE/LAKE LOOP ELEVATED CTA STATION

SHT NO. 1

DRAWING NO. 1 OF 2



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PLOT DATE = 12/3/2021
USER NAME = jscott

DRAWN BY AN DATE 11/22/2021
CHECKED BY MZ DATE 11/22/2021

CDOT CHICAGO DEPARTMENT OF TRANSPORTATION

CHICAGO DEPARTMENT OF TRANSPORTATION

NO.	DATE	DESCRIPTION

SOIL BORING PROFILE

REPLACEMENT OF THE STATE/LAKE LOOP ELEVATED CTA STATION

SHT NO. 2

DRAWING NO. 2 OF 2

APPENDIX C

SOIL BORING LOGS AND ROCK CORE PHOTOGRAPHS

GSG CONSULTANTS, INC.
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BORING NUMBER B-01

CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DATE STARTED 11/8/21 **COMPLETED** 11/9/21

GROUND ELEVATION 14.00 ft CCD **HOLE SIZE** 3 1/4

DRILLING CONTRACTOR GSG Drilling

GROUND WATER LEVELS:

DRILLING METHOD Mud Rotary

AT TIME OF DRILLING --- None

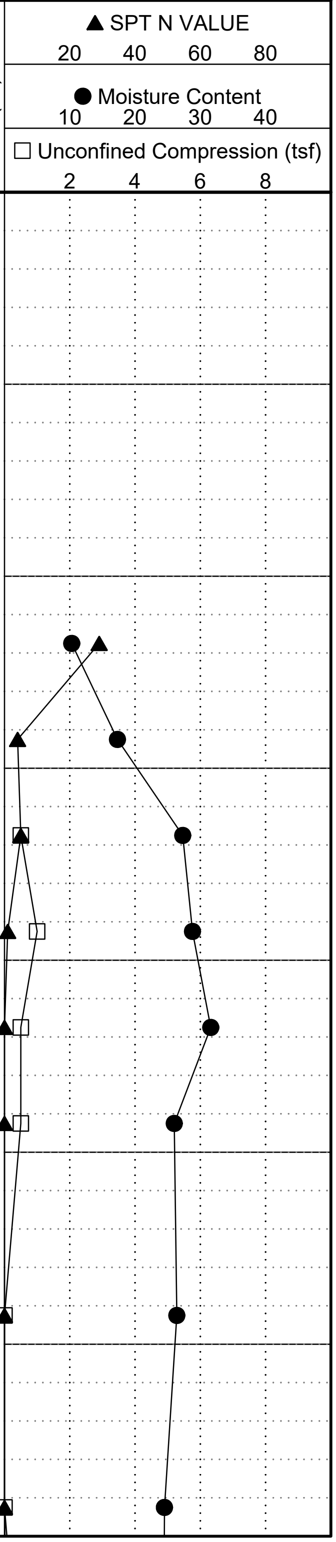
LOGGED BY JEB **CHECKED BY** MZ

AT END OF DRILLING --- NA

NOTES Drill rig: CME

AFTER DRILLING --- NA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0		8 inches of Asphalt				
		4 inches of Granite Paver				
		Hydrovac Brick fragments at 1.0 to 10 feet Granite Paver fragments at 5 to 10 feet				
10		FILL: Sand and Gravel - Brown- Moist	SS 5	78	7-18-11 (29)	
		SILTY CLAY (CL/ML), Gray- Medium Stiff- Moist to Very Moist	SS 6	8	3-3-1 (4)	
			SS 7	100	1-2-3 (5)	0.5
			SS 8	100	0-0-1 (1)	1.0
20		SILTY CLAY (CL/ML), Gray- Soft to Medium Stiff- Moist to Very Moist	SS 9	100	0-0-0 (0)	0.5
			SS 10	100	0-0-0 (0)	0.5
		Vane Shear @27.5' Shear Strength = 0.58 tsf Remolded = 0.36 tsf	SS 12	100	0-0-0 (0)	0
35			SS 13	100	0-0-0 (0)	0



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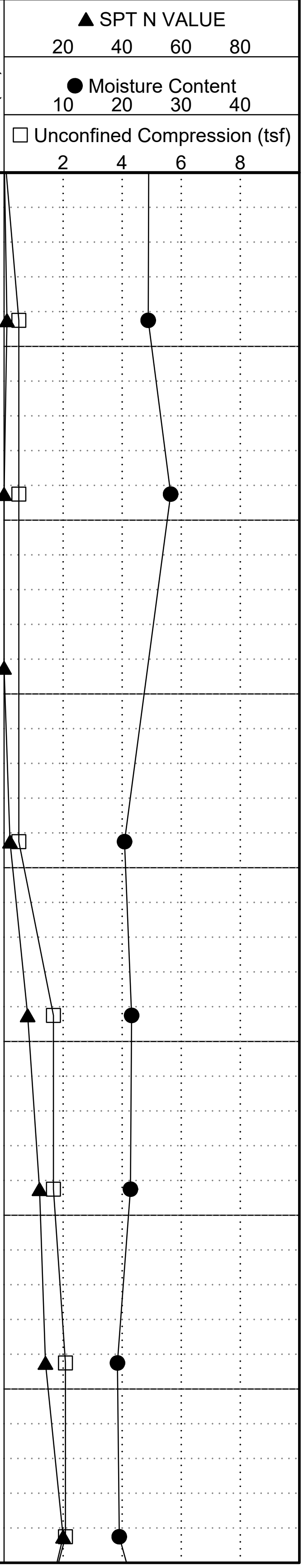
BORING NUMBER B-01

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35	SILTY CLAY (CL/ML), Gray- Soft to Medium Stiff- Moist to Very Moist *(continued)* Vane Shear @37.5' Shear Strength = 0.78 tsf Remolded = 0.58 tsf	SS 14	100	0-0-1 (1)	0.5
40	Push rock at 43.5 feet	SS 15	6	0-0-0 (0)	0.5
45	Vane Shear @47.5' Shear Strength > 0.78 tsf Remolded = 0.52 tsf Push rock at 48.5 feet	SS 16	0	0-0-0 (0)	
50		SS 17	100	0-0-2 (2)	0.5
55	SILTY CLAY (CL/ML), Gray- Medium Stiff to Very Stiff- Moist to Very Moist	SS 18	100	2-3-5 (8)	1.67
60	With three gravel seams at 63.5 to 85.5 feet	SS 19	100	2-5-7 (12)	1.67
65		SS 20	100	2-6-8 (14)	2.08
70		SS 21	100	3-9-11 (20)	2.08
75					



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BORING NUMBER B-01

PAGE 3 OF 4

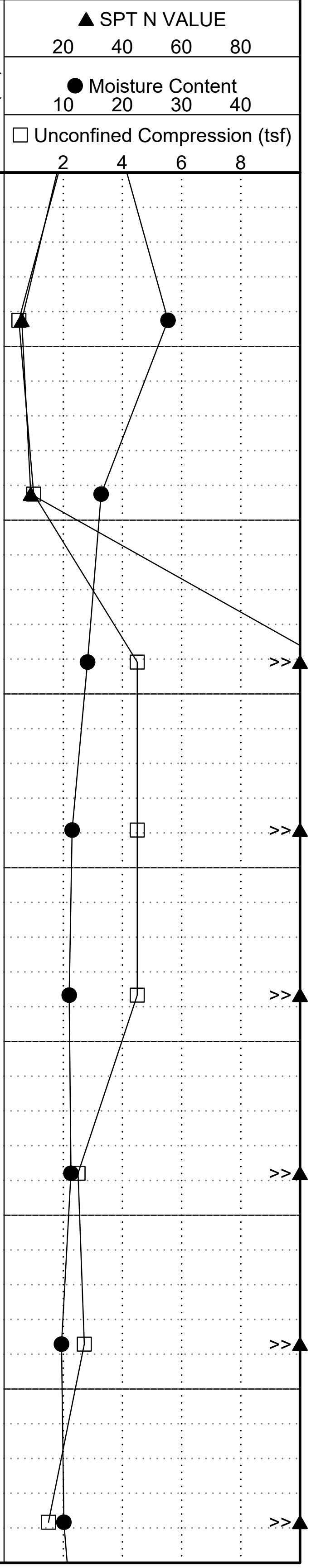
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 / ● Moisture Content 10 20 30 40 / □ Unconfined Compression (tsf) 2 4 6 8
75		SILTY CLAY (CL/ML), Gray- Medium Stiff to Very Stiff- Moist to Very Moist *(continued)*					
80			SS 22	100	2-3-3 (6)	0.5	
85			SS 23	100	2-4-5 (9)	1.0	
90		SILTY CLAY with sand and gravel (CL-ML)- Gray- Stiff to Very Stiff- Moist	SS 24	100	17-41-50/2"	4.5	>>
95			SS 25	80	40-50/4"	4.5	>>
100			SS 26	100	50/4"	4.5	>>
105		With gravel at 103.5 feet	SS 27	86	50-50/1"	2.5	>>
110			SS 28	100	50/5"	2.71	>>
115			SS 29	100	50-50/2"	1.5	>>



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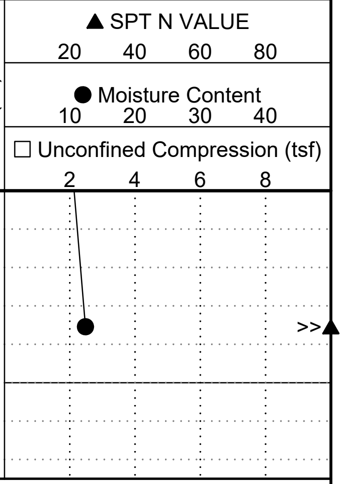
BORING NUMBER B-01

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
115	▨	SILTY CLAY with sand and gravel (CL-ML)- Gray- Stiff to Very Stiff- Moist *(continued)*				
120		CLAYEY GRAVEL (GC)- Gray- Extremely Dense - Moist	SS 30	100	50/1"	
		LIMESTONE- Gray- Weathered Auger refusal at 122.5 feet				

Bottom of borehole at 122.5 feet.



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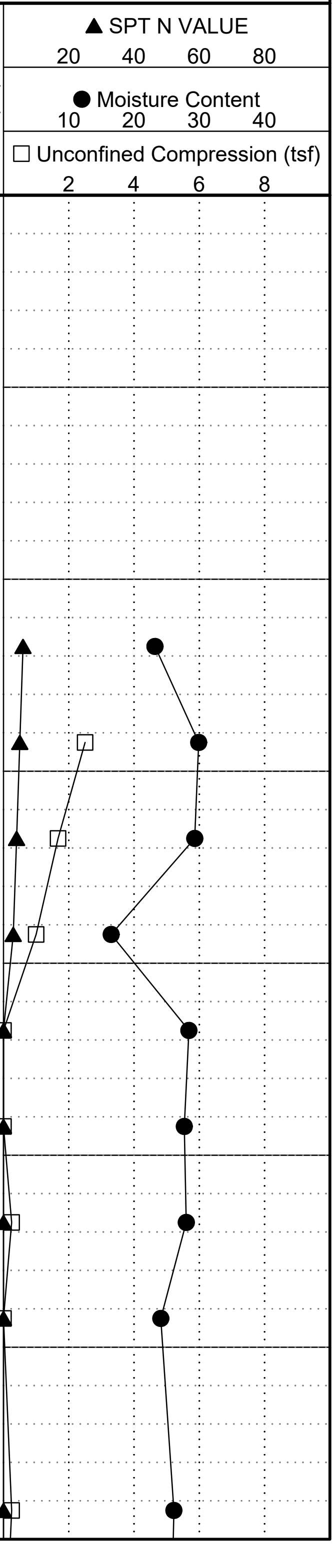
BORING NUMBER B-02

CLIENT	Transystem	**PROJECT NAME**	CTA State-Lake Station
PROJECT NUMBER	20-1038	**PROJECT LOCATION**	Lake St. at State St., Chicago
DATE STARTED	11/3/21 **COMPLETED** 11/4/21	**GROUND ELEVATION**	13.70 ft CCD **HOLE SIZE** 3 1/4
DRILLING CONTRACTOR	GSG Drilling	**GROUND WATER LEVELS:**	
DRILLING METHOD	Mud Rotary	**AT TIME OF DRILLING**	--- None
LOGGED BY	EH **CHECKED BY** MZ	**AT END OF DRILLING**	--- NA
NOTES	Drill rig: Diedrich D-50 TM	**AFTER DRILLING**	--- NA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0	3 inches of Asphalt				
	14 inches of Concrete				
	Hydrovac				
5					
10	FILL: SILT (ML), Light Brown - Moist				
		SS 5	78	3-3-3 (6)	
	SILTY CLAY, trace gravel (CL/ML) - Gray - Medium Stiff to Very Stiff - Moist to Very Moist	SS 6	67	3-3-2 (5)	2.5
15					
		SS 7	100	2-2-2 (4)	1.67
		SS 8	100	0-1-2 (3)	1.0
20	SILTY CLAY, trace gravel (CL/ML) - Gray - Very Soft to Soft - Moist to Very Moist				
		SS 9	100	0-0-0 (0)	0
25		SS 10	100	0-0-0 (0)	0
		SS 11	100	0-0-0 (0)	0.25
30		SS 12	100	0-0-0 (0)	0
35		SS 13	100	0-0-0 (0)	0.25



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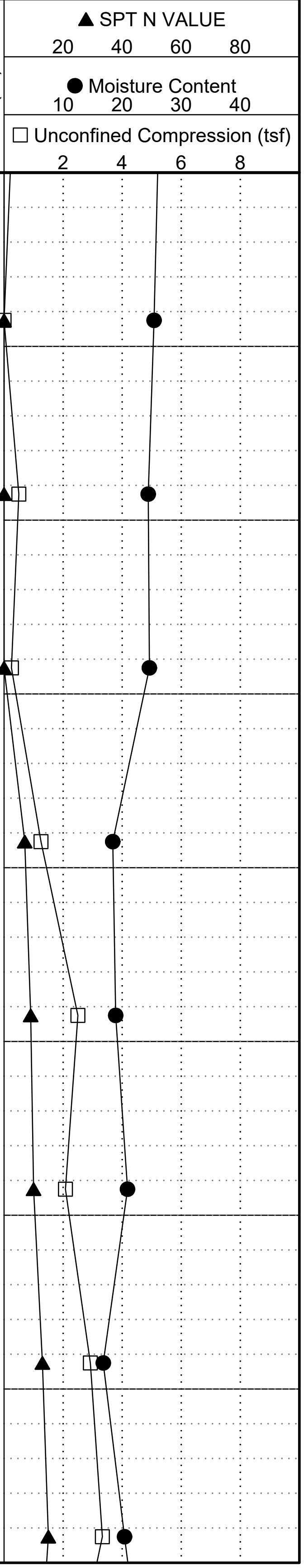
BORING NUMBER B-02

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35	▨	SILTY CLAY, trace gravel (CL/ML) - Gray - Very Soft to Soft - Moist to Very Moist *(continued)*				
40	▨		SS 14	100	0-0-0 (0)	0
45	▨		SS 15	100	0-0-0 (0)	0.5
50	▨		SS 16	100	0-0-0 (0)	0.25
55	▨	SILTY CLAY, trace gravel (CL/ML) - Gray- Stiff to Very Stiff - Moist	SS 17	100	0-3-4 (7)	1.25
60	▨		SS 18	100	3-3-6 (9)	2.5
65	▨		SS 19	100	4-4-6 (10)	2.08
70	▨		SS 20	100	5-5-8 (13)	2.92
75	▨		SS 21	100	5-5-10 (15)	3.33



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BORING NUMBER B-02

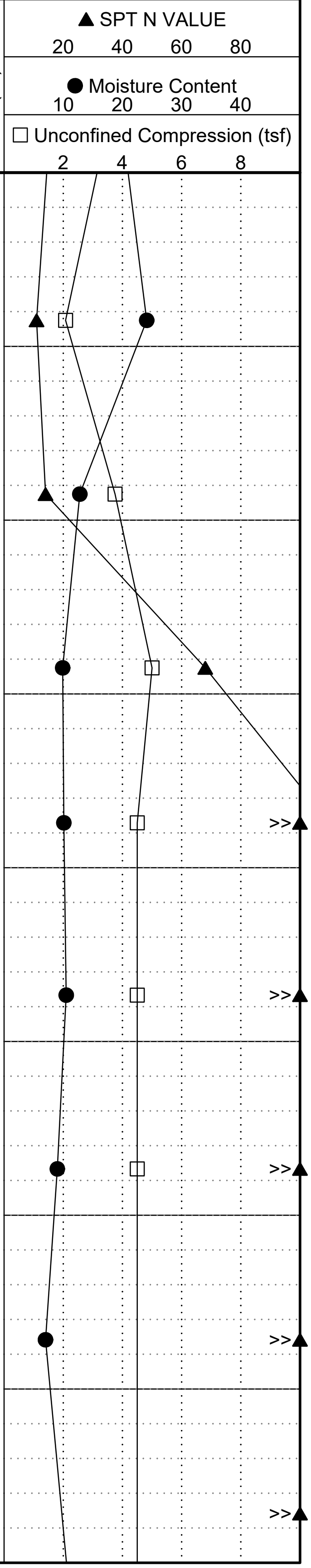
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75		SILTY CLAY, trace gravel (CL/ML) - Gray- Stiff to Very Stiff - Moist *(continued)*				
80			SS 22	100	3-4-7 (11)	2.08
85			SS 23	100	4-7-7 (14)	3.75
90		SILTY CLAY with sand, trace gravel (CL/ML) - Gray - Very Stiff to Hard - Moist	SS 24	100	12-40-28 (68)	5.0
95		With Limestone fragments starting at 93.5 feet	SS 25	100	50/5"	4.5
100			SS 26	50	50/4"	4.5
105			SS 27	100	50/4"	4.5
110		Limestone fragments at 109 feet	SS 28	50	50/2"	
115			SS 29	0	50/2"	



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BORING NUMBER B-02

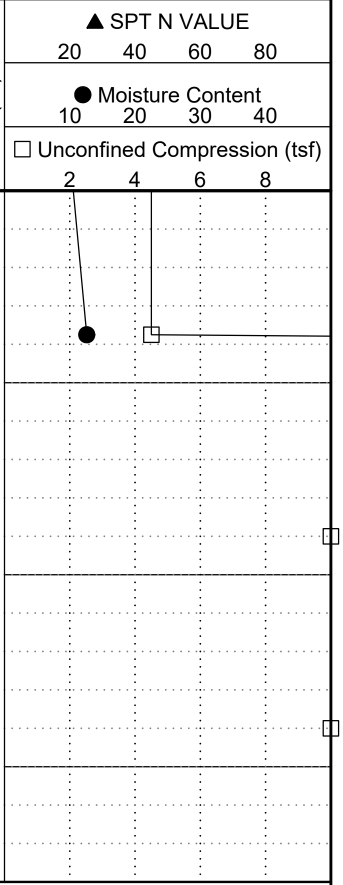
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
115	▨	SILTY CLAY with sand, trace gravel (CL/ML) - Gray - Very Stiff to Hard - Moist *(continued)*	SS 30	17	50	4.5
120						
		LIMESTONE - Gray - Highly Weathered Auger refusal at 123 feet				
		LIMESTONE - Gray - Lighlty Fractured, Weathered, Vuggy Run 1: 123 to 133 feet Recovery: 98.3% RQD: 76.7% (Good)	RC 1	98 (77)		761
125						
130						799



Bottom of borehole at 133.0 feet.

Rock Core Photo: B-02

TOP
123’

BOT
133’

Run	Depth (ft)	Recovery (%)	RQD (%)	RQD Classification	Description	Depth (ft)/ Unconfined Compression Strength (psi)
1	123’ – 133’	98.3	76.7	Good	Gray Limestone Fractured, Weathered, Vuggy	124.2-124.9/10,570 129.0-139.8/11,104

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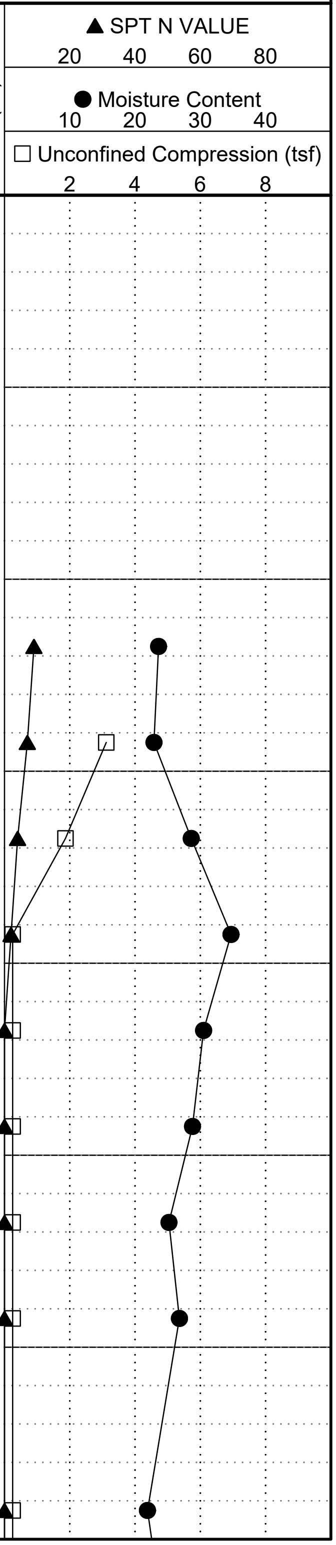
BORING NUMBER B-03

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago
DATE STARTED 11/3/21 **COMPLETED** 11/5/21
GROUND ELEVATION 14.00 ft CCD **HOLE SIZE** 3 1/4
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING --- None
LOGGED BY DM **CHECKED BY** MZ
AT END OF DRILLING --- NA
NOTES Drill rig: CME
AFTER DRILLING --- NA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0	5.5 inches of Asphalt				
	6 inches of Concrete				
	Hydrovac				
5					
10					
	FILL: SILT (ML), Light Browm - Moist				
		SS 5	83	3-4-5 (9)	
		SS 6	67	3-3-4 (7)	3.12
15	SILTY CLAY, trace gravel (CL/ML) - Gray - Stiff to Very Stiff - Very Moist				
		SS 7	100	0-2-2 (4)	1.87
	SILTY CLAY, trace gravel (CL/ML) - Gray- Very Soft to Medium Stiff - Moist to Very Moist				
20		SS 8	100	1-1-1 (2)	0.25
		SS 9	100	0-0-0 (0)	0.25
25		SS 10	100	0-0-0 (0)	0.25
		SS 11	100	0-0-0 (0)	0.25
30		SS 12	100	0-0-0 (0)	0.25
35		SS 13	100	0-0-0 (0)	0.25



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BORING NUMBER B-03

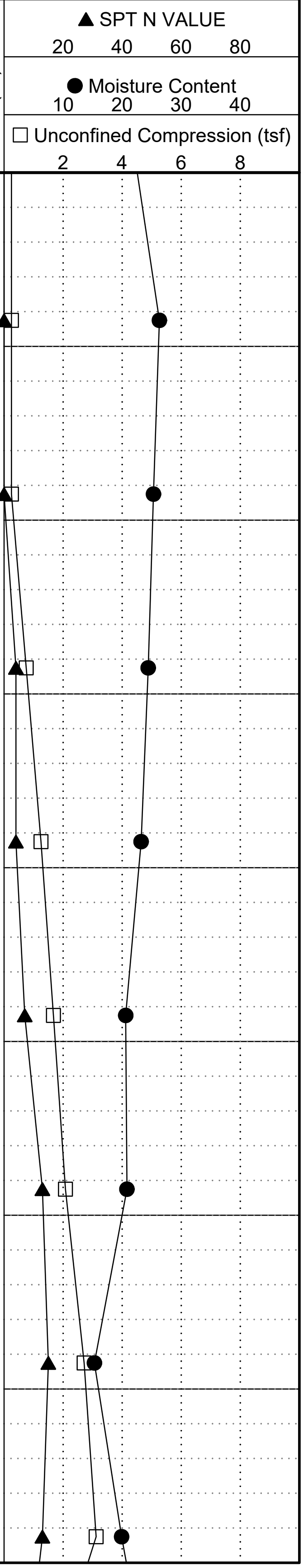
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35		SILTY CLAY, trace gravel (CL/ML) - Gray- Very Soft to Medium Stiff - Moist to Very Moist *(continued)*				
40			SS 14	100	0-0-0 (0)	0.25
45			SS 15	100	0-0-0 (0)	0.25
50			SS 16	100	0-1-3 (4)	0.75
		SILTY CLAY, trace gravel (CL/ML) - Gray- Stiff to Very Stiff- Moist				
55			SS 17	100	0-0-4 (4)	1.25
60			SS 18	100	1-3-4 (7)	1.67
65			SS 19	100	3-6-7 (13)	2.08
70			SS 20	89	3-6-9 (15)	2.71
75			SS 21	100	8-1-12 (13)	3.12



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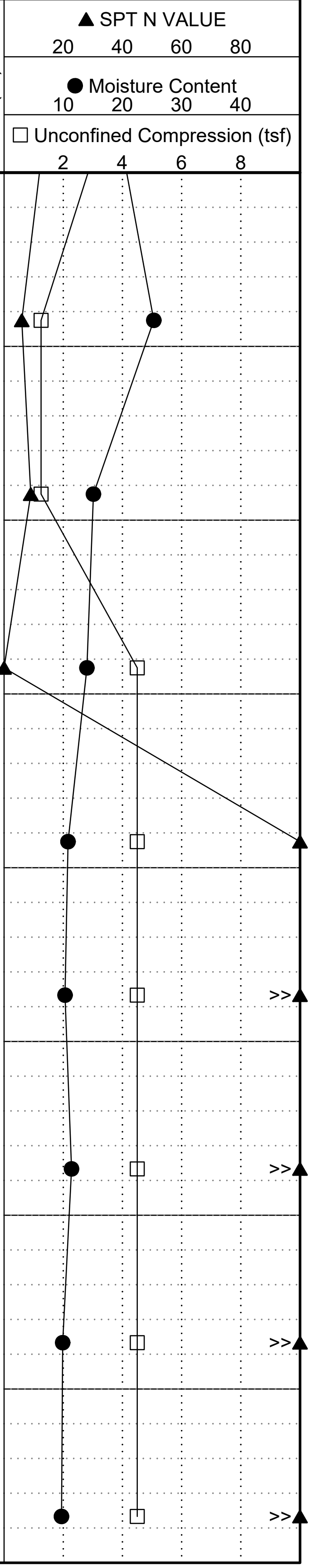
BORING NUMBER B-03

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75	SILTY CLAY, trace gravel (CL/ML) - Gray- Stiff to Very Stiff- Moist *(continued)*				
80		SS 22	100	1-3-3 (6)	1.25
85		SS 23	100	2-4-5 (9)	1.25
	SILTY CLAY, with sand and gravel (CL/ML) - Gray - Hard- Moist				
90		SS 24	22	56-0-0 (0)	4.5
95		SS 25	100	38-44-56 (100)	4.5
100		SS 26	100	53/4"	4.5
105		SS 27	50	50/4"	4.5
110		SS 28	100	50/4"	4.5
115		SS 29	100	52/4"	4.5



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BORING NUMBER B-03

CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 ● Moisture Content 10 20 30 40 ☐ Unconfined Compression (tsf) 2 4 6 8
115	▨	SILTY CLAY, with sand and gravel (CL/ML) - Gray - Hard- Moist *(continued)*					
	▨		SS 30	0	50/4"		>>▲
120	▨						
		LIMESTONE- Gray - Weathered Auger refusal at 123.5 feet					

Bottom of borehole at 123.5 feet.

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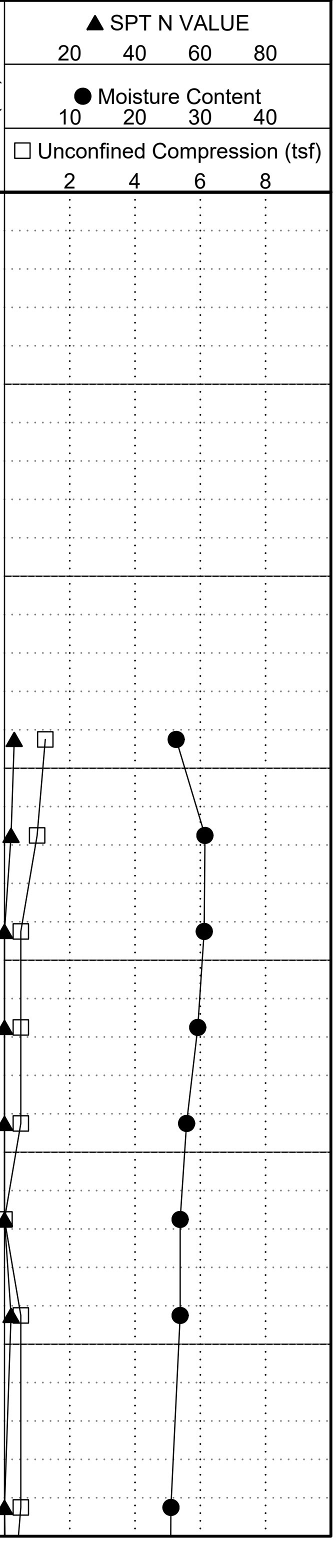
BORING NUMBER B-04

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago
DATE STARTED 11/5/21 **COMPLETED** 11/5/21
GROUND ELEVATION 13.60 ft CCD **HOLE SIZE** 3 1/4
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING --- None
LOGGED BY JEB **CHECKED BY** MZ
AT END OF DRILLING --- NA
NOTES Drill rig: CME
AFTER DRILLING --- NA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0	4 inches of Asphalt				
	9.5 inches of Concrete				
	Hydrovac Debris and Bricks at 1 to 10 feet				
5	Fragments of Granite Pavers at 5 to 10 feet				
10	FILL: SAND and GRAVEL - Brown - Moist				
15	FILL: SILTY CLAY (CL/ML), with sand pocket - Brown and Gray - Stiff - Very Moist	SS 6	78	5-2-1 (3)	1.25
	SILTY CLAY, trace gravel (CL/ML), Gray - Medium Stiff - Moist to Very Moist	SS 7	89	0-1-1 (2)	1.0
20		SS 8	100	0-0-0 (0)	0.5
	SILTY CLAY, trace gravel (CL/ML), Gray - Soft to Medium Stiff - Moist to Very Moist	SS 9	100	0-0-0 (0)	0.5
25		SS 10	61	0-0-0 (0)	0.5
		SS 11	100	0-0-0 (0)	0
30	2 inches of Gravel Seam at 29 feet	SS 12	100	0-1-1 (2)	0.5
35		SS 13	78	0-0-0 (0)	0.5



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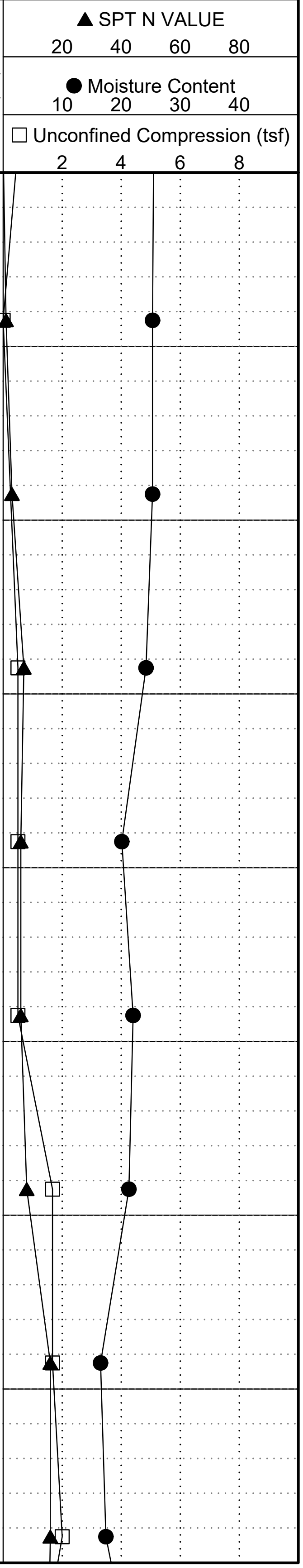
BORING NUMBER B-04

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35		SILTY CLAY, trace gravel (CL/ML), Gray - Soft to Medium Stiff - Moist to Very Moist *(continued)*				
40			SS 14	56	0-0-1 (1)	0
45		Push rock at 43.5 feet	SS 15	6	0-1-2 (3)	
50		2 inches of gravel Seam at 49 feet	SS 16	100	0-6-1 (7)	0.5
55		Clayey gravel, some sand at 54 to 58.5 feet	SS 17	100	1-3-3 (6)	0.5
60			SS 18	72	2-3-3 (6)	0.5
		SILTY CLAY (CL/ML), Gray - Stiff to Hard - Moist				
65			SS 19	100	2-4-4 (8)	1.67
70			SS 20	100	4-7-9 (16)	1.67
75			SS 21	100	11-9-7 (16)	2.0



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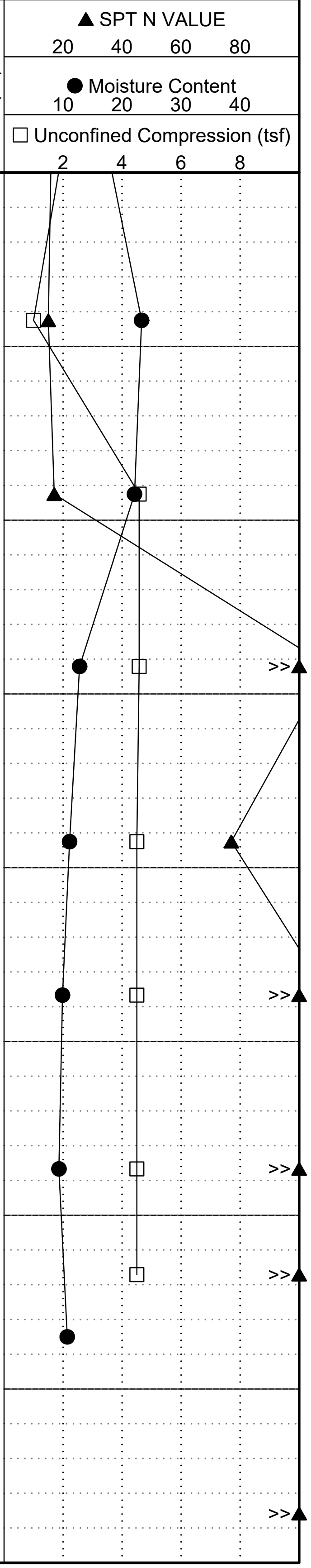
BORING NUMBER B-04

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75	SILTY CLAY (CL/ML), Gray - Stiff to Hard - Moist *(continued)*				
80		SS 22	100	6-7-8 (15)	1.0
85	SILTY CLAY with sand and gravel (CL/ML)- Gray - Stiff to Hard - Moist	SS 23	100	4-6-11 (17)	4.58
90		SS 24	100	35-41-50/5"	4.58
95		SS 25	89	28-36-41 (77)	4.5
100	With Gravel at 98.5 to 113.5 feet	SS 26	100	50/4"	4.5
105		SS 27	100	50/4"	4.5
		SS 28	100	50/5"	4.5
110					
115	LIMESTONE FRAGMENTS with gravel, some clay- Gray- Moist	SS 29	50	50/2"	



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BORING NUMBER B-04

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 ● Moisture Content 10 20 30 40 ☐ Unconfined Compression (tsf) 2 4 6 8
115		LIMESTONE FRAGMENTS with gravel, some clay- Gray- Moist *(continued)*					
120		LIMESTONE - Gray - Highly Weathered Auger refusal at 120.5 feet					

Bottom of borehole at 120.5 feet.

GSG CONSULTANTS, INC.
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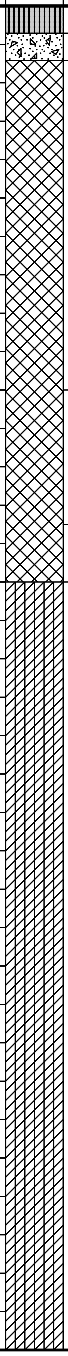
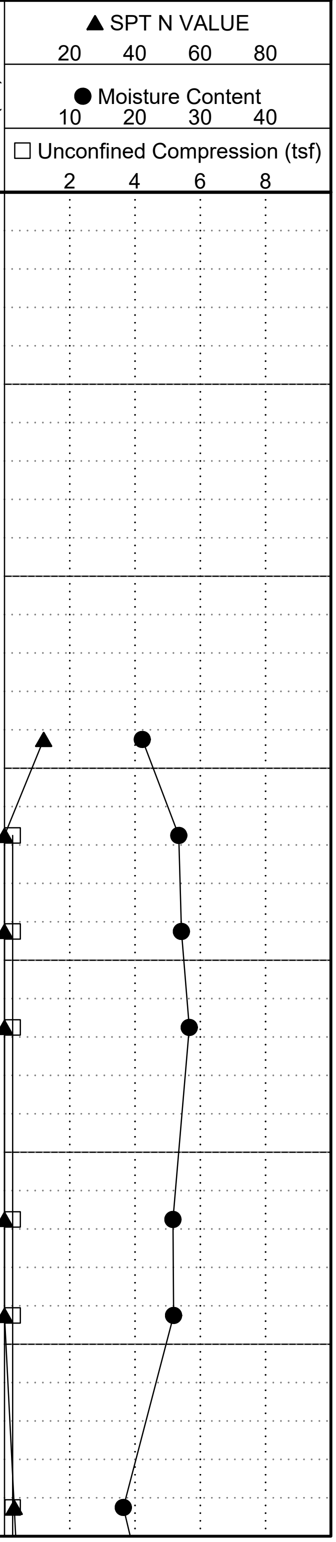
BORING NUMBER B-05

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago
DATE STARTED 11/10/21 **COMPLETED** 11/11/21
GROUND ELEVATION 14.00 ft CCD **HOLE SIZE** 3 1/4
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING --- None
LOGGED BY DM **CHECKED BY** MZ
AT END OF DRILLING --- NA
NOTES Drill rig: Diedrich D-50 ATV
AFTER DRILLING --- NA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0	8.5 inches of Asphalt				
	8.5 inches of Concrete				
	Hydrovac				
10	Blind drill 10 to 13.5 feet for casing setup				
	FILL: SILT with sand, trace gravel - Brown and Gray - Moist	SS 6	28	7-7-5 (12)	
15	SILTY CLAY, trace gravel (CL/ML) - Gray - Very Soft to Soft - Moist to Very Moist				
		SS 7	100	0-0-0 (0)	0.25
20		SS 8	100	0-0-0 (0)	0.25
		SS 9	100	0-0-0 (0)	0.25
25	Vane Shear @25.0' Shear Strength = 0.36 tsf Remolded = 0.17 tsf				
		SS 11	100	0-0-0 (0)	0.25
30		SS 12	100	0-0-0 (0)	0.25
	Vane Shear @32.0' Shear Strength = 0.78 tsf Remolded = 0.31 tsf				
35		SS 13	100	0-1-2 (3)	0.25





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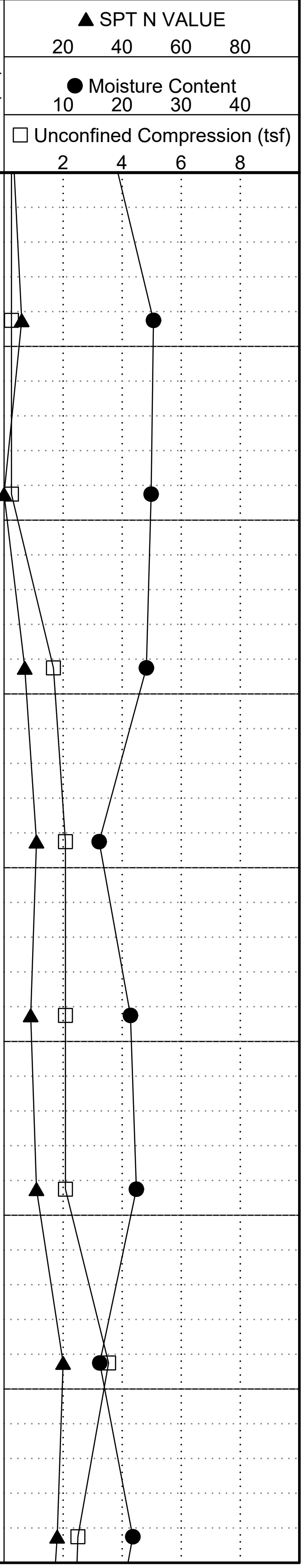
BORING NUMBER B-05

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35		SILTY CLAY, trace gravel (CL/ML) - Gray - Very Soft to Soft - Moist to Very Moist *(continued)*				
40		Clayey gravel seam at 39.5 to 40 feet	SS 14	89	5-3-3 (6)	0.25
		Vane Shear @42.0' Shear Strength = 0.78 tsf Remolded = 0.34 tsf				
45			SS 15	100	0-0-0 (0)	0.25
		SILTY CLAY, trace gravel (CL/ML) - Gray - Stiff to Hard - Moist				
50			SS 16	100	1-3-4 (7)	1.67
55			SS 17	89	3-5-6 (11)	2.08
60			SS 18	100	3-4-5 (9)	2.08
65			SS 19	100	3-5-6 (11)	2.08
70			SS 20	56	5-9-11 (20)	3.54
75			SS 21	100	7-8-10 (18)	2.50



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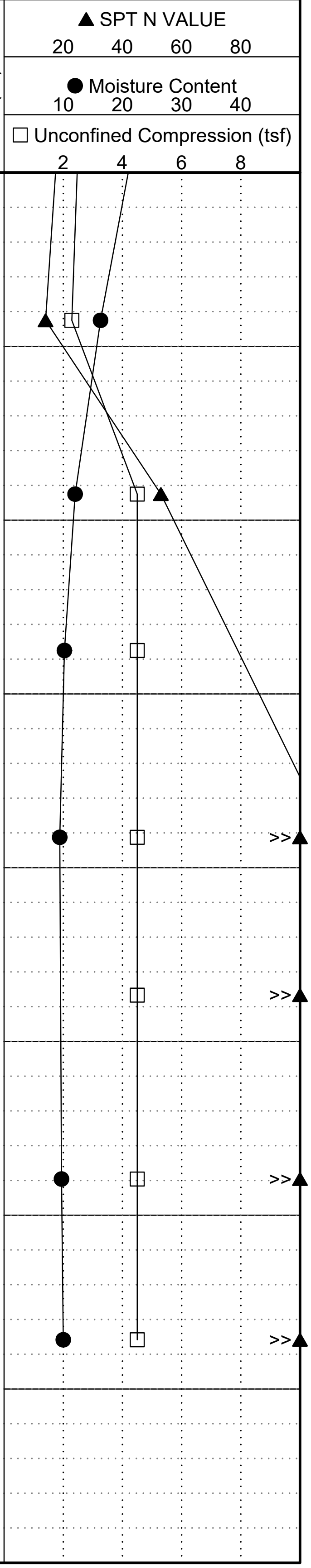
BORING NUMBER B-05

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75	SILTY CLAY, trace gravel (CL/ML) - Gray - Stiff to Hard - Moist *(continued)*				
		SS 22	100	7-7-7 (14)	2.29
80	SILTY CLAY with sand and gravel (CL/ML) - Gray - Hard - Moist				
85		SS 23	100	21-23-30 (53)	4.5
		SS 24	83	50	4.5
90					
95		SS 25	73	32-46-50/3"	4.5
		SS 26	50	50/4"	4.5
100					
105		SS 27	100	48-50/5"	4.5
		SS 28	100	50/2"	4.5
110					
	LIMESTONE Fragments				
115					



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BORING NUMBER B-05

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 ● Moisture Content 10 20 30 40 ☐ Unconfined Compression (tsf) 2 4 6 8
115		LIMESTONE Fragments *(continued)*					
		LIMESTONE - Gray - Highly Weathered					
120		Auger refusal at 121 feet					

Bottom of borehole at 121.0 feet.

GSG CONSULTANTS, INC.
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BORING NUMBER B-06

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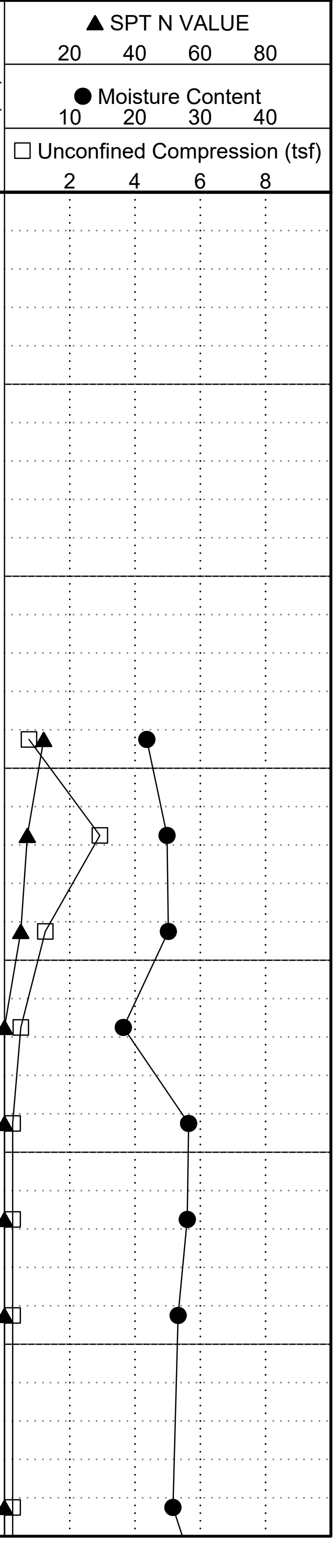
CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago
DATE STARTED 11/8/21 **COMPLETED** 11/10/21
GROUND ELEVATION 14.40 ft CCD **HOLE SIZE** 3 1/4
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING --- None
LOGGED BY DM **CHECKED BY** MZ
AT END OF DRILLING --- NA
NOTES Drill rig: Diedrich D-50 TM
AFTER DRILLING --- NA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0		9 inches of Concrete				
		Hydrovac				
5						
10		FILL: Gravel- Gray- Moist				
		FILL: SILT, trace sand and gravel- Brown and Gray- Moist	SS 6	44	13-3-9 (12)	0.75
15		SILTY CLAY, trace gravel (CL/ML)- Gray- Medium Stiff to Very Stiff - Moist to Very Moist				
			SS 7	100	3-3-4 (7)	2.92
20			SS 8	72	2-2-3 (5)	1.25
			SS 9	100	0-0-0 (0)	0.5
		SILTY CLAY, trace gravel (CL/ML)- Gray- Very Soft to Soft - Moist to Very Moist				
25			SS 10	100	0-0-0 (0)	0.25
			SS 11	67	0-0-0 (0)	0.25
30			SS 12	100	0-0-0 (0)	0.25
35			SS 13	100	0-0-0 (0)	0.25



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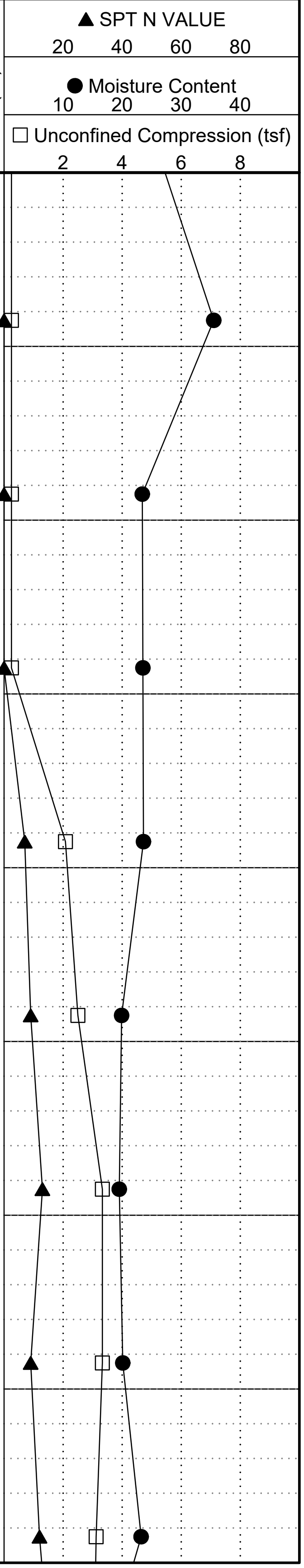
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35		SILTY CLAY, trace gravel (CL/ML)- Gray- Very Soft to Soft - Moist to Very Moist *(continued)*				
40			SS 14	100	0-0-0 (0)	0.25
45			SS 15	89	0-0-0 (0)	0.25
50			SS 16	100	0-0-0 (0)	0.25
55		SILTY CLAY, trace gravel (CL/ML)- Gray- Very Stiff to Hard- Moist	SS 17	100	3-3-4 (7)	2.08
60			SS 18	100	3-4-5 (9)	2.50
65			SS 19	100	4-5-8 (13)	3.33
70			SS 20	100	2-4-5 (9)	3.33
75			SS 21	100	4-6-6 (12)	3.12



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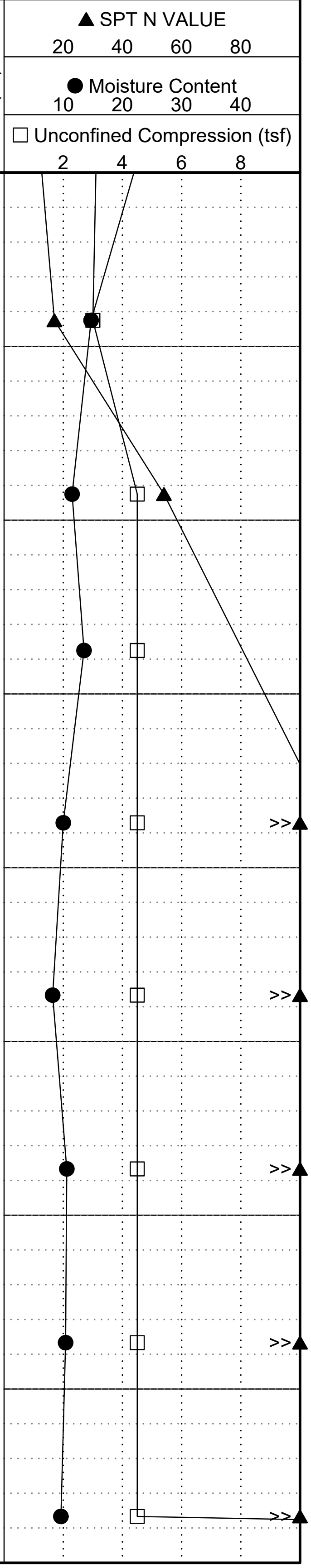
BORING NUMBER B-06

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75	SILTY CLAY, trace gravel (CL/ML)- Gray- Very Stiff to Hard- Moist *(continued)*				
	SILTY CLAY with sand and gravel (CL/ML)- Gray- Very Stiff to Hard- Moist				
80		SS 22	100	5-5-12 (17)	3.0
85		SS 23	89	13-30-24 (54)	4.5
		SS 24	100	50	4.5
90					
		SS 25	100	50/5"	4.5
95					
		SS 26	100	50/4"	4.5
100					
		SS 27	100	50/4"	4.5
105					
		SS 28	50	50/4"	4.5
110					
115		SS 29	100	50/4"	4.5



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BORING NUMBER B-06

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

CLIENT Transystem	**PROJECT NAME** CTA State-Lake Station
PROJECT NUMBER 20-1038	**PROJECT LOCATION** Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 ● Moisture Content 10 20 30 40 ☐ Unconfined Compression (tsf) 2 4 6 8
115	▨	SILTY CLAY with sand and gravel (CL/ML)- Gray- Very Stiff to Hard- Moist *(continued)*					
120		LIMESTONE- Gray- Weathered Auger refusal at 121 feet					
125 130		LIMESTONE- Gray- Weathered, lightly fractured, Vuggy Run 1: 121 to 131 feet Recovery: 100% RQD: 85.4% (Good)	RC 1	100 (85)		563 510	☐ ☐

Bottom of borehole at 131.0 feet.

Rock Core Photo: B-06

TOP
121’

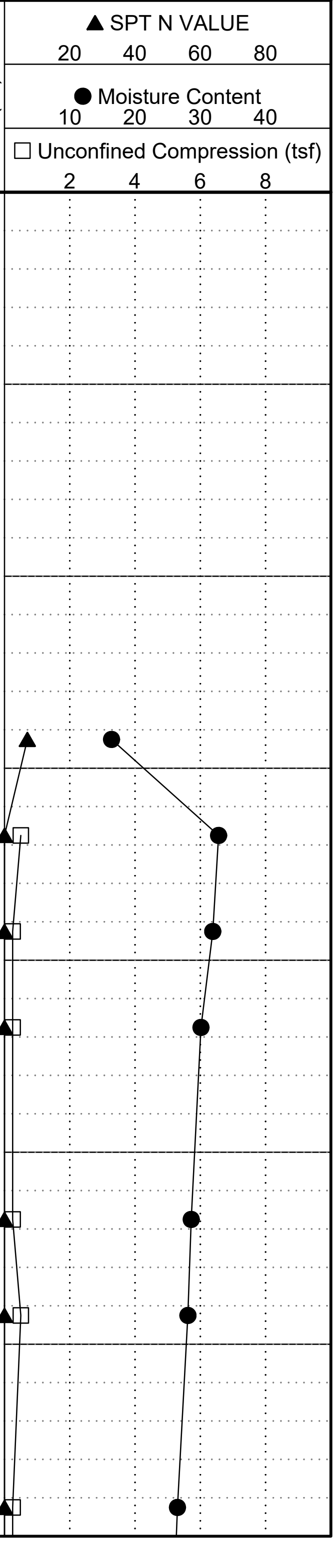
BOT
131’

Run	Depth (ft)	Recovery (%)	RQD (%)	RQD Classification	Description	Depth (ft)/ Unconfined Compression Strength (psi)
1	121’ – 131’	100	85.4	Good	Gray Limestone Lightly Fractured, Weathered, Vuggy	123.0-123.7/7,819 127.6-128.2/7,082

BORING NUMBER B-08

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago
DATE STARTED 11/11/21 **COMPLETED** 11/12/21
GROUND ELEVATION 14.50 ft CCD **HOLE SIZE** 3 1/4
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING --- None
LOGGED BY JEB **CHECKED BY** MZ
AT END OF DRILLING --- NA
NOTES Drill rig: CME
AFTER DRILLING --- NA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0	10.5 inches of Asphalt				
	6.5 inches of Granite Paver				
5	Hydrovac				
10	FILL: SAND with GRAVEL - Brown - Moist				
15	SILTY CLAY, trace gravel (CL/ML) - Gray - Stiff - Moist	SS 6	6	3-3-4 (7)	
	SILTY CLAY with sand and gravel (CL/ML) - Gray - very soft to soft - Moist to Very Moist	SS 7	100	0-0-0 (0)	0.5
20		SS 8	39	0-0-0 (0)	0.25
		SS 9	100	0-0-0 (0)	0.25
25	Vane Shear @25.0' Shear Strength = 0.58 tsf Remolded = 0.22 tsf	SS 11	100	0-0-0 (0)	0.25
30		SS 12	100	0-0-0 (0)	0.5
35	Vane Shear @32.0' Shear Strength = 0.43 tsf Remolded = 0.25 tsf	SS 13	100	0-0-0 (0)	0.25



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BORING NUMBER B-08

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GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
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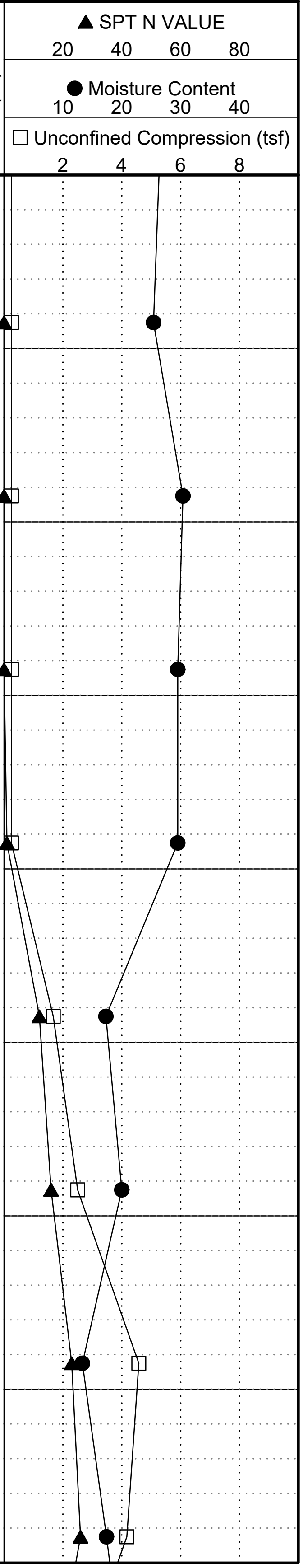
CLIENT Transystem

PROJECT NUMBER 20-1038

PROJECT NAME CTA State-Lake Station

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35		SILTY CLAY with sand and gravel (CL/ML) - Gray - very soft to soft - Moist to Very Moist *(continued)*				
40			SS 14	100	0-0-0 (0)	0.25
		Vane Shear @42.0' Shear Strength = 0.39 tsf Remolded = 0.21 tsf				
45			SS 15	100	0-0-0 (0)	0.25
50			SS 16	100	0-0-0 (0)	0.25
55			SS 17	100	0-0-1 (1)	0.25
		SILTY CLAY, trace gravel (CL/ML) - Gray - Very Stiff to Hard - Moist				
		6 inches of clayey gravel seam at 58.5 feet				
60			SS 18	67	3-5-7 (12)	1.67
65			SS 19	78	5-7-9 (16)	2.5
70			SS 20	100	6-10-13 (23)	4.58
75			SS 21	100	7-10-16 (26)	4.17



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BORING NUMBER B-08

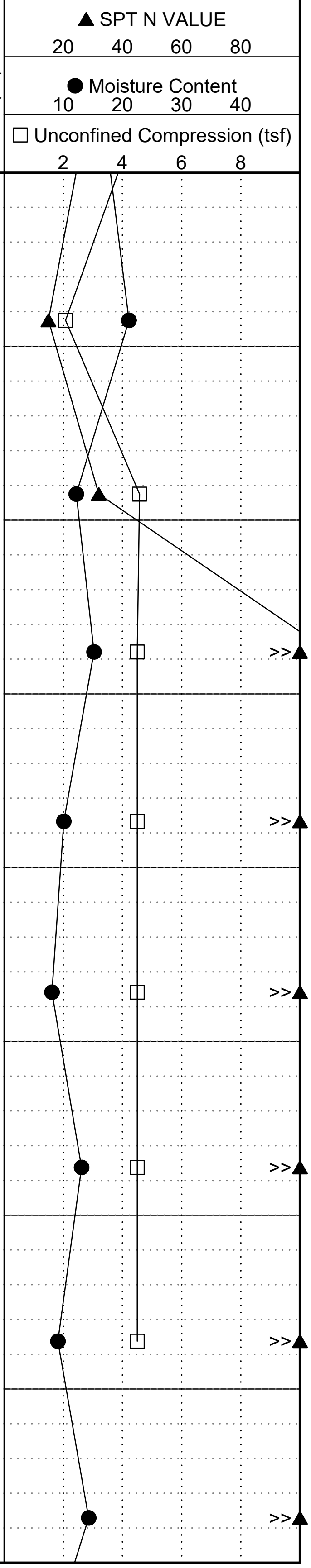
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75	SILTY CLAY, trace gravel (CL/ML) - Gray - Very Stiff to Hard - Moist *(continued)*				
80		SS 22	100	5-7-8 (15)	2.08
85		SS 23	100	12-14-18 (32)	4.58
	SILTY CLAY with sand and gravel (CL/ML) - Gray - Hard - Moist 2 inches of sand seam at 89 feet	SS 24	100	37-50/1"	4.5
90					
		SS 25	50	50/4"	4.5
95					
		SS 26	100	50/2"	4.5
100					
	Limestone fragments at 103.5 feet	SS 27	50	50/3"	4.5
105					
		SS 28	33	50/3"	4.5
110					
		SS 29	10	50/5"	
115					



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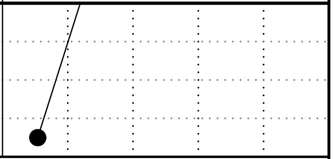
BORING NUMBER B-08

CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 ● Moisture Content 10 20 30 40 ☐ Unconfined Compression (tsf) 2 4 6 8
115		CLAYEY GRAVEL (GC) - Gray - Moist Auger refusal at 119 feet *(continued)*					

Bottom of borehole at 119.0 feet.

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
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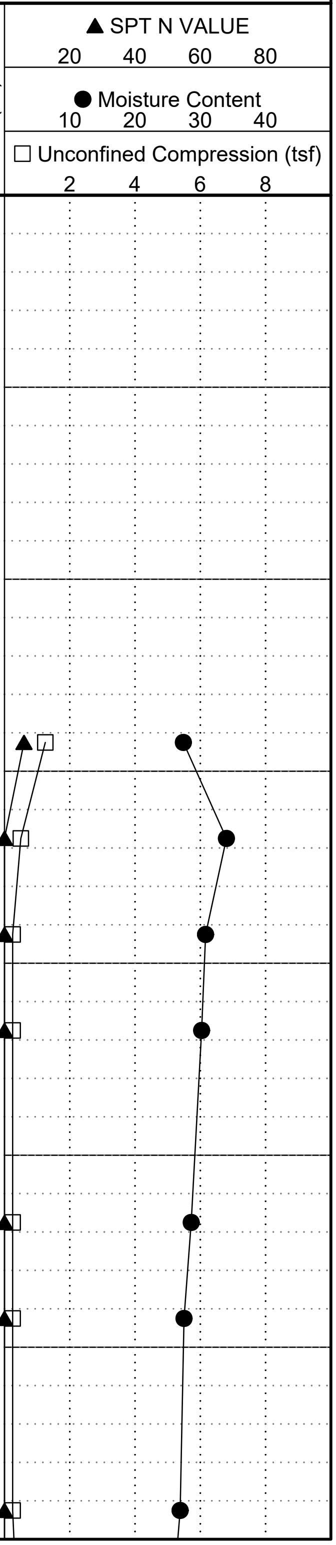
BORING NUMBER B-09

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago
DATE STARTED 11/12/21 **COMPLETED** 11/12/21
GROUND ELEVATION 15.00 ft CCD **HOLE SIZE** 3 1/4
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Mud Rotary
AT TIME OF DRILLING --- None
LOGGED BY JB **CHECKED BY** MZ
AT END OF DRILLING --- NA
NOTES Drill rig: Diedrich D-50 ATV
AFTER DRILLING --- NA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0	6.5 inches of Concrete				
5	Hydrovac				
10	FILL: GRAVEL (GP) - Gray - Moist				
15	SILTY CLAY, trace gravel (CL-ML) - Gray - Stiff - Moist to Very Moist	SS 6	89	0-3-3 (6)	1.25
	SILTY CLAY, trace gravel (CL-ML) - Gray - Very Soft to Soft - Moist to Very Moist	SS 7	100	0-0-0 (0)	0.5
20		SS 8	100	0-0-0 (0)	0.25
		SS 9	100	0-0-0 (0)	0.25
25	Vane Shear @25.0' Shear Strength = 0.41 tsf Remolded = 0.17 tsf				
		SS 11	50	0-0-0 (0)	0.25
30		SS 12	100	0-0-0 (0)	0.25
	Vane Shear @32.0' Shear Strength = 0.39 tsf Remolded = 0.18 tsf				
35		SS 13	100	0-0-0 (0)	0.25



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BORING NUMBER B-09

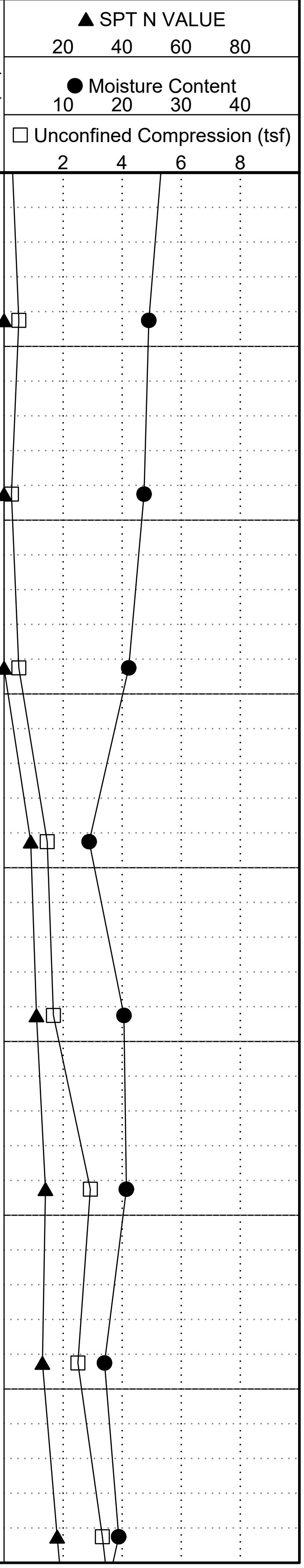
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35		SILTY CLAY, trace gravel (CL-ML) - Gray - Very Soft to Soft - Moist to Very Moist *(continued)*				
40			SS 14	89	0-0-0 (0)	0.5
		Vane Shear @42.0' Shear Strength = 0.43 tsf Remolded = 0.22 tsf				
45			SS 15	89	0-0-0 (0)	0.25
50			SS 16	94	0-0-0 (0)	0.5
		SILTY CLAY, trace sand (CL-ML) - Gray - Stiff to Hard - Moist				
55			SS 17	89	3-4-5 (9)	1.46
60			SS 18	100	4-4-7 (11)	1.67
65			SS 19	100	4-5-9 (14)	2.92
70			SS 20	83	3-6-7 (13)	2.50
75			SS 21	89	5-9-9 (18)	3.33



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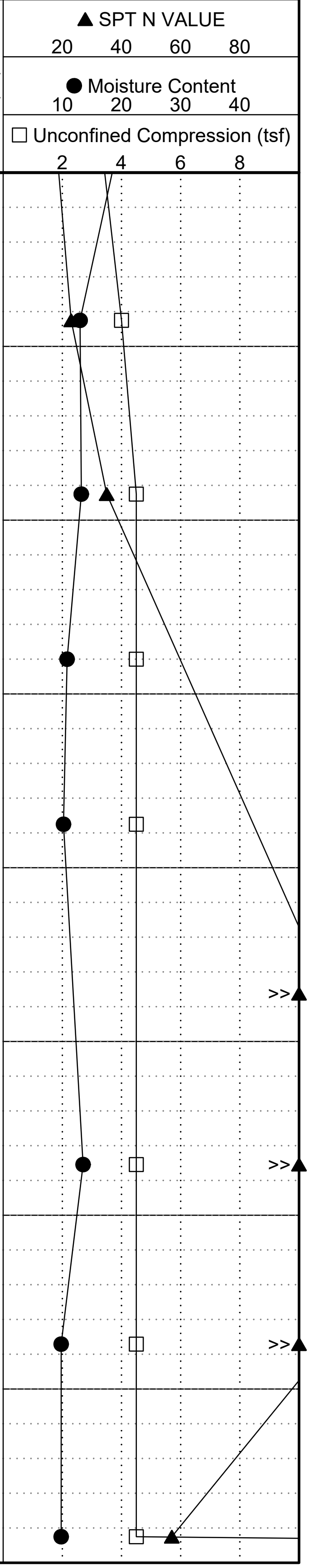
BORING NUMBER B-09

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75	SILTY CLAY, trace sand (CL-ML) - Gray - Stiff to Hard - Moist *(continued)*				
80		SS 22	83	9-9-14 (23)	4.0
	SILTY CLAY with sand, trace gravel (CL-ML) - Gray - Hard - Moist				
85		SS 23	100	12-15-20 (35)	4.5
90		SS 24	100	40-50	4.5
95		SS 25	100	50	4.5
100	Rock Fragments at 98 to 103 feet	SS 26	33	50/3"	
105		SS 27	200	50/1"	4.5
110		SS 28	100	50/5"	4.5
115		SS 29	78	25-25-32 (57)	4.5



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GSG CONSULTANTS, INC.
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Tel: 630.994.2600, www.gsg-consultants.com

BORING NUMBER B-09

CLIENT Transystem
PROJECT NAME CTA State-Lake Station
PROJECT NUMBER 20-1038
PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 ● Moisture Content 10 20 30 40 ☐ Unconfined Compression (tsf) 2 4 6 8
115	▨	SILTY CLAY with sand, trace gravel (CL-ML) - Gray - Hard - Moist *(continued)*					
120		LIMESTONE - Gray - Highly weathered Auger refusal at 121 feet					
125 130		LIMESTONE - Gray - Lighlty Fractured, Weathered, Vuggy Run 1: 121 to 131 feet Recovery: 98.8% RQD: 97.3% (Excellent)	RC 1	99 (97)		937 564	☐ ☐

Bottom of borehole at 131.0 feet.

Rock Core Photo: B-09

Run	Depth (ft)	Recovery (%)	RQD (%)	RQD Classification	Description	Depth (ft)/ Unconfined Compression Strength (psi)
1	121’ – 131’	98.8	97.3	Excellent	Gray Limestone Lightly Fractured, Weathered, Vuggy	121.0-122.0/13,016 129.0-130.0/7,827

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

BORING NUMBER B-10

CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DATE STARTED 11/9/21 **COMPLETED** 11/10/21

GROUND ELEVATION 14.10 ft CCD **HOLE SIZE** 3 1/4

DRILLING CONTRACTOR GSG Drilling

GROUND WATER LEVELS:

DRILLING METHOD Mud Rotary

AT TIME OF DRILLING --- None

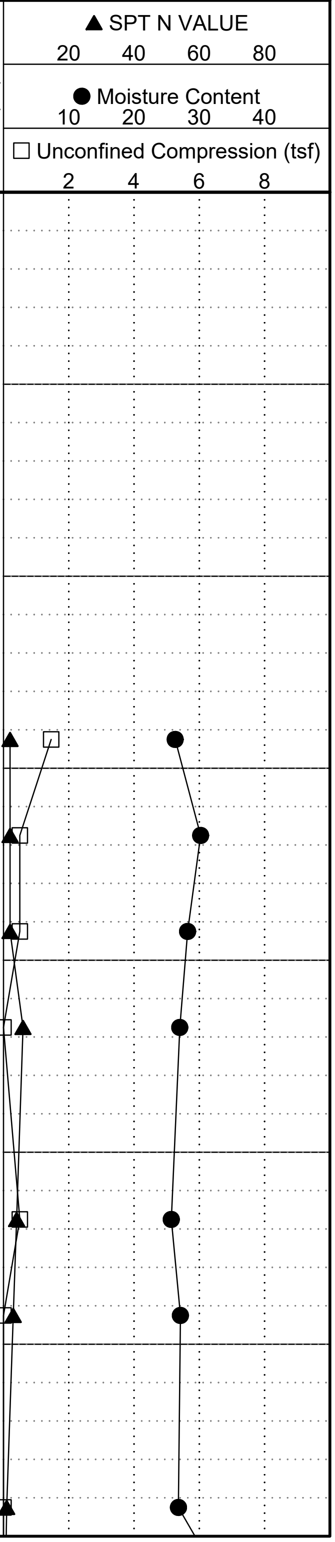
LOGGED BY JEB **CHECKED BY** MZ

AT END OF DRILLING --- NA

NOTES Drill rig: CME

AFTER DRILLING --- NA

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0	11 inches of Concrete				
	Hydrovac Bricks at 1 to 10 feet				
5					
10	FILL: SAND with GRAVEL- Brown- Moist				
	FILL: SILTY CLAY, with woods - Gray - Very Moist	SS 6	100	1-1-1 (2)	1.46
15	SILTY CLAY (CL/ML), Gray - Medium Stiff -Very Moist				
		SS 7	100	1-1-1 (2)	0.5
	SILTY CLAY (CL/ML) - Gray- Very Soft to Soft - Moist to Very Moist	SS 8	100	0-1-1 (2)	0.5
20					
	2 inches of gravel Seam at 21.5 feet	SS 9	100	2-2-4 (6)	0
25					
	Vane Shear @25.0' Shear Strength = 0.78 tsf Remolded = 0.45 tsf	SS 11	100	0-2-2 (4)	0.5
30	4 inches of gravel Seam at 29 feet	SS 12	78	0-1-2 (3)	0
	Vane Shear @32.0' Shear Strength = 0.62 tsf Remolded = 0.43 tsf				
35		SS 13	100	0-0-1 (1)	0



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BORING NUMBER B-10

GSG CONSULTANTS, INC.
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Tel: 630.994.2600, www.gsg-consultants.com

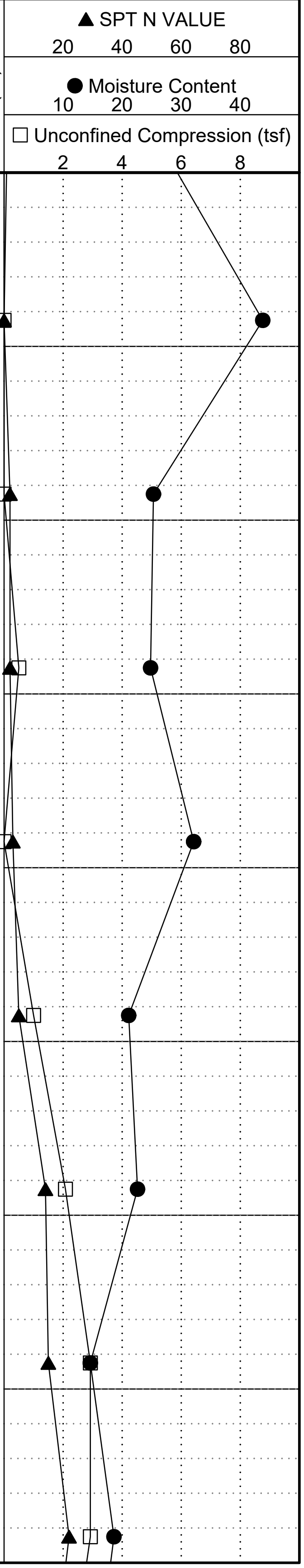
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
35		SILTY CLAY (CL/ML) - Gray- Very Soft to Soft - Moist to Very Moist *(continued)*				
40			SS 14	100	0-0-0 (0)	0
		Vane Shear @42.0' Shear Strength = 0.45 tsf Remolded = 0.34 tsf				
45			SS 15	100	0-1-1 (2)	0
50			SS 16	100	0-1-1 (2)	0.5
		4 inches of Clayey gravel Seam at 53.5 feet	SS 17	67	0-1-2 (3)	0
55		SILTY CLAY (CL/ML) - Gray- Stiff to Very Stiff -Moist				
60			SS 18	89	2-2-3 (5)	1.0
65			SS 19	100	4-6-8 (14)	2.08
		Gravel Seam at 68.5 feet	SS 20	100	6-7-8 (15)	2.92
70						
75			SS 21	100	3-8-14 (22)	2.92



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BORING NUMBER B-10

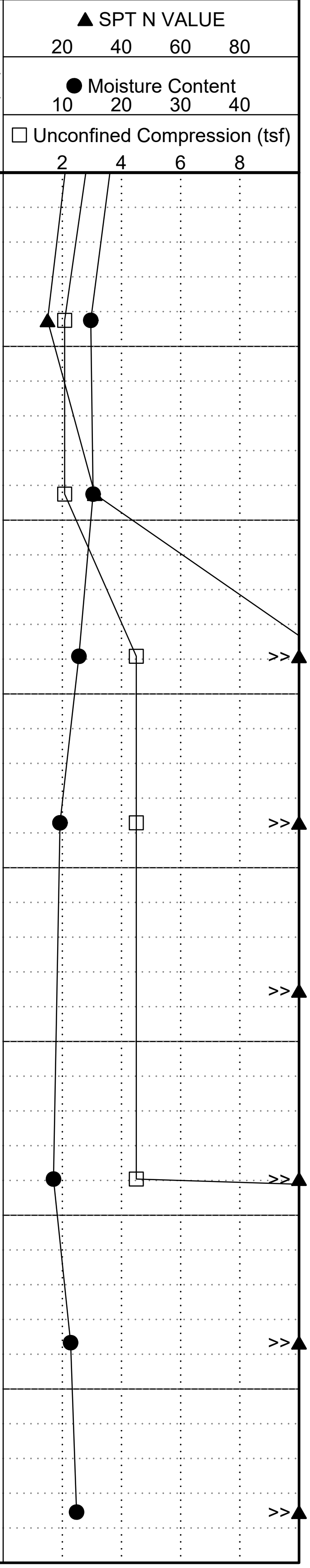
CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
75	SILTY CLAY (CL/ML) - Gray- Stiff to Very Stiff -Moist *(continued)*				
80		SS 22	100	5-7-8 (15)	2.08
85		SS 23	100	9-13-18 (31)	2.08
	SILTY CLAY with sand and gravel (ML)- Gray- Hard -Moist	SS 24	100	50-50/4"	4.5
90					
95		SS 25	100	50/5"	4.5
100		SS 26	0	50/1"	
105		SS 27	55	37-50/5"	4.5
		SS 28	50	50/4"	
110	CLAYEY GRAVEL (GC) - Gray- Extremely Dense - Moist				
115		SS 29	100	50/1"	



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BORING NUMBER B-10

CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)	▲ SPT N VALUE 20 40 60 80 / ● Moisture Content 10 20 30 40 / ☐ Unconfined Compression (tsf) 2 4 6 8
115						
	LIMESTONE- Gray - Highly Weathered Auger refusal at 117.5 feet					
	LIMESTONE - Gray - Vertical Fractures, Weathered, Vuggy Run 1: 117.5 to 127.5 feet Recovery: 99.4% RQD: 66.7% (Fair)	RC 1	99 (67)		673	☐
120						
125					618	☐

Bottom of borehole at 127.5 feet.

Rock Core Photo: B-10

Run	Depth (ft)	Recovery (%)	RQD (%)	RQD Classification	Description	Depth (ft)/ Unconfined Compression Strength (psi)
1	117.5’ – 127.5’	99.4	66.7	Fair	Gray Limestone Fractured, Weathered, Vuggy	122.1-123.1/9,350 125.5-126.5/8,589

Unified Soil Classification

Soil Classification is based on the Unified Soil Classification System and ASTM Designations D-2487 and D-2488. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; they are described as: clays, if they are plastic, and silts if they are slightly Plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the basis of their relative in-place density and fine grained soils on the basis of their consistency. Example: Lean clay with sand, trace gravel, stiff (CL); silty sand, trace gravel, medium dense (SM).

Drilling & Sampling Symbols

		Water Level (ft)
SS :	Split Spoon	
ST :	Thin-Walled Tube	▽ While Drilling
HA:	Hand Auger	▽ After Drilling
AU:	Auger Sample	▼ 24-hour
HS:	Hand Sample	

Standard "N" Penetration: Blows per foot of a 140 pound hammer falling 30 inches on a 2 inch OD split spoon, except where noted.

Major Divisions			Group Symbols	Typical Names
Coarse Grained Soils (More than Half of material is larger than No. 200 sieve size)	**Gravels** (More than hall of coarse fraction is larger than No. 4 sieve size)	**Clean Gravels** (Little or no fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with fines (Appreciable amount of fines)	GM d u	Silty gravels, gravel-sand-clay mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than hall of coarse fraction is smaller than No. 4 sieve size)	**Clean Sands** (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with fines (Appreciable amount of fines)	SM d u	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine Grained Soils More than half of material is smaller than No. 200 sieve size)	**Silts and Clays** (liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or claye fine sands or clayey silts with slight plasticity
			CL	Inorganic clay of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays (liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
	Highly Organic Soils		Pt	Peat and other highly organic soils

Consistency of Cohesive Soil

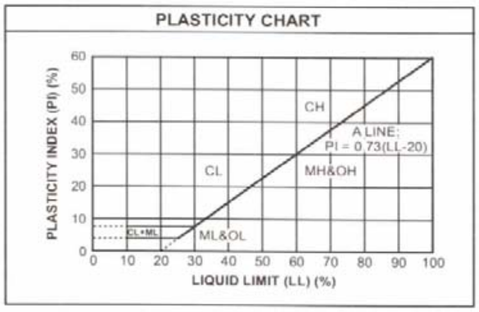
Unconfined Compressive strength, Qu, tsf			N-Blows/ft.		Consistency
	<	0.25	Below 2	<	Very Soft
0.25	-	0.50	2-4	-	Soft
0.50	-	1.0	4-8	-	Medium Stiff
1.0	-	2.0	8-15	-	Stiff
2.0	-	4.0	15-30	-	Very Stiff
4.0	-	8.0	30-50	-	Hard
>	-	8.0	> 50	-	Very Hard

Relative Density of Coarse-Grained Soils

N-Blows/ft.	Relative Density
0-3	Very Loose
4-10	Loose
11-29	Medium Dense
30-49	Dense
50-80	Very Dense
>80	Extremely Dense

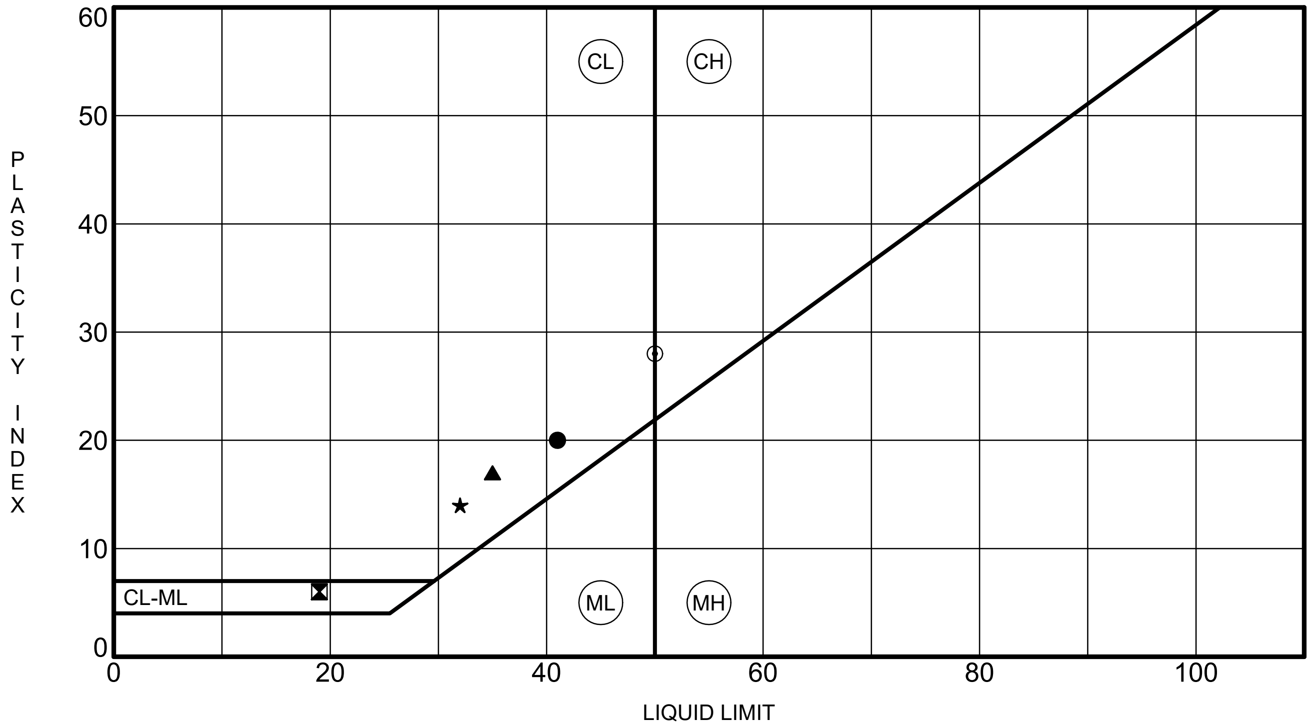
Description Term(s) of Components Present in Sample

Trace < 10%	Little 10-19%
Some 20-34%	And 35-50%



APPENDIX D

LABORATORY TEST RESULTS



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-02**	**21.00**	**41.0**	**21.0**	**20.0**		
☒	**B-02**	**88.50**	**19.0**	**13.0**	**6.0**		
▲	**B-09**	**28.50**	**35.0**	**18.0**	**17.0**		
★	**B-09**	**58.50**	**32.0**	**18.0**	**14.0**		
⊙	**B-10**	**38.50**	**50.0**	**22.0**	**28.0**		

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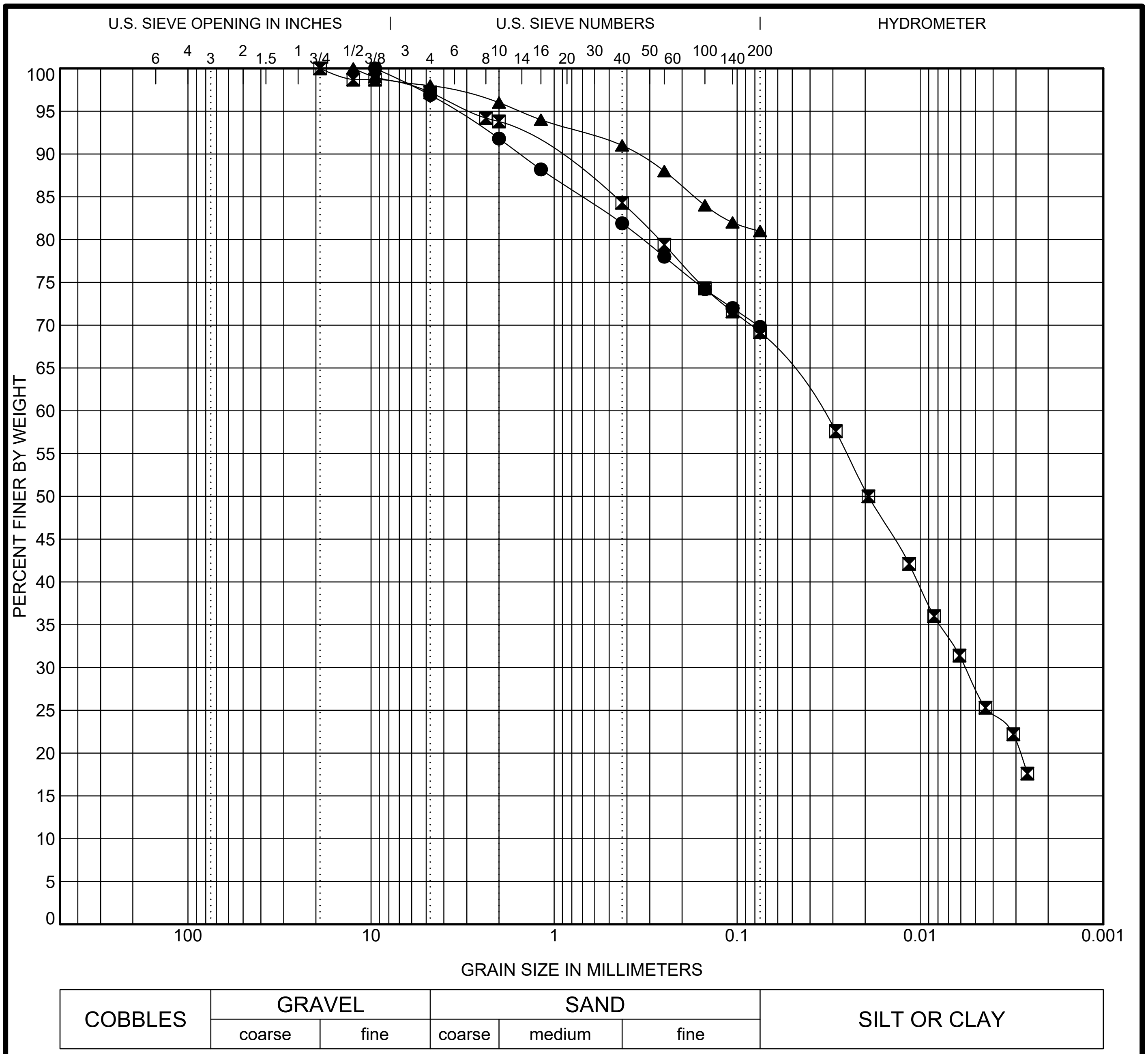
Engineers.Scientists.Construction Managers
735 Remington Road, Schaumburg IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

ATTERBERG LIMITS' RESULTS

Project: Replacement of of the State/Lake Loop
Elevated CTA Station

Location: Chicago, IL

ATTERBERG LIMITS CTA STATE-LAKE.GPJ IL DOT.GDT 11/27/21



	Specimen Identification	Classification	LL	PL	PI	Cc	Cu
●	**B-04** 88.5'	Sandy Silty Clay					
⧗	**B-09** 88.5'	Sandy Silty Clay					
▲	**B-10** 83.5'	Silty Clay with Sand					

	Specimen Identification	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-04** 88.5'	**9.5**				**3.1**	**27.1**	**69.8**	
⧗	**B-09** 88.5'	**19**	**0.035**	**0.006**		**2.8**	**28.0**	**69.2**	
▲	**B-10** 83.5'	**12.5**				**2.0**	**17.0**	**81.0**	

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GRAIN SIZE DISTRIBUTION

Project: Replacement of of the State/Lake Loop
Elevated CTA Station

Location: Chicago, IL

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name: CTA State & Lake

Project No: 20-1038

Boring ID: B-02

Bulk/Prep — MC/CS

Sample Depth (ft): 124.2-124.9

Tester: NJB — Tester: NJB

Lithological Description: limestone

Date: 11/16/21 — Date: 11/19/2021

Formation Name: Silurian

Load Direction: V

Angle Drilled: V

Appearance (e.g. cracks, shearing, spalling): very small vugs throughout

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.9125	4.9165	4.9175	4.9155
Diameter, *in.*	1.9575	1.9650	1.9645	1.9623

Specimen Mass, *g*	608.7	Ratio (2.0-2.5)	
Bulk Density, *pcf*	156.0		2.50

Moisture Condition - D2216

Container ID	LAYS
container, *g*	226.7
container + wet rock, *g*	436.0
container + dry soil, *g*	435.8
moisture content, *w%*	0.1

Preparation Check	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?		X	1.55 degrees, sides uneven
Ends parallel to each other within 0.25 degrees?	X		

Axial Loading

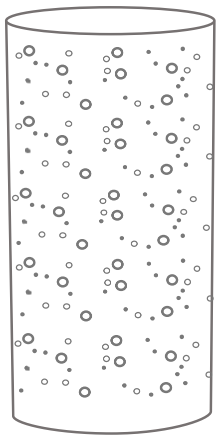
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	75
Time to Failure (2-15 min)	2 min 0 sec
Load @ Failure, *lbf*	32,037
Uniaxial Compressive Strength, *psi*	10,570

Remarks

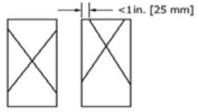
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made. Specimen mass taken with caps on.

After Preparation

Sketch

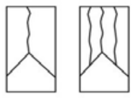


After Break (check applicable appearance)



Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps

☐



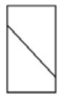
Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end

☒

Type 3
Columnar vertical cracking through both ends, no well-formed cones

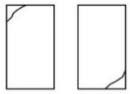
☐

☐ Sketch if Other:



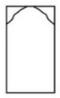
Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1

☐



Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)

☐



Type 6
Similar to Type 5 but end of cylinder is pointed

☐

Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	24-Nov

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name: CTA State & Lake
Project No: 20-1038
Boring ID: B-02
Sample Depth (ft): 129.0-129.8
Lithological Description: limestone
Formation Name: Silurian
Load Direction: V
Angle Drilled: V
Appearance (e.g. cracks, shearing, spalling): very small vugs throughout

	Bulk/Prep	MC/CS
Tester:	NJB	NJB
Date:	11/16/21	11/19/21

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.6230	4.6335	4.6210	4.6258
Diameter, *in.*	1.9795	1.9735	1.9750	1.9760

Specimen Mass, *g*	564.2	Ratio (2.0-2.5)	
Bulk Density, *pcf*	151.5		2.34

Moisture Condition - D2216

Container ID	PEEPS
container, *g*	226.9
container + wet rock, *g*	456.4
container + dry soil, *g*	456.2
moisture content, *w%*	0.1

Preparation Check	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?		X	2.05 degrees, sides uneven
Ends parallel to each other within 0.25 degrees?	X		

Axial Loading

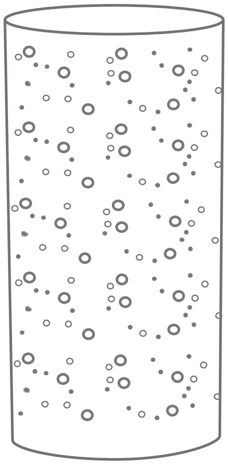
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	75
Time to Failure (2-15 min)	2 min 23 sec
Load @ Failure, *lbf*	34,053
Uniaxial Compressive Strength, *psi*	11,104

Remarks

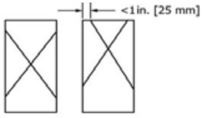
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made. Specimen mass taken with caps on.

After Preparation

Sketch

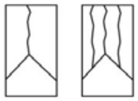


After Break (check applicable appearance)



Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps

☐

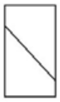


Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end

☐

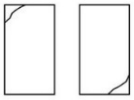
Type 3
Columnar vertical cracking through both ends, no well-formed cones

☒



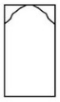
Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1

☐



Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)

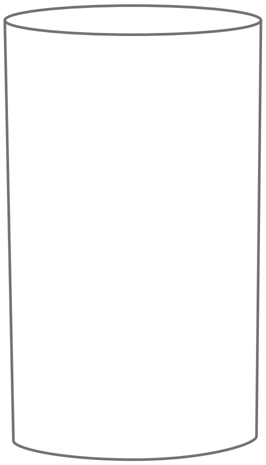
☐



Type 6
Similar to Type 5 but end of cylinder is pointed

☐

☐ Sketch if Other:



Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	24-Nov

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name: CTA State & Lake
Project No: 20-1038
Boring ID: B-06

	Bulk/Prep	MC/CS
Tester:	NJB	NJB
Date:	11/29/21	11/30/21

Sample Depth (ft): 123.0-123.7
Lithological Description: limestone
Formation Name: Silurian
Load Direction: Vertical
Angle Drilled: Vertical
Appearance (e.g. cracks, shearing, spalling): <1% 3-4 mm vugs; ~25% <3 mm vugs;

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.1045	4.0920	4.0940	4.0968
Diameter, *in.*	1.9790	1.9710	1.9680	1.9727

Specimen Mass, *g*	489.7	Ratio (2.0-2.5)	
Bulk Density, *pcf*	149.0		2.08

Moisture Condition - D2216

Container ID	PEZ
container, *g*	226.7
container + wet rock, *g*	546.0
container + dry soil, *g*	542.3
moisture content, *w%*	1.2

Preparation Check

Preparation Check	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?		X	0.95 degrees, uneven sides
Ends parallel to each other within 0.25 degrees?		X	0.75 degrees, uneven sides

Axial Loading

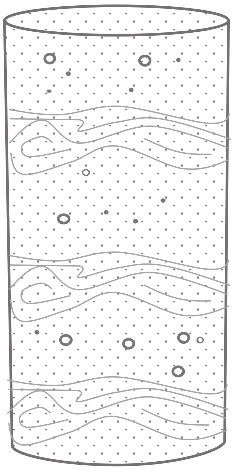
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	74
Time to Failure (2-15 min)	1 min 44 sec
Load @ Failure, *lbf*	23,899
Uniaxial Compressive Strength, *psi*	7,819

Remarks

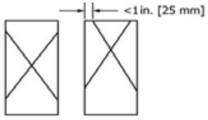
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made. Time to failure was less than 2 minutes.

After Preparation

Sketch

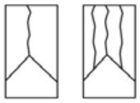


After Break (check applicable appearance)



Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps

☐

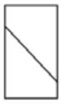


Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end

☐

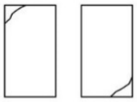
Type 3
Columnar vertical cracking through both ends, no well-formed cones

☐



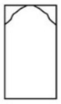
Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1

☒



Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)

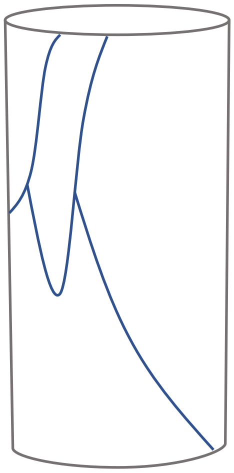
☐



Type 6
Similar to Type 5 but end of cylinder is pointed

☐

☒ Sketch if Other:



Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	12/01/21

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name:	CTA State & Lake	Project No:	20-1038		
Boring ID:	B-06	Bulk/Prep		MC/CS	
Sample Depth (ft):	127.5-128.9	Tester:	NJB	Tester:	NJB
Lithological Description:	limestone	Date:	11/29/21	Date:	11/30/21
Formation Name:	Silurian	Load Direction:	Vertical	Angle Drilled:	Vertical

Appearance (e.g. cracks, shearing, spalling): <1% 3-5 mm vugs; ~15% <3 mm vugs; some pyrite replacement; one crinoid

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.2600	4.2680	4.2620	4.2633
Diameter, *in.*	1.9800	1.9730	1.9815	1.9782

Specimen Mass, *g*	519.7	Ratio (2.0-2.5)
Bulk Density, *pcf*	151.1	2.16

Moisture Condition - D2216

Container ID	DOTS
container, *g*	226.8
container + wet rock, *g*	567.1
container + dry soil, *g*	563.3
moisture content, *w%*	1.1

Preparation Check	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?		X	0.80 degrees, uneven sides
Ends parallel to each other within 0.25 degrees?		X	0.45 degrees, uneven sides

Axial Loading

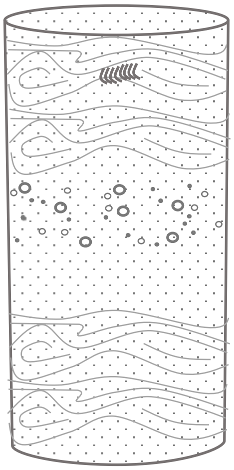
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	74
Time to Failure (2-15 min)	1 min 33 sec
Load @ Failure, *lbf*	21,766
Uniaxial Compressive Strength, *psi*	7,082

Remarks

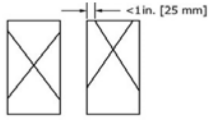
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made. Time to failure was less than 2 minutes.

After Preparation

Sketch

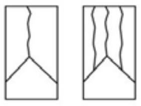


After Break (check applicable appearance)



Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps

☐

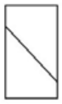


Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end

☐

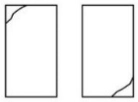
Type 3
Columnar vertical cracking through both ends, no well-formed cones

☐



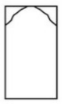
Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1

☒



Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)

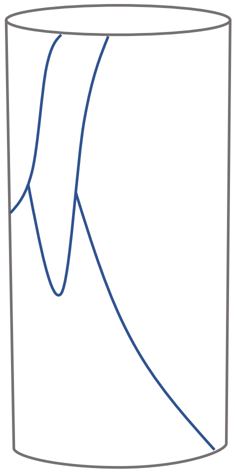
☐



Type 6
Similar to Type 5 but end of cylinder is pointed

☐

☒ Sketch if Other:



Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	12/01/21

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name: CTA State & Lake

Project No: 20-1038

Boring ID: B-09

	Bulk/Prep	MC/CS
Tester:	NJB	NJB
Date:	11/22/21	11/23/21

Sample Depth (ft): 121-122

Lithological Description: limestone

Formation Name: Silurian

Load Direction: V

Angle Drilled: V

Appearance (e.g. cracks, shearing, spalling): <3mm vugs covering 25% of sample

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.3680	4.3685	4.3765	4.3710
Diameter, *in.*	1.9810	1.9870	1.9880	1.9853

Specimen Mass, *g*	566.9	Ratio (2.0-2.5)
Bulk Density, *pcf*	159.6	2.20

Moisture Condition - D2216

Container ID	SWEET
container, *g*	226.4
container + wet rock, *g*	538.3
container + dry soil, *g*	526.8
moisture content, *w%*	3.8

Preparation Check	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?		X	1.00 degrees
Ends parallel to each other within 0.25 degrees?		X	0.45 degrees

Axial Loading

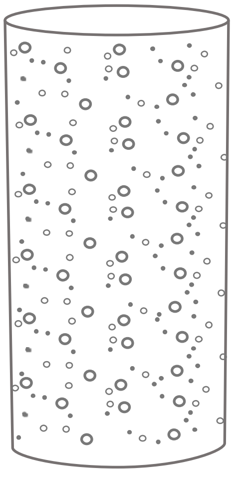
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	75
Time to Failure (2-15 min)	2 min 51 sec
Load @ Failure, *lbf*	40,281
Uniaxial Compressive Strength, *psi*	13,061

Remarks

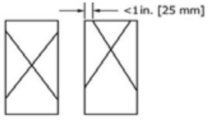
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made. Sample mass taken with one cap on.

After Preparation

Sketch

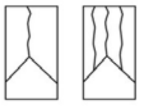


After Break (check applicable appearance)



Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps

☐

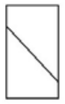


Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end

☒

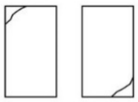
Type 3
Columnar vertical cracking through both ends, no well-formed cones

☐



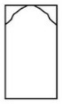
Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1

☐



Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)

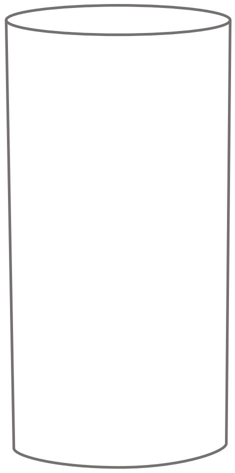
☐



Type 6
Similar to Type 5 but end of cylinder is pointed

☐

☐ Sketch if Other:



Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	11/24/21

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name: CTA State & Lake
Project No: 20-1038
Boring ID: B-09

	Bulk/Prep	MC/CS
Tester:	NJB	NJB
Date:	11/29/21	11/30/21

Sample Depth (ft): 129.0-130.0
Lithological Description: limestone
Formation Name: Silurian
Load Direction: Vertical
Angle Drilled: Vertical
Appearance (e.g. cracks, shearing, spalling): <1% 4-6 mm vugs; ~50% <4 mm vugs; some pyrite replacement; few crinoids

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.3535	4.3275	4.3430	4.3413
Diameter, *in.*	1.9790	1.9895	1.9635	1.9773

Specimen Mass, *g*	541.9	Ratio (2.0-2.5)	
Bulk Density, *pcf*	154.9		2.20

Moisture Condition - D2216

Container ID	GUSHERS
container, *g*	226.4
container + wet rock, *g*	526.4
container + dry soil, *g*	517.1
moisture content, *w%*	3.2

Preparation Check	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?		X	0.95 degrees, uneven sides
Ends parallel to each other within 0.25 degrees?		X	0.85 degrees, uneven sides

Axial Loading

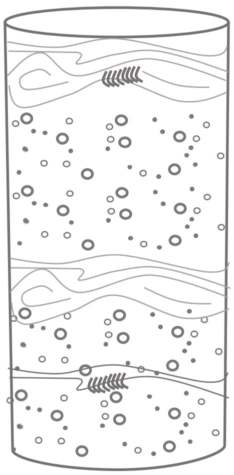
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	74
Time to Failure (2-15 min)	1 min 46 sec
Load @ Failure, *lbf*	24,033
Uniaxial Compressive Strength, *psi*	7,827

Remarks

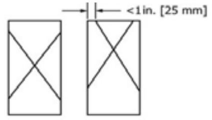
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made. Time to failure was less than 2 minutes.

After Preparation

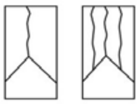
Sketch



After Break (check applicable appearance)

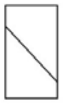


Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps
☐

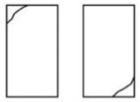


Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end
☐

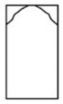
Type 3
Columnar vertical cracking through both ends, no well-formed cones
☐



Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1
☒

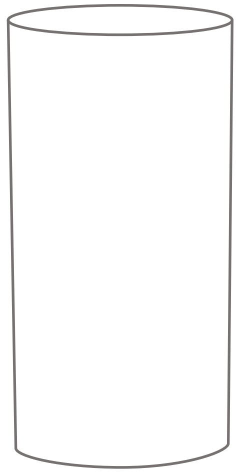


Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)
☐



Type 6
Similar to Type 5 but end of cylinder is pointed
☐

☐ Sketch if Other:



Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	12/01/21

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name: CTA State & Lake
Project No: 20-1038
Boring ID: B-10
Sample Depth (ft): 122.1-125.1
Lithological Description: limestone
Formation Name: Silurian
Load Direction: V
Angle Drilled: V
Appearance (e.g. cracks, shearing, spalling): <2mm vugs covering 15% of sample

	Bulk/Prep	MC/CS
Tester:	NJB	NJB
Date:	11/22/21	11/23/21

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.4495	4.4545	4.4590	4.4543
Diameter, *in.*	1.9945	1.9940	1.9920	1.9935

Specimen Mass, *g*	573.2	Ratio (2.0-2.5)	
Bulk Density, *pcf*	157.1		2.23

Moisture Condition - D2216

Container ID	Blood
container, *g*	227.0
container + wet rock, *g*	497.5
container + dry soil, *g*	493.5
moisture content, *w%*	1.5

Preparation Check

	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?	X		
Ends parallel to each other within 0.25 degrees?		X	0.45 degrees

Axial Loading

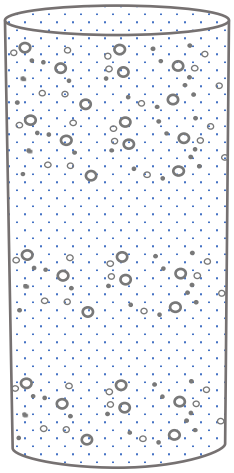
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	75
Time to Failure (2-15 min)	2 min 1 sec
Load @ Failure, *lbf*	29,184
Uniaxial Compressive Strength, *psi*	9,350

Remarks

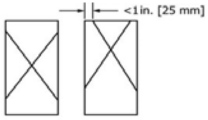
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made.

After Preparation

Sketch

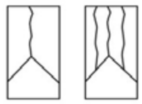


After Break (check applicable appearance)



Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps

☐

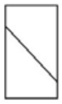


Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end

☐

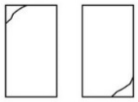
Type 3
Columnar vertical cracking through both ends, no well-formed cones

☐



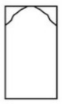
Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1

☒



Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)

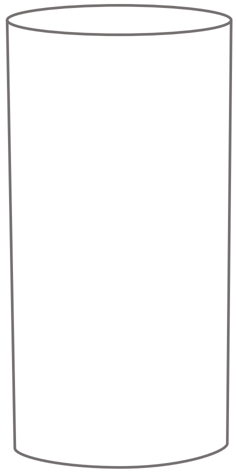
☐



Type 6
Similar to Type 5 but end of cylinder is pointed

☐

☐ Sketch if Other:



Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	11/24/21

Compressive Strength of Rock by ASTM D7012 - Method C

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project Name: CTA State & Lake
Project No: 20-1038
Boring ID: B-10

	Bulk/Prep		MC/CS
Tester:	NJB	Tester:	NJB
Date:	11/22/21	Date:	11/23/21

Sample Depth (ft): 125.5-126.5
Lithological Description: limestone
Formation Name: Silurian
Load Direction: V
Angle Drilled: V
Appearance (e.g. cracks, shearing, spalling): <2mm vugs covering 10% of sample

Bulk Density Determination

	1	2	3	Average
Height, *in.*	4.4855	4.4910	4.4910	4.4892
Diameter, *in.*	1.9925	1.9895	1.9905	1.9908

Specimen Mass, *g*	570.8	Ratio (2.0-2.5)	
Bulk Density, *pcf*	155.6		2.25

Moisture Condition - D2216

Container ID	RITZ
container, *g*	226.7
container + wet rock, *g*	543.0
container + dry soil, *g*	532.2
moisture content, *w%*	3.5

Preparation Check

	Yes	No	Reason/Readings If No:
Ends Flat within 0.02 mm prior to capping?	X		
Ends perpendicular to side within 0.25 degrees?	X		
Ends parallel to each other within 0.25 degrees?		X	0.45 degrees

Axial Loading

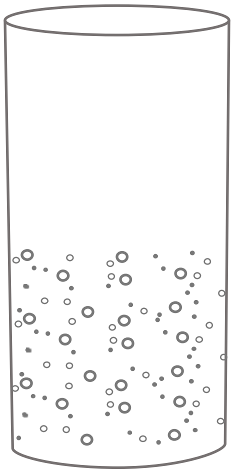
Seating Load (≤1000 psi)	1000
Rate of Loading (73-145 psi/s)	75
Time to Failure (2-15 min)	1 min 52 sec
Load @ Failure, *lbf*	26,736
Uniaxial Compressive Strength, *psi*	8,589

Remarks

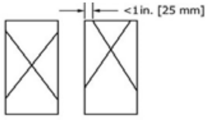
Best efforts have been made for the specimen to meet the required tolerances of D4543. See IH3 Procedure for efforts made. Test completed in less than 2 minutes.

After Preparation

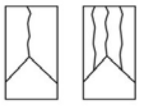
Sketch



After Break (check applicable appearance)

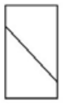


Type 1
Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps
☐

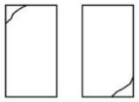


Type 2
Well-formed cone on one end, vertical cracks running through caps, no well-defined cone on other end
☐

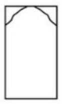
Type 3
Columnar vertical cracking through both ends, no well-formed cones
☐



Type 4
Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1
☒

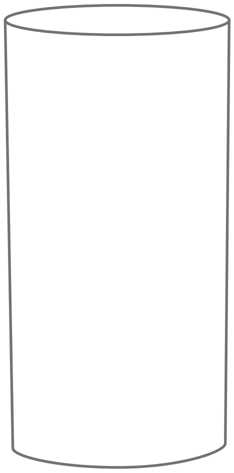


Type 5
Side fractures at top or bottom (occur commonly with unbonded caps)
☐



Type 6
Similar to Type 5 but end of cylinder is pointed
☐

☐ Sketch if Other:



Form ID	TF-RCS	Reviewed By	DE
Revision Date	10/21/2021	Review Date	11/24/21

APPENDIX E

PAVEMET CORE EXHIBITS

Top of Core

Bottom of Core

B-01 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Granite Paver (in.)	Total Thickness (in.)
North Side of Lake Street, West Side of State Street	8	-	4	12

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.


Top of Core

Bottom of Core

B-02 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Total Thickness (in.)
South Side of Lake Street, West Side of State Street	3.0	14.0	17.0

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

B-03 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Total Thickness (in.)
North Side of Lake Street, West Side of State Street	5.5	6.0	11.5

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

B-04 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Total Thickness (in.)
South Side of Lake Street, West Side of State Street	4	9.5	13.5

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

B-05 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Total Thickness (in.)
North Side of Lake Street, West Side of State Street	8.5	8.5	17.0

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

Top of Core

Bottom of Core

B-06 (on Sidewalk) –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Total Thickness (in.)
South Sidewalk of Lake Street, East Side of State Street	-	9	9

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

Top of Core

Bottom of Core

B-07 –Pavement Core

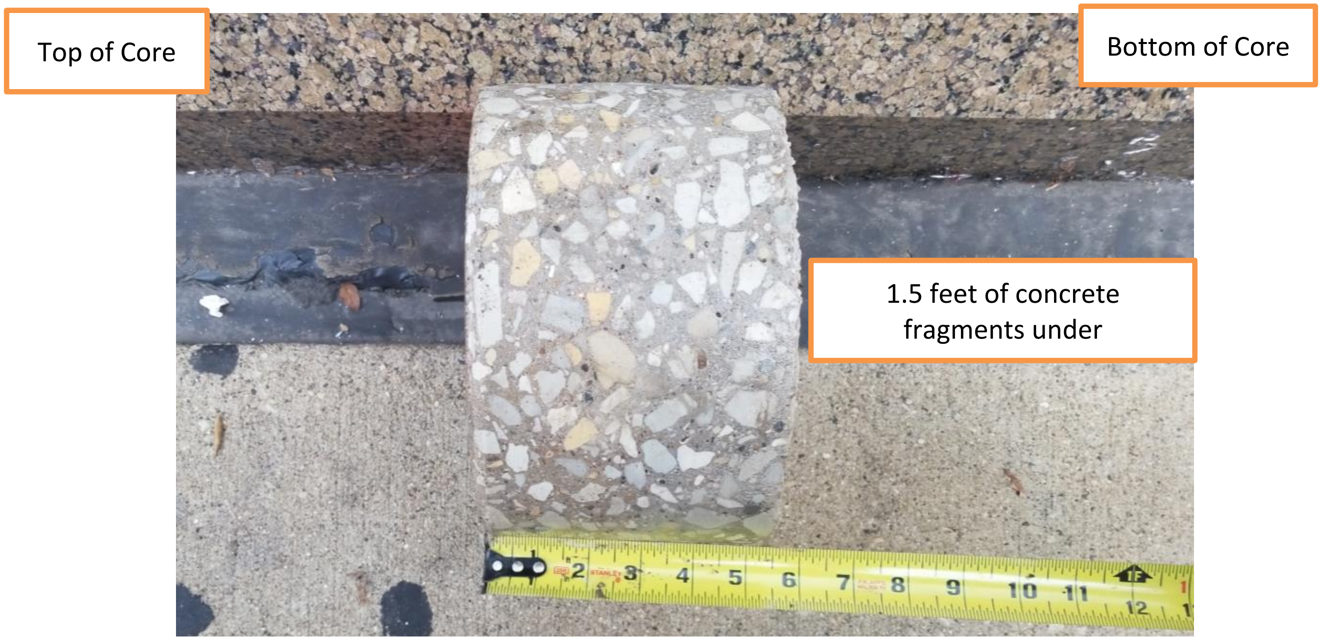
Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Granite Paver (in.)	Total Thickness (in.)
North Side of Lake Street, East Side of State Street	11.0	-	6.0	17.0

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

B-08 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Granite Paver (in.)	Total Thickness (in.)
South Side of Lake Street, East Side of State Street	10.5	-	6.5	17.0

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.



B-09 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Total Thickness (in.)
North Sidewalk of Lake Street, East Side of State Street	-	6.5	6.5

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

Top of Core

Bottom of Core

B-10 –Pavement Core

Core Location	Asphalt Thickness (in.)	Concrete Thickness (in.)	Total Thickness (in.)
State Street	-	11	11

*Pictures of the core measurements may differ from measured values. The measurement is along the maximum thickness of the core sample.

APPENDIX F

SQUEEZE POTENTIAL ANALYSIS

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Squeeze Potential Analysis B-01

CTA STATE LAKE

σv : Total Overburden Stress
Su: Undrained Shear Strength
D: Shaft Diameter

Caisson Squeeze Potential Criteria

Depth / D	σv / Su
4	5
8	6
12	6.5
16	7
20	7.5
24	8
28	8
32	8

Shaft Diameter:	3	ft
Site Elev:	14	CCD
Average Unit Weight:	125	pcf

B-3

Depth (ft)	Elevation (CCD)	Total Overburden (psf)	Su (psf)	Depth to Shaft (D) Ratio	Limiting Value Required to Avoid Squeeze (see table above)	Total Overburden/Su	Will Squeeze Occur (Yes / No)
20	-6	2500	500	6.7	5.7	5.0	No
25	-11	3125	500	8.3	6.1	6.3	Yes
30	-16	3750	580	10.0	6.3	6.5	Yes
35	-21	4375	580	11.7	6.5	7.5	Yes
40	-26	5000	780	13.3	6.6	6.4	No
45	-31	5625	780	15.0	6.9	7.2	Yes
50	-36	6250	780	16.7	7.1	8.0	Yes
55	-41	6875	780	18.3	7.3	8.8	Yes

Squeeze Potential Analysis B-05

CTA STATE LAKE

σv : Total Overburden Stress
Su: Undrained Shear Strength
D: Shaft Diameter

Caisson Squeeze Potential Criteria

Depth / D	σv / Su
4	5
8	6
12	6.5
16	7
20	7.5
24	8
28	8
32	8

Shaft Diameter:	3	ft
Site Elev:	14	CCD
Average Unit Weight:	125	pcf

B-3

Depth (ft)	Elevation (CCD)	Total Overburden (psf)	Su (psf)	Depth to Shaft (D) Ratio	Limiting Value Required to Avoid Squeeze (see table above)	Total Overburden/Su	Will Squeeze Occur (Yes / No)
15	-1	1875	250	5.0	5.3	7.5	Yes
20	-6	2500	250	6.7	5.7	10.0	Yes
25	-11	3125	360	8.3	6.1	8.7	Yes
30	-16	3750	360	10.0	6.2	10.4	Yes
35	-21	4375	780	11.7	6.5	5.6	No
40	-26	5000	780	13.3	6.6	6.4	No
45	-31	5625	780	15.0	6.9	7.2	Yes
50	-36	6250	780	16.7	7.1	8.0	Yes

Squeeze Potential Analysis B-08

CTA STATE LAKE

σv : Total Overburden Stress
Su: Undrained Shear Strength
D: Shaft Diameter

Caisson Squeeze Potential Criteria

Depth / D	σv / Su
4	5
8	6
12	6.5
16	7
20	7.5
24	8
28	8
32	8

Shaft Diameter:	3	ft	
Site Elev:	14	CCD	
Average Unit Weight:	125	pcf	B-3

Depth (ft)	Elevation (CCD)	Total Overburden (psf)	Su (psf)	Depth to Shaft (D) Ratio	Limiting Value Required to Avoid Squeeze (see table above)	Total Overburden/Su	Will Squeeze Occur (Yes / No)
15	-1	1875	500	5.0	5.3	3.8	No
20	-6	2500	250	6.7	5.7	10.0	Yes
25	-11	3125	580	8.3	6.1	5.4	No
30	-16	3750	430	10.0	6.2	8.7	Yes
35	-21	4375	430	11.7	6.5	10.2	Yes
40	-26	5000	430	13.3	6.6	11.6	Yes
45	-31	5625	390	15.0	6.9	14.4	Yes
50	-36	6250	390	16.7	7.1	16.0	Yes
55	-41	6875	390	18.3	8.1	17.6	Yes

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Squeeze Potential Analysis B-09

CTA STATE LAKE

σv : Total Overburden Stress
Su: Undrained Shear Strength
D: Shaft Diameter

Caisson Squeeze Potential Criteria

Depth / D	σv / Su
4	5
8	6
12	6.5
16	7
20	7.5
24	8
28	8
32	8

Shaft Diameter:	3	ft	
Site Elev:	14	CCD	
Average Unit Weight:	125	pcf	B-3

Depth (ft)	Elevation (CCD)	Total Overburden (psf)	Su (psf)	Depth to Shaft (D) Ratio	Limiting Value Required to Avoid Squeeze (see table above)	Total Overburden/Su	Will Squeeze Occur (Yes / No)
15	-1	1875	500	5.0	5.3	3.8	No
20	-6	2500	250	6.7	5.7	10.0	Yes
25	-11	3125	410	8.3	6.1	7.6	Yes
30	-16	3750	410	10.0	6.2	9.1	Yes
35	-21	4375	390	11.7	6.5	11.2	Yes
40	-26	5000	390	13.3	6.6	12.8	Yes
45	-31	5625	430	15.0	6.9	13.1	Yes
50	-36	6250	430	16.7	7.1	14.5	Yes

Squeeze Potential Analysis B-10

CTA STATE LAKE

σv : Total Overburden Stress
Su: Undrained Shear Strength
D: Shaft Diameter

Caisson Squeeze Potential Criteria

Depth / D	σv / Su
4	5
8	6
12	6.5
16	7
20	7.5
24	8
28	8
32	8

Shaft Diameter: 3 ft
Site Elev: 14 CCD
Average Unit Weight: 125 pcf

B-3

Depth (ft)	Elevation (CCD)	Total Overburden (psf)	Su (psf)	Depth to Shaft (D) Ratio	Limiting Value Required to Avoid Squeeze (see table above)	Total Overburden/Su	Will Squeeze Occur (Yes / No)
15	-1	1875	500	5.0	5.3	3.8	No
20	-6	2500	500	6.7	5.7	5.0	No
25	-11	3125	780	8.3	6.1	4.0	No
30	-16	3750	780	10.0	6.2	4.8	No
35	-21	4375	620	11.7	6.5	7.1	Yes
40	-26	5000	620	13.3	6.6	8.1	Yes
45	-31	5625	450	15.0	6.9	12.5	Yes
50	-36	6250	450	16.7	7.1	13.9	Yes
55	-41	6875	450	18.3	7.3	15.3	Yes

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

GEOTECHNICAL DESIGN MEMORANDUM

To: Mr. William Colletti

From: Min Zhang, Ph.D, P.E.
Ala Sassila, Ph.D, P.E.

Date: June 9, 2022

Subject: **Shallow Foundation Recommendations for Stairs**
Proposed State/Lake Loop Elevated CTA Station

This Geotechnical Design Memorandum provides an addendum regarding allowable bearing capacity for shallow foundations for stairs at the proposed State/Lake Loop Elevated CTA Station. The shallow foundation for stairs is anticipated to bear 4 to 5 feet below the existing street grade.

The Structural Geotechnical Report (SGR) dated 12/3/2021 included information for all soil borings completed during the field investigation between November 2 and 13, 2021. The upper 10 feet at each location were hydro-vacuumed as directed by the City of Chicago due to the presence of various shallow underground utilities. No soil samples were collected for the upper 10 feet. However, GSG completed one boring at the initial stage of the project in the vicinity of B-3, which encountered obstruction at approximately 10 feet below the existing grade. Based on this boring, sand fill with gravel was noted from 3.5 feet to 10 feet and had SPT blow counts of 6 blows per foot (bpf). The sand fill appears to extend to a depth of 14 feet based on the results of the other borings completed within the vicinity of the project. Attached please find the boring location and the boring log.

The CTA stairs could be supported upon conventional shallow footings. The shallow footings should be designed for a net allowable bearing capacity of 2,500 psf. Any debris or unsuitable soil within the footing print should be removed and replaced with structural granular fill. The minimum depth of the foundation bearing grade should be 3.5 feet below the final exterior grade to alleviate the effects of frost.

Fine sands tend to become disturbed during footing excavation, therefore, the exposed footing subgrade should be densified/compacted using a vibratory plate or jumping jack due to limited accessibility of the project area. All localized loose sand and debris should be over-excavated and replaced with granular structural fill to the proposed footing grade elevation. The lateral limit of engineered fill placed beneath the footing should extend a minimum 1 foot beyond the outside edges of the footing and from that point outward laterally 1 foot for every 2 feet of fill thickness below the footing. If water seepage occurs during footing excavation or where wet conditions are encountered such that the water cannot be removed with conventional sumping, GSG recommends placing open grade stone similar to IDOT CA-7 to stabilize the bottom of the excavation below the water table. The

CA-7 stone should be placed to 12 inches above the water table, in 12-inch lifts, and should be compacted with the use of a heavy smooth drum roller or heavy vibratory plate compactor until stable. The remaining portion of the excavation beneath the footings should be backfilled using approved structural fill consisting of granular materials such as IDOT CA-6. The structural fill should be placed in 8-inch-thick lifts and compacted to 95% of the material's modified maximum dry density (ASTM D-1557). If the above recommendations are followed, the estimated total settlement of the footing will be in the magnitude of less than one (1) inch, and the differential settlement will be in the magnitude of less than ½ inch.

GSG recommends that subgrade preparation, and structural fill placement and compaction be inspected by a GSG geotechnical engineer to verify the type and strength of soil materials present at the site and their conformance with the geotechnical recommendations in this report.

Attachment 1: Boring Location
Attachment 2: Boring Log


Leo Burnett
N Dearborn St
Renaissance Chicago Downtown
N State St
200 North Dearborn Condos
theWit Chicago - A DoubleTree by Hilton
B-3
State/Lake
W Lake St
E Lake St
Potbelly
Dunkin'
The Chicago Theatre
iParkit
N State St
Google Earth
Earth Point
100 ft
N

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

BORING NUMBER B-3

PAGE 1 OF 1

CLIENT Transystem

PROJECT NAME CTA State-Lake Station

PROJECT NUMBER 20-1038

PROJECT LOCATION Lake St. at State St., Chicago

DATE STARTED 3/23/21 **COMPLETED** 3/23/21

GROUND ELEVATION 14.00 ft CCD **HOLE SIZE** 3 1/4

DRILLING CONTRACTOR GSG Drilling

GROUND WATER LEVELS:

DRILLING METHOD Hollow Stem Auger

AT TIME OF DRILLING --- None

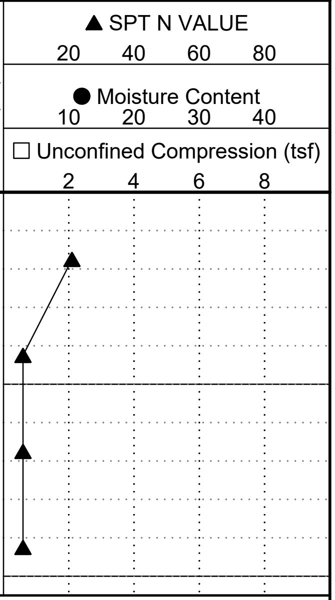
LOGGED BY MH **CHECKED BY** MZ

AT END OF DRILLING --- NA

NOTES Drill rig: CME

AFTER DRILLING --- NA

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY (%)	BLOW COUNTS (N VALUE)	UNCONFINED COMPRESSION (tsf)
0		12 inches of Concrete				
		FILL: SAND and GRAVEL with concrete fragments, Gray - Moist	SS 1	67	15-14-7 (21)	
5		FILL: SAND, trace gravel, Light Brown - Moist	SS 2	67	6-3-3 (6)	
			SS 3	67	5-3-3 (6)	
10			SS 4	89	5-3-3 (6)	



Bottom of borehole at 10.5 feet.

GEOTECH BH PLOTS - GINT STD US.GDT - 6/9/22 12:57 - T:\TRANSYSTEMS\CDOT STATE-LAKE CTA STATION\GEOTECHNICAL\FIELD DATA\CTA STATE-LAKE.GPJ

APPENDIX B

HAZARDOUS BUILDING MATERIALS SURVEY
CTA STATE- LAKE LOOP ELEVATED STATION

Hazardous Building Materials Survey
CTA STATE- LAKE LOOP ELEVATED STATION

Prepared for:

Chicago Department of Transportation

CHICAGO

CDOT PROJECT NO.: D-1-209

Prime Consultant:

TranSystems Corporation
222 S. Riverside Plaza, Suite 610
Chicago, IL 60606

Prepared by:

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

GSG Project No.: 20-1038

November 2021

Hazardous Building Materials Survey
CTA STATE- LAKE LOOP ELEVATED STATION

Prepared for:

Chicago Department of Transportation

CHICAGO

CDOT PROJECT NO.: D-1-209

Prime Consultant:

TranSystems Corporation
222 S. Riverside Plaza, Suite 610
Chicago, IL 60606

Prepared by: epahomi November 2021
Erin Pahomi Date
Geologist/ Asbestos Building Inspector

Reviewed By: November 2021
George Kougias, M.S., LPG Date
Senior Project Manager

Approved By: November 2021
Ala Sassila, PhD, P.E., QC Manager Date

TABLE OF CONTENTS

Section **Page**

Exhibits

Tables

Appendices

EXECUTIVE SUMMARY

GSG Consultants Inc. (GSG) completed a hazardous building materials survey for the proposed CTA State/ Lake elevated platform improvement project. The survey included completing a limited Asbestos and Lead-Based Paint Survey at the State-Lake Loop Elevated Station and Lake-Randolph Mezzanine Station located at N. State Street and Lake Street in Chicago, Illinois. The purpose of this survey was to identify the location and quantity of asbestos-containing material (ACM) and lead-based paint (LBP) within the proposed improvement area. The survey was conducted in the **State-Lake Loop Elevated Station (elevated and street levels)** and the **Lake-Randolph Mezzanine Station (street, mezzanine, and platform levels)** proposed to be affected by the project as identified by TranSystems (Prime Consultant). The survey was limited to visible and readily accessible areas under specific scope of work as provided to GSG by TranSystems.

The Limited Asbestos and Lead-Based Paint Survey was conducted on September 23, 2021, and September 24, 2021, by Illinois Department of Public Health (IDPH) Licensed Asbestos and Lead Inspector, Mr. Joseph Frendling (IDPH# 100-19027 and 015149). The Illinois Department of Public Health (IDPH) issued licenses of the inspectors are provided in **Appendix E** of this report.

Asbestos-Containing Materials: ACM were **identified** within the Lake-Randolph Mezzanine Station (Mezzanine Level) during this limited survey. The materials that were identified as ACM included 12” x 12” Brown vinyl floor tile (VFT) and Mastic and 12” x 12” Gray with Gray Streaks VFT and Mastic. No suspect ACM were present within the State-Lake Loop Elevated Station during the time of this survey. Please refer to **Table 1** for a complete list of materials sampled during this limited survey, **Exhibit 2**, showing approximate suspect ACM sample locations, and **Exhibit 3** showing asbestos locations. The laboratory results are provided in **Appendix A** and reference photographs can be found in **Appendix B**.

Note: Since the scope of work included only visible and accessible areas, it is possible that some ACM may have been omitted from the survey because they may be concealed behind walls and ceilings or had restricted access. Only a destructive survey can reveal all potentially concealed ACM.

Lead-Based Paint: LBP was identified throughout both the State-Lake Loop Elevated Station and the Lake-Randolph Mezzanine Station on many painted surfaces/components tested during this survey using an X-ray fluorescence (XRF) analyzer. The specific materials tested within the stations are summarized in **Table 2. XRF** field data sheets are provided in **Appendix C**.

1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) was retained by TranSystems, prime consultant, to conduct a hazardous building materials survey for the CTA State-Lake Loop Elevated Station (street and platform levels) project. The survey included completing a limited asbestos and lead based sampling and testing for the CTA State-Lake station and the Lake-Randolph Mezzanine Station (street, mezzanine, and platform levels) in Chicago, Illinois. **Exhibit 1,** Project Location Map, shows the Project Area.

1.1 Scope and Objectives

The purpose of this survey was to identify suspect asbestos-containing material (ACM) and lead-based paint (LBP), that may require removal, special handling, and/or disposal prior to planned demolition and/or modification activities.

The asbestos survey was conducted to satisfy requirements of the United States Environmental Protection Agency (USEPA) regulations under 40 CFR Part 61, and Subpart M, National Emission Standards for Hazardous Air Pollutants (NESHAP). The lead-based paint survey was conducted to comply with the requirements of the Chicago Department of Public Health (CDPH) and IDPH regulations.

GSG did not sample or inspect suspect materials that may be present in electrical equipment such as heating, ventilating, and air-conditioning (HVAC) equipment, electrical fuse boxes, electrical disconnects transformers or wiring. It should be noted that power to the building was live during the survey; therefore, wiring or other contents within previously mentioned electrical equipment were not sampled as a safety precaution.

1.2 General Qualifications

The results, findings, conclusions, and recommendations expressed in this report are based on conditions observed during GSG’s survey of the stations. The information contained in this report represents conditions at the time of the survey and may not accurately represent conditions at a later date. The conclusions in this report are based on conditions observed in accessible areas of the stations. However, the possibility exists that suspect hazardous building materials or conditions may exist within wall cavities, voids, or other areas hidden from view which were not observed and cannot be ruled out. Any additional potential hazardous materials encountered that will be disturbed during demolition and/or modification activities and that differ from the materials assessed during this survey, were hidden from view, or were located in an area not accessible will require further sampling and analysis prior to disturbance. The estimated quantities provided herein should be considered approximate and are accurate to the extent allowable under the terms and conditions of our contract. This report has been prepared with generally accepted industry practices and procedures. No other warranty, either expressed or implied, is made.

1.3 Report Organization

The report is divided into five sections which discuss the survey activities and methodology, findings, and conclusions and recommendations associated with the materials/areas addressed during this survey, as follows:

- Section 1.0 - Introduction
- Section 2.0 - Survey Methodology
- Section 3.0 - Summary of Findings
- Section 4.0 - Conclusions and Recommendations
- Section 5.0 – Certification

Supporting documentation is appended and referenced in each section as appropriate

.

2.0 SURVEY METHODOLOGY

This section describes GSG's the Limited Asbestos-Containing Material and Lead-Based Paint Survey approach and methodologies that were utilized during the field investigation activities. The Limited Asbestos and Lead-Based Paint Survey included performing the following tasks:

- ACM Inspection and Testing
- LBP Inspection and Testing

The following sections present an overview of GSG's approach for each type of survey completed as part of this project.

2.1 Asbestos-Containing Materials

GSG completed a visual assessment, identification, and inventory of readily visible and accessible homogeneous areas of suspect ACM prior to collecting any field samples. GSG identified homogeneous areas that consist of building materials appear similar throughout in terms of color and texture. The interior assessment was conducted throughout visually accessible interior areas. Building materials identified as concrete (not including cement panels or pipe and soft concrete), glass (includes fiberglass), wood, masonry, metal, and plastic are not considered suspect ACM and were not sampled.

A physical assessment of each homogeneous area of suspect ACM was conducted to assess the friability and condition of the materials. A friable material is defined by the EPA as a material which can be crumbled, pulverized, or reduced to powder by hand pressure when dry. Friability was assessed by physically touching suspect materials.

Bulk samples of suspect ACM were collected in general accordance with the United Stated Environmental Protection Agency (US EPA) and National Emission Standards for Hazardous Air Pollutants (NESHAPS) regulations and guidelines. Random samples of suspect materials were collected of each homogeneous material. Samples were placed in new sealable containers and labeled with unique sample numbers using an indelible marker. All non-disposable sampling equipment was wet wiped and cleaned before and after each use.

A total of seventy-two (72) bulk samples were collected from various homogeneous areas of suspect ACM from the station/building. Bulk samples were collected from the following materials:

- CMU
- CMU Mortar
- Red Ceramic Tile
- Blue Ceramic Tile

- White Ceramic Tile
- Ceramic Tile Mortar
- Ceramic Tile Grout
- White Door Caulk
- Gray Door Caulk
- White Caulk
- 12” x 12” Brown VFT and Mastic
- 12” x 12” Gray with Gray Streaks VFT and Mastic
- Plaster
- Plaster Finish Coat
- 2” x 2” Ceramic Tile
- 2” x 2” Ceramic Tile Grout
- Granite Tile Grout
- Granite Tile Mortar
- Mortar

Bulk samples were submitted under chain-of-custody to STAT Analysis Corporation (STAT) in Chicago, Illinois for analysis by polarized light microscopy (PLM) with dispersion staining techniques per EPA methodology 600/R-93/116. The percentage of asbestos, where applicable, was determined by microscopic visual estimation. Individual layers (when present) were analyzed, and the results were reported separately. STAT is accredited under the National Voluntary Laboratory Accreditation Program (NVLAP Accreditation No. 101202-0). Refer to **Appendix F** for laboratory accreditations.

2.2 Lead-Based Paint

The LBP survey was conducted in accordance with U.S. Housing and Urban Development (HUD) guidelines[a]. The survey included a visual inspection to identify suspect material, analysis of suspect material, and data recording. The objective of the testing was to identify painted surfaces with a concentration of lead above 1.0 mg/cm^2 by x-ray fluorescence (XRF) analysis, the criteria established by the Environmental Protection Agency (EPA) and HUD for classification of lead-based paint. The survey was performed by an IDPH-Licensed Lead Inspector using an XRF lead paint analyzer; Viken Model Pb200i (Serial Number 2710) manufactured by Viken Detection Corporation of Burlington, MA. A copy of the inspector’s license and training certificate are provided in **Appendix E**.

A portable XRF analyzer was used due to its demonstrated ability to determine if LBP is present on numerous types of surfaces, analyze the paint without destructive sampling or paint removal, and provide sample results immediately and at a relatively low cost per sample. Portable XRF instruments expose a building component to x-rays or gamma radiation, which causes lead to emit x-rays with a characteristic

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[a] U.S. Department of Housing and Urban Development “Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing, Chapter 7, Lead-Based Paint Inspection, Section V, Inspections in Multifamily Housing”.

frequency or energy. The intensity of this radiation is measured by the instrument. The inspector then compares the displayed value (reading) on the analyzer with the inconclusive range or threshold specified in the XRF Performance Characteristic Sheet (**Appendix D**) for the specific substrate being tested. If the reading is less than the lower boundary of the inconclusive range, or less than the threshold, then the reading is considered negative. If the reading is greater than the upper boundary of the inconclusive range, or greater or equal to the threshold, then the reading is considered positive. Readings within the inconclusive range, including its boundary values, are considered inconclusive. Because the inconclusive ranges (1.0 mg/cm^2) and/or thresholds shown in the Performance Characteristic Sheet are based on 1.0 mg/cm^2, positive and negative readings are consistent with the HUD definition of lead-based paint for identification purposes.

The visual survey of interior painted surfaces was conducted to assess if the paint was intact or damaged. Damaged paint appears as cracked, chipped and/or peeling away from the substrate as a result of moisture, wear, heat and/or age. Material that did not exhibit this condition were recorded as intact.

3.0 SUMMARY OF FINDINGS

3.1 Asbestos-Containing Materials

Bulk samples of suspect ACM were collected and analyzed for the presence of asbestos. Results are summarized in **Table 1** and include a description of each material, location, material type, test results, and estimated quantity. Each suspect material was placed into one of three material categories: thermal systems insulation (TSI), surfacing materials (SURF), or miscellaneous materials (MISC). Materials confirmed to contain greater than one percent (1%) asbestos by PLM analysis are indicated to have a "positive" result and are therefore classified as ACM. Materials indicated to have a "negative" result were confirmed by PLM analysis to be non-asbestos containing. ACM were **identified** within the Lake-Randolph Mezzanine Station (Mezzanine Level) during this limited survey. The materials that were identified as ACM included 12" x 12" Brown VFT and Mastic and 12" x 12" Gray with Gray Streaks VFT and Mastic. No suspect ACM were present within the State-Lake Loop Elevated Station during the time of this survey. For laboratory results, please refer to **Appendix A**. Reference photographs are provided in **Appendix B** and bulk sample location plans are provided in **Exhibit 2**.

For the purpose of this building survey, GSG derived its definition of ACM from the Environmental Protection Agency (EPA), which classifies ACM as "any product containing more than one percent (1%) asbestos by volume, when analyzed by Polarized Light Microscopy (PLM).

Materials located in different areas of the same homogeneous area, even though not specifically tested, should be considered positive or negative for asbestos depending on the laboratory sample test results of that particular homogeneous area.

Table 1
Materials Sampled for ACM

Material Description	Location	Material Type [1]	ACM Type & %	Friable	PLM Test Results	Estimated Quantity
CMU	Lake-Randolph Station - Throughout	Misc.	Asbestos Not Detected	No	Negative	N/A
CMU Mortar	Lake-Randolph Station - Throughout	Misc.	Asbestos Not Detected	No	Negative	N/A
Red Ceramic Tile	Lake-Randolph Station – Subway Mezzanine Level Lobby and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A

Material Description	Location	Material Type [1]	ACM Type & %	Friable	PLM Test Results	Estimated Quantity
Blue Ceramic Tile	Lake-Randolph Station - Subway Mezzanine Level Lobby and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
White Ceramic Tile	Lake-Randolph Station - Subway Mezzanine Level Lobby and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
Ceramic Tile Mortar	Lake-Randolph Station - Subway Mezzanine Level Lobby and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
Ceramic Tile Grout	Lake-Randolph Station - Subway Mezzanine Level Lobby and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
White Door Caulk	Lake-Randolph Station - Subway Mezzanine Level Janitorial Closet and Communications Room	Misc.	Asbestos Not Detected	No	Negative	N/A
Gray Door Caulk	Lake-Randolph Station - Throughout	Misc.	Asbestos Not Detected	No	Negative	N/A
White Caulk	Lake-Randolph Station - Subway Mezzanine Level CA Booth and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
12” x 12” Brown VFT and Mastic	**Lake-Randolph Station – Subway Mezzanine Level Concession Area**	**Misc.**	**Chrysotile 1-5%**	**No**	**Positive**	**100 SF**
12” x 12” Gray with Gray Streaks VFT and Mastic	**Lake-Randolph Station - Subway Mezzanine Level Toilet**	**Misc.**	**Chrysotile 1-5%**	**No**	**Positive**	**24 SF**
Plaster	Lake-Randolph Station - Throughout	Misc.	Asbestos Not Detected	No	Negative	N/A
Plaster Finish Coat	Lake-Randolph Station - Throughout	Misc.	Asbestos Not Detected	No	Negative	N/A

Material Description	Location	Material Type [1]	ACM Type & %	Friable	PLM Test Results	Estimated Quantity
2" x 2" Ceramic Tile	Lake-Randolph Station – Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
2" x 2" Ceramic Tile Grout	Lake-Randolph Station – Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
Granite Tile Grout	Lake-Randolph Station – Subway Mezzanine Level Lobby and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
Granite Tile Mortar	Lake-Randolph Station – Subway Mezzanine Level Lobby and Subway Platform Level	Misc.	Asbestos Not Detected	No	Negative	N/A
Mortar	Lake-Randolph Station – Subway Mezzanine Level Southwest Entrance	Misc.	Asbestos Not Detected	No	Negative	N/A

Notes:
[1] TSI= Thermal System Insulation, Surf= Surfacing Material, and Misc. = Miscellaneous
[2] **Quantities are estimates only, all quantities must be field verify.**

3.2 Lead-Based Paint

GSG utilized XRF Viken Pb200i Analyzer was used to identify interior surfaces/components that may contain LBP. According to the XRF Viken Pb200i Analyzer, LBP was **identified** throughout both the State-Lake Loop Elevated Station and the Lake-Randolph Mezzanine Station on many painted surfaces/components tested during this survey. The results of the XRF testing for LBP are summarized in **Table 2** and XRF Field Data Sheets are provided in **Appendix C.**

Table 2
Components/Surfaces Tested for LBP

Room/ Location	Component	Substrate	Color	XRF Readings mg/cm^2	Test Results
State-Lake Loop Elevated Station (Street and Platform Level)					
Southern Entrance	Roof Deck	Steel	White	0.1	Negative
	Roof Truss	Steel	White	0.1	Negative
	Window Header Beam	Steel	White	0.2	Negative
	Center Column	**Steel**	**White**	**1.8**	**Positive**
	Roof Truss Support Column	Steel	White	0.3	Negative
	CA Booth	Wood	White	0.1	Negative
	CA Booth Door	Wood	White	0.1	Negative
	Window Header Support Column	Steel	White	0.6	Negative
	Center Support Column	**Steel**	**White**	**4.0**	**Positive**
	Support Column	Steel	White	0.2	Negative
	East Stair Gate	Steel	White	0.2	Negative
	Canopy Roof Column	Steel	White	0.2	Negative
Southwest Stair	Columns	Steel	White	0.2	Negative
	Corrugated Roof Deck	Metal	White	0.1	Negative
	Roof Deck Support	Metal	White	0.1	Negative
	Guardrail	Steel	White	0.2	Negative
	Round Handrail	Steel	White	0.1	Negative
	Stair Stringer	Steel	Black	0.2	Negative
	Stair Riser	Steel	Black	0.2	Negative
	Gate	Steel	White	0.1	Negative
	Light Fixture	Metal	White	0.1	Negative
	Roof Support Column	Steel	Black	0.2	Negative
	Stair Landing Column	Steel	Black	0.1	Negative
	Structural Steel Column (Track)	Steel	Tan	0.3	Negative
	Street Level Guardrail	Steel	White	0.1	Negative
Southeast Stair	Corrugated Roof Deck	Metal	White	0.2	Negative
	Canopy Roof Support	Steel	White	0.1	Negative

Room/ Location	Component	Substrate	Color	XRF Readings mg/cm^2	Test Results
	Guardrail	Steel	White	0.3	Negative
	Canopy Column	Steel	White	0.3	Negative
	Handrail	Steel	White	0.1	Negative
	Stair Stringer	Steel	Black	0.3	Negative
	Stair Riser	Steel	Black	0.2	Negative
	Landing Column	Steel	White	0.3	Negative
	Stair Tread	Steel	Black	0.4	Negative
Southern Platform	Platform Handrail	Steel	White	0.2	Negative
	Canopy Supply Tool	Steel	White	0.1	Negative
	Handrail	**Steel**	**Yellow**	**3.3**	**Positive**
	Handrail	**Steel**	**White**	**1.5**	**Positive**
	Sign Support Column	Steel	White	0.2	Negative
	Canopy Support Column	Steel	Tan	0.1	Negative
	Canopy Support Column	Steel	Tan	0.2	Negative
	Canopy Joist	Steel	Tan	0.1	Negative
	Canopy Corrugated Roof Deck	Metal	White	0.0	Negative
	Handrail – Top Rail	Steel	White	0.2	Negative
	Handrail – Post	Steel	White	0.3	Negative
	Handrail – Bottom Rail	Steel	White	0.4	Negative
	Platform Guardrail	**Steel**	**Yellow**	**7.1**	**Positive**
	Platform Stringer	**Steel**	**Tan**	**1.4**	**Positive**
	Platform Beam	Steel	Tan	0.4	Negative
	Column Support Beam	Steel	Tan	0.2	Negative
	Platform Structural Beam	Steel	Tan	0.2	Negative
Northern Entrance	Window Well Header	Steel	White	0.3	Negative
	Window Well Header	Steel	White	0.2	Negative
	Window Well Header	Steel	White	0.2	Negative
	Window Wall Header Beam	Steel	White	0.2	Negative
	Roof Joist	Steel	White	0.2	Negative
	Canopy Roof Deck	Metal	White	0.2	Negative
	Canopy Column	Steel	White	0.2	Negative
	Canopy Support	Steel	White	0.3	Negative
	CA Booth Wall	Wood	White	0.4	Negative
	CA Booth Wood Trim	Wood	Blue	0.2	Negative
	Wall Panel	Metal	White	0.1	Negative
	Gate	Steel	White	0.3	Negative
	CA Booth Window Frame	Wood	Black	0.1	Negative
	Wall	Wood	White	0.1	Negative
	Door	Wood	White	-0.2	Negative
	Door Frame	Wood	White	0.1	Negative

Room/ Location	Component	Substrate	Color	XRF Readings mg/cm^2	Test Results
	Ceiling	Wood	White	-0.1	Negative
	Closet Door	Wood	White	0.2	Negative
	Closet Door Frame	Wood	White	0.1	Negative
Northeast Stair	Landing Column	Steel	Black	0.2	Negative
	Stair Stringer	Steel	Black	0.2	Negative
	Stair Tread	Steel	Black	0.2	Negative
	Structural Track Support	Steel	Tan	0.3	Negative
	Column Corrugated Canopy Roof Deck	Metal	White	0.2	Negative
	Canopy Support Column	Steel	White	0.2	Negative
	Stair Guardrail	Steel	White	0.1	Negative
	Stair Riser	Steel	Black	0.0	Negative
	Canopy Column	Steel	White	0.3	Negative
	Gate	Steel	White	0.2	Negative
	Canopy Roof Angle	Steel	White	0.3	Negative
Northwest Stair	Canopy Support Column	Steel	White	0.2	Negative
	Canopy Roof Deck	Metal	White	0.2	Negative
	Canopy Support Angle	Steel	White	0.3	Negative
	Guardrail – Top	Steel	White	0.1	Negative
	Round Handrail	Steel	White	-0.6	Negative
	Canopy Support Angle	Steel	White	0.6	Negative
	Stair Stringer	Steel	Black	0.4	Negative
	Stair Riser	Steel	Black	0.3	Negative
	Stair Support Column	Steel	Black	0.3	Negative
	Stair Tread	Steel	Black	0.4	Negative
	Handrail - Top	Steel	White	0.2	Negative
Northern Platform	Support Column	Steel	White	0.4	Negative
	Support Column	Steel	White	0.1	Negative
	Canopy Support Column	Steel	Tan	0.2	Negative
	Handrail Kick Plate	Steel	White	0.3	Negative
	Handrail	Wood	White	0.0	Negative
	Hand Guardrail	Wood	White	0.2	Negative
	Roof Truss	Steel	White	0.2	Negative
	Canopy Roof Deck	Metal	White	0.0	Negative
	Signpost Column	**Steel**	**White**	**16.2**	**Positive**
	Handrail – Top	**Steel**	**White**	**4.7**	**Positive**
	Handrail – Support Column	**Steel**	**White**	**14.5**	**Positive**
	Handrail – Top Rail	**Steel**	**White**	**8.2**	**Positive**
	Handrail – Bottom	**Steel**	**White**	**8.4**	**Positive**
	Guardrail – Top	**Steel**	**Yellow**	**15.7**	**Positive**
	Guardrail – Bottom	**Steel**	**White**	**82.0**	**Positive**

Room/ Location	Component	Substrate	Color	XRF Readings mg/cm^2	Test Results
Northern Platform (Continued)	**Guardrail – Bottom**	**Steel**	**White**	**97.0**	**Positive**
	Handrail – Top	Steel	White	0.3	Negative
	Support Post Header	**Steel**	**White**	**7.2**	**Positive**
	Platform Support Beam	**Steel**	**Tan**	**5.2**	**Positive**
	Handrail – Top	**Steel**	**White**	**1.5**	**Positive**
	Handrail – Support	**Steel**	**White**	**2.2**	**Positive**
	Handrail – Bottom	Wood	White	0.2	Negative
	Handrail – Top	**Steel**	**White**	**50.0**	**Positive**
	Handrail – Support	Steel	White	0.1	Negative
Lake-Randolph Mezzanine Station (Street, Mezzanine, and Platform Level)					
Mezzanine Lobby	Glazed Tile	Glazed Tile	White	0.3	Negative
	Glazed Tile	Glazed Tile	Light Blue	0.1	Negative
	Glazed Tile	Glazed Tile	Dark Blue	0.2	Negative
	Glazed Tile	**Glazed Tile**	**Red**	**4.0**	**Positive**
	Glazed Tile	**Glazed Tile**	**Red**	**4.3**	**Positive**
	Glazed Tile – Chair Rail	**Glazed Tile**	**Red**	**5.8**	**Positive**
	Glazed Tile	**Glazed Tile**	**Red**	**4.5**	**Positive**
	Plaster Ceiling	Plaster	White	0.3	Negative
Janitorial Services - SLRM-4	North Wall	CMU	White	0.0	Negative
	East Wall	Concrete	White	0.2	Negative
	South Wall	CMU	White	0.2	Negative
	West Wall	CMU	White	0.1	Negative
	Floor	Concrete	White	0.1	Negative
	Ceiling	**Concrete**	**White**	**1.6**	**Positive**
	Ceiling	**Concrete**	**White**	**1.4**	**Positive**
Pump Room - SLRM-4-1	North Wall	CMU	White	0.1	Negative
	East Wall	**Concrete**	**White**	**1.4**	**Positive**
	South Wall	Concrete	White	0.6	Negative
	West Wall	CMU	White	0.1	Negative
	Handrail	Steel	Yellow	0.0	Negative
	Ladder	**Steel**	**Red**	**1.8**	**Positive**
	Ceiling	**Concrete**	**White**	**1.6**	**Positive**
	Floor	Concrete	White	0.3	Negative

Room/ Location	Component	Substrate	Color	XRF Readings mg/cm^2	Test Results
Communications Room	North Wall	Ceramic Tile	White	0.2	Negative
	North Wall	**CMU**	**White**	**1.6**	**Positive**
	East Wall	CMU	White	0.1	Negative
	South Wall	CMU	White	0.3	Negative
	West Wall	CMU	White	0.1	Negative
	Ceiling	**Concrete**	**White**	**1.4**	**Positive**
	Floor	Concrete	Red	0.2	Negative
	Door	Metal	White	0.6	Negative
	Door Frame	Metal	White	0.6	Negative
Storage Room #1 – SLRM-3-2	**North Wall**	**Concrete**	**White**	**1.4**	**Positive**
	East Wall	**Concrete**	**White**	**1.5**	**Positive**
	South Wall	Clay Tile	White	0.6	Negative
	West Wall	Clay Tile	White	0.6	Negative
	Door	Metal	White	0.2	Negative
	Door Frame	Metal	White	0.6	Negative
	Ceiling	Concrete	White	0.6	Negative
	Floor	Concrete	White	0.2	Negative
Electrical Room – SLRM-1	North Wall	Concrete	White	0.3	Negative
	East Wall	CMU	White	0.1	Negative
	South Wall	CMU	White	0.2	Negative
	West Wall	CMU	White	0.2	Negative
	Ceiling	Concrete	White	0.2	Negative
	Floor	Concrete	White	0.4	Negative
CA Booth	North Wall	CMU	White	0.3	Negative
	South Wall	CMU	White	0.3	Negative
	Ceiling	Plaster	White	0.0	Negative
Storage Room #2 – SLRM-6	North Wall	CMU	White	0.2	Negative
	East Wall	Concrete	White	0.3	Negative
	South Wall	Concrete	White	0.2	Negative
	West Wall	CMU	White	0.2	Negative
	Ceiling	Concrete	White	0.0	Negative
	Floor	Floor	White	0.2	Negative
Concession Area	North Wall	CMU	White	0.3	Negative
	East Wall	CMU	White	0.2	Negative
	West Wall	Concrete	White	0.2	Negative
	Ceiling	Concrete	White	0.1	Negative
Vestibule - SLRM-5	North Wall	CMU	White	0.1	Negative
	East Wall	CMU	White	0.0	Negative
	South Wall	CMU	White	0.1	Negative
	West Wall	Concrete	White	0.3	Negative
	Ceiling	Concrete	White	1.5	Negative
Toilet - SLRM-5-1	North Wall	CMU	White	0.0	Negative

Room/ Location	Component	Substrate	Color	XRF Readings mg/cm^2	Test Results
	East Wall	CMU	White	0.2	Negative
	South Wall	CMU	White	0.1	Negative
	West Wall	CMU	White	0.2	Negative
	Floor	Concrete	White	0.3	Negative
	Ceiling	**Concrete**	**White**	**2.1**	**Positive**
Break Room - SLRM-5-2	North Wall	CMU	White	0.0	Negative
	East Wall	CMU	White	0.1	Negative
	South Wall	Concrete	White	0.2	Negative
	West Wal	Concrete	White	0.3	Negative
	Ceiling	**Concrete**	**White**	**1.9**	**Positive**
Electrical Motor Room	North Wall	CMU	White	0.2	Negative
	East Wall	CMU	White	0.2	Negative
	South Wall	CMU	White	0.1	Negative
	West Wall	CMU	White	0.2	Negative
	Ceiling	Concrete	White	0.4	Negative
Storage Room #3 – SLRP1	Clay Tile Wall	Clay	White	0.0	Negative
	Wall	CMU	White	0.1	Negative
	Wall	CMU	White	0.0	Negative
	Ceiling	Concrete	White	0.3	Negative
	Floor	Concrete	White	0.2	Negative
Locker Room – SLRP2	Wall	CMU	White	0.0	Negative
	Wall	CMU	White	0.0	Negative
	Wall	CMU	White	0.1	Negative
	Wall	CMU	White	0.1	Negative
	Ceiling	**Concrete**	**White**	**1.6**	**Positive**
	Floor	Concrete	White	0.1	Negative
	Column	Ceramic	White	0.4	Negative
HVAC Room	Door	Steel	Gray	0.6	Negative
	Door Frame	Steel	Gray	0.4	Negative
	Handrail – Upper	Steel	Gray	0.6	Negative
Subway Platform	**Arch Ceiling**	**Plaster**	**White**	**2.1**	**Positive**
	Ceramic Tile	Ceramic Tile	White	0.1	Negative
	Arch Ceiling	Ceramic Tile	Gold	-0.3	Negative
	Arch Ceiling	Ceramic Tile	Blue	0.1	Negative
	Arch Ceiling	Ceramic Tile	Red	0.1	Negative
	Arch Ceiling	Ceramic Tile	White	0.4	Negative

Room/ Location	Component	Substrate	Color	XRF Readings mg/cm^2	Test Results
	Column	Steel	White	0.4	Negative
	Column	Steel	White	0.5	Negative
	Column	Steel	White	0.5	Negative
	Column	Steel	White	0.6	Negative
	Ceiling	**Plaster**	**White**	**2.6**	**Positive**
	Support Column	Steel	White	0.2	Negative
	Ceiling	**Plaster**	**White**	**1.7**	**Positive**
	Wall Tile	**Ceramic**	**Red**	**5.2**	**Positive**
	Wall Tile	**Ceramic**	**Red**	**4.9**	**Positive**
	Wall Tile	**Ceramic**	**Red**	**6.1**	**Positive**
	Wall Tile	Ceramic	White	0.2	Negative
	Wall Tile	Ceramic	Light Blue	0.2	Negative
	Wall Tile	Ceramic	Dark Blue	0.1	Negative
Street Level Entrance	Southwest Top Rail	Metal	White	0.3	Negative
	Southwest Top Rail	Metal	White	0.2	Negative
	Southwest Top Rail	Metal	White	0.1	Negative
	Southwest Top Rail	Metal	White	0.2	Negative

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 *Asbestos-Containing Materials*

ACM were **identified** within the Lake-Randolph Mezzanine Station (mezzanine Level) during this limited survey. The materials identified as ACM included 12" x 12" Brown VFT and Mastic and 12" x 12" Gray with Gray Streaks VFT and Mastic. No suspect ACM were present within the State-Lake Loop Elevated Station during the time of this survey.

GSG recommends the preparation of an asbestos abatement project design prior to any demolition and/or modification activities in which ACM may be impacted. An asbestos abatement design plan and specifications should include information regarding the location of containments and barriers, type of sealant, and air sampling requirements and clearance during the asbestos abatement activities. The asbestos design plan and specification shall be prepared and signed by an IDPH licensed asbestos project designer in accordance with Illinois regulations. Asbestos abatement work shall be conducted by a licensed abatement contractor under the supervision of a licensed asbestos project manager in accordance with all applicable Federal, state, and local regulations.

Any suspect material that is discovered during the project activities and is not listed in **Table 1**, were not tested during this survey. Such materials shall be assumed and treated as ACM until tested and proven otherwise.

4.2 *Lead-Based Paint*

The LBP survey **identified** LBP on many painted surfaces/components tested throughout both the State-Lake Loop Elevated Station and the Lake-Randolph Mezzanine Station during this limited survey. The specific materials surveyed are summarized in **Table 2** and can be found on the field XRF sheets in **(Appendix C)**.

For the surfaces/components that tested negative during this survey, the Occupational Safety and Health Administration (OSHA) Lead in Construction Standard states that "negative" readings (i.e. those below the HUD/EPA definition of what constitutes LBP (1.0 mg/cm2) DO NOT relieve contractors from performing exposure assessments (personal air monitoring) on their employees per the OSHA Lead Standard, and should not be interpreted as lead is not present. Although a reading may indicate "negative", airborne lead concentrations still may exceed the OSHA Action Level or the OSHA Permissible Exposure Limit (PEL) depending on the work activity. GSG recommends that prior to any demolition and/or modification activities at the stations, engineering control measures be implemented in the renovation area to minimize the generation of dust, and site worker and occupant exposures to lead.

For any surfaces/components that are not listed in **Table 2** were not tested during this survey, such surfaces/components shall be assumed and treated as LBP until tested and proven otherwise.

5.0 CERTIFICATION

The undersigned hereby affirm that the conditions described herein are accurate to the best of our knowledge and belief and are subject to the limitations inherent in the investigative techniques used and any expressed limitations of this survey. Applicable licensing to perform the described survey activities were valid at the time of performance of services in accordance with applicable federal, state and local laws, rules and regulations.

Inspection Performed By:

Joseph Frendling	100-19027	Joseph Frendling	015149
Asbestos Inspector's Name	IDPH License #	Lead Inspector's Name	IDPH License #
Joseph C Frendling Jr.	10.22.2021	Joseph C Frendling Jr.	10.22.2021
Asbestos Inspector's Signature	Date	Lead Inspector's Signature	Date

EXHIBITS

EXHIBIT 1	**Project Location Map**
EXHIBIT 2	**ACM Sample Location Plans**
EXHIBIT 3	**ACM Location Plans**

LEGEND

🟥 **PROJECT AREA**

PROJECT LOCATION MAP

State-Lake Elevated Station and
Lake-Randolph Station
N. State Street and Lake Street
Chicago, IL

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

DRAWN BY:	PROJECT:
EP	20-1038
CHECKED BY:	SCALE:
GK	NTS
DATE:	SHEET #:
10/22/2021	1 of 4
SHEET NAME:	
PL-1	

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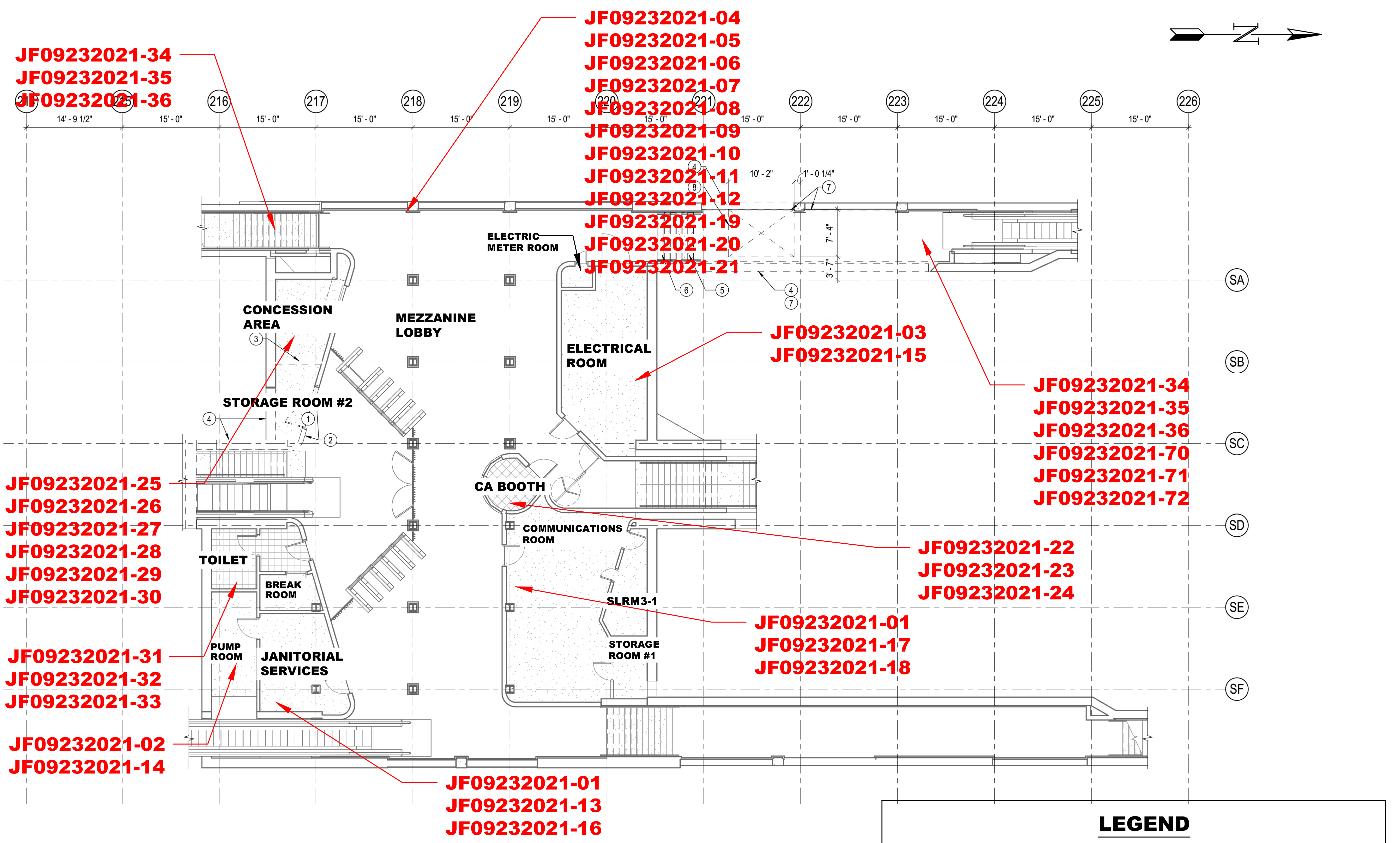


LEGEND

ACM SAMPLE LOCATIONS	**JF09232021-XX**
BATCH NO.	**354749**

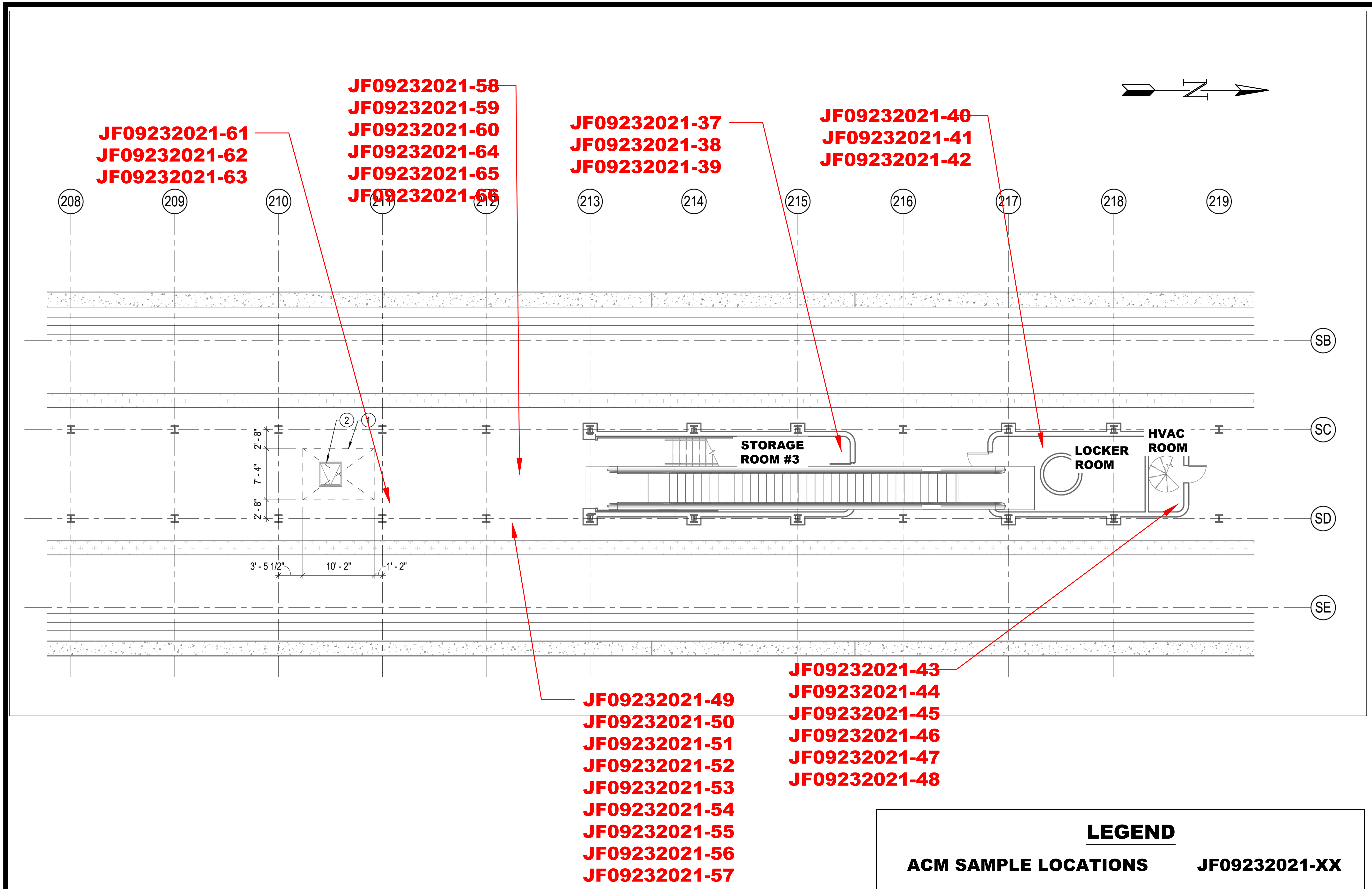
SUSPECT ASBESTOS SAMPLE LOCATION PLAN

Lake-Randolph Mezzanine Station
Subway Mezzanine Level
N. State Street and Lake Street
Chicago, IL

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

DRAWN BY:	PROJECT:
EP	20-1038
CHECKED BY:	SCALE:
GK	NTS
DATE:	SHEET #:
10/22/2021	2 of 4
SHEET NAME:	
SL-1	

T:\TranSystems\CDOT State-Lake CTA Station\Hazardous Materials Survey\CAD\Drawing1.dwg, 10/22/2021 11:18:02 AM, epahomi, ANSI expand B (17.00 x 11.00 Inches)



LEGEND

ACM SAMPLE LOCATIONS	JF09232021-XX
BATCH NO.	354749

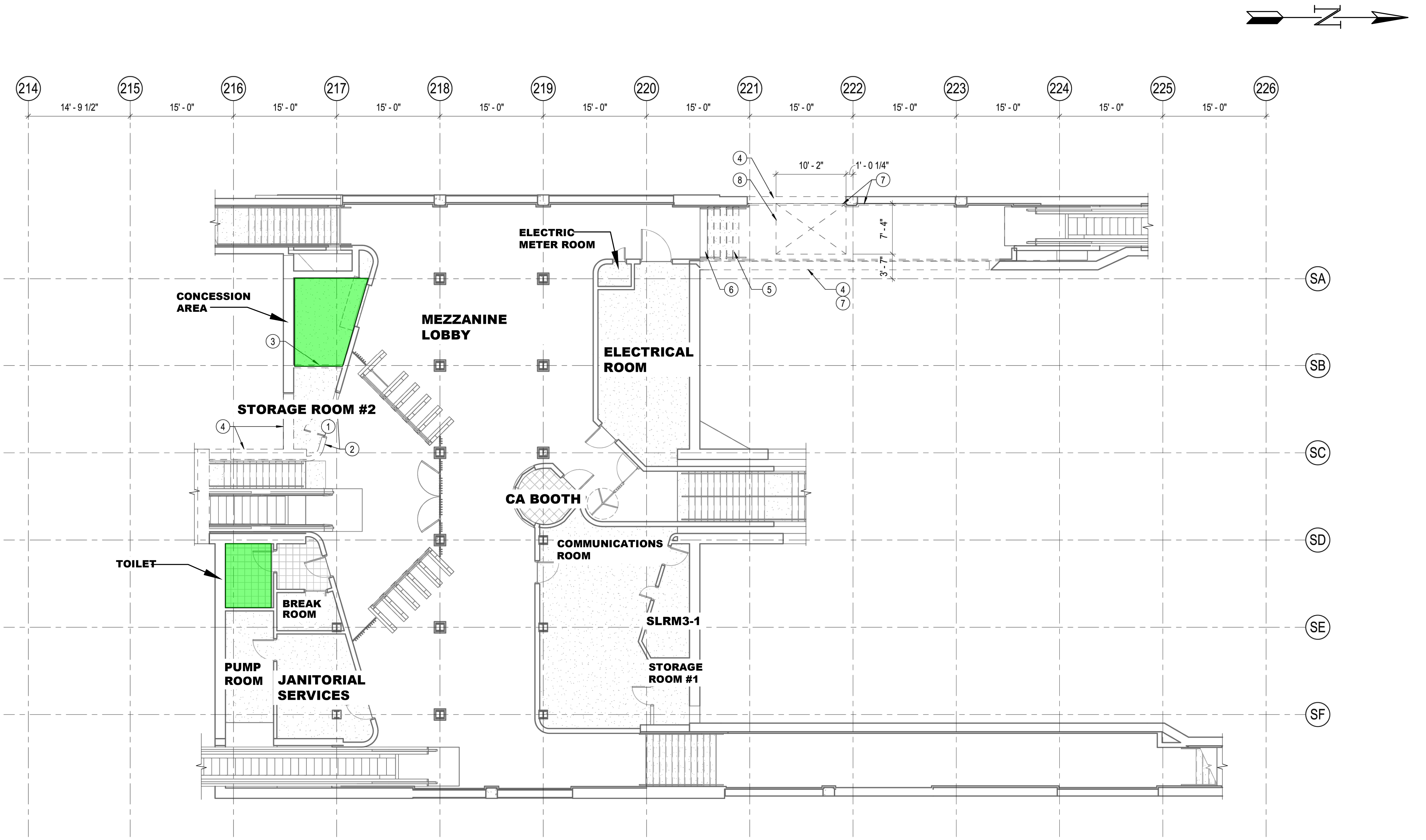
SUSPECT ASBESTOS SAMPLE LOCATION PLAN

Lake-Randolph Mezzanine Station
Subway Platform Level
N. State Street and Lake Street
Chicago, IL

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

DRAWN BY:	PROJECT:
EP	20-1038
CHECKED BY:	SCALE:
GK	NTS
DATE:	SHEET #:
10/22/2021	3 of 4
SHEET NAME:	
SL-2	

T:\TranSystems\CDOT State-Lake CTA Station\Hazardous Materials Survey\CAD\Drawing1.dwg, 10/22/2021 11:18:33 AM, epahomi, ANSI expand B (17.00 x 11.00 Inches)



LEGEND

🟩 12"x12" VFT and Mastic

ASBESTOS-CONTAINING MATERIAL LOCATION PLAN

Lake-Randolph Mezzanine Station
Subway Mezzanine Level
N. State Street and Lake Street
Chicago, IL

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

DRAWN BY:	PROJECT:
EP	20-1038
CHECKED BY:	SCALE:
GK	NTS
DATE:	SHEET #:
10/22/2021	4 of 4

SHEET NAME:
ACM-1

T:\TranSystems\CDOT State-Lake CTA Station\Hazardous Materials Survey\CAD\Drawing1.dwg, 10/22/2021 12:53:28 PM, epahomi, ANSI expand B (17.00 x 11.00 Inches)

APPENDIX A

ANALYTICAL TESTING RESULTS

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com

NVLAP Lab Code 101202-0

ASBESTOS ANALYSIS BY POLARIZED LIGHT MICROSCOPY

Method: EPA/600/R-93/116

GSG Consultants, Inc.
735 Remington Road
Schaumburg, IL 60173
Phone: (630) 994-2600
Fax: (312) 733-5612

Reference:
Location: State and Lake Station
Batch No.: 354749
Customer No.: 4651

Date Received: 09/24/2021
Date Analyzed: 09/29/2021
Date Reported: 09/29/2021
Turn Around Time: 3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749001	JF09232021-01	ND	Cellulose 1-5% Binder 95-99%
354749002	JF09232021-02	ND	Cellulose 1-5% Binder 95-99%
354749003	JF09232021-03	ND	Cellulose 1-5% Binder 95-99%
354749004	JF09232021-04	ND	Cellulose 1-5% Binder 95-99%
354749005	JF09232021-05	ND	Cellulose 1-5% Binder 95-99%
354749006	JF09232021-06	ND	Cellulose 1-5% Binder 95-99%
354749007	JF09232021-07	ND	Cellulose 1-5% Binder 95-99%
354749008	JF09232021-08	ND	Cellulose 1-5% Binder 95-99%
354749009	JF09232021-09	ND	Cellulose 1-5% Binder 95-99%
354749010	JF09232021-10	ND	Cellulose 1-5% Binder 95-99%

ND = Asbestos Not Detected (Not Present) NA = Not Analyzed NS = Not Submitted

Components of inhomogeneous samples are analyzed per our Standard Operating Procedure, or per customer request.

The use of the NVLAP logo does not imply endorsement by NVLAP or any agency of the US Government.

Analyzed by Name :

Daniel Mikos / Microscopist

Date: 09/29/2021

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com

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GSG Consultants, Inc.
735 Remington Road
Schaumburg, IL 60173
Phone: (630) 994-2600
Fax: (312) 733-5612

Reference:		Date Received:	09/24/2021
Location:	State and Lake Station	Date Analyzed:	09/29/2021
Batch No.:	354749	Date Reported:	09/29/2021
Customer No.:	4651	Turn Around Time:	3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749011	JF09232021-11	ND	Cellulose 1-5% Binder 95-99%
354749012	JF09232021-12	ND	Cellulose 1-5% Binder 95-99%
354749013	JF09232021-13	ND	Cellulose 1-5% Binder 95-99%
354749014	JF09232021-14	ND	Cellulose 1-5% Binder 95-99%
354749015	JF09232021-15	ND	Cellulose 1-5% Binder 95-99%
354749016	JF09232021-16	ND	Cellulose 1-5% Binder 95-99%
354749017	JF09232021-17	ND	Cellulose 1-5% Binder 95-99%
354749018	JF09232021-18	ND	Cellulose 1-5% Binder 95-99%
354749019	JF09232021-19	ND	Cellulose 1-5% Binder 95-99%
354749020	JF09232021-20	ND	Cellulose 1-5% Binder 95-99%

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Analyzed by Name :

Daniel Mikos / Microscopist

Date: 09/29/2021

ASBESTOS ANALYSIS BY POLARIZED LIGHT MICROSCOPY

Method: EPA/600/R-93/116

GSG Consultants, Inc.
735 Remington Road
Schaumburg, IL 60173
Phone: (630) 994-2600
Fax: (312) 733-5612

Reference:
Location: State and Lake Station
Batch No.: 354749
Customer No.: 4651

Date Received: 09/24/2021
Date Analyzed: 09/29/2021
Date Reported: 09/29/2021
Turn Around Time: 3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749021	JF09232021-21	ND	Cellulose 1-5% Binder 95-99%
354749022	JF09232021-22	ND	Cellulose 1-5% Binder 95-99%
354749023	JF09232021-23	ND	Cellulose 1-5% Binder 95-99%
354749024	JF09232021-24	ND	Cellulose 1-5% Binder 95-99%
354749025	JF09232021-25	Chrysotile 1-5%	Binder 95-99%
354749026	JF09232021-26	NA	
354749027	JF09232021-27	NA	
354749028	JF09232021-25M	Chrysotile 1-5%	Binder 95-99%
354749029	JF09232021-26M	NA	
354749030	JF09232021-27M	NA	
354749031	JF09232021-28	Chrysotile 1-5%	Binder 95-99%
354749032	JF09232021-29	NA	
354749033	JF09232021-30	NA	
354749034	JF09232021-28M	Chrysotile 1-5%	Binder 95-99%
354749035	JF09232021-29M	NA	

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Daniel Mikos / Microscopist

Date: 09/29/2021

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NVLAP Lab Code 101202-0

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GSG Consultants, Inc.
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Schaumburg, IL 60173
Phone: (630) 994-2600
Fax: (312) 733-5612

Reference:		Date Received:	09/24/2021
Location:	State and Lake Station	Date Analyzed:	09/29/2021
Batch No.:	354749	Date Reported:	09/29/2021
Customer No.:	4651	Turn Around Time:	3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749036	JF09232021-30M	NA	
354749037	JF09232021-31	Chrysotile 1-5%	Binder 95-99%
354749038	JF09232021-32	NA	
354749039	JF09232021-33	NA	
354749040	JF09232021-31M	Chrysotile 1-5%	Binder 95-99%
354749041	JF09232021-32M	NA	
354749042	JF09232021-33M	NA	
354749043	JF09232021-34	ND	Cellulose 1-5% Binder 95-99%
354749044	JF09232021-35	ND	Cellulose 1-5% Binder 95-99%
354749045	JF09232021-36	ND	Cellulose 1-5% Binder 95-99%
354749046	JF09232021-37	ND	Cellulose 1-5% Binder 95-99%
354749047	JF09232021-38	ND	Cellulose 1-5% Binder 95-99%
354749048	JF09232021-39	ND	Cellulose 1-5% Binder 95-99%

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Analyzed by Name :
Daniel Mikos / Microscopist

Date: 09/29/2021

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Phone: (630) 994-2600
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Reference:
Location: State and Lake Station
Batch No.: 354749
Customer No.: 4651

Date Received: 09/24/2021
Date Analyzed: 09/29/2021
Date Reported: 09/29/2021
Turn Around Time: 3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749049	JF09232021-40	ND	Cellulose 1-5% Binder 95-99%
354749050	JF09232021-41	ND	Cellulose 1-5% Binder 95-99%
354749051	JF09232021-42	ND	Cellulose 1-5% Binder 95-99%
354749052	JF09232021-43	ND	Cellulose 1-5% Binder 95-99%
354749053	JF09232021-44	ND	Cellulose 1-5% Binder 95-99%
354749054	JF09232021-45	ND	Cellulose 1-5% Binder 95-99%
354749055	JF09232021-46	ND	Cellulose 1-5% Binder 95-99%
354749056	JF09232021-47	ND	Cellulose 1-5% Binder 95-99%
354749057	JF09232021-48	ND	Cellulose 1-5% Binder 95-99%
354749058	JF09232021-49	ND	Cellulose 1-5% Binder 95-99%

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Analyzed by Name :

Daniel Mikos / Microscopist

Date: 09/29/2021

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Reference:		Date Received:	09/24/2021
Location:	State and Lake Station	Date Analyzed:	09/29/2021
Batch No.:	354749	Date Reported:	09/29/2021
Customer No.:	4651	Turn Around Time:	3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749059	JF09232021-50	ND	Cellulose 1-5% Binder 95-99%
354749060	JF09232021-51	ND	Cellulose 1-5% Binder 95-99%
354749061	JF09232021-52	ND	Cellulose 1-5% Binder 95-99%
354749062	JF09232021-53	ND	Cellulose 1-5% Binder 95-99%
354749063	JF09232021-54	ND	Cellulose 1-5% Binder 95-99%
354749064	JF09232021-55	ND	Cellulose 1-5% Binder 95-99%
354749065	JF09232021-56	ND	Cellulose 1-5% Binder 95-99%
354749066	JF09232021-57	ND	Cellulose 1-5% Binder 95-99%
354749067	JF09232021-58	ND	Cellulose 1-5% Binder 95-99%
354749068	JF09232021-59	ND	Cellulose 1-5% Binder 95-99%

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Analyzed by Name :

Daniel Mikos / Microscopist

Date: 09/29/2021

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Batch No.: 354749
Customer No.: 4651

Date Received: 09/24/2021
Date Analyzed: 09/29/2021
Date Reported: 09/29/2021
Turn Around Time: 3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749069	JF09232021-60	ND	Cellulose 1-5% Binder 95-99%
354749070	JF09232021-61	ND	Cellulose 1-5% Binder 95-99%
354749071	JF09232021-62	ND	Cellulose 1-5% Binder 95-99%
354749072	JF09232021-63	ND	Cellulose 1-5% Binder 95-99%
354749073	JF09232021-64	ND	Cellulose 1-5% Binder 95-99%
354749074	JF09232021-65	ND	Cellulose 1-5% Binder 95-99%
354749075	JF09232021-66	ND	Cellulose 1-5% Binder 95-99%
354749076	JF09232021-67	ND	Cellulose 1-5% Binder 95-99%
354749077	JF09232021-68	ND	Cellulose 1-5% Binder 95-99%
354749078	JF09232021-69	ND	Cellulose 1-5% Binder 95-99%

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Daniel Mikos / Microscopist

Date: 09/29/2021

ASBESTOS ANALYSIS BY POLARIZED LIGHT MICROSCOPY

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Fax: (312) 733-5612

Reference:
Location: State and Lake Station
Batch No.: 354749
Customer No.: 4651

Date Received: 09/24/2021
Date Analyzed: 09/29/2021
Date Reported: 09/29/2021
Turn Around Time: 3 Days

Laboratory Sample	Customer Sample Number	Asbestos Components (%)	Non-Asbestos Components (%)
354749079	JF09232021-70	ND	Cellulose 1-5% Binder 95-99%
354749080	JF09232021-71	ND	Cellulose 1-5% Binder 95-99%
354749081	JF09232021-72	ND	Cellulose 1-5% Binder 95-99%

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Components of inhomogeneous samples are analyzed per our Standard Operating Procedure, or per customer request.

Analyzed by Name :
Daniel Mikos / Microscopist

Date: 09/29/2021

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Engineering and Industrial Hygiene Services
735 Remington Road
Schaumburg, IL 60173
(630) 994-2600 Fax: (312) 733-5612
www.gsg-consultants.com

Page 1 **of** 6

354749

PLM BULK LABORATORY ANALYSIS FORM

Project Name: State and Lake Station	**Project Manager:** George Kargias
Project Number:	**Building Inspector:** Joseph Frendling
Project Address:	**IDPH Number:** 100-19027
City/ State: Chicago, IL	**Work Day:** S M T W TH [✓ F] S
Client: TranSystems	**Analyze by Method:** EPA/600/R-93-116
Date: 9/24/21	

Field Number	HA Number	Type of material, specific sample location (i.e. Room Number, Building Construction Date)
JF09232021-01	01	CMU Janitorial Services
-02		Pump Room
-03		Electrical Room
-04	02	Glazed Tile - Red coat base - Mezzanine Lobby
-05		
-06		
-07	03	Glazed Tile - Blue Mezzanine Lobby
-08		
-09		
-10	04	Glazed Tile mortar Mezzanine Lobby
-11		
-12		

TURN AROUND TIME:
1 Day
2 Days
[✓ 3 Days]
(5 Day) Other

COMMENTS: E-mail Results to:
Epahomi@gsg-consultants.com

STOP AT FIRST POSITIVE

CHAIN OF CUSTODY RECORD

Collected By(Signature)	Date: 9/24/21	Time: 1:39pm	Relinquished by (Signature)	Date:	Time:
Received by: (Signature)	Date:	Time:	Relinquished by: (signature)	Date:	Time:
Dispatched by: (Signature, if mailed)	Date:	Time:	Received for Laboratory by: ed	Date: 9/24/21	Time: 1400

Definitions: BLK-Bulk Sample, PLM-Polarized Light Microscopy, TEM-Transmission Electron Microscope.

GSG CONSULTANTS, INC.
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Schaumburg, IL 60173
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www.gsg-consultants.com

354749

Page 2 of 6

PLM BULK LABORATORY ANALYSIS FORM

Project Name: State and Lake Station	**Project Manager:** George Kaglas
Project Number:	**Building Inspector:** Joesph Frendling
Project Address:	**IDPH Number:** 100-19027
City/ State: Chicago, IL	**Work Day:** S M T W TH [✓ F] S
Client: TranSystems	**Analyze by Method:** EPA/600/R-93-116
Date: 9/24/21	

Field Number	HA Number	Type of material, specific sample location (i.e. Room Number, Building Construction Date)
JF09232021-13	05	CMU Mortar Janitorial services
-14	|	| Pump Room
-15	|	| Electrical Room
-16	06	White Door Caulk Janitorial Closet
7	|	| Communications Room
18	|	| |
-19	07	Gray Door Caulk Mezzanine Lobby
-20	|	| ||
-21	|	| ||
-22	08	White caulk CA Booth
-23	|	| |
-24	|	| |

TURN AROUND TIME: 1 Day 2 Days [✓ 3 Days] (5 Day) Other

COMMENTS: E-mail Results to: Epahomi@gsg-consultants.com

STOP AT FIRST POSITIVE

CHAIN OF CUSTODY RECORD

Collected By(Signature)	Date: 9/24/21	Time: 1:30pm	Relinquished by (Signature)	Date:	Time:
Received by: (Signature)	Date:	Time:	Relinquished by: (signature)	Date:	Time:
Dispatched by: (Signature, if mailed)	Date:	Time:	Received for Laboratory by:	Date: 9/24/21	Time: 1400

Definitions: BLK-Bulk Sample, PLM-Polarized Light Microscopy, TEM-Transmission Electron Microscope.

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Page 3 of 6

354749

PLM BULK LABORATORY ANALYSIS FORM

Project Name: State and Lake Station	**Project Manager:** George Kagias
Project Number:	**Building Inspector:** Joesph Friedling
Project Address:	**IDPH Number:** 100-19027
City/ State: Chicago, IL	**Work Day:** S M T W [✓ TH] F S
Client: Transystems	**Analyze by Method:** EPA/600/R-93-116
Date: 9/23/21	

Field Number	**HA Number**	**Type of material, specific sample location (i.e. Room Number, Building Construction Date)**
JF09232021-25	09	12"x12" Brown VFT Concession Area
-26	|	| |
-27	|	| |
-28	10	12"x12" Brown VFT mastic Concession Area
-29	|	| |
-30	|	| |
-31	11	12"x12 Gray w/gray streaks VFT +mastic Toilet
-32	|	| |
-33	|	| |
-34	12	Plaster substrate Subway Mezzanine
35	|	
-36	|	

TURN AROUND TIME: **1 Day** **2 Days** **3 Days** **(5 Day) Other**	**COMMENTS:** E-mail Results to: Epahomi@gsg-consultants.com STOP AT FIRST POSITIVE

CHAIN OF CUSTODY RECORD

Collected By(Signature)	Date: 9/24/21	Time: 1:30	Relinquished by (Signature)	Date:	Time:
Received by: (Signature)	Date:	Time:	Relinquished by: (signature)	Date:	Time:
Dispatched by: (Signature, if mailed)	Date:	Time:	Received for Laboratory by:	Date: 9/24/21	Time: 1400

Definitions: BLK-Bulk Sample, PLM-Polarized Light Microscopy, TEM-Transmission Electron Microscope.

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Page 4 **of** 6

354749

PLM BULK LABORATORY ANALYSIS FORM

Project Name: State and Lake station	**Project Manager:** George Kagia)
Project Number:	**Building Inspector:** Joseph Frendling
Project Address:	**IDPH Number:** 100-19027
City/ State: Chicago, IL	**Work Day:** S M T W TH [✓ F] S
Client: Transystems	**Analyze by Method:** EPA/600/R-93-116
Date: 9/24/21	

Field Number	HA Number	Type of material, specific sample location (i.e. Room Number, Building Construction Date)
JF09232021-37	13	White caulk Subway Platform storage room 3
-38	|	| |
-39	|	| |
-40	14	White caulk Subway Platform Locker Room (SLRP2)
-41	|	| |
-42	|	| |
-43	15	Gray caulk Subway Platform
-44	|	| |
-45	|	| |
-46	16	Plaster Subway Platform
-47	|	| |
-48	|	| |

TURN AROUND TIME: 1 Day 2 Days [✓ 3 Days] **(5 Day) Other**	**COMMENTS:** E-mail Results to: Epahomi@gsg-consultants.com STOP AT FIRST POSITIVE

CHAIN OF CUSTODY RECORD

Collected By(Signature)	Date: 9/24/21	Time: 1:30	Relinquished by (Signature)	Date:	Time:
Received by: (Signature)	Date:	Time:	Relinquished by: (signature)	Date:	Time:
Dispatched by: (Signature, if mailed)	Date:	Time:	Received for Laboratory by: ul	Date: 9/24/21	Time: 1400

Definitions: BLK-Bulk Sample, PLM-Polarized Light Microscopy, TEM-Transmission Electron Microscope.

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354749

Page 5 **of** 6

PLM BULK LABORATORY ANALYSIS FORM

Project Name: State and Lake Station	**Project Manager:** George Kougias
Project Number:	**Building Inspector:** Joseph Frendling
Project Address:	**IDPH Number:** 100-19027
City/ State: Chicago, IL	**Work Day:** S M T W TH [✓ F] S
Client: Transystems	**Analyze by Method:** EPA/600/R-93-116
Date: 9/24/21	

Field Number	**HA Number**	**Type of material, specific sample location (i.e. Room Number, Building Construction Date)**
JF09242021-49	17	White caulk - Subway platform Arched Ceiling
-50	|	
-51	|	
-52	18	White ceramic Tile Subway platform Arched Ceiling
-53	|	| |
-54	|	
-55	19	White Ceramic Tile grout Subway platform Archway Ceiling
-56	|	| |
-57	|	
-58	20	Granite Tile grout Subway Platform
-59	|	| |
-60	|	

TURN AROUND TIME: 1 Day 2 Days 3 Days **(5 Day) Other**	**COMMENTS:** E-mail Results to: Epahomi@gsg-consultants.com STOP AT FIRST POSITIVE

CHAIN OF CUSTODY RECORD

Collected By(Signature)	*Date:* 9/24/21	*Time:* 1:30pm	Relinquished by (Signature)	*Date:*	*Time:*
Received by: (Signature)	*Date:*	*Time:*	Relinquished by: (signature)	*Date:*	*Time:*
Dispatched by: (Signature, if mailed)	*Date:*	*Time:*	Received for Laboratory by:	*Date:* 9/24/21	*Time:* 1400

Definitions: BLK-Bulk Sample, PLM-Polarized Light Microscopy, TEM-Transmission Electron Microscope.

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Page 6 **of** 6

354749

PLM BULK LABORATORY ANALYSIS FORM

Project Name: State and Lake station	**Project Manager:** George Kagal
Project Number:	**Building Inspector:** Joseph Fradling
Project Address:	**IDPH Number:** 100-19027
City/ State: Chicago, IL	**Work Day:** S M T W TH [✓ F] S
Client: Transystems	**Analyze by Method:**
Date: 9/24/21	**EPA/600/R-93-116**

Field Number	**HA Number**	**Type of material, specific sample location (i.e. Room Number, Building Construction Date)**
JF09242021-61	21	Ceramic Tile Grout Subway platform
-62	|	| |
-63		
-64	22	Granite Tile mortar Subway platform
65	|	| |
-66	|	
-67	23	Plaster finish coat Subway Mezzanine
-68	|	| |
-69		
-70	24	mortar 162 entrance Street level
-71	|	| |
-72		

TURN AROUND TIME: 1 Day 2 Days [✓ 3 Days] **(5 Day) Other**	**COMMENTS:** E-mail Results to: Epahomi@gsg-consultants.com STOP AT FIRST POSITIVE

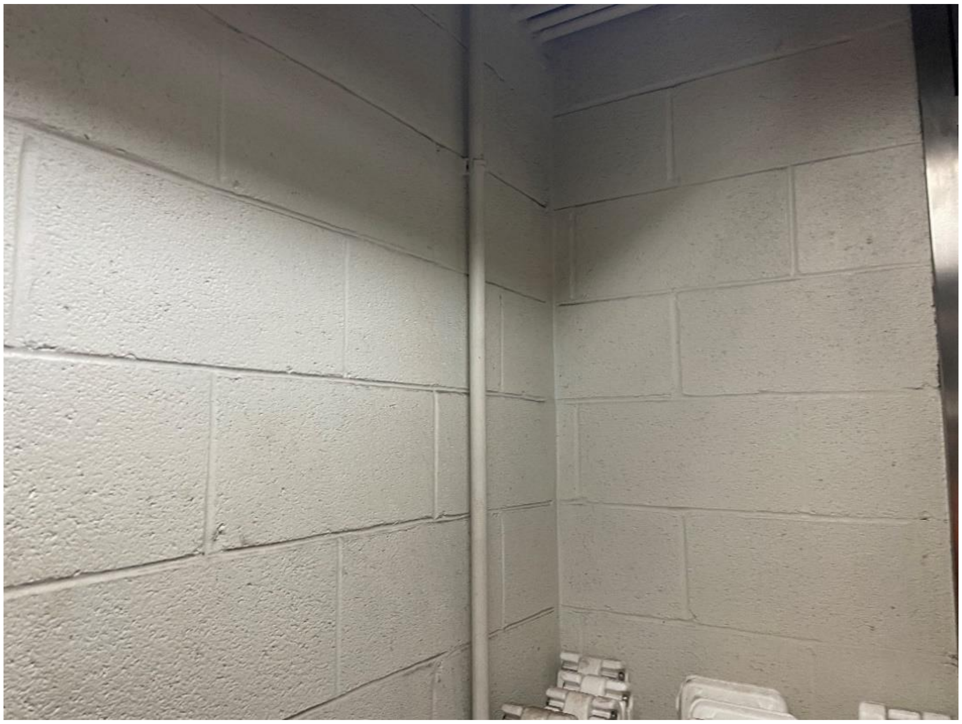
CHAIN OF CUSTODY RECORD

Collected By(Signature)	*Date:* 9/24/21	*Time:* 1:30pm	Relinquished by (Signature)	*Date:*	*Time:*
Received by: (Signature)	*Date:*	*Time:*	Relinquished by: (signature)	*Date:*	*Time:*
Dispatched by: (Signature, if mailed)	*Date:*	*Time:*	Received for Laboratory by:	*Date:* 9/24/21	*Time:* 1400

Definitions: BLK-Bulk Sample, PLM-Polarized Light Microscopy, TEM-Transmission Electron Microscope.

APPENDIX B

REFERENCE PHOTOGRAPHS(S)



Material Description:
Suspect ACM CMU

Photo Location:
Lake-Randolph Station, Mezzanine Level - Janitorial Services Room

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM CMU Mortar

Photo Location:
Lake-Randolph Station, Mezzanine Level - Janitorial Services Room

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM Red Ceramic Tile

Photo Location:
Lake-Randolph Station,
Mezzanine Level -
Mezzanine Lobby

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM Blue Ceramic Tile

Photo Location:
Lake-Randolph Station,
Mezzanine Level -
Mezzanine Lobby

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM Ceramic Tile Mortar

Photo Location:
Lake-Randolph Station, Mezzanine Level - Mezzanine Lobby

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM White Door Caulk

Photo Location:
Lake-Randolph Station, Mezzanine Level - Janitorial Services Room

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM Gray Door Caulk

Photo Location:
Lake-Randolph Station, Mezzanine Level - Mezzanine Lobby

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM White Caulk

Photo Location:
Lake-Randolph Station, Mezzanine Level - CA Booth

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State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM 12” x 12” Gray with Gray Streaks VFT and Mastic

Photo Location:
Lake-Randolph Station, Mezzanine Level - Concession Area

Material Description:
Suspect ACM 12” x 12” Brown VFT and Mastic

Photo Location:
Lake-Randolph Station, Mezzanine Level - Toilet

Material Description:
Suspect ACM White Caulk

Photo Location:
Lake-Randolph Station, Platform Level - Storage Room #3

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Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-9/24/2021

Material Description:
Suspect ACM White Caulk

Photo Location:
Lake-Randolph Station, Platform Level - Locker Room

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State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
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Schaumburg, Illinois 60173

Date:
9/23/2021-9/24/2021

Material Description:
Suspect ACM Gray Caulk

Photo Location:
Lake-Randolph Station, Platform Level - Subway Platform

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
Suspect ACM Plaster

Photo Location:
Lake-Randolph Station, Platform Level - Subway Platform

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State/Lake Elevated Loop Station
Chicago, IL 60601

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735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description: Suspect ACM 2” x 2” Ceramic Tile and Grout

Photo Location: Lake-Randolph Station, Mezzanine Level - Subway Escalator

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State/Lake Elevated Loop Station
Chicago, IL 60601

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735 Remington Road
Schaumburg, Illinois 60173

Date: 9/23/2021-9/24/2021

Material Description: Suspect ACM Granite Tile Grout and Mortar

Photo Location: Lake-Randolph Station, Platform Level - Subway Platform

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
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Schaumburg, Illinois 60173

Date: 9/23/2021-9/24/2021

Material Description:
Suspect ACM Plaster Finish Coat

Photo Location:
Lake-Randolph Station, Platform Level - Subway Platform

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Chicago, IL 60601

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Date:
9/23/2021-
9/24/2021

Material Description:
LBP Center Support Column

Photo Location:
State/Lake Station, Elevated Track Level – Southern Entrance

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State/Lake Elevated Loop Station
Chicago, IL 60601

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Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
LBP Support Column

Photo Location:
State/Lake Elevated Station, Track Level – Southern Entrance

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State/Lake Elevated Loop Station
Chicago, IL 60601

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Schaumburg, Illinois 60173

Date:
9/23/2021-9/24/2021

Material Description:
LBP Handrail

Photo Location:
State/Lake Elevated Station, Track Level – Southern Platform

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

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Schaumburg, Illinois 60173

Date:
9/23/2021-9/24/2021

Material Description:
LBP Platform Guardrail

Photo Location:
State/Lake Elevated Station, Track Level – Southern Platform

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

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Schaumburg, Illinois 60173

Date:
9/23/2021-9/24/2021

Material Description:
LBP Platform Stringer

Photo Location:
State/Lake Elevated Station, Track Level – Southern Platform

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

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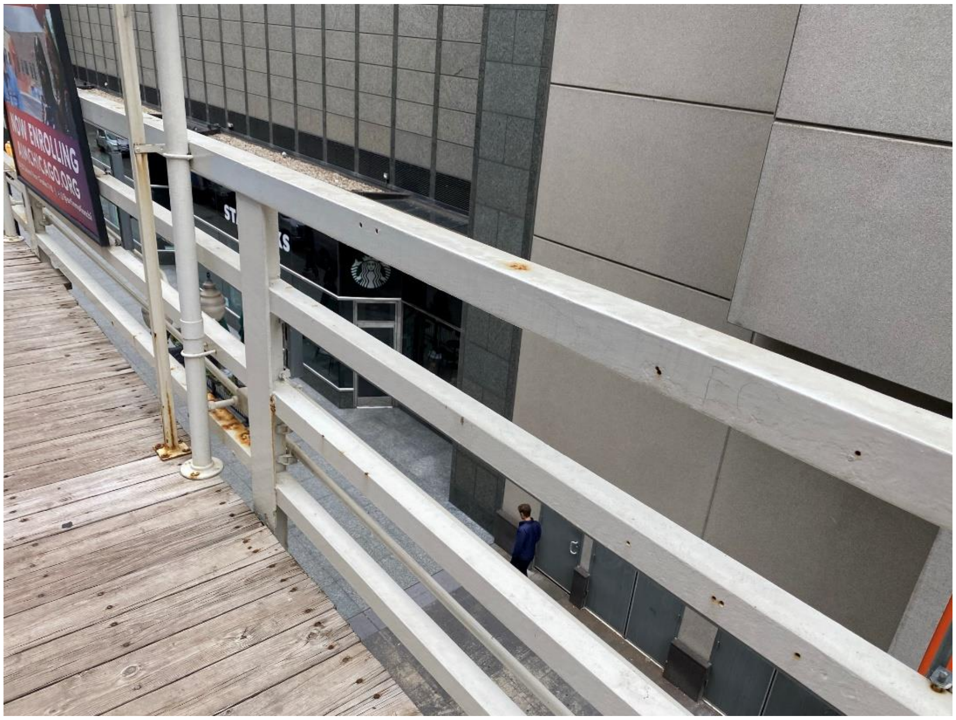
Schaumburg, Illinois 60173

Date:
9/23/2021-9/24/2021



Material Description:
LBP Handrail

Photo Location:
State/Lake Elevated Station, Track Level – Northern Platform

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State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
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Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
LBP Platform Support Beam

Photo Location:
State/Lake Elevated Station, Track Level – Northern Platform

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State/Lake Elevated Loop Station
Chicago, IL 60601

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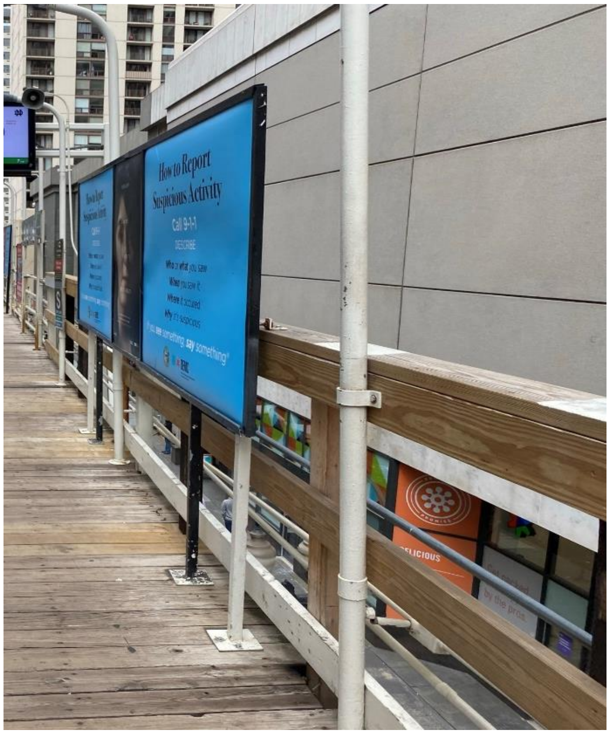
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021



Material Description:
LBP Signpost

Photo Location:
State/Lake Elevated Station, Track Level – Northern Platform

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
LBP Glazed Wall Tile

Photo Location:
Lake-Randolph Station, Mezzanine Level - Mezzanine Lobby

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
LBP Concrete Ceiling

Photo Location:
Lake-Randolph Station, Mezzanine Level - Pump Room

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State/Lake Elevated Loop Station
Chicago, IL 60601

GSG Consultants, Inc.
735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
LBP Ladder

Photo Location:
Lake-Randolph Station, Mezzanine Level - Pump Room

TRANSYSTEMS CORPORATION
State/Lake Elevated Loop Station
Chicago, IL 60601

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735 Remington Road
Schaumburg, Illinois 60173

Date:
9/23/2021-
9/24/2021

Material Description:
LBP CMU

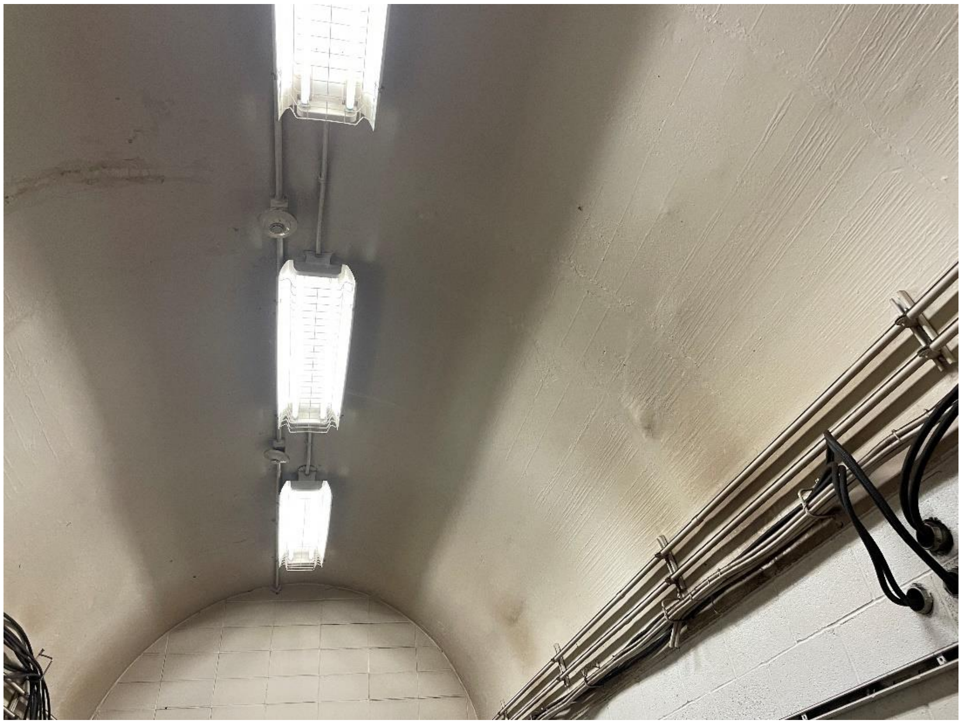
Photo Location:
Lake-Randolph Station, Mezzanine Level - Communications Room

Date:
9/23/2021-
9/24/2021

Material Description:
LBP Concrete Wall

Photo Location:
Lake-Randolph Station, Mezzanine Level - Storage Room (SLRM-3-2)

Date:
9/23/2021-
9/24/2021



Material Description:
LBP Plaster Ceiling

Photo Location:
Lake-Randolph Station, Platform Level - Subway Platform

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State/Lake Elevated Loop Station
Chicago, IL 60601

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Date:
9/23/2021-
9/24/2021

APPENDIX C

XRF FIELD DATA SHEET(S)

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XRF ENVIRONMENTAL DATA SHEETS

Project Name: State / Lake ACM/LBP	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State: Chicago	**XRF Serial Number:**
Client: Transsystems	**Comments:**
Date: 09/23/21	

Shot	Room/Area	Reading	Component	Walls N	Walls E	Walls S	Walls W	Ceiling C	Floor F	Substrate	Color	Damage/ Comments
1	Calibration	1.0										
	Calibration	-0.1										
	Calibration	0.8										
	Unpaid, S.	-0.1	Roof deck					X		Steel	White	
5	Mezzanine	0.1	Roof truss					X		|	|	
	|	0.2	Window header			X				|	|	
	|	1.8	Center beam column			X				|	|	
	|	0.3	4x4 Roof truss support column					X		|	|	4" x10", Adj. to rotogate
	West stair	0.2	Columns				X			|	|	West stair mezz level
0	mezz. level	0.1	Corrugated roof deck					X		Metal	|	
	|	0.1	Roof deck support angle					X		"	|	3" x 3"
	|	0.2	Guardrail				X			Steel	|	2" x 2"
	|	0.1	Round handrail				X			"	|	
	|	0.2	Stair Stringer						X	"	Black	
15	|	0.2	Stair riser						X	"	"	
	|	0.1	Gate							"	White	
	|	0.1	Light fixture					X		Metal	"	4 foot
	|	0.2	Roof support column					X		Steel	"	3" x 3" angle
		0.1	Landing (stair) column						X	|	Black	8" Street Level
20		0.3	Structural steel column (track)							|	Tan	

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:
Project Number:
Project Address:
City/ State:
Client:
Date:

Project Manager:
Building Inspector:
IDPH Number:
XRF Serial Number:
Comments:

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
21	〃	0.1	Street level guardrail							Steel	White	
	Unpaid S Mezz.	0.1	CA Booth		X					Wood	〃	
	〃	0.1	CA Booth Door							〃	〃	
	〃	0.6	Window header support col.			X				Steel	〃	4" x 4"
25	〃	4.0	Center support col.			X				〃	〃	Window header
	〃	0.2	Support column							〃	〃	4" round
	〃	0.2	East stair gate		X					〃	〃	
	〃	0.2	Canopy roof column					X		〃	〃	
	East stair Mezz. level	0.2	Corrugated roof deck					X		Metal	〃	Canopy
30	〃	0.1	Canopy roof support					X		Steel	〃	3" x 3" angle
	〃	0.3	Guardrail	X						〃	〃	2" x 2"
	〃	0.3	Canopy column	X						〃	〃	3" x 3" angle
	〃	0.1	Handrail	X						〃	〃	1.5"
	〃	0.3	Stair stringer						X	〃	Black	
35	〃	0.2	Stair riser						X	〃	〃	
	〃	0.3	Landing column		X					〃	White	Street level
	〃	0.4	Stair Tread						X	〃	Black	〃
	Paid S. Mezz.	0.2	Platform handrail			X				〃	White	
	〃	0.1	Canopy support col							〃	〃	Round
40	〃	3.3	Handrail							〃	Yellow	

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:
Project Number:
Project Address:
City/ State:
Client:
Date:
Project Manager:
Building Inspector:
IDPH Number:
XRF Serial Number:
Comments:

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
41	"	1.5	Handrail				X			Steel	White	Platform extension West end
	"	0.2	Sign Support column				X			"	"	10" x 6 " West end
	"	0.1	Canopy support col.							"	Tan	
	"	0.2	SE Canopy Support Col.					X		"	Tan	
45	"	0.1	Canopy Joyce					X		"	"	
	"	0.0	Canopy Corr. Roof deck					X		Metal	White	
	"	0.2	Handrail Toprail			X				Steel	"	East end
	"	0.3	Handrail Post			X				"	"	"
	"	0.4	Handrail Bottomrail			X				"	"	2"x2" Angle "
50	"	7.1	Platform guardrail		X					"	Yellow	East end
	"	1.4	Platform stringer							"	Tan	East end
	"	0.4	Platform beam							"	Tan	"
	"	0.2	Column support beam						X	"	Tan	
	"	0.2	Platform structural beam							"	"	
55	North platform East stair	0.2	Landing column						X	"	Black	Street Level
	"	0.2	Stair stringer						X	"	"	"
	"	0.2	Stair Tread							"	"	East "
	"	0.3	Structural track support							"	Tan	Main col. "
	"	0.2	Col. Corr. canopy roof deck					X		Metal	White	
60	"	0.2	Canopy support col.							Steel	White	3" x 3" Angle

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	**Room/Area**	**Reading**	**Component**	**Walls**				**Ceiling**	**Floor**	**Substrate**	**Color**	**Damage/ Comments**
				N	**E**	**S**	**W**	**C**	**F**			
61	"	0.1	Stair guard rail							Steel	White	2"x 2" Round
	"	0.0	Stair riser							"	Black	
	"	0.3	Canopy column							"	White	8" x 8"
	"	0.2	Gate							"	"	
65	"	0.3	Canopy Roof Angle					X		"	"	
	Unpaid N. Mezz.	0.2	Window wall header	X						"	"	Support col. (E)
		0.2	"	X						"	"	" (C)
	"	0.2	"	X						"	"	" (W)
	"	0.2	Window wall header beam					X		"	"	
70	"	0.2	Roof joyce					X		"	"	
	"	0.2	Canopy roof deck					X		Corr. Metal	"	
	"	0.2	Canopy column							Steel	"	
	"	0.3	Canopy support							"	"	Round
	"	0.4	CA Booth Wall	X						Wood	"	
75	"	0.2	CA Booth Wood Trim							Wood	Blue	
	"	0.1	Wall Panel							Corr. Metal	White	West Gate
	"	0.3	Gate							Steel	"	"
	"	0.1	CA Booth Window Frame	X						Wood	Black	Inside CA Booth
	"	0.1	Wall	X						Wood	White	"
80	"	-0.2	Door							"	"	

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
81	"	0.1	Door Frame			X				Wood	White	Inside CA
	"	-0.1	Ceiling					X		"	"	"
	"	0.2	Closet Door							"	"	"
	"	0.1	Closet Door frame							"	"	"
85	N Park	0.4	Support col.							Steel	White	Adj. to Rotogate
	Mezz.	0.1	Support col.							"	"	Road
	"	0.2	Canopy support col							"	Tan	East End
	"	0.3	Handrail Kickplate							"	White	"
	"	0.0	Handrail							Wood	White	2" x 6" "
90	"	0.2	Hand Guardrail							Wood	Yellow	East end
	"	0.2	Roof truss					X		Steel	White	
	"	0.0	Canopy post deck							Corr. Metal	"	
	"	16.2	Sign post column							Steel	"	West end
	"	4.7	Handrail top							"	"	"
95	"	14.5	Handrail Support col.							"	"	"
	"	8.2	Handrail toprail							"	"	"
	"	8.4	Handrail bottom							"	"	"
	"	15.7	Guardrail top							"	Yellow	"
	"	82.0	Guardrail bottom							"	"	"
100	"	97.0	"							"	"	"

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls N	Walls E	Walls S	Walls W	Ceiling C	Floor F	Substrate	Color	Damage/ Comments
101	"	9.3	Top Handrail	X						Steel	White	West End
	"	7.2	Support post handrail	X						"	"	"
	"	5.2	Platform support beam	X						"	Tan	" Stringer 6"
	"	1.5	Top Handrail	X						"	White	WE Rand
105	"	2.2	Handrail support	X						"	"	" 2"
	"	0.2	Bottom handrail	X						Wood	"	WE
	"	50.0	Handrail top	X						Steel	"	Center
	"	0.1	Handrail support	X						"	"	"
	NW Mezz. Stair	0.2	Canopy support col.			X				"	"	
110	"	0.2	Canopy roof deck							Corr. Metal	"	
	"	0.3	Canopy support angle							Steel	"	2" x 2"
	"	0.1	Top guardrail							│	│	2"x 2" angle
	"	-0.6	Round hand rail							│	│	
	"	0.6	Canopy support angle							│	│	3" x 3"
115	"	0.4	Stair stringer						X	│	Black	
	"	0.3	Stair riser							│	"	
	"	0.3	Stair support col.							│	"	Strut Level
	"	0.4	Stair thread							│	"	│
	"	0.2	Top handrail							│	White	│
120		.										

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
121	Subway Mezz. Lobby	0.3	Glazed tile	X						Glazed ~~[illegible]~~ tile	White	8" x 8"
		0.1	"	X						"	Light blue	"
	"	0.2	"	X						"	Dark blue	"
	"	4.0	"	X						"	Red	" Cove Base
125	"	4.3	"	X						"	"	" "
	"	5.8	"	X						"	"	" Chair Rail
	"	4.5	"		X					"	"	12"x 8"
	"	0.3	Plaster ceiling					X		Plaster	White	
	Jan. Services	0.0	Wall	X						CMU	White	
130	SLRM-4	0.2	|		X					Concrete	"	
	"	0.2	|			X				CMU	"	
	"	0.1	|				X			"	"	
	"	0.1	Floor						X	Concrete	"	
	"	1.6	Ceiling					X		"	"	
135	"	1.4	"					X		"	"	
	SLRM-4-1	0.1	Wall	X						CMU	White	
	"	1.4	|		X					Concrete	"	
	"	0.6	|			X				"	"	
	"	0.1	|				X			CMU	"	
140	"	0.0	Handrail							Steel	Yellow	

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
	(Pump Room)			N	E	S	W	C	F			
141	SLRM-4-1	1.8	Ladder							Steel	Red	
	"	1.6	Ceiling					X		Concrete	White	
	"	0.3	Floor						X	"	White	
	Comm. Room	0.2	Wall	X						Ceramic Tile	"	
145	"	1.6	Wall	X						CMU	"	140 ft^2 approx.
	"	0.1	"		X					CMU	"	
	"	0.3	"			X				"	"	
	"	0.1	"				X			"	"	
	"	1.4	Ceiling					X		Concrete	"	
150	"	0.2	Floor						X	"	Red	
	Comm Room	0.6	Door							Metal	White	Unable to enter
	SLRM3-1	0.6	Doorframe							"	"	SLRM3-1
	Storage Room	1.4	Wall	X						Concrete	"	
	SLRM3-2	1.5	|		X					"	"	
155	"	0.6	|			X				Clay Tile	"	
	"	0.6	|				X			"	"	
	"	0.2	Door							Metal	"	
	"	0.6	Doorframe							"	"	
	"	0.6	Ceiling					X		Concrete	"	
160	"	0.2	Floor						X	"	"	

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
161	Electrical	0.3	Wall	X						Concrete	White	
	Room SLRM1	0.1	"		X					CMU	White	
	"	0.2	"			X				CMU	"	
	"	0.2	"				X			"	"	
165	"	0.2	Ceiling					X		Concrete	"	
	"	0.4	Floor						X	Concrete	"	
	CA Booth	0.3	Wall	X						CMU	"	
	"	0.3	Wall		NA	X	NA			"	"	
	"	0.0	Ceiling					X		Plaster	"	
170	St. Room 2	0.2	Wall	X						CMU	"	
	SLRM6	0.3	"		X					Concrete	"	
	"	0.2	"			X				"	"	
	"	0.2	"				X			CMU	"	
	"	0.0	Ceiling					X		Concrete	"	
175	"	0.2	Floor						X	Floor	"	
	Concession	0.3	Wall	X						CMU	"	
	"	0.2	"		X					"	"	S Wall - Inaccessible
	"	0.2	"				X			Concrete	"	
	"	0.1	Ceiling					X		"	"	
180	SLRM5	0.1	Wall	X						CMU	"	

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
181	"	0.0	Wall		X					CMU	White	
	"	0.1	"			X				"	"	
	"	0.3	"				X			Concrete	"	
	"	1.5	Ceiling					X		Concrete	"	
185	SLRM 5-1	0.0	Wall	X						CMU		
	"	0.2	"		X							
	"	0.1	"			X						
	"	0.2	"				X					
	"	0.3	Floor						X	Concrete		
190	"	2.1	Ceiling					X		"		
	SLRM 5-2	0.0	Wall	X						CMU		
	"	0.1	"		X					"		
	"	0.2	"			X				Concrete		
	"	0.3	"				X			"		
195	"	1.9	"					X		Concrete		
	Electric	0.2	Wall	X						CMU	White	
	Motor Room	0.2			X							
	"	0.1				X						
	"	0.2					X					
200	"	0.4	Ceiling					X		Concrete		

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
201	Subway	0.0	Ceiling Tile					X		Tile	Red	2" x 2"
Stairs	Platform	0.2	"					X		"	White	2" x 2"
	Maint.-1	1.4	Wall	X						Clay Tile	White	
	|	0.0	|		X					CMU	|	
205	|	17.0	|			X				Clay Tile	|	
	|	0.1	|				X			CMU	|	
	|	1.4	Arch Ceiling					X		Concrete	|	
	|	0.2	Floor						X	"	Red	
	Maint. 2	1.4	Door							Metal	White	
210	"	0.6	Door frame							Metal	Blue	
	"	0.6	Wall	X						Clay Tile	White	
	"	1.4	|				X			Clay Tile	White	
	"	1.5	|			X				Concrete	White	
	"	0.4	|		X					Clay Tile	White	
215	"	1.4	Arch ceiling							Concrete	White	
		.										
		.										
		.										
		.										
220		.										

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
1	Cal	0.0										
	Cal	1.1										
	Cal	0.1										
SLRP1	Storage room #3	.										
5	|	0.0	clay tile wall		X					clay	white	
	|	0.1	wall			X				CMU	|	
	|	0.0	|				X			|	|	
	|	0.3	ceiling					X		concrete	|	
	|	0.2	floor						X	|	|	
0	subway	5.2	wall tile							ceramic	red	2" accent peice (chair)
	|	4.9	|							|	|	coat base
	|	6.1	|							|	|	2" bullnose accent peice (upper)
	|	0.2	|							|	white	
	|	0.2	|							|	light Blue	
5	|	0.1	|							|	Dark Blue	
SLRP2	Locker Room	0.0	wall	X						CMU	White	
	|	0.0	|		X					|	|	
	|	0.1	|			X				|	|	
	|	0.1	|				X			|	|	
0	|	1.6	ceiling							concrete	|	

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
1	Locker Room	0.1	floor						X	Concrete	white	
		0.4	column							Ceramic		2"x8"
	Platform	0.2	support column							Steel		
		1.7	Ceiling					X		Plaster		Between SLRP1 & SLRP2
5	Vestibule SLRP 3	0.1	wall	X						CMU		
		0.2			X							
		0.1				X						
		0.1					X					
		0.1	Ceiling					X		Concrete		
0		0.6	Stair Hand rail							Steel	Gray	
	HVAC Room	0.6	Door									
		0.4	Door Frame									
		0.6	Hand (upper) rail									
	SLRP4 Electric Room	0.2	wall	X						CMU	white	
5		0.3			X					Clay Tile		
		0.0				X				CMU		
		0.0					X			Clay Tile		
		1.4	Ceiling					X		Concrete		
	Platform	2.6						X		Plaster		
0		.										

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State: 212057	**XRF Serial Number:**
Client:	**Comments:**
Date:	

SLRTS

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
	Subway			N	E	S	W	C	F			
1	Electric Room #2	0.1	wall	X						CMU	white	
	│	0.0	│		X					Clay Tile	│	
	│	0.3	│			X				│	│	
	│	0.5	│				X			│	│	
5	│	0.1	Ceiling					X		Concrete	│	
	│	0.2	Floor						X	│	│	
	Signal Main Room	0.6	wall	X						Clay Tile	│	
	│	0.6	│		X					│	│	
	│	0.1	│			X				Concrete	│	
0	│	0.2	│				X			CMU	│	
	Platform	2.1	Arch Ceiling					X		Plaster	│	Lake-Randolph/ State
	│	0.1	2"x2" Ceramic Tile							Ceramic Tile		
		.										
		.										
5		.										
		.										
		.										
		.										
		.										
0		.										

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XRF ENVIRONMENTAL DATA SHEETS

Project Name:	**Project Manager:**
Project Number:	**Building Inspector:**
Project Address:	**IDPH Number:**
City/ State:	**XRF Serial Number:**
Client:	**Comments:**
Date:	

Shot	Room/Area	Reading	Component	Walls				Ceiling	Floor	Substrate	Color	Damage/ Comments
				N	E	S	W	C	F			
1	Subway Plat	-0.3	Arch Ceiling					X		Ceramic Tile	Gold	Between columns 210 + 211
	|	0.1	|					X		|	Blue	
	|	0.1	|					X		|	Red	
	|	0.4	|					X		|	White	
5	|	0.4	column							Steel	|	NE 210
	|	0.5	|							|	|	S 210
	|	0.5	|							|	|	211 N
	|	0.6	|							|	|	211 S
	Street level entrance	0.3	TOP Band							metal	Brown	NE
0	|	0.2	|							|	|	SE
	|	0.1	|							|	|	SW
	|	0.2	|							|	|	NW
		.										
		.										
5		.										
		.										
		.										
		.										
		.										
0		.										

APPENDIX D

VIKEN MODEL Pb200i
PERFORMANCE CHARACTERISTICS SHEETS

Performance Characteristic Sheet

EFFECTIVE DATE: **December 1, 2015**

MANUFACTURER AND MODEL:

Make:	***Heuresis***
Models:	***Model Pb200i***
Source:	***^{57}Co, 5 mCi (nominal – new source)***

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Action Level mode

XRF CALIBRATION CHECK LIMITS:

0.8 to 1.2 mg/cm^2 (inclusive)

SUBSTRATE CORRECTION:

Not applicable

INCONCLUSIVE RANGE OR THRESHOLD:

ACTION LEVEL MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results not corrected for substrate bias on any substrate	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

BACKGROUND INFORMATION

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated using test results on building components in the HUD archive. Testing was conducted on 146 test samples in November 2015, with two separate instruments running software version 2.1-2 in Action Level test mode. The actual source strength of each instrument on the day of testing was approximately 2.0 mCi; source ages were approximately one year.

OPERATING PARAMETERS

Performance parameters shown in this sheet are applicable only when properly operating the instrument using the manufacturer's instructions and procedures described in Chapter 7 of the HUD Guidelines.

XRF CALIBRATION CHECK:

The calibration of the XRF instrument should be checked using the paint film nearest 1.0 mg/cm^2 in the NIST Standard Reference Material (SRM) used (e.g., for NIST SRM 2579, use the 1.02 mg/cm^2 film).

If the average (rounded to 1 decimal place) of three readings is outside the acceptable calibration check range, follow the manufacturer's instructions to bring the instrument into control before XRF testing proceeds.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the paint film nearest 1.0 mg/cm^2 for substrate correction is provided:

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over the NIST SRM paint film nearest to 1.0 mg/cm^2 at test locations that have been scraped bare of their paint covering. Compute the correction values as follows:

> Using the same XRF instrument, take three readings on a bare substrate area covered with the NIST SRM paint film nearest 1 mg/cm^2. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the NIST SRM.
>
> Compute the correction value for each substrate type where XRF readings indicate substrate correction is needed by computing the average of all six readings as shown below.
>
> For each substrate type (the 1.02 mg/cm^2 NIST SRM is shown in this example; use the actual lead loading of the NIST SRM used for substrate correction):
>
> Correction value = (1st + 2nd + 3rd + 4th + 5th + 6th *Reading*)/6 - 1.02 mg/cm^2
>
> Repeat this procedure for each substrate requiring substrate correction in the house or housing development.

EVALUATING THE QUALITY OF XRF TESTING:

Randomly select ten testing combinations for retesting from each house or from two randomly selected units in multifamily housing.

Conduct XRF re-testing at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below. Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family and multi-family housing, a result is defined as a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Calculate the average of the original XRF result and the retest XRF result for each testing combination.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the average of all ten original XRF readings.

Compute the average of all ten re-test XRF readings.

Find the absolute difference of the two averages.

If the difference is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

In the Action Level paint test mode, the instrument takes the longest time to complete readings close to the Federal standard of 1.0 mg/cm^2. The table below shows the mean and standard deviation of actual reading times by reading level for paint samples during the November 2015 archive testing. The tested instruments reported readings to one decimal place. No significant differences in reading times by substrate were observed. These times apply only to instruments with the same source strength as those tested (2.0 mCi). Instruments with stronger sources will have shorter reading times and those with weaker sources, longer reading times, than those in the table.

Mean and Standard Deviation of Reading Times in Action Level Mode by Reading Level

Reading (mg/cm^2)	**Mean Reading Time (seconds)**	**Standard Deviation (seconds)**
< 0.7	3.48	0.47
0.7	7.29	1.92
0.8	13.95	1.78
0.9 – 1.2	15.25	0.66
1.3 – 1.4	6.08	2.50
≥ 1.5	3.32	0.05

CLASSIFICATION OF RESULTS:

XRF results are classified as **positive** if they are **greater than or equal** to the stated threshold for the instrument (1.0 mg/cm^2), and *negative* if they are *less than* the threshold.

DOCUMENTATION:

A report titled *Methodology for XRF Performance Characteristic Sheets* (EPA 747-R-95-008) provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. The report may be downloaded at http://www2.epa.gov/lead/methodology-xrf-performance-characteristic-sheets-epa-747-r-95-008-september-1997.

This XRF Performance Characteristic Sheet (PCS) was developed by QuanTech, Inc., under a contract with the XRF manufacturer.

APPENDIX E

ASBESTOS & LEAD INSPECTOR / RISK ASSESSOR LICENSE(S) & CERTIFICATION(S)

IDPH

ASBESTOS PROFESSIONAL LICENSE

ID NUMBER	ISSUED	EXPIRES
100 - 19027	5/7/2021	05/15/2022

JOSEPH C FRENDLING, JR
2942 W VAN BUREN ST
CHICAGO, IL 60612

Environmental Health

ENDORSEMENTS	TC EXPIRES
INSPECTOR	2/13/2022

Alteration of this license shall result in legal action
This license issued under authority of the State of Illinois Department of Public Health
This license is valid only when accompanied by a valid training course certificate.

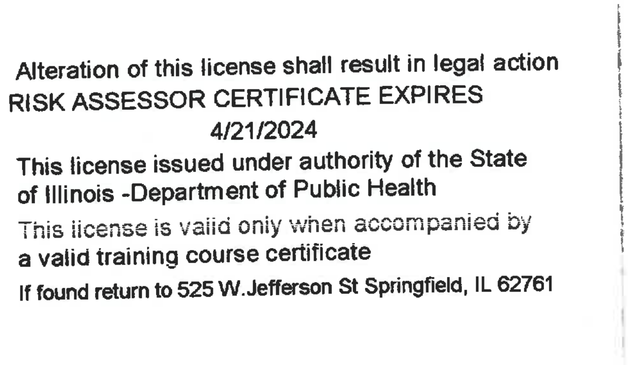
IDPH

LEAD RISK ASSESSOR LICENSE

LEAD ID	ISSUED	EXPIRES
015149	5/6/2021	1/31/2022

Joseph C Frendling, Jr.
12522 South 73rd Avenue
Palos Heights, IL 60463

ILLINOIS LEAD PROGRAM
Environmental Health



Alteration of this license shall result in legal action
RISK ASSESSOR CERTIFICATE EXPIRES
4/21/2024
This license issued under authority of the State of Illinois -Department of Public Health
This license is valid only when accompanied by a valid training course certificate
If found return to 525 W.Jefferson St Springfield, IL 62761

7233 S. Adams Street | Willowbrook, IL 60527
(630) 655-3900 | www.otssafety.com

2021

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Asbestos Building Inspector
Initial

Occupational Training & Supply, Inc. certifies that

Erin Pahomi

has successfully completed the Asbestos Building Inspector Initial course and has passed the competency exam with a minimum score of 70%. The course is accredited by the Illinois Department of Public Health and Indiana Department of Environmental Management for purposes of accreditation in accordance with EPA 40 CFR 763, Asbestos Hazard Emergency response Act (AHERA) and TSCA Title II.

Course Date: 2/22/2021 - 2/24/2021

Exam Date: 2/24/2021

Expiration Date: 2/24/2022

Certificate Number: ABI2102240569

Kathy DeSalvo

Kathy DeSalvo, Director

APPENDIX F

LABORATORY ACCREDITATIONS

United States Department of Commerce
National Institute of Standards and Technology

NVLAP®

Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 101202-0

STAT Analysis Corporation
Chicago, IL

is accredited by the National Voluntary Laboratory Accreditation Program for specific services, listed on the Scope of Accreditation, for:

Asbestos Fiber Analysis

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communique dated January 2009).

2020-07-01 through 2021-06-30
Effective Dates

For the National Voluntary Laboratory Accreditation Program

NVLAP® National Voluntary Laboratory Accreditation Program

DEPARTMENT OF COMMERCE ★ UNITED STATES OF AMERICA ★

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

STAT Analysis Corporation
STAT Analysis Corporation
2242 W. Harrison Suite 200
Chicago, IL 60612
Mr. Sean Hayes
Phone: 312-733-0551
Email: shayes@statanalysis.com
http://www.STATAnalysis.com

ASBESTOS FIBER ANALYSIS — NVLAP LAB CODE 101202-0

Bulk Asbestos Analysis

Code	***Description***
18/A01	EPA -- 40 CFR Appendix E to Subpart E of Part 763, Interim Method of the Determination of Asbestos in Bulk Insulation Samples
18/A03	EPA 600/R-93/116: Method for the Determination of Asbestos in Bulk Building Materials

Airborne Asbestos Analysis

Code	***Description***
18/A02	U.S. EPA's "Interim Transmission Electron Microscopy Analytical Methods-Mandatory and Nonmandatory-and Mandatory Section to Determine Completion of Response Actions" as found in 40 CFR, Part 763, Subpart E, Appendix A.

For the National Voluntary Laboratory Accreditation Program

Effective 2020-07-01 through 2021-06-30

APPENDIX C

PHASE II ENVIRONMENTAL SITE ASSESSMENT REPORT

Phase II Environmental Site Assessment Report
CTA STATE-LAKE LOOP ELEVATED STATION
Chicago, Illinois

Prepared for:

Chicago Department of Transportation

CHICAGO

CDOT PROJECT NO.: D-1-209

Prime Consultant:

TranSystems Corporation
222 S. Riverside Plaza, Suite 610
Chicago, IL 60606

Prepared by:

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

GSG Project No.: 20-1038

January 2022

Phase II Environmental Site Assessment Report
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Prepared for:

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CDOT PROJECT NO.: D-1-209

Prime Consultant:

TranSystems Corporation
222 S. Riverside Plaza, Suite 610
Chicago, IL 60606

WRITTEN BY:

Robert Schneider

Robert Schneider, L.P.G. Project Geologist

January 17, 2022
Date

REVIEWED BY:

Ted Cagney, L.P.G., Project Manager

January 17, 2022
Date

APPROVED BY:

Ala Sassila, PhD, P.E., QC Manager

January 17, 2022
Date

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ACRONYMS

ACM	Asbestos Containing Material
bsg	Below Surface Grade
CCDD	Clean Construction or Demolition Debris
COC	Contaminant of Concern
CCD	Chicago City Datum (579.88 ft. above mean tide New York)
CW	Construction Worker
GPS	Global Positioning System
GRO	Groundwater Remediation Objective
IAC	Illinois Administrative Code
IEPA	Illinois Environmental Protection Agency
ILCS	Illinois Compiled Statutes
LBP	Lead Based Paint
MAC	Maximum Allowable Concentration
MSA	Metropolitan Statistical Area
NELAP	National Environmental Laboratory Accreditation Program
NRCS	Natural Resources Conservation Service
PESA	Preliminary Environmental Site Assessment
PID	Photoionization Detector
PNA	Polynuclear Aromatic Hydrocarbon
ppm	Parts per Million
PSI	Preliminary Site Investigation
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
REC	Recognized Environmental Condition
ROW	Right-of-Way
SCGW	Soil Component of the Groundwater Ingestion Exposure Route
SRO	Soil Remediation Objective
STAT	STAT Analysis Corporation
SVOC	Semi-Volatile Organic Compound
TACO	Tiered Approached to Corrective Action Objectives
TAL	Target Analyte List
TCL	Target Compound List
USCS	Unified Soil Classification System
USFO	Uncontaminated Soil Fill Operation
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) completed a Phase II Environmental Site Assessment (ESA) for the proposed replacement of the Chicago Department of Transportation (CDOT) State/Lake Loop Elevated Station, located at the intersection of North State Street and Lake Street (Site) in Chicago, Cook County, Illinois 60601. **Exhibit 1, Site Location Map,** shows the project general view of the Site. The Site is approximately 110,000 square feet (2.5 acres) in size and is currently occupied by the 27,000 square foot Chicago Transit Authority (CTA) rail line elevated approximately 20 feet above Lake Street. The Site is located at portions of State and Lake Streets and portions of buildings at the corners of the State and Lake intersection.

1.1 SITE BACKGROUND

GSG performed a Phase I ESA to identify Recognized Environmental Conditions (RECs) or Potentially Impacted Properties (PIPs) for the Site in October 2020. The Phase I ESA revealed the following RECs/PIPs in connection with the Site:

Property Name	REC(s)/PIP(s)	Regulatory Database(s)	Land Use
CDOT State-Lake CTA Station (Site)	Suspected Presence of Impacted Subsurface (railroad tracks, unknown fill)	None	Railroad
ComEd/CTA Substation 10 E. Lake Street	Former SRP site (NFR, no ICs)	FINDS, ECHO, RCRA-VSQG, ASBESTOS, BOL, SPILLS, SRP, CHICAGO ENV	Electrical Substation
The D.A. Droferrgs 16 E. Lake Street	Historical 500-gallon gasoline UST (removed)	CHICAGO ENV	Commercial
The Alred B Peslman & Company 6 E. Lake Street	Historical 3,000-gallon fuel oil UST	CHICAGO ENV	Commercial
Balaban & Katz Corporation 214 N. State Street	1,000-gallon gasoline UST	CHICAGO ENV	Commercial
City of Chicago 201 N. Dearborn Street	Two (2) former 3,000-gallon gasoline USTs, spill	SPILLS	Municipal

Property Name	REC(s)/PIP(s)	Regulatory Database(s)	Land Use
Hardwood Lumber Corp/Accurate Recycling Solutions 201 N. State St.	Diesel release reported in June 1995 (NFR)	IL RG LUST, CHICAGO ENV, SPILLS	Commercial
200 N. State Street	40-50 gallon diesel spill reported in July 2006	CHICAGO ENV, SPILLS	Commercial

Exhibit 2, RECs Map, shows the location of RECs / PIPs associated with the Site.

1.2 OBJECTIVES

The objectives of the Phase II ESA were as follows:

- Determine areas of soil impacted by special waste or regulated substances associated with Recognized Environmental Concerns (RECs) identified in the Phase I ESA report.
- Evaluate soils laboratory analytical data and determine location of materials exceeding Illinois Environmental Protection Agency (IEPA) Tiered Approach to Corrective Action Objectives (TACO) Tier 1 Soil Remediation Objectives for Residential Properties (35 Ill. Admin. Code 742), and/or the most stringent maximum allowable concentration (MAC) for chemical constituents in uncontaminated soil established pursuant to Subpart F of 35 Ill. Admin. Code 1100.605.
- Provide recommendations regarding soil management and disposal options and identify locations of impacted soils where Construction Worker Precautions will be required during construction activities of the proposed improvement.

1.3 ORGANIZATION

This Phase II ESA Report is organized into the following sections:

- **Section 1.0 – Introduction**

  This section presents a brief description of the Site location, the primary objectives of the investigation, the findings of the Phase I ESA performed within the Site and organization of this report.

- **Section 2.0 – Field Investigation Procedures**

  This section outlines the rationale for sampling and field activities associated with the Site investigation and field observations.

- **Section 3.0 – Investigation Results**

  This section provides a summary of soil analytical results, an evaluation and interpretation of the data obtained, an analysis of applicable regulatory requirements, and an evaluation of soil reuse and management options.

- **Section 4.0 – Conclusions and Recommendations**

  This section presents relevant findings and conclusions of the investigation along with recommendations for further actions.

- **Section 5.0 – References**

  This section presents a list of references used in the preparation of this report.

2.0 FIELD INVESTIGATION PROCEDURES

This section describes the soil boring procedures, utility clearance, sample identification protocol, sampling and analyses program, quality control, and soil sampling procedures. **Exhibit 1**, **Site Location Map**, shows the Site and the boring locations.

Field investigation activities were conducted under the direct supervision of the GSG Field Manager. All properties on which field investigation activities were performed under the authority of the CTA and the City of Chicago.

2.1 SOIL SAMPLING PROTOCOL

GSG developed a soil sampling plan based on the proposed improvement and location of the RECs identified in relation to the Site. The sampling plan included advancement of ten (10) soil borings (B-1 through B-10). Borings were placed in areas where the proposed improvement work is to be located. Soil samples were collected from the upper three (3) feet to characterize fill materials immediately beneath the surface pavement, at approximately 10 feet below surface grade (bsg) to characterize soils/fill materials at the base of the hydro-vacuumed interval, and at 20 feet bsg to be placed on "hold" and analyzed as needed.

2.2 UTILITY CLEARANCE

Prior to drilling, GSG notified the Chicago DIGGER one-call system for utility locates within the public right-of-way (ROW) and the CTA for utility locates within the Site. Boring locations were adjusted as needed based on utility conflicts, site conditions, and other access issues. Specifically, B-7 was not advanced due to structural and utility conflicts.

2.3 SOIL SAMPLING PROCEDURES

GSG advanced nine (9) borings to bedrock (encountered between 117.5 and 123.5 feet bsg) under the direction of the GSG Field Manager. Nine (9) soil borings were advanced using either a Dietrich D-50 or CME drill rig, hydro-vacuuming to approximately 10 feet bsg prior to drilling. The borings were continuously sampled from existing ground surface to termination depth in each boring at twice per every five-foot interval using 18-inch split-spoon samplers. Field equipment was decontaminated and cleaned prior to each use. The samples were collected utilizing hand equipment. Soil boring logs of the top twenty (20) feet of each boring are provided in **Appendix A**.

GSG's Field Manager inspected each soil sample interval for the presence of soil staining and/or olfactory impacts, and color and texture were classified per the Unified Soil Classification System (USCS). Soil samples were screened in 1-foot intervals using a calibrated Photoionization Detector (PID) for the presence of VOCs using the headspace procedure. PID readings above ambient air, recorded in parts per million (ppm), were measured and recorded on the field boring logs. Soil samples for VOC analysis were collected immediately after sample retrieval in accordance with *SW-846 Method 5035* using an Encore^{TM} sampler and transported to the laboratory in a separate cooler.

Following the collection of the VOC samples, soil samples to be analyzed for SVOCs/PNAs, PCBs, Pesticides, TAL Metals, Total Cyanide, and pH were collected. Soil samples were taken directly from the acetate liners and placed in clean laboratory-supplied sampling containers with Teflon®-lined lids. A new pair of clean disposable gloves were worn while collecting samples and were changed at each new boring location to prevent any cross-contamination of the samples. All soil samples were labeled with a unique identifier, placed in a cooler packed with ice, stabilized to a temperature of between 1 and 4 degrees Celsius (°C), transported to STAT Analysis Corporation (STAT), a National Environmental Laboratory Accreditation Program (NELAP) certified laboratory, and received under standard chain-of-custody procedures.

Detailed descriptions of the subsurface soils and PID readings recorded during the field investigation are provided in **Appendix A, Soil Boring Logs**. The stratifications shown on the boring logs represent the conditions only at the actual boring locations and the approximate boundary between subsurface materials; however, the actual transition may be gradual.

2.4 GROUNDWATER SAMPLING PROCEDURES

No water was present after drilling activities were completed; therefore, groundwater samples were not collected.

2.5 SAMPLING AND ANALYSES PROGRAM

GSG developed analytical testing program for the Phase II based on the nature of the RECs identified in the Phase I ESA. The soil samples collected during the PSI investigation were submitted for analysis to STAT in accordance with the procedures outlined in *SW-846, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*. STAT reported that all laboratory analysis and quality control/quality assurance procedures were performed in accordance with the requirements of *35 Illinois Administrative Code (IAC) 186, Accreditation of Environmental Laboratories*. The **Laboratory Analytical Reports**, including the Chains of Custody, are included in **Appendix B**. Soil samples were analyzed for some or all the following parameters:

- Volatile Organic Compounds (VOCs) (US EPA Methods 5035/8260B);
- Semi-volatile Organic Compounds (SVOCs)/Polynuclear Aromatic Hydrocarbons (PNAs) (US EPA Method 8270C);
- Polychlorinated Biphenyls (PCBs): US EPA Method SW8082A
- Pesticides: US EPA Method SW8081B
- Target Analyte List (TAL) Total Metals (US EPA Methods 6020A/7471B);
- Total Cyanide (US EPA Method 9012A); and
- pH (US EPA Method 9045C).

3.0 INVESTIGATION RESULTS

This section presents the results of GSG's field investigation and includes a discussion of laboratory analytical results compared to applicable screening criteria, significant field observations, Site geology and topography, a review of applicable regulatory requirements, and an evaluation of soil management options.

Samples were analyzed for the parameters listed in **Section 2.5**. Laboratory results were reviewed by GSG for field and laboratory precision, accuracy, and completeness in accordance with procedures and QC limits. Laboratory data packages are included as **Appendix B.**

3.1 GENERAL FIELD OBSERVATIONS

General observations made during GSG's site investigation are summarized as follows:

- Fill was observed in all nine (9) borings, consisting predominantly of brown sand and gravel with brick fragments and granite pavers, extending to a maximum depth of fifteen (15) feet bsg. CA-6 fill was encountered in boring B-6 beneath the pavement to a depth of approximately ten (10) feet bsg;
- Native materials encountered during the investigation typically consisted of gray silty clay, with trace gravel below the fill layer to a depth of at least twenty (20) feet bsg;
- No water was present once drilling activities were completed;
- Petroleum odors were not observed; and
- PID readings were not observed above ambient air.

3.2 SITE GEOLOGY

GSG reviewed published geologic information to develop an understanding of site geology and anticipated groundwater flow direction. Groundwater flow can be locally impacted by utilities, wells, or other human-induced changes, but generally corresponds with surface topography. The 2012 USGS 7.5-minute Chicago Loop Quadrangle shows the Site to be sloping generally from west to east, generally toward Lake Michigan.

According to the "Potential for Contamination of Shallow Aquifers in Illinois (Plate 1)," (Richard C. Berg, John P. Kempton, ISGS, 1984), the Site is located within the M rating area. The geologic materials in the M rating area consist of "manmade land." The potential for contamination not known.

Based on the "Potential for Contamination of Shallow Aquifers by Surface and Near-Surface Waste Disposal (Plate 2)", the Site is located within the M rating area. The geologic materials in the M rating area consist of "manmade land." The potential for contamination is not known.

3.3 STRATIGRAPHY

Evaluation of the stratigraphy of the boreholes advanced during the investigation revealed fill material at all locations consisting of predominantly of brown sand and gravel with brick fragments and granite pavers, extending to a maximum depth of fifteen (15) feet below surface grade (bsg). CA-6 fill was encountered in boring B-6 beneath the pavement to a depth of approximately ten (10) feet bsg. Native materials encountered during the investigation typically consisted of gray silty clay, with trace gravel below the fill layer to the maximum boring termination depth of twenty (20) feet bsg. Detailed descriptions of the subsurface soils, visual observations, and any PID readings recorded during the site investigation are provided in **Appendix A, Soil Boring Logs.**

3.4 SAMPLE RATIONALE AND ANALYSES

Eighteen (18) soil samples from the nine (9) boring locations were analyzed during the field investigation. Soil samples were selected for laboratory analysis based on the soil classification, sample interval, visual and olfactory observations, and PID readings. Groundwater samples were not collected due to groundwater not being encountered during the Phase II ESA activities.

3.5 ANALYTICAL DATA EVALUATIONS

3.5.1 COMPARISON TO TACO TIER 1 SOIL REMEDIATION OBJECTIVES

Soil analytical results were compared to the Tiered Approached to Corrective Action Objectives (TACO) Tier 1 Soil Remediation Objectives (SROs) for Residential Use exposure scenario for the Ingestion, Inhalation, and the Soil Component of the Groundwater (SCGW) (Class I) Ingestion exposure routes listed in *35 IAC Part 742, Appendix B, Table A [Illinois Pollution Control Board (IPCB), 2013]*.

As part of this evaluation, Ionizable Organics [*Appendix B, Table A, footnote (i)*] and Inorganics [*Appendix B, Table A, footnote (m)*] with pH-dependent solubility were compared to pH-specific SROs for the SCGW (Class I) Ingestion exposure route, presented in *35 IAC Part 742, Appendix B, Tables C and D (IPCB, 2013)*.

The evaluation of the five (5) PNAs (Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Dibenzo(a,h)anthracene, and Indeno(1,2,3-c,d)pyrene), per *Appendix B, Table A, footnote w*, may be compared to the concentrations of Polynuclear Aromatic Hydrocarbon Chemicals in Background Soils (in any populated area), presented in *35 IAC Part 742, Appendix A, Table H*.

As an alternative in the evaluation of Inorganics [*Appendix B, Table A, footnote (m)*], soil sample extraction results from either the TCLP or SPLP analyses may be compared to the SCGW (Class I) Ingestion exposure routes listed in *35 IAC Part 742, Appendix B, Table A (IPCB, 2013)*.

Soil analytical results compared to TACO Tier 1 Soil Remediation Objectives (SROs) for Residential Properties for the Ingestion, Inhalation, and the Soil Component of the Groundwater (SCGW) (Class I)

Ingestion exposure routes are shown in **Tables 1a-1e, Soil Analytical Results Compared to TACO Tier 1 Residential and Construction Worker SROs**, which are provided at the end of this report.

Following a comparison review of the data, five (5) of the eighteen (18) samples exceed TACO Tier 1 Residential Ingestion exposure route SROs, six (6) of the eighteen (18) samples exceed TACO Tier 1 SCGW Ingestion exposure route SROs, and six (6) of the eighteen (18) samples exceed TACO Tier 1 Construction Worker Inhalation exposure route SROs.

Table 3-1, TACO Tier 1 Residential SRO and CCDD MAC Exceedances, presented below, summarizes the sample locations and soil results that exceeded the TACO Tier 1 Residential exposure route SROs, Soil Component of the Groundwater (Class I) SROs, and CCDD MAC Values.

3.5.2 COMPARISON TO CCDD MAXIMUM ALLOWABLE CONCENTRATION VALUES

GSG compared the soil analytical results to the most stringent CCDD Maximum Allowable Concentration (MAC) values listed in *35 IAC Part 1100.605, Subpart F [IPCB, 2012]*.

As an alternative to the MAC value for Inorganics [*footnote (m) MAC Table*], soil sample extraction results from either the TCLP or SPLP analyses may be compared to the SCGW (Class I) Ingestion exposure routes listed in *35 IAC Part 742, Appendix B, Table A [IPCB, 2013]*.

Soil samples with detections of Inorganics shall be determined to meet the CCDD requirements if any of the following analyses meet the screening criteria:

1. Total concentration is below the MAC value;
2. TCLP result is below the TACO Tier 1 SCGW (Class I) SRO; or
3. SPLP result is below the TACO Tier 1 SCGW (Class I) SRO.

Soil analytical results compared to most stringent CCDD Maximum Allowable Concentration (MAC) values listed in *35 IAC Part 1100.605, Subpart F*, are shown in **Tables 2a-2e, Soil Analytical Results Compared to CCDD MAC Values**, which are provided at the end of this report.

GSG compared the soil analytical results to most stringent CCDD Maximum Allowable Concentration (MAC) values listed in 35 IAC Part 1100.605, Subpart F. Following a comparison review of the data, below is a summary of the findings:

- Seven (7) of the eighteen (18) samples exceed the CCDD most stringent MAC Values;
- Five (5) of the eighteen (18) samples exceed the populated MSA County MAC Values;
- Six (6) of the eighteen (18) samples exceed the populated non-MSA County MAC Values; and
- Ten (10) of the eighteen (18) samples were outside of the CCDD-acceptable pH range.

Following a comparison review of the data, only four (4) samples (B-2-2, B-3-2, B-4-2, and B-6-2) meet the requirements for disposal at a CCDD facility or USFO operation.

Table 3-1, TACO Tier 1 Residential SRO and CCDD MAC Exceedances, presented earlier in this section, lists COCs with concentrations exceeding the corresponding CCDD MAC screening criteria.

TABLE 3-1 TACO TIER 1 RESIDENTIAL SROS AND CCDD MAC EXCEEDANCES							
Sample ID	**Exceeding Constituent**	**Result**	**Residential SROs**		**SCGW SROs**	**CCDD MAC Values**	**Elevation Range of Impacted Soil**
			Ingestion	**Inhalation**	**Class I**	**MSA/Chicago/ Non-MSA/Non-Pop**	
		(mg/kg)	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(ft. above CCD)**
B-1							
B-1-1	Carbazole	1.3	32	NC	**0.6**	**0.6**	5.12 to -4.88
	Benzo(a)anthracene	9.9	**1.1**[b]	NC	**2**	**1.8/1.1/0.9/0.9**	
	Benzo(a)pyrene	8.1	**1.3**[b]	NC	**8**	**2.1/1.3/0.98/0.09**	
	Benzo(b)fluoranthene	8.0	**1.5**[b]	NC	**5**	**2.1/1.5/0.9/0.9**	
	Dibenz(a,h)anthracene	2.1	**0.20**[b]	NC	**2**	**0.42/0.20/0.15/0.09**	
	Indeno(1,2,3-cd)pyrene	4.0	**0.9**	NC	14	**1.6/0.9/0.9/0.9**	
	Cobalt	43	4,700	NC	NC	**20**	
	Lead	120	400	NC	NC[a]	**107**	
	pH	9.74	NC	NC	NC	**6.25-9.0**	
B-1-2	pH	9.04	NC	NC	NC	**6.25-9.0**	-4.88 to -14.88*
B-2							
B-2-1	Benzo(a)anthracene	3.3	**1.1**[b]	NC	**2**	**1.8/1.1/0.9/0.9**	7.12 to -1.88
	Benzo(a)pyrene	3.2	**1.3**[b]	NC	8	**2.1/1.3/0.98/0.09**	
	Benzo(b)fluoranthene	3.0	**1.5**[b]	NC	5	**2.1/1.5/0.9/0.9**	
	Dibenz(a,h)anthracene	1.1	**0.20**[b]	NC	2	**0.42/0.20/0.15/0.09**	
	Indeno(1,2,3-cd)pyrene	1.8	**0.9**	NC	14	**1.6/0.9/0.9/0.9**	
	Cobalt	22	4,700	NC	NC	**20**	
	Lead	210	400	NC	NC[a]	**107**	
	Mercury	1.5	23	10	NC[a]	**0.89**	
	pH	9.83	NC	NC	NC	**6.25-9.0**	
B-3							
B-3-1	Carbazole	0.84	32	NC	**0.6**	**0.6**	5.12 to -4.88
	Benzo(a)anthracene	21	**1.1**[b]	NC	**2**	**1.8/1.1/0.9/0.9**	
	Benzo(a)pyrene	19	**1.3**[b]	NC	**8**	**2.1/1.3/0.98/0.09**	
	Benzo(b)fluoranthene	16	**1.5**[b]	NC	**5**	**2.1/1.5/0.9/0.9**	
	Benzo(k)fluoranthene	14	**9**	NC	49	**9**	
	Dibenz(a,h)anthracene	5.1	**0.20**[b]	NC	**2**	**0.42/0.20/0.15/0.09**	
	Indeno(1,2,3-cd)pyrene	9.9	**0.9**	NC	14	**1.6/0.9/0.9/0.9**	
	pH	9.38	NC	NC	NC	**6.25-9.0**	

TABLE 3-1
TACO TIER 1 RESIDENTIAL SROS AND CCDD MAC EXCEEDANCES

Sample ID	**Exceeding Constituent**	**Result**	**Residential SROs**		**SCGW SROs**	**CCDD MAC Values**	**Elevation Range of Impacted Soil**
			Ingestion	**Inhalation**	**Class I**	**MSA/Chicago/ Non-MSA/Non-Pop**	
		(mg/kg)	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(ft. above CCD)**
B-4							
B-4-1	Benzo(a)anthracene	11	**1.1[b]**	NC	**2**	**1.8/1.1/0.9/0.9**	5.12 to -4.88
	Benzo(a)pyrene	9.1	**1.3[b]**	NC	**8**	**2.1/1.3/0.98/0.09**	
	Benzo(b)fluoranthene	7.7	**1.5[b]**	NC	**5**	**2.1/1.5/0.9/0.9**	
	Dibenz(a,h)anthracene	2.5	**0.20[b]**	NC	**2**	**0.42/0.20/0.15/0.09**	
	Indeno(1,2,3-cd)pyrene	4.6	**0.9**	NC	14	**1.6/0.9/0.9/0.9**	
	Lead	260	400	NC	NC[a]	**107**	
	pH	10.59	NC	NC	NC	**6.25-9.0**	
B-5							
B-5-1	Benzo(a)anthracene	1.8	**1.1[b]**	NC	2	1.8/**1.1/0.9/0.9**	5.12 to -4.88
	Benzo(a)pyrene	1.6	**1.3[b]**	NC	8	2.1/**1.3/0.98/0.09**	
	Dibenz(a,h)anthracene	0.52	**0.20[b]**	NC	2	**0.42/0.20/0.15/0.09**	
	Lead	440	**400**	NC	NC[a]	**107**	
	pH	9.62	NC	NC	NC	**6.25-9.0**	
B-5-2	Chromium	24	230	270	24[a]	**21**	-4.88 to -14.88*
B-6							
B-6-1	pH	9.02	NC	NC	NC	**6.25-9.0**	6.12 to -2.88
B-8							
B-8-1	Aluminum	15,000	NC	NC	NC	**9,500/9,500/9,200**	6.12 to -3.88
	Chromium	25	230	270	**24[a]**	**21**	
	Iron	27,000	NC	NC	NC	**15,900/15,900/15,000**	
B-8-2	Chromium	30	230	270	**28[a]**	**21**	-3.88 to -13.88*
B-9							
B-9-1	pH	9.63	NC	NC	NC	**6.25-9.0**	6.12 to -2.88
B-9-2	Chromium	22	230	270	28[a]	**21**	-2.88 to -13.88*
B-10							
B-10-1	Lead	140	400	NC	NC[a]	**107**	5.12 to -3.88
	pH	9.67	NC	NC	NC	**6.25-9.0**	
B-10-2	pH	9.49	NC	NC	NC	**6.25-9.0**	-3.88 to -14.88*

Bold Regulatory Value Exceeded
[a] pH specific SROs, 35 IAC 742, Appendix B, Table C
[b] Location specific background value
NC No toxicity criteria set for this exposure route or no criteria at the given sample pH
* Impacted soil extends below the limits of the boring; Contractor should field verify extent of impacted soils for disposal purpose.

3.5.3 COMPARISON TO TACO TIER 1 CONSTRUCTION WORKER SOIL REMEDIATION OBJECTIVES

GSG compared soil analytical data to the TACO Tier 1 Construction Worker (CW) SROs for the Soil Ingestion and Soil Inhalation exposure routes, listed in *35 IAC Part 742, Appendix B, Table B (IPCB, 2013)*, to determine locations within the Site that pose a potential health risk to workers involved in construction activities. Soil analytical results as compared to Construction Worker SROs are shown in **Tables 1a-1e, Soil Analytical Results Compared to TACO Tier 1 Residential and Construction Worker SROs** included at the back of this report. Following a comparison review of the data, six (6) of the 18 samples exceeded the TACO Tier 1 Construction Worker SROs.

Table 3-2, TACO Tier 1 Construction Worker SRO Exceedances, presented below, lists COCs with concentrations exceeding the TACO Tier 1 CW SROs. Construction Worker Precautions will need to be implemented at the impacted boring locations.

TABLE 3-2
TACO TIER 1 CONSTRUCTION WORKER SRO EXCEEDANCES

Sample ID	Exceeding Constituent	Result	Construction Worker SROs		Elevation Range of Impacted Soil
			Ingestion	Inhalation	
		(mg/kg)	(mg/kg)	(mg/kg)	(ft. above CCD)
B-1					
B-1-1	Mercury	0.34	61	**0.1**	5.12 to -4.88
B-2					
B-2-1	Mercury	1.5	61	**0.1**	7.12 to -1.88
B-3					
B-3-1	Benzo(a)pyrene	19	**17**	NC	5.12 to -4.88
	Mercury	0.18	61	**0.1**	
B-4					
B-4-1	Mercury	0.54	61	**0.1**	5.12 to -4.88
B-5					
B-5-1	Mercury	0.43	61	**0.1**	5.12 to -4.88
B-8					
B-8-1	Mercury	0.6	61	**0.1**	6.12 to -3.88

Bold Regulatory Value Exceeded

3.6 SOIL MANAGEMENT EVALUATION

In accordance with applicable regulations, GSG evaluated the soil analytical results to determine soil management options within the Site. Soil management options include reuse on site; disposal at an off-site approved USFO or CCDD facility, or Subtitle D non-hazardous disposal facility; and placement of construction worker safety precautions on reused soils to protect workers in these areas.

Soils that were determined to exceed the TACO Tier 1 Soil Remediation Objectives cannot be reused on site and must be disposed of at a licensed Subtitle D facility. Soils that exceed the CCDD MAC values and/or are outside the acceptable pH range may be reused on site, but any excess and/or unsuitable soils that need to be removed from the site must be disposed of at a licensed Subtitle D facility.

Based on the results of the Phase II ESA, the **shallow materials (materials between the surface and approximately 10 feet bsg)** at six (6) boring locations (B-1, B-2, B-3, B-4, B-5, and B-8) and the **deeper materials (materials below approximately 10 feet bsg)** at one (1) boring location (B-8) exceed one (1) or more TACO Tier 1 residential and/or construction worker SROs. These materials are generally unsuitable to be reused on site and must be disposed of at a Subtitle D facility as solid waste.

The **deeper materials** at four (4) borings (B-1, B-5, B-9, and B-10) and **shallow materials** at three (3) borings (B-6, B-9, and B-10) only exceed the CCDD MAC values and/or are outside the acceptable pH range may be reused on site, if suitable. While **deeper materials** at four (4) borings (B-2, B-3, B-4, and B-6) may disposed of at a licensed CCDD facility or an Uncontaminated Soil Fill Operation (USFO).

Discussions regarding soil suitability for reuse in this report are based on environmental considerations only. The design engineer, and/or contractor, should refer to the project geotechnical reports for geotechnical considerations and recommendations.

GSG determined the location of impacted soil exceeding the TACO Tier 1 Construction Worker SROs, as presented in **Table 3-2,** *"TACO Tier 1 Construction Worker SRO Exceedances",* and **Exhibit 4, Soil Management Plan**. Construction Worker Precautions will need to be implemented in these locations during construction activities.

3.6.1 EXTENT OF SOIL IMPACTS

The extent of impacted soil at each boring location was calculated using the following methodology:

- Horizontal: The extent of impacted soil was measured at one-half the distance between borings with nearest clean sample location that does not exceed the applicable TACO Tier 1 SROs or CCDD MAC values; where there were no adjacent borings, the extent of impacted soil will extend to the existing/proposed ROW line, or the limits of construction, whichever distance is greater.

- Vertical: The extent of impacted soil was measured to the next clean sample elevation or the boring termination depths, whichever was shallower.

Table 3-3, *"Summary of Soil Impacts",* below, is a summary of the soil impacts and lists the soil disposal options for each sample collected within the Site. **Exhibit 4, Soil Management Plan**, shows the locations and depths of the various soil classifications and management options for the Site.

TABLE 3-3
SUMMARY OF SOIL IMPACTS

Boring ID	Sample ID	PID Readings Above Background (ppm)	pH	Contaminants of Concern		Soil Management		
				Above All Applicable Comparison Criteria	Above Most Stringent MAC, Chicago MAC, or SCGW Criteria Only	Eligible for CCDD or USFO	Soil Disposal Classification	Construction Worker Precautions
B-1	B-1-1	None detected	**9.74**	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene	Carbazole Indeno(1,2,3-cd)pyrene Cobalt Lead	No	Non-Special Waste	**Yes**
	B-1-2	None detected	**9.04**	None	None	No	Onsite Reuse	No
B-2	B-2-1	None detected	**9.83**	Benzo(a)anthracene	Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene Cobalt Lead Mercury	No	Non-Special Waste	**Yes**
	B-2-2	None detected	8.79	None	None	Yes	Unrestricted	No
B-3	B-3-1	None detected	**9.38**	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene	Carbazole Benzo(k)fluoranthene Indeno(1,2,3-cd)pyrene	No	Non-Special Waste	**Yes**
	B-3-2	None detected	8.38	None	None	Yes	Unrestricted	No
B-4	B-4-1	None detected	**10.59**	Benzo(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene	Indeno(1,2,3-cd)pyrene Lead	No	Non-Special Waste	**Yes**
	B-4-2	None detected	8.98	None	None	Yes	Unrestricted	No

TABLE 3-3
SUMMARY OF SOIL IMPACTS

Boring ID	Sample ID	PID Readings Above Background (ppm)	pH	Contaminants of Concern		Soil Management		
				Above All Applicable Comparison Criteria	Above Most Stringent MAC, Chicago MAC, or SCGW Criteria Only	Eligible for CCDD or USFO	Soil Disposal Classification	Construction Worker Precautions
B-5	B-5-1	None detected	**9.62**	Lead	Benzo(a)anthracene Benzo(a)pyrene Dibenz(a,h)anthracene	No	Non-Special Waste	**Yes**
	B-5-2	None detected	8.34	None	Chromium	No	Onsite Reuse	No
B-6	B-6-1	None detected	**9.02**	None	None	No	Onsite Reuse	No
	B-6-2	None detected	8.26	None	None	Yes	Unrestricted	No
B-8	B-8-1	None detected	8.32	None	Aluminum Chromium Iron	No	Non-Special Waste	**Yes**
	B-8-2	None detected	8.11	None	Chromium	No	Non-Special Waste	No
B-9	B-9-1	None detected	**10.79**	None	None	No	Onsite Reuse	No
	B-9-2	None detected	8.20	None	Chromium	No	Onsite Reuse	No
B-10	B-10-1	None detected	**9.67**	None	Lead	No	Onsite Reuse	No
	B-10-2	None detected	**9.49**	None	None	No	Onsite Reuse	No

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

Eighteen (18) soil samples from the CTA State-Lake Loop Elevated Station site, located at the intersection of North State Street and Lake Street in Chicago, Cook County, Illinois were analyzed as part of this Phase II ESA. Shallow soil samples were analyzed for the target compound list and deeper soil samples were analyzed for PNAs and RCRA metals. The analytical results were compared to applicable TACO Tier 1 Residential Soil Remediation Objectives (SROs), Clean Construction and Demolition Debris Maximum Allowable Concentrations (CCDD MAC) Values and TACO Tier 1 Construction Worker SROs. Based on this evaluation, GSG provided recommendations for soil management options during construction activities at the site.

4.2 RECOMMENDATIONS

Special Provisions for Removal and Disposal of Regulated Substances (IDOT, 2018) specifies conditions for the removal and disposal of regulated materials.

Following a comparison review of the data, five (5) of the eighteen (18) samples exceed TACO Tier 1 Residential Ingestion exposure route SROs, six (6) of the eighteen (18) samples exceed TACO Tier 1 SCGW Ingestion exposure route SROs, and six (6) of the eighteen (18) samples exceed TACO Tier 1 Construction Worker Inhalation exposure route SROs. These soils cannot be reused on-site and must be disposed of at a Subtitle D facility, if require removal from the site.

GSG compared the soil analytical results to most stringent CCDD Maximum Allowable Concentration (MAC) values listed in 35 IAC Part 1100.605, Subpart F. Following a comparison review of the data, below is a summary of the findings:

- Seven (7) of the eighteen (18) samples exceed the CCDD most stringent MAC Values;
- Five (5) of the eighteen (18) samples exceed the populated MSA County MAC Values;
- Six (6) of the eighteen (18) samples exceed the populated non-MSA County MAC Values; and
- Ten (10) of the eighteen (18) samples were outside of the CCDD-acceptable pH range.

Soils that only exceed the CCDD MAC values and/or the outside the acceptable pH range may be reused on site, but any excess and/or unsuitable soils that need to be removed from the site must be disposed of at a licensed Subtitle D facility.

Following a comparison review of the data against the TACO Tier 1 Construction Worker SROs, it was revealed that six (6) of the eighteen (18) samples exceed the TACO Tier 1 Construction Worker Inhalation SRO for Mercury. Construction Worker Precautions will be necessary when working in the affected areas. Soil sample results compared to Tier 1 Construction Worker SROs are presented in **Tables 1a-1e, Soil**

Analytical Results Compared to TACO Tier 1 Residential and Construction Worker SROs, which are provided at the end of this report.

Soils at all other locations within the Site are classified as “Unrestricted” and may be managed on site or disposed of at a CCDD facility or a USFO, if the soils are with acceptable range of pH values for acceptance at a CCDD facility or a USFO and do not exhibit any PID readings above ambient air levels.

Groundwater was not encountered in any of the borings after completion of the Phase II ESA activities. If groundwater is encountered within trenches during construction activities, it may be managed on site and allowed to infiltrate back into the ground. If managed off site, the groundwater must be sampled, analyzed, and characterized to determine how the groundwater will be collected, containerized, and transported to an off-site facility. Off-site disposal of groundwater requires treatment and testing, prior to any discharge. Off-site disposal of groundwater would require proper waste characterization and acceptance at an approved Special Waste disposal facility.

4.2.1 FURTHER INVESTIGATION

GSG does not recommend further investigation of the Site since soil has been fully characterized. However, if evidence of soil contamination such as visual and/or olfactory are discovered during the construction phase, or if work is performed outside the bounds of the Site, soil should be tested and evaluated.

4.2.2 PREVENTION OF CONTAMINANT MIGRATION

GSG recommends implementing soil containment and stormwater runoff control measures during construction to prevent the potential of contaminants migration from any impacted soils that are stockpiled within the Site. If soil must be stockpiled, GSG recommends that the Contractor containerize or place separately any non-special waste, special waste, non-hazardous waste, or hazardous waste soils, if encountered, separately on plastic sheeting, covered with plastic sheeting, and protect with 12-inch to 18-inch berms until subsequent loading, transportation, and disposal. The Contractor shall not allow runoff from stockpiled soil or material to enter storm drains or leave the site.

4.2.3 CONSTRUCTION WORKER EXPOSURE MONITORING

Areas with COC concentrations above the Tier 1 Construction Worker SROs will require Construction Worker exposure notifications.

During the site investigation, no elevated PID readings were recorded . If soil unearthed during excavation activities exhibits PID readings, odors, or discoloration indicative of contamination, GSG recommends that the soil to be sampled and characterize to determine appropriate disposal option and construction worker protection requirements. Construction worker health and safety is the responsibility of the construction contractor.

4.2.4 CONDITIONS AND RESTRICTIONS

Discussions in this report regarding soil and groundwater management, including suitability for reuse and disposal, are based on environmental considerations only. The design engineer, and/or contractor, should refer to the project geotechnical reports for geotechnical considerations regarding soil suitability for reuse within the Site.

This report is intended for use by the CDOT and its representatives for the sole purpose of evaluating the conditions and proposed soil and groundwater management at the Site in anticipation of future construction activities. GSG is not responsible for the use of this report, its findings, conclusions, and recommendations, by those parties outside CDOT authority or beyond its intended purpose.

Any soils that exhibit hazardous waste characteristics upon completion of waste characterization testing would require disposal at a Subtitle C landfill. GSG does not anticipate any soils would be classified as hazardous waste based on the available analytical data.

5.0 REFERENCES

Berg, Richard C., Kempton, John P., and Cartwright, Keros, 1984, *Potential for Contamination of Shallow Aquifers from Land Burial of Municipal Wastes*, Illinois State Geological Survey (ISGS), Champaign-Urbana, Illinois.

GSG Consultants, Inc., October 2020, Phase I Environmental Site Assessment, prepared for TranSystems Corporation, Chicago, Illinois.

Illinois Pollution Control Board (IPCB), July 15, 2013, FINAL, *35 Illinois Administrative Code, Part 742, Tiered Approach to Corrective Action Objectives*, Amended.

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United States Environmental Protection Agency. (US EPA), August 13, 2015, FINAL *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, U S EPA publication SW–846, Update V, Federal Register Vol. 80, No. 156, pp. 48522 - 48528.

Willman, H.B., 1971, *Summary of the Geology of the Chicago Area*, Illinois State Geological Survey (ISGS), Urbana, Illinois.

TABLES

Table 1a
Soil Analytical Results
VOCs
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	RESIDENTIAL		CONSTRUCTION WORKER		SOIL COMPONENT TO GROUNDWATER	Sample	B-1-1	B-2-1	B-3-1	B-4-1	B-5-1
						Date	11/01/21	11/01/21	11/01/21	11/01/21	11/04/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I*	**Depth (ft)**	2-3	1-2	1-2	2-3	2-3
VOCs											
Acetone	70,000	100,000	NC	100,000	25		< 0.070	< 0.071	< 0.086	< 0.093	< 0.078
Benzene	12	0.8	2,300	2.2	0.03		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Bromodichloromethane	10	3,000	2,000	3,000	0.6		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Bromoform	81	53	16,000	140	0.8		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Bromomethane	110	10	1,000	3.9	0.2		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010
2-Butanone	NC	NC	NC	NC	NC		< 0.070	< 0.071	< 0.086	< 0.093	< 0.078
Carbon disulfide	7,800	720	20,000	9.0	32		< 0.046	< 0.048	< 0.057	< 0.062	< 0.052
Carbon tetrachloride	5	0.3	410	0.90	0.07		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Chlorobenzene	1,600	130	4,100	1.3	1		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Chloroethane	NC	NC	NC	NC	NC		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010
Chloroform	100	0.3	2,000	0.76	0.6		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Chloromethane	NC	NC	NC	NC	NC		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010
Dibromochloromethane	1,600	1,300	41,000	1,300	0.4		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
1,1-Dichloroethane	7,800	1,300	200,000	130	23		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
1,2-Dichloroethane	7	0.4	1,400	0.99	0.02		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
1,1-Dichloroethene	3,900	290	10,000	3.0	0.06		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
cis-1,2-Dichloroethene	780	1,200	20,000	1,200	0.4		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
trans-1,2-Dichloroethene	1,600	3,100	41,000	3,100	0.7		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
1,2-Dichloropropane	9	15	1,800	0.50	0.03		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
cis-1,3-Dichloropropene	6.4	1.1	1200	0.39	0.004		< 0.0019	< 0.0019	< 0.0023	< 0.0025	< 0.0021
trans-1,3-Dichloropropene	6.4	1.1	1200	0.39	0.004		< 0.0019	< 0.0019	< 0.0023	< 0.0025	< 0.0021
Ethylbenzene	7,800	400	20,000	58	13		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
2-Hexanone	NC	NC	NC	NC	NC		< 0.019	< 0.019	< 0.023	< 0.025	< 0.021
4-Methyl-2-pentanone	NC	NC	NC	NC	NC		< 0.019	< 0.019	< 0.023	< 0.025	< 0.021
Methylene chloride	85	13	12,000	34	0.02		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010
Methyl tert-butyl ether	780	8,800	2,000	140	0.32		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Styrene	16,000	1,500	41,000	430	4		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
1,1,2,2-Tetrachloroethane	NC	NC	NC	NC	NC		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Tetrachloroethene	12	11	2,400	28	0.06		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Toluene	16,000	650	410,000	42	12		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
1,1,1-Trichloroethane	NC	1,200	NC	1,200	2		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
1,1,2-Trichloroethane	310	1,800	8,200	1,800	0.02		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Trichloroethene	58	5	1,200	12	0.06		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Vinyl chloride	0.46	0.28	170	1.1	0.01		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052
Xylenes, Total	16,000	320	41,000	5.6	150		< 0.014	< 0.014	< 0.017	< 0.019	< 0.016

NOTES
1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. SROs = Soil Remediation Objectives
4. TACO = Tiered Approach to Corrective Action
5. VOCs = Volatile Organic Compounds

Table 1a

Soil Analytical Results

VOCs

TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario

CTA State-Lake Loop Elevated Station

Chicago, Illinois

ANALYTES	RESIDENTIAL		CONSTRUCTION WORKER		SOIL COMPONENT TO GROUNDWATER	**Sample**	B-6-1	B-8-1	B-9-1	B-10-1
						Date	11/08/21	11/12/21	11/14/21	11/04/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I*	**Depth (ft)**	1-2	2-3	1-2	2-3
VOCs										
Acetone	70,000	100,000	NC	100,000	25		< 0.065	< 0.088	< 0.099	< 0.093
Benzene	12	0.8	2,300	2.2	0.03		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Bromodichloromethane	10	3,000	2,000	3,000	0.6		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Bromoform	81	53	16,000	140	0.8		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Bromomethane	110	10	1,000	3.9	0.2		< 0.0086	< 0.012	< 0.013	< 0.012
2-Butanone	NC	NC	NC	NC	NC		< 0.065	< 0.088	< 0.099	< 0.093
Carbon disulfide	7,800	720	20,000	9.0	32		< 0.043	< 0.059	< 0.066	< 0.062
Carbon tetrachloride	5	0.3	410	0.90	0.07		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Chlorobenzene	1,600	130	4,100	1.3	1		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Chloroethane	NC	NC	NC	NC	NC		< 0.0086	< 0.012	< 0.013	< 0.012
Chloroform	100	0.3	2,000	0.76	0.6		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Chloromethane	NC	NC	NC	NC	NC		< 0.0086	< 0.012	< 0.013	< 0.012
Dibromochloromethane	1,600	1,300	41,000	1,300	0.4		< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1-Dichloroethane	7,800	1,300	200,000	130	23		< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,2-Dichloroethane	7	0.4	1,400	0.99	0.02		< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1-Dichloroethene	3,900	290	10,000	3.0	0.06		< 0.0043	< 0.0059	< 0.0066	< 0.0062
cis-1,2-Dichloroethene	780	1,200	20,000	1,200	0.4		< 0.0043	< 0.0059	< 0.0066	< 0.0062
trans-1,2-Dichloroethene	1,600	3,100	41,000	3,100	0.7		< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,2-Dichloropropane	9	15	1,800	0.50	0.03		< 0.0043	< 0.0059	< 0.0066	< 0.0062
cis-1,3-Dichloropropene	6.4	1.1	1200	0.39	0.004		< 0.0017	< 0.0023	< 0.0026	< 0.0025
trans-1,3-Dichloropropene	6.4	1.1	1200	0.39	0.004		< 0.0017	< 0.0023	< 0.0026	< 0.0025
Ethylbenzene	7,800	400	20,000	58	13		< 0.0043	< 0.0059	< 0.0066	< 0.0062
2-Hexanone	NC	NC	NC	NC	NC		< 0.017	< 0.023	< 0.026	< 0.025
4-Methyl-2-pentanone	NC	NC	NC	NC	NC		< 0.017	< 0.023	< 0.026	< 0.025
Methylene chloride	85	13	12,000	34	0.02		< 0.0086	< 0.012	< 0.013	< 0.012
Methyl tert-butyl ether	780	8,800	2,000	140	0.32		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Styrene	16,000	1,500	41,000	430	4		< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1,2,2-Tetrachloroethane	NC	NC	NC	NC	NC		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Tetrachloroethene	12	11	2,400	28	0.06		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Toluene	16,000	650	410,000	42	12		< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1,1-Trichloroethane	NC	1,200	NC	1,200	2		< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1,2-Trichloroethane	310	1,800	8,200	1,800	0.02		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Trichloroethene	58	5	1,200	12	0.06		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Vinyl chloride	0.46	0.28	170	1.1	0.01		< 0.0043	< 0.0059	< 0.0066	< 0.0062
Xylenes, Total	16,000	320	41,000	5.6	150		< 0.013	< 0.018	< 0.020	< 0.019

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. SROs = Soil Remediation Objectives
4. TACO = Tiered Approach to Corrective Action
5. VOCs = Volatile Organic Compounds

Table 1b
Soil Analytical Results
SVOCs
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**RESIDENTIAL**		**CONSTRUCTION WORKER**		**SOIL COMPONENT TO GROUNDWATER**	**Sample**	B-1-1	B-2-1	B-3-1	B-4-1	B-5-1	B-6-1	B-8-1	B-9-1	B-10-1
						Date	11/01/21	11/01/21	11/01/21	11/01/21	11/04/21	11/08/21	11/12/21	11/14/21	11/04/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I*	**Depth (ft)**	2-3	1-2	1-2	2-3	2-3	1-2	2-3	1-2	2-3
SVOCs															
Aniline	NC	NC	NC	NC	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.35
Benzidine	NC	NC	NC	NC	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
Benzoic acid	310,000	NC	820,000	NC	400		< 0.92	< 0.97	< 0.88	< 0.95	< 0.93	< 0.88	< 1.1	< 0.90	< 0.85
Benzyl alcohol	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Bis(2-chloroethoxy)methane	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Bis(2-chloroethyl)ether	0.6	0.2	75	0.66	0.0004		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Bis(2-ethylhexyl)phthalate	46	31,000	4,100	31,000	3,600		< 0.92	< 0.97	< 0.88	< 0.95	< 0.93	< 0.88	< 1.1	< 0.90	< 0.85
4-Bromophenyl phenyl ether	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Butyl benzyl phthalate	16,000	930	410,000	930	930		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Carbazole	32	NC	6,200	NC	0.6		**1.3**	< 0.20	**0.84**	0.29	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Chloroaniline	310	NC	820	NC	0.7		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Chloro-3-methylphenol	NC	NC	NC	NC	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
2-Chloronaphthalene	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Chlorophenol	390	53,000	10,000	53,000	1.5		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Chlorophenyl phenyl ether	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Dibenzofuran	NC	NC	NC	NC	NC		0.80	< 0.20	1.6	0.61	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
1,2-Dichlorobenzene	7,000	560	18,000	310	17		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
1,3-Dichlorobenzene	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
1,4-Dichlorobenzene	NC	11,000	NC	340	2		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
3,3´-Dichlorobenzidine	1	NC	280	NC	0.007		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4-Dichlorophenol	230	NC	610	NC	1		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Diethyl phthalate	63,000	2,000	1,000,000	2,000	470		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4-Dimethylphenol	1,600	NC	41,000	NC	9		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Dimethyl phthalate	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4,6-Dinitro-2-methylphenol	NC	NC	NC	NC	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
2,4-Dinitrophenol	160	NC	410	NC	0.2		< 0.92	< 0.97	< 0.88	< 0.95	< 0.93	< 0.88	< 1.1	< 0.90	< 0.85
2,4-Dinitrotoluene	0.9	NC	180	NC	0.0008		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
2,6-Dinitrotoluene	0.9	NC	180	NC	0.0007		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
Di-n-butyl phthalate	7,800	2,300	200,000	2,300	2,300		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Di-n-octyl phthalate	1,600	10,000	4,100	10,000	10,000		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachlorobenzene	0.4	1	78	2.6	2		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachlorobutadiene	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachlorocyclopentadiene	550	10	14,000	1.1	400		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachloroethane	78	NC	2,000	NC	0.5		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Isophorone	15,600	4,600	410,000	4,600	8		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18

Table 1b

Soil Analytical Results
SVOCs
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	RESIDENTIAL		CONSTRUCTION WORKER		SOIL COMPONENT TO GROUNDWATER	Sample	B-1-1	B-2-1	B-3-1	B-4-1	B-5-1	B-6-1	B-8-1	B-9-1	B-10-1
						Date	11/01/21	11/01/21	11/01/21	11/01/21	11/04/21	11/08/21	11/12/21	11/14/21	11/04/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I*	Depth (ft)	2-3	1-2	1-2	2-3	2-3	1-2	2-3	1-2	2-3
SVOCs															
2-Methylnaphthalene	NC	NC	NC	NC	NC		< 0.19	< 0.20	0.35	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Methylphenol	3,900	NC	100,000	NC	15		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Methylphenol	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Nitroaniline	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
3-Nitroaniline	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Nitroaniline	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Nitrophenol	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Nitrophenol	NC	NC	NC	NC	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
Nitrobenzene	39	92	1,000	9.4	0.1		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
N-Nitrosodi-n-propylamine	0.09	NC	18	NC	0.00005		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
N-Nitrosodimethylamine	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
N-Nitrosodiphenylamine	130	NC	25,000	NC	1		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
2, 2'-oxybis(1-Chloropropane)	NC	NC	NC	NC	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Pentachlorophenol	3	NC	520	NC	0.02		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
Phenol	23,000	NC	61,000	NC	100		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Pyridine	NC	NC	NC	NC	NC		< 0.74	< 0.78	< 0.71	< 0.77	< 0.75	< 0.71	< 0.89	< 0.72	< 0.68
1,2,4-Trichlorobenzene	780	3,200	2,000	920	5		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4,5-Trichlorophenol	7,800	NC	200,000	NC	26		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4,6-Trichlorophenol	58	200	11,000	540	0.07		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. SROs = Soil Remediation Objectives
4. SVOCs = Semi-Volatile Organic Compounds
5. TACO = Tiered Approach to Corrective Action

BOLD	Result exceeds one or more Tier 1 SROs

Table 1c

Soil Analytical Results
Pesticides/PCBs
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**RESIDENTIAL**		**CONSTRUCTION WORKER**		**SOIL COMPONENT TO GROUNDWATER**	**Sample**	B-1-1	B-2-1	B-3-1	B-4-1	B-5-1	B-6-1	B-8-1	B-9-1	B-10-1
						Date	11/01/21	11/01/21	11/01/21	11/01/21	11/04/21	11/08/21	11/12/21	11/14/21	11/04/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I*	**Depth (ft)**	2-3	1-2	1-2	2-3	2-3	1-2	2-3	1-2	2-3
Pesticides															
4,4´-DDD	3	NC	520	NC	16		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
4,4´-DDE	2	NC	370	NC	54		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
4,4´-DDT	2	NC	100	2,100	32		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Aldrin	0.04	3	6.1	9.3	0.5		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
alpha-BHC	0.1	0.8	20	2.1	0.0005		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
alpha-Chlordane	NC	NC	NC	NC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
beta-BHC	NC	NC	NC	NC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Chlordane	1.8	72	100	22	10		< 0.018	< 0.019	< 0.017	< 0.018	< 0.018	< 0.017	< 0.021	< 0.017	< 0.017
delta-BHC	NC	NC	NC	NC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Dieldrin	0.04	1	7.8	3.1	0.004		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endosulfan I	470	NC	1,200	NC	18		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endosulfan II	470	NC	1,200	NC	18		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endosulfan sulfate	NC	NC	NC	NC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endrin	23	NC	61	NC	1		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endrin aldehyde	NC	NC	NC	NC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endrin ketone	NC	NC	NC	NC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
gamma-BHC	0.5	NC	96	NC	0.009		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
gamma-Chlordane	NC	NC	NC	NC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Heptachlor	0.1	0.1	28	16	23		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Heptachlor epoxide	0.07	5	2.7	13	0.7		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Methoxychlor	390	NC	1,000	NC	160		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Toxaphene	0.6	89	110	240	31		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.035
PCBs															
Aroclor 1016	1	NC	1	NC	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1221	1	NC	1	NC	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1232	1	NC	1	NC	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1242	1	NC	1	NC	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1248	1	NC	1	NC	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1254	1	NC	1	NC	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1260	1	NC	1	NC	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. PCBs = Polychlorinated Bipheyls
4. SROs = Soil Remediation Objectives
5. TACO = Tiered Approach to Corrective Action

Table 1d

Soil Analytical Results
PNAs
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	RESIDENTIAL		CONSTRUCTION WORKER		SOIL COMPONENT TO GROUNDWATER	Sample	B-1-1	B-1-2	B-2-1	B-2-2	B-3-1	B-3-2	B-4-1	B-4-2	B-5-1
						Date	11/01/21	11/08/21	11/01/21	11/04/21	11/01/21	11/04/21	11/01/21	11/08/21	11/04/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I*	Depth (ft)	2-3	10-11	1-2	9-10	1-2	10-11	2-3	10-11	2-3
PNAs															
Acenaphthene	4,700	NC	120,000	NC	570		1.2	< 0.039	0.26	< 0.041	2.3	< 0.039	1.1	< 0.043	0.1
Acenaphthylene	NC	NC	NC	NC	NC		0.068	0.088	0.12	< 0.041	0.22	< 0.039	0.51	< 0.043	0.16
Anthracene	23,000	NC	610,000	NC	12,000		3.7	0.16	1.0	< 0.041	10	< 0.039	3.7	< 0.043	0.4
Benzo(a)anthracene	1.1*	NC	170	NC	2		**9.9**	0.63	**3.3**	< 0.041	**21**	< 0.039	**11**	< 0.043	**1.8**
Benzo(a)pyrene	1.3*	NC	17	NC	8		**8.1**	0.55	**3.2**	< 0.041	**19**	< 0.039	**9.1**	< 0.043	**1.6**
Benzo(b)fluoranthene	1.5*	NC	170	NC	5		**8.0**	0.45	**3.0**	< 0.041	**16**	< 0.039	**7.7**	< 0.043	1.3
Benzo(g,h,i)perylene	NC	NC	NC	NC	NC		4.3	0.26	1.9	< 0.041	11	< 0.039	4.5	< 0.043	0.81
Benzo(k)fluoranthene	9	NC	1,700	NC	49		6.7	0.48	2.3	< 0.041	**14**	< 0.039	7.1	< 0.043	1.3
Chrysene	88	NC	17,000	NC	160		9.3	0.57	3.2	< 0.041	18	< 0.039	9.0	< 0.043	1.5
Dibenz(a,h)anthracene	0.20*	NC	17	NC	2		**2.3**	0.17	**1.1**	< 0.041	**5.1**	< 0.039	**2.5**	< 0.043	**0.52**
Fluoranthene	3,100	NC	82,000	NC	4,300		22	1.1	5.9	< 0.041	44	< 0.039	20	< 0.043	2.5
Fluorene	3,100	NC	82,000	NC	560		1.3	0.04	0.17	< 0.041	2.8	< 0.039	1.3	< 0.043	0.078
Indeno(1,2,3-cd)pyrene	0.9	NC	170	NC	14		**4.0**	0.26	**1.8**	< 0.041	**9.9**	< 0.039	**4.6**	< 0.043	0.79
Naphthalene	1,600	170	4,100	1.8	12		0.19	< 0.039	< 0.039	< 0.041	0.34	< 0.039	0.20	< 0.043	0.12
Phenanthrene	NC	NC	NC	NC	NC		17	0.56	2.7	< 0.041	36	< 0.039	13	0.046	1
Pyrene	2,300	NC	61,000	NC	4,200		18	1.0	5.8	< 0.041	44	< 0.039	18	< 0.043	2.4

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. * = Location specific background value
4. PNAs = Polynuclear Aromatic Hydrocarbons
5. SROs = Soil Remediation Objectives
6. TACO = Tiered Approach to Corrective Action

BOLD Result exceeds one or more Tier 1 SROs

Table 1d

Soil Analytical Results
PNAs
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**RESIDENTIAL**		**CONSTRUCTION WORKER**		**SOIL COMPONENT TO GROUNDWATER**	**Sample**	B-5-2	B-6-1	B-6-2	B-8-1	B-8-2	B-9-1	B-9-2	B-10-1	B-10-2
						Date	11/12/21	11/08/21	11/08/21	11/12/21	11/12/21	11/14/21	11/14/21	11/04/21	11/10/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I*	**Depth (ft)**	10-11	1-2	9-10	2-3	10-11	1-2	9-10	2-3	9-10
PNAs															
Acenaphthene	4,700	NC	120,000	NC	570		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Acenaphthylene	NC	NC	NC	NC	NC		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Anthracene	23,000	NC	610,000	NC	12,000		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	0.069	< 0.042
Benzo(a)anthracene	1.1*	NC	170	NC	2		< 0.042	< 0.035	< 0.041	0.052	< 0.043	0.057	< 0.040	0.26	< 0.042
Benzo(a)pyrene	1.3*	NC	17	NC	8		< 0.042	< 0.035	< 0.041	0.06	< 0.043	0.049	< 0.040	0.18	< 0.042
Benzo(b)fluoranthene	1.5*	NC	170	NC	5		< 0.042	< 0.035	< 0.041	0.052	< 0.043	0.059	< 0.040	0.19	0.048
Benzo(g,h,i)perylene	NC	NC	NC	NC	NC		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	0.046	< 0.040	0.12	0.062
Benzo(k)fluoranthene	9	NC	1,700	NC	49		< 0.042	< 0.035	< 0.041	0.056	< 0.043	0.049	< 0.040	0.16	0.045
Chrysene	88	NC	17,000	NC	160		< 0.042	< 0.035	< 0.041	0.057	< 0.043	0.064	< 0.040	0.23	< 0.042
Dibenz(a,h)anthracene	0.20*	NC	17	NC	2		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	0.078	0.061
Fluoranthene	3,100	NC	82,000	NC	4,300		< 0.042	< 0.035	< 0.041	0.086	< 0.043	0.079	< 0.040	0.43	< 0.042
Fluorene	3,100	NC	82,000	NC	560		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Indeno(1,2,3-cd)pyrene	0.9	NC	170	NC	14		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	0.1	< 0.042
Naphthalene	1,600	170	4,100	1.8	12		< 0.042	< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Phenanthrene	NC	NC	NC	NC	NC		0.067	< 0.035	0.11	0.071	< 0.043	0.057	0.052	0.22	< 0.042
Pyrene	2,300	NC	61,000	NC	4,200		< 0.042	< 0.035	< 0.041	0.066	< 0.043	0.083	< 0.040	0.38	< 0.042

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. * = Location specific background value
4. PNAs = Polynuclear Aromatic Hydrocarbons
5. SROs = Soil Remediation Objectives
6. TACO = Tiered Approach to Corrective Action

BOLD Result exceeds one or more Tier 1 SROs

Table 1e

Soil Analytical Results
Inorganics
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**RESIDENTIAL**		**CONSTRUCTION WORKER**		**SOIL COMPONENT TO GROUNDWATER**			**Appendix A, Table G, MSA Background**	**Sample**	*B-1-1*	*B-1-2*	*B-2-1*	B-2-2	*B-3-1*	B-3-2
									Date	*11/01/21*	*11/08/21*	*11/01/21*	11/04/21	*11/01/21*	11/04/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I (pH specific)*				**Depth (ft)**	*2-3*	*10-11*	*1-2*	9-10	*1-2*	10-11
Metals					7.75 to 8.24	8.25 to 8.74	8.75 to 9.0								
Aluminum	NC	NC	NC	NC	NC	NC	NC	9,500		*3000*	*NA*	*3500*	NA	*1800*	NA
Antimony	31	NC	82	NC	5	5	5	4.0		*< 2.1*	*NA*	*< 2.2*	NA	*< 2.0*	NA
Arsenic	13.0	750	61	25,000	31	32	33	13.0		*4.4*	*5.7*	*3.6*	3.7	*3.0*	3.0
Barium	5,500	690,000	14,000	870,000	2,100	NC	NC	110		*49*	*46*	*31*	20	*15*	11
Beryllium	160	1,300	410	44,000	8,000	NC	NC	0.59		*< 0.53*	*NA*	*< 0.55*	NA	*< 0.50*	NA
Cadmium	78	1,800	200	59,000	430	NC	NC	0.6		*< 0.53*	*< 0.57*	*< 0.55*	< 0.59	*< 0.50*	< 0.57
Calcium	NC	NC	NC	NC	NC	NC	NC	9,300		***88000***	*NA*	***73000***	NA	***66000***	NA
Chromium	230	270	4,100	690	28**	24**	21**	16.2		*5.6*	***21***	*8.5*	9.4	*4.1*	7.9
Cobalt	4,700	NC	12,000	NC	NC	NC	NC	8.9		***43***	*NA*	***22***	NA	***9.0***	NA
Copper	2,900	NC	8,200	NC	330,000	NC	NC	20		***48***	*NA*	***48***	NA	*13*	NA
Cyanide	1,600	NC	4,100	NC	40	40	40	0.51		*< 0.56*	*NA*	*< 0.59*	NA	*< 0.53*	NA
Iron	NC	NC	NC	NC	NC	NC	NC	15,900		*9200*	*NA*	*8100*	NA	*7100*	NA
Lead	400	NC	700	NC	107	107	282	36.0		***120***	*14*	***210***	6.3	*31*	6.0
Magnesium	325,000	NC	730,000	NC	NC	NC	NC	4,820		***42000***	*NA*	***31000***	NA	***32000***	NA
Manganese	1,600	69,000	4,100	8,700	NC	NC	NC	636		*330*	*NA*	*400*	NA	*270*	NA
Mercury	23	10	61	0.1	8.0	NC	NC	0.06		***0.34***	***0.078***	***1.5***	0.031	***0.18***	< 0.018
Nickel	1,600	13,000	4,100	440,000	3,800	NC	NC	18.0		*7.5*	*NA*	*12*	NA	*5.6*	NA
Potassium	NC	NC	NC	NC	NC	NC	NC	1,268		*600*	*NA*	*610*	NA	*380*	**NA**
Selenium	390	NC	1,000	NC	2.4	1.8	1.3	0.48		*< 1.1*	*< 1.1*	*< 1.1*	< 1.2	*< 1.0*	< 1.1
Silver	390	NC	1,000	NC	110	NC	NC	0.55		***2.7***	*< 1.1*	***1.6***	< 1.2	*< 1.0*	< 1.1
Sodium	NC	NC	NC	NC	NC	NC	NC	130		***890***	*NA*	***860***	NA	***1000***	NA
Thallium	6.3	NC	160	NC	3.8	4.4	4.9	0.32		*< 1.1*	*NA*	*< 1.1*	NA	*< 1.0*	NA
Vanadium	550	NC	1,400	NC	980	980	980	25.2		*11*	*NA*	*12*	NA	*8.3*	NA
Zinc	23,000	NC	61,000	NC	53,000	NC	NC	95.0		***120***	*NA*	***170***	NA	*41*	NA
pH	NC	NC	NC	NC	NC	NC	NC	NC		*9.74*	*9.04*	*9.83*	8.79	*9.38*	8.38

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. *Italicized* samples are outside pH range 4.5 to 9.0 and were not compared to Soil Component to Groundwater Ingestion criteria.
3. NC = No toxicity criteria for this exposure route
4. NA = Not Analyzed
5. * Counties within Metropolitan Statistical Area Value
6. ** Class I pH Specific Value
7. SROs = Soil Remediation Objectives
8. TACO = Tiered Approach to Corrective Action
9. TAL = Target Analyte List
10. TCLP = Toxicity Characteristic Leaching Procedure

BOLD Result exceeds one or more Tier 1 SROs

Table 1e

Soil Analytical Results
Inorganics
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	RESIDENTIAL		CONSTRUCTION WORKER		SOIL COMPONENT TO GROUNDWATER			Appendix A, Table G, MSA Background	Sample	*B-4-1*	B-4-2	*B-5-1*	B-5-2	*B-6-1*	B-6-2
									Date	*11/01/21*	11/08/21	*11/04/21*	11/12/21	*11/08/21*	11/08/21
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I (pH specific)*				Depth (ft)	*2-3*	10-11	*2-3*	10-11	*1-2*	9-10
Metals					7.75 to 8.24	8.25 to 8.74	8.75 to 9.0								
Aluminum	NC	NC	NC	NC	NC	NC	NC	9,500		*2200*	NA	*3600*	NA	*990*	NA
Antimony	31	NC	82	NC	5	5	5	4.0		*< 2.1*	NA	*2.8*	NA	*< 2.0*	NA
Arsenic	13.0	750	61	25,000	31	32	33	13.0		*4.3*	2.8	*5.4*	9.3	*< 1.0*	9.2
Barium	5,500	690,000	14,000	870,000	2,100	NC	NC	110		*57*	20	*78*	51	*3.2*	49
Beryllium	160	1,300	410	44,000	8,000	NC	NC	0.59		*< 0.53*	NA	*< 0.54*	NA	*< 0.51*	NA
Cadmium	78	1,800	200	59,000	430	NC	NC	0.6		*< 0.53*	< 0.60	*< 0.54*	< 0.60	*< 0.51*	< 0.56
Calcium	NC	NC	NC	NC	NC	NC	NC	9,300		***87000***	NA	***77000***	NA	***19000***	NA
Chromium	230	270	4,100	690	28**	24**	21**	16.2		*6.0*	8.3	*8.5*	**24**	*2.6*	**21**
Cobalt	4,700	NC	12,000	NC	NC	NC	NC	8.9		*6.4*	NA	*5.1*	NA	*1.2*	NA
Copper	2,900	NC	8,200	NC	330,000	NC	NC	20		***54***	NA	***54***	NA	*< 2.5*	NA
Cyanide	1,600	NC	4,100	NC	40	40	40	0.51		*< 0.58*	NA	*< 0.56*	NA	*< 0.53*	NA
Iron	NC	NC	NC	NC	NC	NC	NC	15,900		*7100*	NA	*11000*	NA	*2300*	NA
Lead	400	NC	700	NC	107	107	282	36.0		***260***	12	***440***	19	*1.7*	17
Magnesium	325,000	NC	730,000	NC	NC	NC	NC	4,820		***44000***	NA	***35000***	NA	***12000***	NA
Manganese	1,600	69,000	4,100	8,700	NC	NC	NC	636		*280*	NA	*430*	NA	*110*	NA
Mercury	23	10	61	0.1	8.0	NC	NC	0.06		***0.54***	< 0.023	***0.43***	0.027	*< 0.020*	< 0.023
Nickel	1,600	13,000	4,100	440,000	3,800	NC	NC	18.0		*7.5*	NA	*9.2*	NA	*2.6*	NA
Potassium	NC	NC	NC	NC	NC	NC	NC	1,268		*530*	NA	*810*	NA	*750*	NA
Selenium	390	NC	1,000	NC	2.4	1.8	1.3	0.48		*< 1.1*	< 1.2	*< 1.1*	< 1.2	*< 1.0*	< 1.1
Silver	390	NC	1,000	NC	110	NC	NC	0.55		*< 1.1*	< 1.2	*< 1.1*	< 1.2	*< 1.0*	< 1.1
Sodium	NC	NC	NC	NC	NC	NC	NC	130		***600***	NA	***2300***	NA	***250***	NA
Thallium	6.3	NC	160	NC	3.8	4.4	4.9	0.32		*< 1.1*	NA	*< 1.1*	NA	*< 1.0*	NA
Vanadium	550	NC	1,400	NC	980	980	980	25.2		*9.9*	NA	*15*	NA	*2.6*	NA
Zinc	23,000	NC	61,000	NC	53,000	NC	NC	95.0		***130***	NA	***270***	NA	*< 5.1*	NA
pH	NC	NC	NC	NC	NC	NC	NC	NC		*10.59*	8.98	*9.62*	8.34	*9.02*	8.26

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. *Italicized* samples are outside pH range 4.5 to 9.0 and were not compared to Soil Component to Groundwater Ingestion criteria.
3. NC = No toxicity criteria for this exposure route
4. NA = Not Analyzed
5. * Counties within Metropolitan Statistical Area Value
6. ** Class I pH Specific Value
7. SROs = Soil Remediation Objectives
8. TACO = Tiered Approach to Corrective Action
9. TAL = Target Analyte List
10. TCLP = Toxicity Characteristic Leaching Procedure

BOLD Result exceeds one or more Tier 1 SROs

Table 1e

Soil Analytical Results
Inorganics
TACO Tier 1 SROs for the Residential Property Construction Worker Use Scenario
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**RESIDENTIAL**		**CONSTRUCTION WORKER**		**SOIL COMPONENT TO GROUNDWATER**			**Appendix A, Table G, MSA Background**	**Sample**	B-8-1	B-8-2	*B-9-1*	B-9-2	*B-10-1*	*B-10-2*
									Date	11/12/21	11/12/21	*11/14/21*	11/14/21	*11/04/21*	*11/10/21*
	Ingestion	*Inhalation*	*Ingestion*	*Inhalation*	*Class I (pH specific)*				**Depth (ft)**	2-3	10-11	*1-2*	9-10	*2-3*	*9-10*
Metals					7.75 to 8.24	8.25 to 8.74	8.75 to 9.0								
Aluminum	NC	NC	NC	NC	NC	NC	NC	9,500		**15000**	NA	*1900*	NA	*1100*	*NA*
Antimony	31	NC	82	NC	5	5	5	4.0		< 2.4	NA	*< 2.0*	NA	*< 2.0*	*NA*
Arsenic	13.0	750	61	25,000	31	32	33	13.0		8.2	9.2	*3.4*	10	*2.6*	*9.2*
Barium	5,500	690,000	14,000	870,000	2,100	NC	NC	110		50	37	*21*	38	*6.7*	*52*
Beryllium	160	1,300	410	44,000	8,000	NC	NC	0.59		0.86	NA	*< 0.51*	NA	*< 0.51*	*NA*
Cadmium	78	1,800	200	59,000	430	NC	NC	0.6		< 0.60	< 0.64	*< 0.51*	< 0.58	*< 0.51*	*< 0.60*
Calcium	NC	NC	NC	NC	NC	NC	NC	9,300		**48000**	NA	***35000***	NA	***43000***	*NA*
Chromium	230	270	4,100	690	28**	24**	21**	16.2		**25**	**30**	*5.6*	**22**	*3.2*	***20***
Cobalt	4,700	NC	12,000	NC	NC	NC	NC	8.9		**14**	NA	*2.0*	NA	*2.3*	*NA*
Copper	2,900	NC	8,200	NC	330,000	NC	NC	20		**34**	NA	*16*	NA	*4.9*	*NA*
Cyanide	1,600	NC	4,100	NC	40	40	40	0.51		< 0.67	NA	*< 0.54*	NA	*< 0.53*	*NA*
Iron	NC	NC	NC	NC	NC	NC	NC	15,900		**27000**	NA	*5900*	NA	*5200*	*NA*
Lead	400	NC	700	NC	107	107	282	36.0		16	18	*84*	16	***140***	*16*
Magnesium	325,000	NC	730,000	NC	NC	NC	NC	4,820		**25000**	NA	***13000***	NA	***24000***	*NA*
Manganese	1,600	69,000	4,100	8,700	NC	NC	NC	636		420	NA	*110*	NA	*180*	*NA*
Mercury	23	10	61	0.1	8.0	NC	NC	0.06		**0.6**	0.027	***0.071***	0.023	*0.049*	*< 0.023*
Nickel	1,600	13,000	4,100	440,000	3,800	NC	NC	18.0		**39**	NA	*5.4*	NA	*3.4*	*NA*
Potassium	NC	NC	NC	NC	NC	NC	NC	1,268		**3800**	NA	*640*	NA	*270*	*NA*
Selenium	390	NC	1,000	NC	2.4	1.8	1.3	0.48		< 1.2	< 1.3	*< 1.0*	< 1.1	*< 1.0*	*< 1.2*
Silver	390	NC	1,000	NC	110	NC	NC	0.55		< 1.2	< 1.3	*< 1.0*	< 1.1	*< 1.0*	*< 1.2*
Sodium	NC	NC	NC	NC	NC	NC	NC	130		**1700**	NA	***330***	NA	***230***	*NA*
Thallium	6.3	NC	160	NC	3.8	4.4	4.9	0.32		< 1.2	NA	*< 1.0*	NA	*< 1.0*	*NA*
Vanadium	550	NC	1,400	NC	980	980	980	25.2		26	NA	*7.4*	NA	*5.7*	*NA*
Zinc	23,000	NC	61,000	NC	53,000	NC	NC	95.0		62	NA	*72*	NA	*20*	*NA*
pH	NC	NC	NC	NC	NC	NC	NC	NC		8.32	8.11	*9.63*	8.20	*9.67*	*9.49*

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. *Italicized* samples are outside pH range 4.5 to 9.0 and were not compared to Soil Component to Groundwater Ingestion criteria.
3. NC = No toxicity criteria for this exposure route
4. NA = Not Analyzed
5. * Counties within Metropolitan Statistical Area Value
6. ** Class I pH Specific Value
7. SROs = Soil Remediation Objectives
8. TACO = Tiered Approach to Corrective Action
9. TAL = Target Analyte List
10. TCLP = Toxicity Characteristic Leaching Procedure

BOLD	Result exceeds one or more Tier 1 SROs

Table 2a
Soil Analytical Results
VOCs Compared to CCDD MAC Values
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	CCDD MAC Values	Sample	B-1-1	B-2-1	B-3-1	B-4-1	B-5-1	B-6-1	B-8-1	B-9-1	B-10-1
		Date	11/01/21	11/01/21	11/01/21	11/01/21	11/04/21	11/08/21	11/12/21	11/14/21	11/04/21
		Depth (ft)	2-3	1-2	1-2	2-3	2-3	1-2	2-3	1-2	2-3
VOCs											
Acetone	25		< 0.070	< 0.071	< 0.086	< 0.093	< 0.078	< 0.065	< 0.088	< 0.099	< 0.093
Benzene	0.03		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Bromodichloromethane	0.6		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Bromoform	0.8		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Bromomethane	0.2		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010	< 0.0086	< 0.012	< 0.013	< 0.012
2-Butanone (Methyl Ethyl Ketone)	17		< 0.070	< 0.071	< 0.086	< 0.093	< 0.078	< 0.065	< 0.088	< 0.099	< 0.093
Carbon disulfide	9		< 0.046	< 0.048	< 0.057	< 0.062	< 0.052	< 0.043	< 0.059	< 0.066	< 0.062
Carbon tetrachloride	0.07		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Chlorobenzene	1		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Chloroethane	NC		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010	< 0.0086	< 0.012	< 0.013	< 0.012
Chloroform	0.3		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Chloromethane	NC		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010	< 0.0086	< 0.012	< 0.013	< 0.012
Dibromochloromethane	0.4		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1-Dichloroethane	23		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,2-Dichloroethane	0.02		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1-Dichloroethene	0.06		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
cis-1,2-Dichloroethene	0.4		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
trans-1,2-Dichloroethene	0.7		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,2-Dichloropropane	0.03		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
cis-1,3-Dichloropropene	0.005		< 0.0019	< 0.0019	< 0.0023	< 0.0025	< 0.0021	< 0.0017	< 0.0023	< 0.0026	< 0.0025
trans-1,3-Dichloropropene	0.005		< 0.0019	< 0.0019	< 0.0023	< 0.0025	< 0.0021	< 0.0017	< 0.0023	< 0.0026	< 0.0025
Ethylbenzene	13		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
2-Hexanone	NC		< 0.019	< 0.019	< 0.023	< 0.025	< 0.021	< 0.017	< 0.023	< 0.026	< 0.025
4-Methyl-2-pentanone	NC		< 0.019	< 0.019	< 0.023	< 0.025	< 0.021	< 0.017	< 0.023	< 0.026	< 0.025
Methylene chloride	0.02		< 0.0093	< 0.0095	< 0.011	< 0.012	< 0.010	< 0.0086	< 0.012	< 0.013	< 0.012
Methyl tert-butyl ether	0.32		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Styrene	4		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1,2,2-Tetrachloroethane	NC		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Tetrachloroethene	0.06		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Toluene	12		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1,1-Trichloroethane	2		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
1,1,2-Trichloroethane	0.02		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Trichloroethene	0.06		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Vinyl chloride	0.01		< 0.0046	< 0.0048	< 0.0057	< 0.0062	< 0.0052	< 0.0043	< 0.0059	< 0.0066	< 0.0062
Xylenes, Total	5.6		< 0.014	< 0.014	< 0.017	< 0.019	< 0.016	< 0.013	< 0.018	< 0.020	< 0.019

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. CCDD = Clean Construction or Demolition Debris
3. MAC = Maximum Allowable Concentration
4. NC = No toxicity criteria for this exposure route
5. NA = Not Analyzed
6. VOCs = Volatile Organic Compounds

Table 2b

Soil Analytical Results
SVOCs Compared to CCDD MAC Values
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**CCDD MAC Values**	**Sample**	B-1-1	B-2-1	B-3-1	B-4-1	B-5-1	B-6-1	B-8-1	B-9-1	B-10-1
		Date	11/01/21	11/01/21	11/01/21	11/01/21	11/04/21	11/08/21	11/12/21	11/14/21	11/04/21
		Depth (ft)	2-3	1-2	1-2	2-3	2-3	1-2	2-3	1-2	2-3
SVOCs											
Aniline	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.35
Benzidine	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
Benzoic acid	400		< 0.92	< 0.97	< 0.88	< 0.95	< 0.93	< 0.88	< 1.1	< 0.90	< 0.85
Benzyl alcohol	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Bis(2-chloroethoxy)methane	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Bis(2-chloroethyl)ether	0.66		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Bis(2-ethylhexyl)phthalate	46		< 0.92	< 0.97	< 0.88	< 0.95	< 0.93	< 0.88	< 1.1	< 0.90	< 0.85
4-Bromophenyl phenyl ether	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Butyl benzyl phthalate	930		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Carbazole	0.6		***1.3***	< 0.20	***0.84***	0.29	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Chloroaniline	0.7		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Chloro-3-methylphenol	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
2-Chloronaphthalene	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Chlorophenol	1.5		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Chlorophenyl phenyl ether	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Dibenzofuran	NC		0.8	< 0.20	1.6	0.61	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
1,2-Dichlorobenzene	17		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
1,3-Dichlorobenzene	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
1,4-Dichlorobenzene	2		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
3,3´-Dichlorobenzidine	1.3		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4-Dichlorophenol	0.48		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Diethyl phthalate	470		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4-Dimethylphenol	9		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Dimethyl phthalate	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4,6-Dinitro-2-methylphenol	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
2,4-Dinitrophenol	3.3		< 0.92	< 0.97	< 0.88	< 0.95	< 0.93	< 0.88	< 1.1	< 0.90	< 0.85
2,4-Dinitrotoluene	0.25		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
2,6-Dinitrotoluene	0.26		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
Di-n-butyl phthalate	2,300		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Di-n-octyl phthalate	1,600		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachlorobenzene	0.4		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachlorobutadiene	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachlorocyclopentadiene	1.1		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Hexachloroethane	0.5		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Isophorone	8		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Methylnaphthalene	NC		< 0.19	< 0.20	0.35	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Methylphenol	15		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Methylphenol	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Nitroaniline	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
3-Nitroaniline	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Nitroaniline	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2-Nitrophenol	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
4-Nitrophenol	NC		< 0.37	< 0.39	< 0.35	< 0.38	< 0.37	< 0.35	< 0.44	< 0.36	< 0.34
Nitrobenzene	0.26		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
N-Nitrosodi-n-propylamine	0.0018		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
N-Nitrosodimethylamine	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
N-Nitrosodiphenylamine	1		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
2, 2'-oxybis(1-Chloropropane)	NC		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Pentachlorophenol	0.02		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.034
Phenol	100		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
Pyridine	NC		< 0.74	< 0.78	< 0.71	< 0.77	< 0.75	< 0.71	< 0.89	< 0.72	< 0.68
1,2,4-Trichlorobenzene	5		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4,5-Trichlorophenol	26		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18
2,4,6-Trichlorophenol	0.66		< 0.19	< 0.20	< 0.18	< 0.19	< 0.19	< 0.18	< 0.23	< 0.18	< 0.18

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. CCDD = Clean Construction or Demolition Debris
3. MAC = Maximum Allowable Concentration
4. NC = No toxicity criteria for this exposure route
5. NA = Not Analyzed
6. SVOCs = Semi-Volatile Organic Compounds

Bold Italicized Sample result above CCDD MAC Values.

Table 2c

Soil Analytical Results

PNAs Compared to CCDD MAC Values

CTA State-Lake Loop Elevated Station

Chicago, Illinois

ANALYTES	CCDD MAC Values			Sample	B-1-1	B-1-2	B-2-1	B-2-2	B-3-1	B-3-2	B-4-1	B-4-2	B-5-1	B-5-2
	Populated MSA [5]	*Populated Non-MSA* [6]	*Non-Populated* [7]	**Date**	11/01/21	11/08/21	11/01/21	11/04/21	11/01/21	11/04/21	11/01/21	11/08/21	11/04/21	11/12/21
				Depth (ft)	2-3	10-11	1-2	9-10	1-2	10-11	2-3	10-11	2-3	10-11
PNAs														
Acenaphthene	570	570	570		1.2	< 0.039	0.26	< 0.041	2.3	< 0.039	1.1	< 0.043	0.1	< 0.042
Acenaphthylene	85	85	85		0.068	0.088	0.12	< 0.041	0.22	< 0.039	0.51	< 0.043	0.16	< 0.042
Anthracene	12,000	12,000	12,000		3.7	0.16	1	< 0.041	10	< 0.039	3.7	< 0.043	0.4	< 0.042
Benzo(a)anthracene	1.8	0.9	0.9		***9.9***	0.63	***3.3***	< 0.041	***21***	< 0.039	***11***	< 0.043	*1.8*	< 0.042
Benzo(a)pyrene	2.1	0.98	0.09		***8.1***	***0.55***	***3.2***	< 0.041	***19***	< 0.039	***9.1***	< 0.043	*1.6*	< 0.042
Benzo(b)fluoranthene	2.1	0.9	0.9		***8***	0.45	***3***	< 0.041	***16***	< 0.039	***7.7***	< 0.043	*1.3*	< 0.042
Benzo(g,h,i)perylene	2,300	2,300	2,300		4.3	0.26	1.9	< 0.041	11	< 0.039	4.5	< 0.043	0.81	< 0.042
Benzo(k)fluoranthene	9	9	9		6.7	0.48	2.3	< 0.041	***14***	< 0.039	7.1	< 0.043	1.3	< 0.042
Chrysene	88	88	88		9.3	0.57	3.2	< 0.041	18	< 0.039	9	< 0.043	1.5	< 0.042
Dibenzo(a,h)anthracene	0.42	0.15	0.09		***2.3***	*0.17*	***1.1***	< 0.041	***5.1***	< 0.039	***2.5***	< 0.043	***0.52***	< 0.042
Fluoranthene	3,100	3,100	3,100		22	1.1	5.9	< 0.041	44	< 0.039	20	< 0.043	2.5	< 0.042
Fluorene	560	560	560		1.3	0.04	0.17	< 0.041	2.8	< 0.039	1.3	< 0.043	0.078	< 0.042
Indeno(1,2,3-cd)pyrene	1.6	0.9	0.9		***4***	0.26	***1.8***	< 0.041	***9.9***	< 0.039	***4.6***	< 0.043	0.79	< 0.042
Naphthalene	1.8	1.8	1.8		0.19	< 0.039	< 0.039	< 0.041	0.34	< 0.039	0.2	< 0.043	0.12	< 0.042
Phenanthrene	210	210	210		17	0.56	2.7	< 0.041	36	< 0.039	13	0.046	1	0.067
Pyrene	2,300	2,300	2,300		18	1	5.8	< 0.041	44	< 0.039	18	< 0.043	2.4	< 0.042

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. NA = Not Analyzed
4. PNAs = Polynuclear Aromatic Hydrocarbons
5. Populated MSA = populated area in a MSA excluding Chicago
6. Populated Non-MSA = populated area in a non-MSA county
7. Non-Populated = outside a populated area
8. Metropolitan Statistical Areas (MSA) as defined in Board Note, 35 IAC 742. Appendix A, Table G)

Bold Italicized	Sample result above CCDD Populated Metropolitan Statistical Areas (MSA) County MAC Values.
Italicized	Sample result above CCDD Populated Non-MSA County MAC Values.
Bold Italicized	Sample result above CCDD Non-Populated Area MAC Values.

Table 2c

Soil Analytical Results
PNAs Compared to CCDD MAC Values
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**CCDD MAC Values**			**Sample**	B-6-1	B-6-2	B-8-1	B-8-2	B-9-1	B-9-2	B-10-1	B-10-2
	Populated MSA [5]	*Populated Non-MSA* [6]	*Non-Populated* [7]	**Date**	11/08/21	11/08/21	11/12/21	11/12/21	11/14/21	11/14/21	11/04/21	11/10/21
				Depth (ft)	1-2	9-10	2-3	10-11	1-2	9-10	2-3	9-10
PNAs												
Acenaphthene	570	570	570		< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Acenaphthylene	85	85	85		< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Anthracene	12,000	12,000	12,000		< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	0.069	< 0.042
Benzo(a)anthracene	1.8	0.9	0.9		< 0.035	< 0.041	0.052	< 0.043	0.057	< 0.040	0.26	< 0.042
Benzo(a)pyrene	2.1	0.98	0.09		< 0.035	< 0.041	0.06	< 0.043	0.049	< 0.040	***0.18***	< 0.042
Benzo(b)fluoranthene	2.1	0.9	0.9		< 0.035	< 0.041	0.052	< 0.043	0.059	< 0.040	0.19	0.048
Benzo(g,h,i)perylene	2,300	2,300	2,300		< 0.035	< 0.041	< 0.044	< 0.043	0.046	< 0.040	0.12	0.062
Benzo(k)fluoranthene	9	9	9		< 0.035	< 0.041	0.056	< 0.043	0.049	< 0.040	0.16	0.045
Chrysene	88	88	88		< 0.035	< 0.041	0.057	< 0.043	0.064	< 0.040	0.23	< 0.042
Dibenzo(a,h)anthracene	0.42	0.15	0.09		< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	0.078	0.061
Fluoranthene	3,100	3,100	3,100		< 0.035	< 0.041	0.086	< 0.043	0.079	< 0.040	0.43	< 0.042
Fluorene	560	560	560		< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Indeno(1,2,3-cd)pyrene	1.6	0.9	0.9		< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	0.1	< 0.042
Naphthalene	1.8	1.8	1.8		< 0.035	< 0.041	< 0.044	< 0.043	< 0.036	< 0.040	< 0.034	< 0.042
Phenanthrene	210	210	210		< 0.035	0.11	0.071	< 0.043	0.057	0.052	0.22	< 0.042
Pyrene	2,300	2,300	2,300		< 0.035	< 0.041	0.066	< 0.043	0.083	< 0.040	0.38	< 0.042

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. NC = No toxicity criteria for this exposure route
3. NA = Not Analyzed
4. PNAs = Polynuclear Aromatic Hydrocarbons
5. Populated MSA = populated area in a MSA excluding Chicago
6. Populated Non-MSA = populated area in a non-MSA county
7. Non-Populated = outside a populated area
8. Metropolitan Statistical Areas (MSA) as defined in Board Note, 35 IAC 742. Appendix A, Table G)

🟨 ***Bold Italicized***	Sample result above CCDD Populated Metropolitan Statistical Areas (MSA) County MAC Values.
🟨 *Italicized*	Sample result above CCDD Populated Non-MSA County MAC Values.
Bold Italicized	Sample result above CCDD Non-Populated Area MAC Values.

Table 2d

Soil Analytical Results
Inorganics and pH Compared to CCDD MAC Values
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**CCDD MAC Values**		**Sample**	B-1-1	B-1-2	B-2-1	B-2-2	B-3-1	B-3-2	B-4-1	B-4-2	B-5-1	B-5-2	B-6-1
	MSA County	*Non-MSA County*	**Date**	11/01/21	11/08/21	11/01/21	11/04/21	11/01/21	11/04/21	11/01/21	11/08/21	11/04/21	11/12/21	11/08/21
			Depth (ft)	2-3	10-11	1-2	9-10	1-2	10-11	2-3	10-11	2-3	10-11	1-2
Inorganics (mg/kg)														
Aluminum	9,500	9,200		3000	NA	3500	NA	1,800	NA	2200	NA	3600	NA	990
Antimony	5	5		< 2.1	NA	< 2.2	NA	< 2.0	NA	< 2.1	NA	2.8	NA	< 2.0
Arsenic	13	11.3		4.4	5.7	3.6	3.7	3.0	3	4.3	2.8	5.4	9.3	< 1.0
Barium	1,500	1,500		49	46	31	20	15	11	57	20	78	51	3.2
Beryllium	22	22		< 0.53	NA	< 0.55	NA	< 0.50	NA	< 0.53	NA	< 0.54	NA	< 0.51
Cadmium	5.2	5.2		< 0.53	< 0.57	< 0.55	< 0.59	< 0.50	< 0.57	< 0.53	< 0.60	< 0.54	< 0.60	< 0.51
Calcium	NC	NC		88000	NA	73000	NA	66,000	NA	87000	NA	77000	NA	19000
Chromium	21	21		5.6	21	8.5	9.4	4.1	7.9	6	8.3	8.5	***24***	2.6
Cobalt	20	20		***43***	NA	***22***	NA	9	NA	6.4	NA	5.1	NA	1.2
Copper	2,900	2,900		48	NA	48	NA	13	NA	54	NA	54	NA	< 2.5
Cyanide	40	40		< 0.56	NA	< 0.59	NA	< 0.53	NA	< 0.58	NA	< 0.56	NA	< 0.53
Iron	15,900	15,000		9200	NA	8100	NA	7100	NA	7100	NA	11000	NA	2300
Lead	107	107		***120***	14	***210***	6.3	31	6	***260***	12	***440***	19	1.7
Magnesium	325,000	325,000		42000	NA	31000	NA	32000	NA	44000	NA	35000	NA	12000
Manganese	636	630		330	NA	400	NA	270	NA	280	NA	430	NA	110
Mercury (Total)	0.89	0.89		0.34	0.078	***1.5***	0.031	0.18	< 0.018	0.54	< 0.023	0.43	0.027	< 0.020
Nickel	100	100		7.5	NA	12	NA	5.6	NA	7.5	NA	9.2	NA	2.6
Potassium	NC	NC		600	NA	610	NA	380	NA	530	NA	810	NA	750
Selenium	1.3	1.3		< 1.1	< 1.1	< 1.1	< 1.2	< 1.0	< 1.1	< 1.1	< 1.2	< 1.1	< 1.2	< 1.0
Silver	4.4	4.4		2.7	< 1.1	1.6	< 1.2	< 1.0	< 1.1	< 1.1	< 1.2	< 1.1	< 1.2	< 1.0
Sodium	NC	NC		890	NA	860	NA	1000	NA	600	NA	2300	NA	250
Thallium	2.6	2.6		< 1.1	NA	< 1.1	NA	< 1.0	NA	< 1.1	NA	< 1.1	NA	< 1.0
Vanadium	550	550		11	NA	12	NA	8.3	NA	9.9	NA	15	NA	2.6
Zinc	5,100	5,100		120	NA	170	NA	41	NA	130	NA	270	NA	< 5.1
pH	6.25-9.0			9.74	9.04	9.83	8.79	9.38	8.38	10.59	8.98	9.62	8.34	9.02

NOTES

1. CCDD = Clean Construction or Demolition Debris
2. MAC = Maximum Allowable Concentration
3. NA = Not Analyzed
4. NC = No toxicity criteria for this exposure route
5. TCLP = Toxicity Characteristic Leaching Procedure
6. **Bold*** = Excluded under footnote m of the MAC Table
7. Metropolitan Statistical Areas (MSA) as defined in Board Note, 35 IAC

Bold Italicized	Sample result above CCDD Metropolitan Statistical Areas (MSA) County MAC Values.
Bold Italicized	Sample result above CCDD Non-MSA County MAC Values only.
🟩	Sample result out of pH range for CCDD MAC Values.

Table 2d

Soil Analytical Results
Inorganics and pH Compared to CCDD MAC Values
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	CCDD MAC Values		**Sample**	B-6-2	B-8-1	B-8-2	B-9-1	B-9-2	B-10-1	B-10-2
	MSA County	*Non-MSA County*	**Date**	11/08/21	11/12/21	11/12/21	11/14/21	11/14/21	11/04/21	11/10/21
			Depth (ft)	9-10	2-3	10-11	1-2	9-10	2-3	9-10
Inorganics (mg/kg)										
Aluminum	9,500	9,200		NA	***15000***	NA	1900	NA	1100	NA
Antimony	5	5		NA	< 2.4	NA	< 2.0	NA	< 2.0	NA
Arsenic	13	11.3		9.2	8.2	9.2	3.4	10	2.6	9.2
Barium	1,500	1,500		49	50	37	21	38	6.7	52
Beryllium	22	22		NA	0.86	NA	< 0.51	NA	< 0.51	NA
Cadmium	5.2	5.2		< 0.56	< 0.60	< 0.64	< 0.51	< 0.58	< 0.51	< 0.60
Calcium	NC	NC		NA	48000	NA	35000	NA	43000	NA
Chromium	21	21		21	***25***	***30***	5.6	***22***	3.2	20
Cobalt	20	20		NA	14	NA	2	NA	2.3	NA
Copper	2,900	2,900		NA	34	NA	16	NA	4.9	NA
Cyanide	40	40		NA	< 0.67	NA	< 0.54	NA	< 0.53	NA
Iron	15,900	15,000		NA	***27000***	NA	5900	NA	5200	NA
Lead	107	107		17	16	18	84	16	***140***	16
Magnesium	325,000	325,000		NA	25000	NA	13000	NA	24000	NA
Manganese	636	630		NA	420	NA	110	NA	180	NA
Mercury (Total)	0.89	0.89		< 0.023	0.6	0.027	0.071	0.023	0.049	< 0.023
Nickel	100	100		NA	39	NA	5.4	NA	3.4	NA
Potassium	NC	NC		NA	3800	NA	640	NA	270	NA
Selenium	1.3	1.3		< 1.1	< 1.2	< 1.3	< 1.0	< 1.1	< 1.0	< 1.2
Silver	4.4	4.4		< 1.1	< 1.2	< 1.3	< 1.0	< 1.1	< 1.0	< 1.2
Sodium	NC	NC		NA	1700	NA	330	NA	230	NA
Thallium	2.6	2.6		NA	< 1.2	NA	< 1.0	NA	< 1.0	NA
Vanadium	550	550		NA	26	NA	7.4	NA	5.7	NA
Zinc	5,100	5,100		NA	62	NA	72	NA	20	NA
pH	6.25-9.0			8.26	8.32	8.11	9.63	8.20	9.67	9.49

NOTES

1. CCDD = Clean Construction or Demolition Debris
2. MAC = Maximum Allowable Concentration
3. NA = Not Analyzed
4. NC = No toxicity criteria for this exposure route
5. TCLP = Toxicity Characteristic Leaching Procedure
6. **Bold*** = Excluded under footnote m of the MAC Table
7. Metropolitan Statistical Areas (MSA) as defined in Board Note, 35 IAC

Bold Italicized	Sample result above CCDD Metropolitan Statistical Areas (MSA) County MAC Values.
Bold Italicized	Sample result above CCDD Non-MSA County MAC Values only.
🟩	Sample result out of pH range for CCDD MAC Values.

Table 2e

Soil Analytical Results
Pesticides, Herbicides, and PCBs Compared to CCDD MAC Values
CTA State-Lake Loop Elevated Station
Chicago, Illinois

ANALYTES	**CCDD MAC Values**	**Sample**	B-1-1	B-2-1	B-3-1	B-4-1	B-5-1	B-6-1	B-8-1	B-9-1	B-10-1
		Date	11/01/21	11/01/21	11/01/21	11/01/21	11/04/21	11/08/21	11/12/21	11/14/21	11/04/21
		Depth (ft)	2-3	1-2	1-2	2-3	2-3	1-2	2-3	1-2	2-3
Pesticides											
4,4´-DDD	3		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
4,4´-DDE	2		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
4,4´-DDT	2		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Aldrin	0.94		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
alpha-BHC	0.0074		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
alpha-Chlordane	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
beta-BHC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Chlordane	1.8		< 0.018	< 0.019	< 0.017	< 0.018	< 0.018	< 0.017	< 0.021	< 0.017	< 0.017
delta-BHC	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Dieldrin	0.603		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endosulfan I	18		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endosulfan II	18		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endosulfan sulfate	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endrin	1		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endrin aldehyde	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Endrin ketone	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
gamma-BHC	0.009		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
gamma-Chlordane	NC		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Heptachlor	0.871		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Heptachlor epoxide	1.005		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Methoxychlor	160		< 0.0018	< 0.0019	< 0.0017	< 0.0018	< 0.0018	< 0.0017	< 0.0021	< 0.0017	< 0.0017
Toxaphene	0.6		< 0.037	< 0.039	< 0.035	< 0.038	< 0.037	< 0.035	< 0.044	< 0.036	< 0.035
PCBs											
Aroclor 1016	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1221	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1232	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1242	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1248	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1254	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Aroclor 1260	NC		< 0.090	< 0.094	< 0.085	< 0.092	< 0.090	< 0.084	< 0.11	< 0.086	< 0.084
Total PCBs	1		ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES

1. All results expressed in milligrams per kilogram (mg/kg)
2. CCDD = Clean Construction or Demolition Debris
3. MAC = Maximum Allowable Concentration
4. NA = Not Analyzed
5. NC = No toxicity criteria for this exposure route
6. ND = Not Detected at the reporting limit
7. PCBs = Polychlorinated Biphenyls

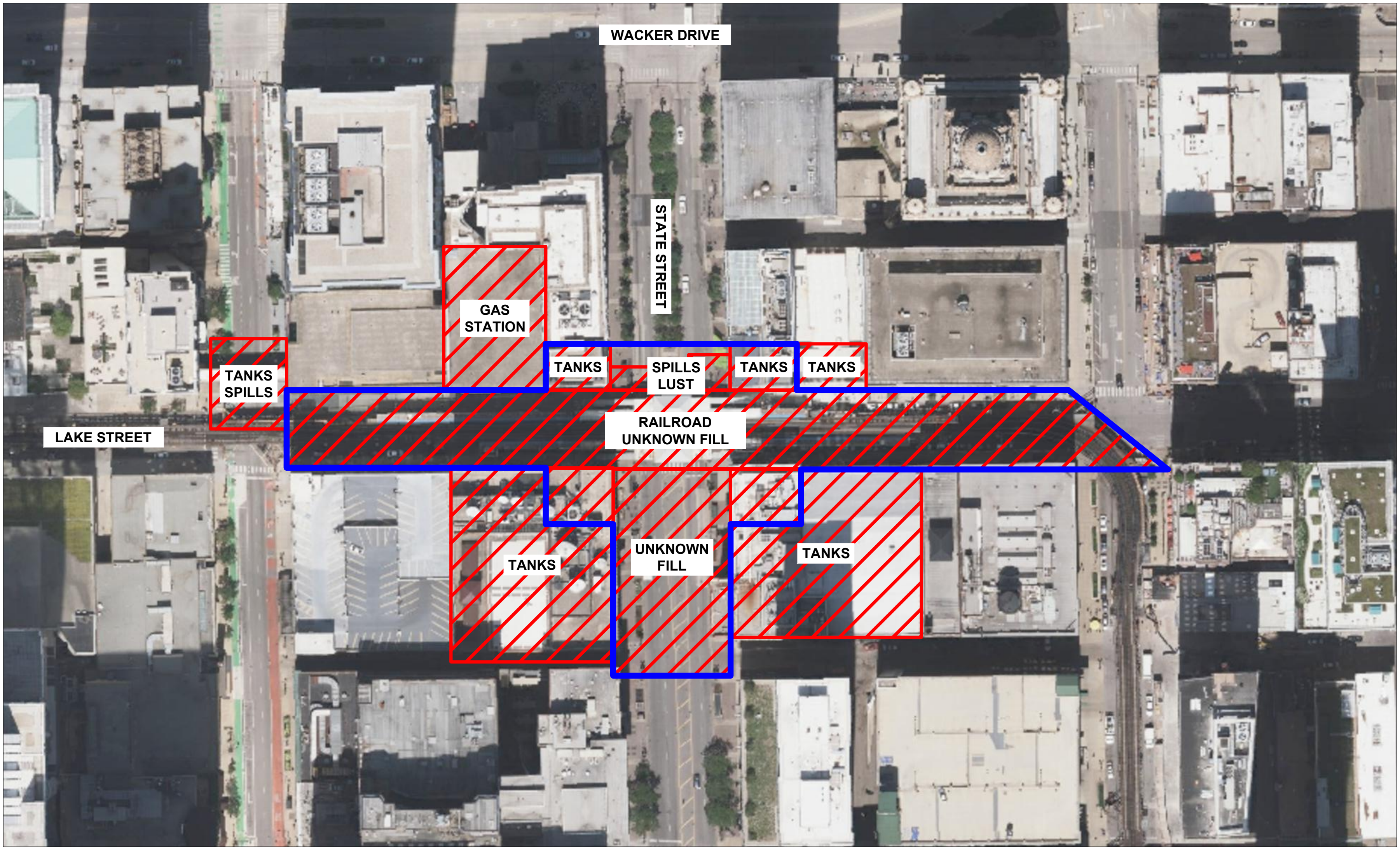
EXHIBITS

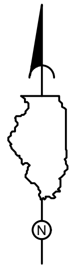
EXHIBIT 1	Site Location Map
EXHIBIT 2	RECs Map
EXHIBIT 3	Boring Location Map
EXHIBIT 4	Soil Management Plan

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

SCALE:	1" = 1000'
DRAWN BY:	EM
CHECKED BY:	RS
DATE:	1/17/2022

EXHIBIT 1 - SITE LOCATION MAP
CTA STATE-LAKE LOOP ELEVATED STATION
NORTH STATE STREET & LAKE STREET
CHICAGO, ILLINOIS





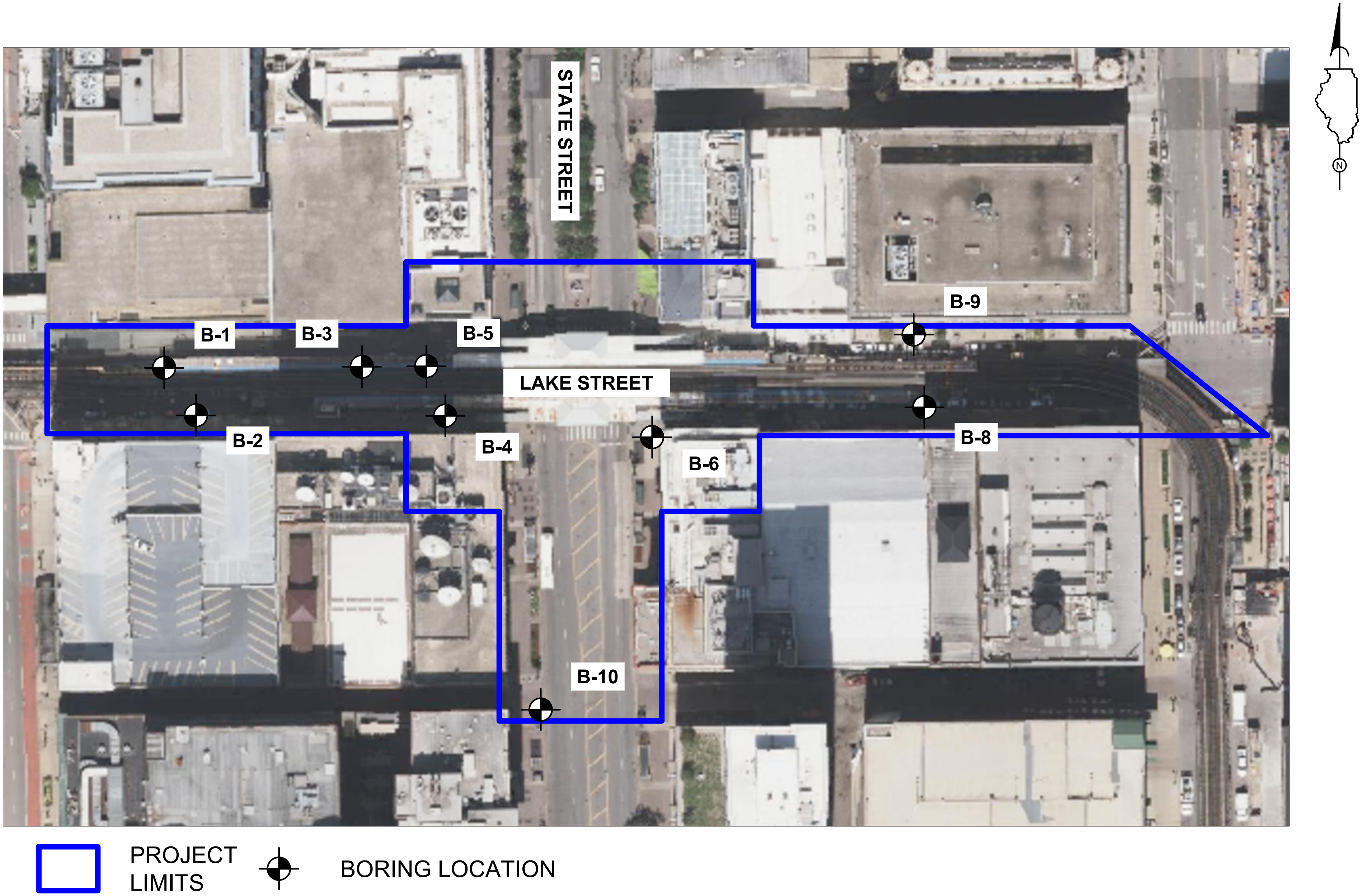
☐ PROJECT LIMITS

▨ RECs

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

SCALE: 1" = 150'	DRAWN BY: EM
	CHECKED BY: RS
	DATE: 1/17/2022

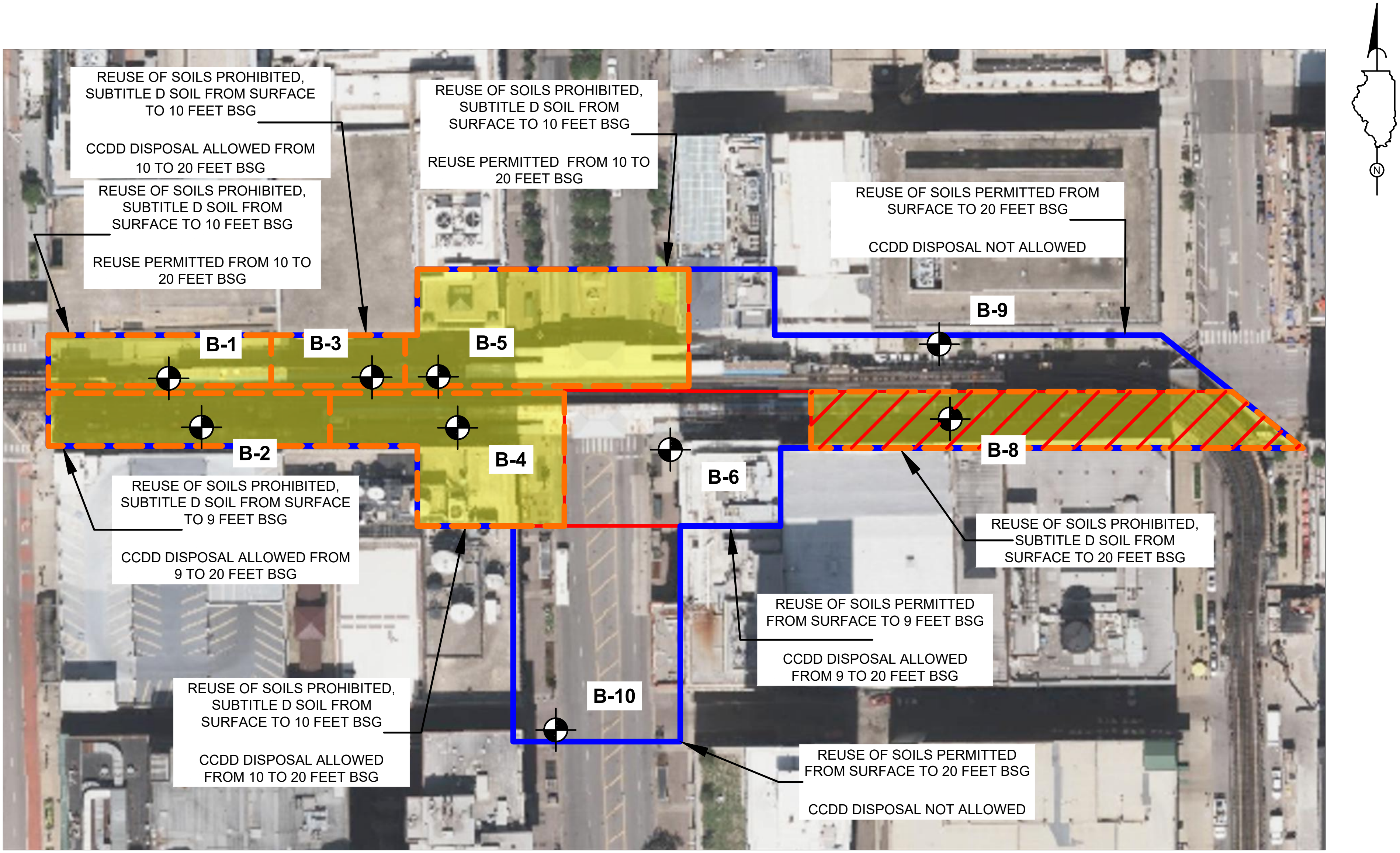
EXHIBIT 2 - RECs MAP
CTA STATE-LAKE LOOP ELEVATED STATION
NORTH STATE STREET & LAKE STREET
CHICAGO, ILLINOIS



GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

SCALE:	1" = 100'
DRAWN BY:	EM
CHECKED BY:	RS
DATE:	1/17/2022

EXHIBIT 3 - BORING LOCATION MAP
CTA STATE-LAKE LOOP ELEVATED STATION
NORTH STATE STREET & LAKE STREET
CHICAGO, ILLINOIS



REUSE OF SOILS PROHIBITED, SUBTITLE D SOIL FROM SURFACE TO 10 FEET BSG

CCDD DISPOSAL ALLOWED FROM 10 TO 20 FEET BSG

REUSE OF SOILS PROHIBITED, SUBTITLE D SOIL FROM SURFACE TO 10 FEET BSG

REUSE PERMITTED FROM 10 TO 20 FEET BSG

REUSE OF SOILS PROHIBITED, SUBTITLE D SOIL FROM SURFACE TO 10 FEET BSG

REUSE PERMITTED FROM 10 TO 20 FEET BSG

REUSE OF SOILS PERMITTED FROM SURFACE TO 20 FEET BSG

CCDD DISPOSAL NOT ALLOWED

REUSE OF SOILS PROHIBITED, SUBTITLE D SOIL FROM SURFACE TO 9 FEET BSG

CCDD DISPOSAL ALLOWED FROM 9 TO 20 FEET BSG

REUSE OF SOILS PROHIBITED, SUBTITLE D SOIL FROM SURFACE TO 20 FEET BSG

REUSE OF SOILS PERMITTED FROM SURFACE TO 9 FEET BSG

CCDD DISPOSAL ALLOWED FROM 9 TO 20 FEET BSG

REUSE OF SOILS PROHIBITED, SUBTITLE D SOIL FROM SURFACE TO 10 FEET BSG

CCDD DISPOSAL ALLOWED FROM 10 TO 20 FEET BSG

REUSE OF SOILS PERMITTED FROM SURFACE TO 20 FEET BSG

CCDD DISPOSAL NOT ALLOWED

🟦 PROJECT LIMITS	⊕ BORING LOCATION	▨ NO SOILS PERMITTED FOR REUSE	🟨 SUBTITLE D SOILS	– – CONSTRUCTION WORKER PRECAUTIONS

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735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

SCALE: 1" = 100'	DRAWN BY: EM
	CHECKED BY: RS
	DATE: 1/17/2022

EXHIBIT 4 - SOIL MANAGEMENT PLAN
CTA STATE-LAKE LOOP ELEVATED STATION
NORTH STATE STREET & LAKE STREET
CHICAGO, ILLINOIS

APPENDICES

APPENDIX A	Soil Boring Logs
APPENDIX B	Laboratory Analytical Reports

APPENDIX A

Soil Boring Logs

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-1

PAGE 1 OF 1

CLIENT TranSystems		**PROJECT NAME** CTA State-Lake Loop Elevated Station	
PROJECT NUMBER 21-1038		**PROJECT LOCATION** Chicago, IL	
DATE STARTED 11/08/21	**COMPLETED** 11/09/21	**GROUND ELEVATION**	**HOLE SIZE**
DRILLING CONTRACTOR GSG Drilling		**GROUND WATER LEVELS:**	
DRILLING METHOD Direct Push		**AT TIME OF DRILLING** ---	
LOGGED BY JEB	**CHECKED BY** RS	**AT END OF DRILLING** ---	
NOTES Hydrovac to 10 feet below grade		**AFTER DRILLING** ---	

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0				0.5	Asphalt	
				1.5	Concrete	
			PID = 0		FILL, brown sand and gravel, granite pavers at 5-10', brick at 1-10'	
	SS B-1-1		PID = 0			
			PID = 0			
5			PID = 0			
			PID = 0			
			PID = 0			
			PID = 0			
			PID = 0			
10			PID = 0			
	SS B-1-2		PID = 0			
			PID = 0			
			PID = 0	13.5		
			PID = 0		(CL-ML) Gray silty clay	
15			PID = 0			
			PID = 0			
			PID = 0			
			PID = 0			
			PID = 0			
20	SS B-1-3		PID = 0	20.0		

Bottom of borehole at 20.0 feet.

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735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-2

PAGE 1 OF 1

CLIENT TranSystems

PROJECT NAME CTA State-Lake Loop Elevated Station

PROJECT NUMBER 21-1038

PROJECT LOCATION Chicago, IL

DATE STARTED 11/02/21 **COMPLETED** 11/03/21

GROUND ELEVATION **HOLE SIZE**

DRILLING CONTRACTOR GSG Drilling

GROUND WATER LEVELS:

DRILLING METHOD Direct Push

AT TIME OF DRILLING ---

LOGGED BY JEB **CHECKED BY** RS

AT END OF DRILLING ---

NOTES

AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG		MATERIAL DESCRIPTION	WELL DIAGRAM
0					0.3	Asphalt	
					0.8	Concrete	
5	SS B-2-1 SS B-2-2		PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0		10.0	FILL, brown sand and gravel	
10			PID = 0 PID = 0 PID = 0		13.5	FILL, gray clayey silt	
15 20	SS B-2-3		PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0		20.0	(CL-ML) Gray silty clay, trace gravel	

Bottom of borehole at 20.0 feet.

ENVIRONMENTAL BH - GINT STD US.GDT - 01/05/22 14:22 - T:\TRANSYSTEMS\CDOT STATE-LAKE CTA STATION\ENVIRONMENTAL\PHASE II ESA\EXHIBITS AND BORING LOGS\GINT FILES\STATE-LAKE PHASE II ESA.GPJ

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-3

PAGE 1 OF 1

CLIENT TranSystems		**PROJECT NAME** CTA State-Lake Loop Elevated Station	
PROJECT NUMBER 21-1038		**PROJECT LOCATION** Chicago, IL	
DATE STARTED 11/03/21	**COMPLETED** 11/05/21	**GROUND ELEVATION**	**HOLE SIZE**
DRILLING CONTRACTOR GSG Drilling		**GROUND WATER LEVELS:**	
DRILLING METHOD Direct Push		**AT TIME OF DRILLING** ---	
LOGGED BY JEB	**CHECKED BY** RS	**AT END OF DRILLING** ---	
NOTES Hydrovac to 10 feet below grade		**AFTER DRILLING** ---	

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG		MATERIAL DESCRIPTION	WELL DIAGRAM
0				▨	0.5	Asphalt	
					1.0	Concrete	
	SS B-3-1		PID = 0			FILL, brown sand and gravel	
			PID = 0				
			PID = 0				
			PID = 0				
5			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
10	SS B-3-2		PID = 0		10.5	FILL, light brown silt	
			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0		14.5	(CL-ML) Gray silty clay, trace gravel	
15			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
20	SS B-3-3		PID = 0		20.0		

Bottom of borehole at 20.0 feet.

ENVIRONMENTAL BH - GINT STD US.GDT - 01/05/22 14:22 - T:\TRANSYSTEMS\CDOT STATE-LAKE CTA STATION\ENVIRONMENTAL\PHASE II ESA\EXHIBITS AND BORING LOGS\GINT FILES\STATE-LAKE PHASE II ESA.GPJ

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-4

PAGE 1 OF 1

CLIENT TranSystems
PROJECT NAME CTA State-Lake Loop Elevated Station
PROJECT NUMBER 21-1038
PROJECT LOCATION Chicago, IL
DATE STARTED 11/05/21 **COMPLETED** 11/05/21
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Direct Push
AT TIME OF DRILLING ---
LOGGED BY JEB **CHECKED BY** RS
AT END OF DRILLING ---
NOTES Hydrovac to 10 feet below grade
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG		MATERIAL DESCRIPTION	WELL DIAGRAM
0					0.3	Asphalt	
					1.1	Concrete	
			PID = 0			FILL, brown sand and gravel, granite pavers at 5-10', debris/brick at 1-10'	
	SS B-4-1		PID = 0				
			PID = 0				
5			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
10			PID = 0				
	SS B-4-2		PID = 0				
			PID = 0				
			PID = 0		13.5		
			PID = 0			(ML) Brown-gray, mottled, clayey silt	
15			PID = 0				
			PID = 0		16.0		
			PID = 0			(CL-ML) Gray silty clay, trace gravel	
			PID = 0				
	SS B-4-3		PID = 0				
20			PID = 0		20.0		

Bottom of borehole at 20.0 feet.

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-5

PAGE 1 OF 1

CLIENT TranSystems

PROJECT NAME CTA State-Lake Loop Elevated Station

PROJECT NUMBER 21-1038

PROJECT LOCATION Chicago, IL

DATE STARTED 11/10/21 **COMPLETED** 11/10/21

GROUND ELEVATION **HOLE SIZE**

DRILLING CONTRACTOR GSG Drilling

GROUND WATER LEVELS:

DRILLING METHOD Direct Push

AT TIME OF DRILLING ---

LOGGED BY JEB **CHECKED BY** RS

AT END OF DRILLING ---

NOTES Hydrovac to 10 feet below grade

AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG		MATERIAL DESCRIPTION	WELL DIAGRAM
0				▨	0.8	Asphalt	
				▒	1.4	Concrete	
5	☒ SS B-5-1		PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0 PID = 0	▩	10.0	FILL, brown sand and gravel	
10	☒ SS B-5-2		PID = 0 PID = 0 PID = 0		13.5	No recovery, drilling for casing	
15			PID = 0 PID = 0	▩	15.0	FILL, brown-gray, mottled, silty clay loam	
20	☒ SS B-5-3		PID = 0 PID = 0 PID = 0 PID = 0 PID = 0	▥	20.0	(CL-ML) Gray silty clay, trace gravel	

Bottom of borehole at 20.0 feet.

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-6

PAGE 1 OF 1

CLIENT	TranSystems	**PROJECT NAME**	CTA State-Lake Loop Elevated Station
PROJECT NUMBER	21-1038	**PROJECT LOCATION**	Chicago, IL
DATE STARTED	11/08/21 **COMPLETED** 11/10/21	**GROUND ELEVATION**	**HOLE SIZE**
DRILLING CONTRACTOR	GSG Drilling	**GROUND WATER LEVELS:**	
DRILLING METHOD	Direct Push	**AT TIME OF DRILLING**	---
LOGGED BY	JEB **CHECKED BY** RS	**AT END OF DRILLING**	---
NOTES	Hydrovac to 9.9 feet below grade	**AFTER DRILLING**	---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0				0.8	Concrete	
	SS B-6-1				FILL, CA-6 gravel	
			PID = 0			
			PID = 0			
			PID = 0			
5			PID = 0			
			PID = 0			
			PID = 0			
			PID = 0			
	SS B-6-2		PID = 0			
10			PID = 0	9.9		
			PID = 0		No recovery, boulder obstruction	
			PID = 0			
			PID = 0			
			PID = 0	13.5		
15			PID = 0	14.5	FILL, gray silt, trace gravel	
			PID = 0		(CL-ML) Gray silty clay, trace gravel	
			PID = 0			
			PID = 0			
	SS B-6-3		PID = 0			
20			PID = 0	20.0		

Bottom of borehole at 20.0 feet.

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-8

CLIENT TranSystems

PROJECT NAME CTA State-Lake Loop Elevated Station

PROJECT NUMBER 21-1038

PROJECT LOCATION Chicago, IL

DATE STARTED 11/11/21 **COMPLETED** 11/12/21

GROUND ELEVATION **HOLE SIZE**

DRILLING CONTRACTOR GSG Drilling

GROUND WATER LEVELS:

DRILLING METHOD Direct Push

AT TIME OF DRILLING ---

LOGGED BY JEB **CHECKED BY** RS

AT END OF DRILLING ---

NOTES Hydrovac to 10 feet below grade

AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG		MATERIAL DESCRIPTION	WELL DIAGRAM
0					1.0	Asphalt	
					1.5	Concrete	
			PID = 0			FILL, brown sand and gravel	
	SS B-8-1		PID = 0				
			PID = 0				
5			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
			PID = 0				
10			PID = 0				
	SS B-8-2		PID = 0				
			PID = 0				
			PID = 0		13.5		
			PID = 0			(CL-ML) Gray silty clay, trace gravel	
15			PID = 0				
			PID = 0		16.0		
			PID = 0			(CL-ML) Gray silty clay loam	
			PID = 0				
			PID = 0				
20	SS B-8-3		PID = 0		20.0		

Bottom of borehole at 20.0 feet.

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-9

PAGE 1 OF 1

CLIENT TranSystems
PROJECT NAME CTA State-Lake Loop Elevated Station
PROJECT NUMBER 21-1038
PROJECT LOCATION Chicago, IL
DATE STARTED 11/12/21 **COMPLETED** 11/14/21
GROUND ELEVATION **HOLE SIZE**
DRILLING CONTRACTOR GSG Drilling
GROUND WATER LEVELS:
DRILLING METHOD Direct Push
AT TIME OF DRILLING ---
LOGGED BY JEB **CHECKED BY** RS
AT END OF DRILLING ---
NOTES Hydrovac to 10 feet below grade
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0				0.6	Concrete	
1					FILL, brown sand and gravel	
2	SS B-9-1		PID = 0			
3			PID = 0			
4			PID = 0			
5			PID = 0			
6			PID = 0			
7			PID = 0			
8			PID = 0			
9			PID = 0			
10	SS B-9-2		PID = 0	10.0	FILL, gravel, cobbles and concrete	
11			PID = 0			
12			PID = 0			
13			PID = 0	13.5	(CL-ML) Gray silty clay, trace gravel	
14			PID = 0			
15			PID = 0			
16			PID = 0			
17			PID = 0			
18			PID = 0			
19			PID = 0			
20	SS B-9-3		PID = 0	20.0		

Bottom of borehole at 20.0 feet.

GSG Consultants
735 Remington Road
Schaumburg, Illinois 60173
Telephone: 630-994-2600

BORING NUMBER B-10

PAGE 1 OF 1

CLIENT TranSystems

PROJECT NAME CTA State-Lake Loop Elevated Station

PROJECT NUMBER 21-1038

PROJECT LOCATION Chicago, IL

DATE STARTED 11/09/21 **COMPLETED** 11/10/21

GROUND ELEVATION **HOLE SIZE**

DRILLING CONTRACTOR GSG Drilling

GROUND WATER LEVELS:

DRILLING METHOD Direct Push

AT TIME OF DRILLING ---

LOGGED BY JEB **CHECKED BY** RS

AT END OF DRILLING ---

NOTES Hydrovac to 10 feet below grade

AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	ENVIRONMENTAL DATA	GRAPHIC LOG	MATERIAL DESCRIPTION	WELL DIAGRAM
0				0.5	Red concrete	
				1.5	Concrete	
			PID = 0		FILL, brown sand and gravel	
	SS B-10-1		PID = 0			
			PID = 0			
5			PID = 0			
			PID = 0			
			PID = 0			
			PID = 0			
	SS		PID = 0			
10	B-10-2		PID = 0			
			PID = 0			
			PID = 0			
			PID = 0	13.5		
			PID = 0		(CL-ML) Gray silty clay	
15			PID = 0			
			PID = 0			
			PID = 0			
			PID = 0			
	SS		PID = 0			
20	B-10-3		PID = 0	20.0		

Bottom of borehole at 20.0 feet.

APPENDIX B

Laboratory Analytical Reports

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditations: IEPA ELAP 100445; ORELAP IL300001; AIHA-LAP, LLC 101160; NVLAP LabCode 101202-0

November 16, 2021

GSG Consultants, Inc.
2942 W. Van Buren St.
Chicago, IL 60612
Telephone: (312) 733-6262
Fax: (312) 733-5612

Analytical Report for STAT Work Order: 21110018 Revision 0

RE: State & Lake, Chicago

Dear GSG Consultants, Inc.:

STAT Analysis received 5 samples for the referenced project on 11/1/2021 3:31:00 PM. The analytical results are presented in the following report.

All analyses were performed in accordance with the requirements of 35 IAC Part 186 / NELAP standards. Analyses were performed in accordance with methods as referenced on the analytical report. Those analytical results expressed on a dry weight basis are also noted on the analytical report.

All analyses were performed within established holding time criteria, and all Quality Control criteria met EPA or laboratory specifications except when noted in the Case Narrative or Analytical Report. If required, an estimate of uncertainty for the analyses can be provided. A listing of accredited methods/parameters can also be provided.

Thank you for the opportunity to serve you and I look forward to working with you in the future. If you have any questions regarding the enclosed materials, please contact me at (312) 733-0551.

Sincerely,

Justice Kwateng
Project Manager

STAT Analysis Corporation **Date:** November 16, 2021

Client: GSG Consultants, Inc.
Project: State & Lake, Chicago
Work Order: 21110018 Revision 0

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Tag Number	Collection Date	Date Received
21110018-001A	B-1-1		11/1/2021 9:30:00 AM	11/1/2021
21110018-001B	B-1-1		11/1/2021 9:30:00 AM	11/1/2021
21110018-002A	B-2-1		11/1/2021 10:15:00 AM	11/1/2021
21110018-002B	B-2-1		11/1/2021 10:15:00 AM	11/1/2021
21110018-003A	B-3-1		11/1/2021 11:00:00 AM	11/1/2021
21110018-003B	B-3-1		11/1/2021 11:00:00 AM	11/1/2021
21110018-004A	B-4-1		11/1/2021 12:30:00 PM	11/1/2021
21110018-004B	B-4-1		11/1/2021 12:30:00 PM	11/1/2021
21110018-005A	B-9-1		11/1/2021 1:30:00 PM	11/1/2021
21110018-005B	B-9-1		11/1/2021 1:30:00 PM	11/1/2021

CASE NARRATIVE

The Total Metals Continuing Calibration Verification (CCV) had recovery of Antimony outside of control limits (87%, 85% recovery, QC limits 90-110%).

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-001

Client Sample ID: B-1-1
Collection Date: 11/1/2021 9:30:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/2/2021**		Analyst: **CBG**
Acetone	ND	0.070		mg/Kg-dry	1	11/15/2021
Benzene	ND	0.0046		mg/Kg-dry	1	11/15/2021
Bromodichloromethane	ND	0.0046		mg/Kg-dry	1	11/15/2021
Bromoform	ND	0.0046		mg/Kg-dry	1	11/15/2021
Bromomethane	ND	0.0093		mg/Kg-dry	1	11/15/2021
2-Butanone	ND	0.070		mg/Kg-dry	1	11/15/2021
Carbon disulfide	ND	0.046		mg/Kg-dry	1	11/15/2021
Carbon tetrachloride	ND	0.0046		mg/Kg-dry	1	11/15/2021
Chlorobenzene	ND	0.0046		mg/Kg-dry	1	11/15/2021
Chloroethane	ND	0.0093		mg/Kg-dry	1	11/15/2021
Chloroform	ND	0.0046		mg/Kg-dry	1	11/15/2021
Chloromethane	ND	0.0093		mg/Kg-dry	1	11/15/2021
Dibromochloromethane	ND	0.0046		mg/Kg-dry	1	11/15/2021
1,1-Dichloroethane	ND	0.0046		mg/Kg-dry	1	11/15/2021
1,2-Dichloroethane	ND	0.0046		mg/Kg-dry	1	11/15/2021
1,1-Dichloroethene	ND	0.0046		mg/Kg-dry	1	11/15/2021
cis-1,2-Dichloroethene	ND	0.0046		mg/Kg-dry	1	11/15/2021
trans-1,2-Dichloroethene	ND	0.0046		mg/Kg-dry	1	11/15/2021
1,2-Dichloropropane	ND	0.0046		mg/Kg-dry	1	11/15/2021
cis-1,3-Dichloropropene	ND	0.0019		mg/Kg-dry	1	11/15/2021
trans-1,3-Dichloropropene	ND	0.0019		mg/Kg-dry	1	11/15/2021
Ethylbenzene	ND	0.0046		mg/Kg-dry	1	11/15/2021
2-Hexanone	ND	0.019		mg/Kg-dry	1	11/15/2021
4-Methyl-2-pentanone	ND	0.019		mg/Kg-dry	1	11/15/2021
Methylene chloride	ND	0.0093		mg/Kg-dry	1	11/15/2021
Methyl tert-butyl ether	ND	0.0046		mg/Kg-dry	1	11/15/2021
Styrene	ND	0.0046		mg/Kg-dry	1	11/15/2021
1,1,2,2-Tetrachloroethane	ND	0.0046		mg/Kg-dry	1	11/15/2021
Tetrachloroethene	ND	0.0046		mg/Kg-dry	1	11/15/2021
Toluene	ND	0.0046		mg/Kg-dry	1	11/15/2021
1,1,1-Trichloroethane	ND	0.0046		mg/Kg-dry	1	11/15/2021
1,1,2-Trichloroethane	ND	0.0046		mg/Kg-dry	1	11/15/2021
Trichloroethene	ND	0.0046		mg/Kg-dry	1	11/15/2021
Vinyl chloride	ND	0.0046		mg/Kg-dry	1	11/15/2021
Xylenes, Total	ND	0.014		mg/Kg-dry	1	11/15/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **DM**
Acenaphthene	1.2	0.037		mg/Kg-dry	1	11/5/2021
Acenaphthylene	0.068	0.037		mg/Kg-dry	1	11/5/2021

Qualifiers:		
	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-001

Client Sample ID: B-1-1
Collection Date: 11/1/2021 9:30:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **DM**
Aniline	ND	0.37		mg/Kg-dry	1	11/5/2021
Anthracene	3.7	0.037		mg/Kg-dry	1	11/5/2021
Benz(a)anthracene	9.9	0.18		mg/Kg-dry	5	11/8/2021
Benzidine	ND	0.37		mg/Kg-dry	1	11/5/2021
Benzo(a)pyrene	8.1	0.18		mg/Kg-dry	5	11/8/2021
Benzo(b)fluoranthene	8.0	0.18		mg/Kg-dry	5	11/8/2021
Benzo(g,h,i)perylene	4.3	0.037		mg/Kg-dry	1	11/5/2021
Benzo(k)fluoranthene	6.7	0.18		mg/Kg-dry	5	11/8/2021
Benzoic acid	ND	0.92		mg/Kg-dry	1	11/5/2021
Benzyl alcohol	ND	0.19		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethoxy)methane	ND	0.19		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethyl)ether	ND	0.19		mg/Kg-dry	1	11/5/2021
Bis(2-ethylhexyl)phthalate	ND	0.92		mg/Kg-dry	1	11/5/2021
4-Bromophenyl phenyl ether	ND	0.19		mg/Kg-dry	1	11/5/2021
Butyl benzyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
Carbazole	1.3	0.19		mg/Kg-dry	1	11/5/2021
4-Chloroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Chloro-3-methylphenol	ND	0.37		mg/Kg-dry	1	11/5/2021
2-Chloronaphthalene	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Chlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Chlorophenyl phenyl ether	ND	0.19		mg/Kg-dry	1	11/5/2021
Chrysene	9.3	0.18		mg/Kg-dry	5	11/8/2021
Dibenz(a,h)anthracene	2.3	0.037		mg/Kg-dry	1	11/5/2021
Dibenzofuran	0.80	0.19		mg/Kg-dry	1	11/5/2021
1,2-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
1,3-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
1,4-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
3,3´-Dichlorobenzidine	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4-Dichlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Diethyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4-Dimethylphenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Dimethyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
4,6-Dinitro-2-methylphenol	ND	0.37		mg/Kg-dry	1	11/5/2021
2,4-Dinitrophenol	ND	0.92		mg/Kg-dry	1	11/5/2021
2,4-Dinitrotoluene	ND	0.037		mg/Kg-dry	1	11/5/2021
2,6-Dinitrotoluene	ND	0.037		mg/Kg-dry	1	11/5/2021
Di-n-butyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
Di-n-octyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-001

Client Sample ID: B-1-1
Collection Date: 11/1/2021 9:30:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **DM**
Fluoranthene	22	0.18		mg/Kg-dry	5	11/8/2021
Fluorene	1.3	0.037		mg/Kg-dry	1	11/5/2021
Hexachlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
Hexachlorobutadiene	ND	0.19		mg/Kg-dry	1	11/5/2021
Hexachlorocyclopentadiene	ND	0.19		mg/Kg-dry	1	11/5/2021
Hexachloroethane	ND	0.19		mg/Kg-dry	1	11/5/2021
Indeno(1,2,3-cd)pyrene	4.0	0.037		mg/Kg-dry	1	11/5/2021
Isophorone	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Methylnaphthalene	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Methylphenol	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Methylphenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Naphthalene	0.19	0.037		mg/Kg-dry	1	11/5/2021
2-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
3-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Nitrophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Nitrophenol	ND	0.37		mg/Kg-dry	1	11/5/2021
Nitrobenzene	ND	0.037		mg/Kg-dry	1	11/5/2021
N-Nitrosodi-n-propylamine	ND	0.037		mg/Kg-dry	1	11/5/2021
N-Nitrosodimethylamine	ND	0.19		mg/Kg-dry	1	11/5/2021
N-Nitrosodiphenylamine	ND	0.037		mg/Kg-dry	1	11/5/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.19		mg/Kg-dry	1	11/5/2021
Pentachlorophenol	ND	0.037		mg/Kg-dry	1	11/5/2021
Phenanthrene	17	0.18		mg/Kg-dry	5	11/8/2021
Phenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Pyrene	18	0.18		mg/Kg-dry	5	11/8/2021
Pyridine	ND	0.74		mg/Kg-dry	1	11/5/2021
1,2,4-Trichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4,5-Trichlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4,6-Trichlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.090		mg/Kg-dry	1	11/2/2021
Aroclor 1221	ND	0.090		mg/Kg-dry	1	11/2/2021
Aroclor 1232	ND	0.090		mg/Kg-dry	1	11/2/2021
Aroclor 1242	ND	0.090		mg/Kg-dry	1	11/2/2021
Aroclor 1248	ND	0.090		mg/Kg-dry	1	11/2/2021
Aroclor 1254	ND	0.090		mg/Kg-dry	1	11/2/2021
Aroclor 1260	ND	0.090		mg/Kg-dry	1	11/2/2021

	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
Qualifiers:	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-001

Client Sample ID: B-1-1
Collection Date: 11/1/2021 9:30:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0018		mg/Kg-dry	1	11/2/2021
4,4´-DDE	ND	0.0018		mg/Kg-dry	1	11/2/2021
4,4´-DDT	ND	0.0018		mg/Kg-dry	1	11/2/2021
Aldrin	ND	0.0018		mg/Kg-dry	1	11/2/2021
alpha-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
alpha-Chlordane	ND	0.0018		mg/Kg-dry	1	11/2/2021
beta-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
Chlordane	ND	0.018		mg/Kg-dry	1	11/2/2021
delta-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
Dieldrin	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endosulfan I	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endosulfan II	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endosulfan sulfate	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endrin	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endrin aldehyde	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endrin ketone	ND	0.0018		mg/Kg-dry	1	11/2/2021
gamma-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
gamma-Chlordane	ND	0.0018		mg/Kg-dry	1	11/2/2021
Heptachlor	ND	0.0018		mg/Kg-dry	1	11/2/2021
Heptachlor epoxide	ND	0.0018		mg/Kg-dry	1	11/2/2021
Methoxychlor	ND	0.0018		mg/Kg-dry	1	11/2/2021
Toxaphene	ND	0.037		mg/Kg-dry	1	11/2/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Aluminum	3000	21		mg/Kg-dry	10	11/8/2021
Antimony	ND	2.1		mg/Kg-dry	10	11/8/2021
Arsenic	4.4	1.1		mg/Kg-dry	10	11/8/2021
Barium	49	1.1		mg/Kg-dry	10	11/8/2021
Beryllium	ND	0.53		mg/Kg-dry	10	11/8/2021
Cadmium	ND	0.53		mg/Kg-dry	10	11/8/2021
Calcium	88000	64		mg/Kg-dry	10	11/8/2021
Chromium	5.6	1.1		mg/Kg-dry	10	11/8/2021
Cobalt	43	1.1		mg/Kg-dry	10	11/8/2021
Copper	48	2.6		mg/Kg-dry	10	11/8/2021
Iron	9200	32		mg/Kg-dry	10	11/8/2021
Lead	120	0.53		mg/Kg-dry	10	11/8/2021
Magnesium	42000	32		mg/Kg-dry	10	11/8/2021
Manganese	330	1.1		mg/Kg-dry	10	11/8/2021
Nickel	7.5	1.1		mg/Kg-dry	10	11/8/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
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HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-001

Client Sample ID: B-1-1
Collection Date: 11/1/2021 9:30:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A**	**(SW3050B)**		Prep Date: **11/8/2021**		Analyst: **JG**
Potassium	600	32		mg/Kg-dry	10	11/8/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/8/2021
Silver	2.7	1.1		mg/Kg-dry	10	11/8/2021
Sodium	890	64		mg/Kg-dry	10	11/8/2021
Thallium	ND	1.1		mg/Kg-dry	10	11/8/2021
Vanadium	11	1.1		mg/Kg-dry	10	11/8/2021
Zinc	120	5.3		mg/Kg-dry	10	11/8/2021
Mercury	**SW7471B**			Prep Date: **11/5/2021**		Analyst: **LB**
Mercury	0.34	0.020		mg/Kg-dry	1	11/9/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/3/2021**		Analyst: **MD**
Cyanide	ND	0.56		mg/Kg-dry	1	11/4/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/12/2021**		Analyst: **RW**
pH	9.74			pH Units	1	11/12/2021
Percent Moisture	**D2974**			Prep Date: **11/5/2021**		Analyst: **HYM**
Percent Moisture	11.1	0.2	*	wt%	1	11/5/2021

Qualifiers:

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HT - Sample received past holding time
* - Non-accredited parameter

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S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-002

Client Sample ID: B-2-1
Collection Date: 11/1/2021 10:15:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/2/2021**		Analyst: **CZ**
Acetone	ND	0.071		mg/Kg-dry	1	11/12/2021
Benzene	ND	0.0048		mg/Kg-dry	1	11/12/2021
Bromodichloromethane	ND	0.0048		mg/Kg-dry	1	11/12/2021
Bromoform	ND	0.0048		mg/Kg-dry	1	11/12/2021
Bromomethane	ND	0.0095		mg/Kg-dry	1	11/12/2021
2-Butanone	ND	0.071		mg/Kg-dry	1	11/12/2021
Carbon disulfide	ND	0.048		mg/Kg-dry	1	11/12/2021
Carbon tetrachloride	ND	0.0048		mg/Kg-dry	1	11/12/2021
Chlorobenzene	ND	0.0048		mg/Kg-dry	1	11/12/2021
Chloroethane	ND	0.0095		mg/Kg-dry	1	11/12/2021
Chloroform	ND	0.0048		mg/Kg-dry	1	11/12/2021
Chloromethane	ND	0.0095		mg/Kg-dry	1	11/12/2021
Dibromochloromethane	ND	0.0048		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethane	ND	0.0048		mg/Kg-dry	1	11/12/2021
1,2-Dichloroethane	ND	0.0048		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethene	ND	0.0048		mg/Kg-dry	1	11/12/2021
cis-1,2-Dichloroethene	ND	0.0048		mg/Kg-dry	1	11/12/2021
trans-1,2-Dichloroethene	ND	0.0048		mg/Kg-dry	1	11/12/2021
1,2-Dichloropropane	ND	0.0048		mg/Kg-dry	1	11/12/2021
cis-1,3-Dichloropropene	ND	0.0019		mg/Kg-dry	1	11/12/2021
trans-1,3-Dichloropropene	ND	0.0019		mg/Kg-dry	1	11/12/2021
Ethylbenzene	ND	0.0048		mg/Kg-dry	1	11/12/2021
2-Hexanone	ND	0.019		mg/Kg-dry	1	11/12/2021
4-Methyl-2-pentanone	ND	0.019		mg/Kg-dry	1	11/12/2021
Methylene chloride	ND	0.0095		mg/Kg-dry	1	11/12/2021
Methyl tert-butyl ether	ND	0.0048		mg/Kg-dry	1	11/12/2021
Styrene	ND	0.0048		mg/Kg-dry	1	11/12/2021
1,1,2,2-Tetrachloroethane	ND	0.0048		mg/Kg-dry	1	11/12/2021
Tetrachloroethene	ND	0.0048		mg/Kg-dry	1	11/12/2021
Toluene	ND	0.0048		mg/Kg-dry	1	11/12/2021
1,1,1-Trichloroethane	ND	0.0048		mg/Kg-dry	1	11/12/2021
1,1,2-Trichloroethane	ND	0.0048		mg/Kg-dry	1	11/12/2021
Trichloroethene	ND	0.0048		mg/Kg-dry	1	11/12/2021
Vinyl chloride	ND	0.0048		mg/Kg-dry	1	11/12/2021
Xylenes, Total	ND	0.014		mg/Kg-dry	1	11/12/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **DM**
Acenaphthene	0.26	0.039		mg/Kg-dry	1	11/5/2021
Acenaphthylene	0.12	0.039		mg/Kg-dry	1	11/5/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-002

Client Sample ID: B-2-1
Collection Date: 11/1/2021 10:15:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **DM**
Aniline	ND	0.39		mg/Kg-dry	1	11/5/2021
Anthracene	1.0	0.039		mg/Kg-dry	1	11/5/2021
Benz(a)anthracene	3.3	0.039		mg/Kg-dry	1	11/5/2021
Benzidine	ND	0.39		mg/Kg-dry	1	11/5/2021
Benzo(a)pyrene	3.2	0.039		mg/Kg-dry	1	11/5/2021
Benzo(b)fluoranthene	3.0	0.039		mg/Kg-dry	1	11/5/2021
Benzo(g,h,i)perylene	1.9	0.039		mg/Kg-dry	1	11/5/2021
Benzo(k)fluoranthene	2.3	0.039		mg/Kg-dry	1	11/5/2021
Benzoic acid	ND	0.97		mg/Kg-dry	1	11/5/2021
Benzyl alcohol	ND	0.20		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethoxy)methane	ND	0.20		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethyl)ether	ND	0.20		mg/Kg-dry	1	11/5/2021
Bis(2-ethylhexyl)phthalate	ND	0.97		mg/Kg-dry	1	11/5/2021
4-Bromophenyl phenyl ether	ND	0.20		mg/Kg-dry	1	11/5/2021
Butyl benzyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
Carbazole	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Chloroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Chloro-3-methylphenol	ND	0.39		mg/Kg-dry	1	11/5/2021
2-Chloronaphthalene	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Chlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Chlorophenyl phenyl ether	ND	0.20		mg/Kg-dry	1	11/5/2021
Chrysene	3.2	0.039		mg/Kg-dry	1	11/5/2021
Dibenz(a,h)anthracene	1.1	0.039		mg/Kg-dry	1	11/5/2021
Dibenzofuran	ND	0.20		mg/Kg-dry	1	11/5/2021
1,2-Dichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
1,3-Dichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
1,4-Dichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
3,3´-Dichlorobenzidine	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4-Dichlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Diethyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4-Dimethylphenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Dimethyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
4,6-Dinitro-2-methylphenol	ND	0.39		mg/Kg-dry	1	11/5/2021
2,4-Dinitrophenol	ND	0.97		mg/Kg-dry	1	11/5/2021
2,4-Dinitrotoluene	ND	0.039		mg/Kg-dry	1	11/5/2021
2,6-Dinitrotoluene	ND	0.039		mg/Kg-dry	1	11/5/2021
Di-n-butyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
Di-n-octyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021

Qualifiers:		
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	* - Non-accredited parameter	H - Holding time exceeded

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Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-002

Client Sample ID: B-2-1
Collection Date: 11/1/2021 10:15:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **DM**
Fluoranthene	5.9	0.19		mg/Kg-dry	5	11/9/2021
Fluorene	0.17	0.039		mg/Kg-dry	1	11/5/2021
Hexachlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
Hexachlorobutadiene	ND	0.20		mg/Kg-dry	1	11/5/2021
Hexachlorocyclopentadiene	ND	0.20		mg/Kg-dry	1	11/5/2021
Hexachloroethane	ND	0.20		mg/Kg-dry	1	11/5/2021
Indeno(1,2,3-cd)pyrene	1.8	0.039		mg/Kg-dry	1	11/5/2021
Isophorone	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Methylnaphthalene	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Methylphenol	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Methylphenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Naphthalene	ND	0.039		mg/Kg-dry	1	11/5/2021
2-Nitroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
3-Nitroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Nitroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Nitrophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Nitrophenol	ND	0.39		mg/Kg-dry	1	11/5/2021
Nitrobenzene	ND	0.039		mg/Kg-dry	1	11/5/2021
N-Nitrosodi-n-propylamine	ND	0.039		mg/Kg-dry	1	11/5/2021
N-Nitrosodimethylamine	ND	0.20		mg/Kg-dry	1	11/5/2021
N-Nitrosodiphenylamine	ND	0.039		mg/Kg-dry	1	11/5/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.20		mg/Kg-dry	1	11/5/2021
Pentachlorophenol	ND	0.039		mg/Kg-dry	1	11/5/2021
Phenanthrene	2.7	0.039		mg/Kg-dry	1	11/5/2021
Phenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Pyrene	5.8	0.19		mg/Kg-dry	5	11/9/2021
Pyridine	ND	0.78		mg/Kg-dry	1	11/5/2021
1,2,4-Trichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4,5-Trichlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4,6-Trichlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1221	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1232	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1242	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1248	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1254	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1260	ND	0.094		mg/Kg-dry	1	11/2/2021

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-002

Client Sample ID: B-2-1
Collection Date: 11/1/2021 10:15:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0019		mg/Kg-dry	1	11/2/2021
4,4´-DDE	ND	0.0019		mg/Kg-dry	1	11/2/2021
4,4´-DDT	ND	0.0019		mg/Kg-dry	1	11/2/2021
Aldrin	ND	0.0019		mg/Kg-dry	1	11/2/2021
alpha-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
alpha-Chlordane	ND	0.0019		mg/Kg-dry	1	11/2/2021
beta-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
Chlordane	ND	0.019		mg/Kg-dry	1	11/2/2021
delta-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
Dieldrin	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endosulfan I	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endosulfan II	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endosulfan sulfate	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endrin	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endrin aldehyde	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endrin ketone	ND	0.0019		mg/Kg-dry	1	11/2/2021
gamma-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
gamma-Chlordane	ND	0.0019		mg/Kg-dry	1	11/2/2021
Heptachlor	ND	0.0019		mg/Kg-dry	1	11/2/2021
Heptachlor epoxide	ND	0.0019		mg/Kg-dry	1	11/2/2021
Methoxychlor	ND	0.0019		mg/Kg-dry	1	11/2/2021
Toxaphene	ND	0.039		mg/Kg-dry	1	11/2/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Aluminum	3500	22		mg/Kg-dry	10	11/8/2021
Antimony	ND	2.2		mg/Kg-dry	10	11/8/2021
Arsenic	3.6	1.1		mg/Kg-dry	10	11/8/2021
Barium	31	1.1		mg/Kg-dry	10	11/8/2021
Beryllium	ND	0.55		mg/Kg-dry	10	11/8/2021
Cadmium	ND	0.55		mg/Kg-dry	10	11/8/2021
Calcium	73000	66		mg/Kg-dry	10	11/8/2021
Chromium	8.5	1.1		mg/Kg-dry	10	11/8/2021
Cobalt	22	1.1		mg/Kg-dry	10	11/8/2021
Copper	48	2.8		mg/Kg-dry	10	11/8/2021
Iron	8100	33		mg/Kg-dry	10	11/8/2021
Lead	210	0.55		mg/Kg-dry	10	11/8/2021
Magnesium	31000	33		mg/Kg-dry	10	11/8/2021
Manganese	400	1.1		mg/Kg-dry	10	11/8/2021
Nickel	12	1.1		mg/Kg-dry	10	11/8/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-002

Client Sample ID: B-2-1
Collection Date: 11/1/2021 10:15:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Potassium	610	33		mg/Kg-dry	10	11/8/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/8/2021
Silver	1.6	1.1		mg/Kg-dry	10	11/8/2021
Sodium	860	66		mg/Kg-dry	10	11/8/2021
Thallium	ND	1.1		mg/Kg-dry	10	11/8/2021
Vanadium	12	1.1		mg/Kg-dry	10	11/8/2021
Zinc	170	5.5		mg/Kg-dry	10	11/8/2021
Mercury	**SW7471B**			Prep Date: **11/5/2021**		Analyst: **LB**
Mercury	1.5	0.063		mg/Kg-dry	3	11/9/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/3/2021**		Analyst: **MD**
Cyanide	ND	0.59		mg/Kg-dry	1	11/4/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/12/2021**		Analyst: **RW**
pH	9.83			pH Units	1	11/12/2021
Percent Moisture	**D2974**			Prep Date: **11/5/2021**		Analyst: **HYM**
Percent Moisture	14.8	0.2	*	wt%	1	11/5/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-003

Client Sample ID: B-3-1
Collection Date: 11/1/2021 11:00:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/2/2021**		Analyst: **CZ**
Acetone	ND	0.086		mg/Kg-dry	1	11/12/2021
Benzene	ND	0.0057		mg/Kg-dry	1	11/12/2021
Bromodichloromethane	ND	0.0057		mg/Kg-dry	1	11/12/2021
Bromoform	ND	0.0057		mg/Kg-dry	1	11/12/2021
Bromomethane	ND	0.011		mg/Kg-dry	1	11/12/2021
2-Butanone	ND	0.086		mg/Kg-dry	1	11/12/2021
Carbon disulfide	ND	0.057		mg/Kg-dry	1	11/12/2021
Carbon tetrachloride	ND	0.0057		mg/Kg-dry	1	11/12/2021
Chlorobenzene	ND	0.0057		mg/Kg-dry	1	11/12/2021
Chloroethane	ND	0.011		mg/Kg-dry	1	11/12/2021
Chloroform	ND	0.0057		mg/Kg-dry	1	11/12/2021
Chloromethane	ND	0.011		mg/Kg-dry	1	11/12/2021
Dibromochloromethane	ND	0.0057		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethane	ND	0.0057		mg/Kg-dry	1	11/12/2021
1,2-Dichloroethane	ND	0.0057		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethene	ND	0.0057		mg/Kg-dry	1	11/12/2021
cis-1,2-Dichloroethene	ND	0.0057		mg/Kg-dry	1	11/12/2021
trans-1,2-Dichloroethene	ND	0.0057		mg/Kg-dry	1	11/12/2021
1,2-Dichloropropane	ND	0.0057		mg/Kg-dry	1	11/12/2021
cis-1,3-Dichloropropene	ND	0.0023		mg/Kg-dry	1	11/12/2021
trans-1,3-Dichloropropene	ND	0.0023		mg/Kg-dry	1	11/12/2021
Ethylbenzene	ND	0.0057		mg/Kg-dry	1	11/12/2021
2-Hexanone	ND	0.023		mg/Kg-dry	1	11/12/2021
4-Methyl-2-pentanone	ND	0.023		mg/Kg-dry	1	11/12/2021
Methylene chloride	ND	0.011		mg/Kg-dry	1	11/12/2021
Methyl tert-butyl ether	ND	0.0057		mg/Kg-dry	1	11/12/2021
Styrene	ND	0.0057		mg/Kg-dry	1	11/12/2021
1,1,2,2-Tetrachloroethane	ND	0.0057		mg/Kg-dry	1	11/12/2021
Tetrachloroethene	ND	0.0057		mg/Kg-dry	1	11/12/2021
Toluene	ND	0.0057		mg/Kg-dry	1	11/12/2021
1,1,1-Trichloroethane	ND	0.0057		mg/Kg-dry	1	11/12/2021
1,1,2-Trichloroethane	ND	0.0057		mg/Kg-dry	1	11/12/2021
Trichloroethene	ND	0.0057		mg/Kg-dry	1	11/12/2021
Vinyl chloride	ND	0.0057		mg/Kg-dry	1	11/12/2021
Xylenes, Total	ND	0.017		mg/Kg-dry	1	11/12/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Acenaphthene	2.3	0.035		mg/Kg-dry	1	11/5/2021
Acenaphthylene	0.22	0.035		mg/Kg-dry	1	11/5/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-003

Client Sample ID: B-3-1
Collection Date: 11/1/2021 11:00:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Aniline	ND	0.35		mg/Kg-dry	1	11/5/2021
Anthracene	10	0.35		mg/Kg-dry	10	11/8/2021
Benz(a)anthracene	21	0.35		mg/Kg-dry	10	11/8/2021
Benzidine	ND	0.35		mg/Kg-dry	1	11/5/2021
Benzo(a)pyrene	19	0.35		mg/Kg-dry	10	11/8/2021
Benzo(b)fluoranthene	16	0.35		mg/Kg-dry	10	11/8/2021
Benzo(g,h,i)perylene	11	0.35		mg/Kg-dry	10	11/8/2021
Benzo(k)fluoranthene	14	0.35		mg/Kg-dry	10	11/8/2021
Benzoic acid	ND	0.88		mg/Kg-dry	1	11/5/2021
Benzyl alcohol	ND	0.18		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethoxy)methane	ND	0.18		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethyl)ether	ND	0.18		mg/Kg-dry	1	11/5/2021
Bis(2-ethylhexyl)phthalate	ND	0.88		mg/Kg-dry	1	11/5/2021
4-Bromophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/5/2021
Butyl benzyl phthalate	ND	0.18		mg/Kg-dry	1	11/5/2021
Carbazole	0.84	0.18		mg/Kg-dry	1	11/5/2021
4-Chloroaniline	ND	0.18		mg/Kg-dry	1	11/5/2021
4-Chloro-3-methylphenol	ND	0.35		mg/Kg-dry	1	11/5/2021
2-Chloronaphthalene	ND	0.18		mg/Kg-dry	1	11/5/2021
2-Chlorophenol	ND	0.18		mg/Kg-dry	1	11/5/2021
4-Chlorophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/5/2021
Chrysene	18	0.35		mg/Kg-dry	10	11/8/2021
Dibenz(a,h)anthracene	5.1	0.35		mg/Kg-dry	10	11/8/2021
Dibenzofuran	1.6	0.18		mg/Kg-dry	1	11/5/2021
1,2-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/5/2021
1,3-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/5/2021
1,4-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/5/2021
3,3´-Dichlorobenzidine	ND	0.18		mg/Kg-dry	1	11/5/2021
2,4-Dichlorophenol	ND	0.18		mg/Kg-dry	1	11/5/2021
Diethyl phthalate	ND	0.18		mg/Kg-dry	1	11/5/2021
2,4-Dimethylphenol	ND	0.18		mg/Kg-dry	1	11/5/2021
Dimethyl phthalate	ND	0.18		mg/Kg-dry	1	11/5/2021
4,6-Dinitro-2-methylphenol	ND	0.35		mg/Kg-dry	1	11/5/2021
2,4-Dinitrophenol	ND	0.88		mg/Kg-dry	1	11/5/2021
2,4-Dinitrotoluene	ND	0.035		mg/Kg-dry	1	11/5/2021
2,6-Dinitrotoluene	ND	0.035		mg/Kg-dry	1	11/5/2021
Di-n-butyl phthalate	ND	0.18		mg/Kg-dry	1	11/5/2021
Di-n-octyl phthalate	ND	0.18		mg/Kg-dry	1	11/5/2021

	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
Qualifiers:	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client:	GSG Consultants, Inc.	**Client Sample ID:**	B-3-1
Work Order:	21110018 Revision 0	**Collection Date:**	11/1/2021 11:00:00 AM
Project:	State & Lake, Chicago	**Matrix:**	Soil
Lab ID:	21110018-003		

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Fluoranthene	44	1.7		mg/Kg-dry	50	11/9/2021
Fluorene	2.8	0.035		mg/Kg-dry	1	11/5/2021
Hexachlorobenzene	ND	0.18		mg/Kg-dry	1	11/5/2021
Hexachlorobutadiene	ND	0.18		mg/Kg-dry	1	11/5/2021
Hexachlorocyclopentadiene	ND	0.18		mg/Kg-dry	1	11/5/2021
Hexachloroethane	ND	0.18		mg/Kg-dry	1	11/5/2021
Indeno(1,2,3-cd)pyrene	9.9	0.35		mg/Kg-dry	10	11/8/2021
Isophorone	ND	0.18		mg/Kg-dry	1	11/5/2021
2-Methylnaphthalene	0.35	0.18		mg/Kg-dry	1	11/5/2021
2-Methylphenol	ND	0.18		mg/Kg-dry	1	11/5/2021
4-Methylphenol	ND	0.18		mg/Kg-dry	1	11/5/2021
Naphthalene	0.34	0.035		mg/Kg-dry	1	11/5/2021
2-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/5/2021
3-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/5/2021
4-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/5/2021
2-Nitrophenol	ND	0.18		mg/Kg-dry	1	11/5/2021
4-Nitrophenol	ND	0.35		mg/Kg-dry	1	11/5/2021
Nitrobenzene	ND	0.035		mg/Kg-dry	1	11/5/2021
N-Nitrosodi-n-propylamine	ND	0.035		mg/Kg-dry	1	11/5/2021
N-Nitrosodimethylamine	ND	0.18		mg/Kg-dry	1	11/5/2021
N-Nitrosodiphenylamine	ND	0.035		mg/Kg-dry	1	11/5/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.18		mg/Kg-dry	1	11/5/2021
Pentachlorophenol	ND	0.035		mg/Kg-dry	1	11/5/2021
Phenanthrene	36	0.35		mg/Kg-dry	10	11/8/2021
Phenol	ND	0.18		mg/Kg-dry	1	11/5/2021
Pyrene	44	0.35		mg/Kg-dry	10	11/8/2021
Pyridine	ND	0.71		mg/Kg-dry	1	11/5/2021
1,2,4-Trichlorobenzene	ND	0.18		mg/Kg-dry	1	11/5/2021
2,4,5-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/5/2021
2,4,6-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/5/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.085		mg/Kg-dry	1	11/2/2021
Aroclor 1221	ND	0.085		mg/Kg-dry	1	11/2/2021
Aroclor 1232	ND	0.085		mg/Kg-dry	1	11/2/2021
Aroclor 1242	ND	0.085		mg/Kg-dry	1	11/2/2021
Aroclor 1248	ND	0.085		mg/Kg-dry	1	11/2/2021
Aroclor 1254	ND	0.085		mg/Kg-dry	1	11/2/2021
Aroclor 1260	ND	0.085		mg/Kg-dry	1	11/2/2021

	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
Qualifiers:	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-003

Client Sample ID: B-3-1
Collection Date: 11/1/2021 11:00:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0017		mg/Kg-dry	1	11/2/2021
4,4´-DDE	ND	0.0017		mg/Kg-dry	1	11/2/2021
4,4´-DDT	ND	0.0017		mg/Kg-dry	1	11/2/2021
Aldrin	ND	0.0017		mg/Kg-dry	1	11/2/2021
alpha-BHC	ND	0.0017		mg/Kg-dry	1	11/2/2021
alpha-Chlordane	ND	0.0017		mg/Kg-dry	1	11/2/2021
beta-BHC	ND	0.0017		mg/Kg-dry	1	11/2/2021
Chlordane	ND	0.017		mg/Kg-dry	1	11/2/2021
delta-BHC	ND	0.0017		mg/Kg-dry	1	11/2/2021
Dieldrin	ND	0.0017		mg/Kg-dry	1	11/2/2021
Endosulfan I	ND	0.0017		mg/Kg-dry	1	11/2/2021
Endosulfan II	ND	0.0017		mg/Kg-dry	1	11/2/2021
Endosulfan sulfate	ND	0.0017		mg/Kg-dry	1	11/2/2021
Endrin	ND	0.0017		mg/Kg-dry	1	11/2/2021
Endrin aldehyde	ND	0.0017		mg/Kg-dry	1	11/2/2021
Endrin ketone	ND	0.0017		mg/Kg-dry	1	11/2/2021
gamma-BHC	ND	0.0017		mg/Kg-dry	1	11/2/2021
gamma-Chlordane	ND	0.0017		mg/Kg-dry	1	11/2/2021
Heptachlor	ND	0.0017		mg/Kg-dry	1	11/2/2021
Heptachlor epoxide	ND	0.0017		mg/Kg-dry	1	11/2/2021
Methoxychlor	ND	0.0017		mg/Kg-dry	1	11/2/2021
Toxaphene	ND	0.035		mg/Kg-dry	1	11/2/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Aluminum	1800	20		mg/Kg-dry	10	11/8/2021
Antimony	ND	2.0		mg/Kg-dry	10	11/8/2021
Arsenic	3.0	1.0		mg/Kg-dry	10	11/8/2021
Barium	15	1.0		mg/Kg-dry	10	11/8/2021
Beryllium	ND	0.50		mg/Kg-dry	10	11/8/2021
Cadmium	ND	0.50		mg/Kg-dry	10	11/8/2021
Calcium	66000	60		mg/Kg-dry	10	11/8/2021
Chromium	4.1	1.0		mg/Kg-dry	10	11/8/2021
Cobalt	9.0	1.0		mg/Kg-dry	10	11/8/2021
Copper	13	2.5		mg/Kg-dry	10	11/8/2021
Iron	7100	30		mg/Kg-dry	10	11/8/2021
Lead	31	0.50		mg/Kg-dry	10	11/8/2021
Magnesium	32000	30		mg/Kg-dry	10	11/8/2021
Manganese	270	1.0		mg/Kg-dry	10	11/8/2021
Nickel	5.6	1.0		mg/Kg-dry	10	11/8/2021

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018   Revision   0
Project: State & Lake, Chicago
Lab ID: 21110018-003

Client Sample ID: B-3-1
Collection Date: 11/1/2021 11:00:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Potassium	380	30		mg/Kg-dry	10	11/8/2021
Selenium	ND	1.0		mg/Kg-dry	10	11/8/2021
Silver	ND	1.0		mg/Kg-dry	10	11/8/2021
Sodium	1000	60		mg/Kg-dry	10	11/8/2021
Thallium	ND	1.0		mg/Kg-dry	10	11/8/2021
Vanadium	8.3	1.0		mg/Kg-dry	10	11/8/2021
Zinc	41	5.0		mg/Kg-dry	10	11/8/2021
Mercury	**SW7471B**			Prep Date: **11/5/2021**		Analyst: **LB**
Mercury	0.18	0.016		mg/Kg-dry	1	11/9/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/3/2021**		Analyst: **MD**
Cyanide	ND	0.53		mg/Kg-dry	1	11/4/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/12/2021**		Analyst: **RW**
pH	9.38			pH Units	1	11/12/2021
Percent Moisture	**D2974**			Prep Date: **11/5/2021**		Analyst: **HYM**
Percent Moisture	5.8	0.2	*	wt%	1	11/5/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-004

Client Sample ID: B-4-1
Collection Date: 11/1/2021 12:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/2/2021**		Analyst: **CZ**
Acetone	ND	0.093		mg/Kg-dry	1	11/12/2021
Benzene	ND	0.0062		mg/Kg-dry	1	11/12/2021
Bromodichloromethane	ND	0.0062		mg/Kg-dry	1	11/12/2021
Bromoform	ND	0.0062		mg/Kg-dry	1	11/12/2021
Bromomethane	ND	0.012		mg/Kg-dry	1	11/12/2021
2-Butanone	ND	0.093		mg/Kg-dry	1	11/12/2021
Carbon disulfide	ND	0.062		mg/Kg-dry	1	11/12/2021
Carbon tetrachloride	ND	0.0062		mg/Kg-dry	1	11/12/2021
Chlorobenzene	ND	0.0062		mg/Kg-dry	1	11/12/2021
Chloroethane	ND	0.012		mg/Kg-dry	1	11/12/2021
Chloroform	ND	0.0062		mg/Kg-dry	1	11/12/2021
Chloromethane	ND	0.012		mg/Kg-dry	1	11/12/2021
Dibromochloromethane	ND	0.0062		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethane	ND	0.0062		mg/Kg-dry	1	11/12/2021
1,2-Dichloroethane	ND	0.0062		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethene	ND	0.0062		mg/Kg-dry	1	11/12/2021
cis-1,2-Dichloroethene	ND	0.0062		mg/Kg-dry	1	11/12/2021
trans-1,2-Dichloroethene	ND	0.0062		mg/Kg-dry	1	11/12/2021
1,2-Dichloropropane	ND	0.0062		mg/Kg-dry	1	11/12/2021
cis-1,3-Dichloropropene	ND	0.0025		mg/Kg-dry	1	11/12/2021
trans-1,3-Dichloropropene	ND	0.0025		mg/Kg-dry	1	11/12/2021
Ethylbenzene	ND	0.0062		mg/Kg-dry	1	11/12/2021
2-Hexanone	ND	0.025		mg/Kg-dry	1	11/12/2021
4-Methyl-2-pentanone	ND	0.025		mg/Kg-dry	1	11/12/2021
Methylene chloride	ND	0.012		mg/Kg-dry	1	11/12/2021
Methyl tert-butyl ether	ND	0.0062		mg/Kg-dry	1	11/12/2021
Styrene	ND	0.0062		mg/Kg-dry	1	11/12/2021
1,1,2,2-Tetrachloroethane	ND	0.0062		mg/Kg-dry	1	11/12/2021
Tetrachloroethene	ND	0.0062		mg/Kg-dry	1	11/12/2021
Toluene	ND	0.0062		mg/Kg-dry	1	11/12/2021
1,1,1-Trichloroethane	ND	0.0062		mg/Kg-dry	1	11/12/2021
1,1,2-Trichloroethane	ND	0.0062		mg/Kg-dry	1	11/12/2021
Trichloroethene	ND	0.0062		mg/Kg-dry	1	11/12/2021
Vinyl chloride	ND	0.0062		mg/Kg-dry	1	11/12/2021
Xylenes, Total	ND	0.019		mg/Kg-dry	1	11/12/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Acenaphthene	1.1	0.038		mg/Kg-dry	1	11/5/2021
Acenaphthylene	0.51	0.038		mg/Kg-dry	1	11/5/2021

	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
Qualifiers:	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-004

Client Sample ID: B-4-1
Collection Date: 11/1/2021 12:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Aniline	ND	0.38		mg/Kg-dry	1	11/5/2021
Anthracene	3.7	0.038		mg/Kg-dry	1	11/5/2021
Benz(a)anthracene	11	0.19		mg/Kg-dry	5	11/8/2021
Benzidine	ND	0.38		mg/Kg-dry	1	11/5/2021
Benzo(a)pyrene	9.1	0.19		mg/Kg-dry	5	11/8/2021
Benzo(b)fluoranthene	7.7	0.19		mg/Kg-dry	5	11/8/2021
Benzo(g,h,i)perylene	4.5	0.038		mg/Kg-dry	1	11/5/2021
Benzo(k)fluoranthene	7.1	0.19		mg/Kg-dry	5	11/8/2021
Benzoic acid	ND	0.95		mg/Kg-dry	1	11/5/2021
Benzyl alcohol	ND	0.19		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethoxy)methane	ND	0.19		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethyl)ether	ND	0.19		mg/Kg-dry	1	11/5/2021
Bis(2-ethylhexyl)phthalate	ND	0.95		mg/Kg-dry	1	11/5/2021
4-Bromophenyl phenyl ether	ND	0.19		mg/Kg-dry	1	11/5/2021
Butyl benzyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
Carbazole	0.29	0.19		mg/Kg-dry	1	11/5/2021
4-Chloroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Chloro-3-methylphenol	ND	0.38		mg/Kg-dry	1	11/5/2021
2-Chloronaphthalene	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Chlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Chlorophenyl phenyl ether	ND	0.19		mg/Kg-dry	1	11/5/2021
Chrysene	9.0	0.19		mg/Kg-dry	5	11/8/2021
Dibenz(a,h)anthracene	2.5	0.038		mg/Kg-dry	1	11/5/2021
Dibenzofuran	0.61	0.19		mg/Kg-dry	1	11/5/2021
1,2-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
1,3-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
1,4-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
3,3´-Dichlorobenzidine	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4-Dichlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Diethyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4-Dimethylphenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Dimethyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
4,6-Dinitro-2-methylphenol	ND	0.38		mg/Kg-dry	1	11/5/2021
2,4-Dinitrophenol	ND	0.95		mg/Kg-dry	1	11/5/2021
2,4-Dinitrotoluene	ND	0.038		mg/Kg-dry	1	11/5/2021
2,6-Dinitrotoluene	ND	0.038		mg/Kg-dry	1	11/5/2021
Di-n-butyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021
Di-n-octyl phthalate	ND	0.19		mg/Kg-dry	1	11/5/2021

Qualifiers:		
	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-004

Client Sample ID: B-4-1
Collection Date: 11/1/2021 12:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Fluoranthene	20	0.19		mg/Kg-dry	5	11/8/2021
Fluorene	1.3	0.038		mg/Kg-dry	1	11/5/2021
Hexachlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
Hexachlorobutadiene	ND	0.19		mg/Kg-dry	1	11/5/2021
Hexachlorocyclopentadiene	ND	0.19		mg/Kg-dry	1	11/5/2021
Hexachloroethane	ND	0.19		mg/Kg-dry	1	11/5/2021
Indeno(1,2,3-cd)pyrene	4.6	0.038		mg/Kg-dry	1	11/5/2021
Isophorone	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Methylnaphthalene	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Methylphenol	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Methylphenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Naphthalene	0.20	0.038		mg/Kg-dry	1	11/5/2021
2-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
3-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/5/2021
2-Nitrophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
4-Nitrophenol	ND	0.38		mg/Kg-dry	1	11/5/2021
Nitrobenzene	ND	0.038		mg/Kg-dry	1	11/5/2021
N-Nitrosodi-n-propylamine	ND	0.038		mg/Kg-dry	1	11/5/2021
N-Nitrosodimethylamine	ND	0.19		mg/Kg-dry	1	11/5/2021
N-Nitrosodiphenylamine	ND	0.038		mg/Kg-dry	1	11/5/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.19		mg/Kg-dry	1	11/5/2021
Pentachlorophenol	ND	0.038		mg/Kg-dry	1	11/5/2021
Phenanthrene	13	0.19		mg/Kg-dry	5	11/8/2021
Phenol	ND	0.19		mg/Kg-dry	1	11/5/2021
Pyrene	18	0.19		mg/Kg-dry	5	11/8/2021
Pyridine	ND	0.77		mg/Kg-dry	1	11/5/2021
1,2,4-Trichlorobenzene	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4,5-Trichlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
2,4,6-Trichlorophenol	ND	0.19		mg/Kg-dry	1	11/5/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.092		mg/Kg-dry	1	11/2/2021
Aroclor 1221	ND	0.092		mg/Kg-dry	1	11/2/2021
Aroclor 1232	ND	0.092		mg/Kg-dry	1	11/2/2021
Aroclor 1242	ND	0.092		mg/Kg-dry	1	11/2/2021
Aroclor 1248	ND	0.092		mg/Kg-dry	1	11/2/2021
Aroclor 1254	ND	0.092		mg/Kg-dry	1	11/2/2021
Aroclor 1260	ND	0.092		mg/Kg-dry	1	11/2/2021

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Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-004

Client Sample ID: B-4-1
Collection Date: 11/1/2021 12:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0018		mg/Kg-dry	1	11/2/2021
4,4´-DDE	ND	0.0018		mg/Kg-dry	1	11/2/2021
4,4´-DDT	ND	0.0018		mg/Kg-dry	1	11/2/2021
Aldrin	ND	0.0018		mg/Kg-dry	1	11/2/2021
alpha-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
alpha-Chlordane	ND	0.0018		mg/Kg-dry	1	11/2/2021
beta-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
Chlordane	ND	0.018		mg/Kg-dry	1	11/2/2021
delta-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
Dieldrin	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endosulfan I	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endosulfan II	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endosulfan sulfate	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endrin	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endrin aldehyde	ND	0.0018		mg/Kg-dry	1	11/2/2021
Endrin ketone	ND	0.0018		mg/Kg-dry	1	11/2/2021
gamma-BHC	ND	0.0018		mg/Kg-dry	1	11/2/2021
gamma-Chlordane	ND	0.0018		mg/Kg-dry	1	11/2/2021
Heptachlor	ND	0.0018		mg/Kg-dry	1	11/2/2021
Heptachlor epoxide	ND	0.0018		mg/Kg-dry	1	11/2/2021
Methoxychlor	ND	0.0018		mg/Kg-dry	1	11/2/2021
Toxaphene	ND	0.038		mg/Kg-dry	1	11/2/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Aluminum	2200	21		mg/Kg-dry	10	11/8/2021
Antimony	ND	2.1		mg/Kg-dry	10	11/8/2021
Arsenic	4.3	1.1		mg/Kg-dry	10	11/8/2021
Barium	57	1.1		mg/Kg-dry	10	11/8/2021
Beryllium	ND	0.53		mg/Kg-dry	10	11/8/2021
Cadmium	ND	0.53		mg/Kg-dry	10	11/8/2021
Calcium	87000	63		mg/Kg-dry	10	11/8/2021
Chromium	6.0	1.1		mg/Kg-dry	10	11/8/2021
Cobalt	6.4	1.1		mg/Kg-dry	10	11/8/2021
Copper	54	2.6		mg/Kg-dry	10	11/8/2021
Iron	7100	32		mg/Kg-dry	10	11/8/2021
Lead	260	0.53		mg/Kg-dry	10	11/8/2021
Magnesium	44000	32		mg/Kg-dry	10	11/8/2021
Manganese	280	1.1		mg/Kg-dry	10	11/8/2021
Nickel	7.5	1.1		mg/Kg-dry	10	11/8/2021

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-004

Client Sample ID: B-4-1
Collection Date: 11/1/2021 12:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Potassium	530	32		mg/Kg-dry	10	11/8/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/8/2021
Silver	ND	1.1		mg/Kg-dry	10	11/8/2021
Sodium	600	63		mg/Kg-dry	10	11/8/2021
Thallium	ND	1.1		mg/Kg-dry	10	11/8/2021
Vanadium	9.9	1.1		mg/Kg-dry	10	11/8/2021
Zinc	130	5.3		mg/Kg-dry	10	11/8/2021
Mercury	**SW7471B**			Prep Date: **11/5/2021**		Analyst: **LB**
Mercury	0.54	0.022		mg/Kg-dry	1	11/9/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/3/2021**		Analyst: **MD**
Cyanide	ND	0.58		mg/Kg-dry	1	11/4/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/12/2021**		Analyst: **RW**
pH	10.6			pH Units	1	11/12/2021
Percent Moisture	**D2974**			Prep Date: **11/5/2021**		Analyst: **HYM**
Percent Moisture	13.3	0.2	*	wt%	1	11/5/2021

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* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-005

Client Sample ID: B-9-1
Collection Date: 11/1/2021 1:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/2/2021**		Analyst: **CZ**
Acetone	ND	0.082		mg/Kg-dry	1	11/12/2021
Benzene	ND	0.0055		mg/Kg-dry	1	11/12/2021
Bromodichloromethane	ND	0.0055		mg/Kg-dry	1	11/12/2021
Bromoform	ND	0.0055		mg/Kg-dry	1	11/12/2021
Bromomethane	ND	0.011		mg/Kg-dry	1	11/12/2021
2-Butanone	ND	0.082		mg/Kg-dry	1	11/12/2021
Carbon disulfide	ND	0.055		mg/Kg-dry	1	11/12/2021
Carbon tetrachloride	ND	0.0055		mg/Kg-dry	1	11/12/2021
Chlorobenzene	ND	0.0055		mg/Kg-dry	1	11/12/2021
Chloroethane	ND	0.011		mg/Kg-dry	1	11/12/2021
Chloroform	ND	0.0055		mg/Kg-dry	1	11/12/2021
Chloromethane	ND	0.011		mg/Kg-dry	1	11/12/2021
Dibromochloromethane	ND	0.0055		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethane	ND	0.0055		mg/Kg-dry	1	11/12/2021
1,2-Dichloroethane	ND	0.0055		mg/Kg-dry	1	11/12/2021
1,1-Dichloroethene	ND	0.0055		mg/Kg-dry	1	11/12/2021
cis-1,2-Dichloroethene	ND	0.0055		mg/Kg-dry	1	11/12/2021
trans-1,2-Dichloroethene	ND	0.0055		mg/Kg-dry	1	11/12/2021
1,2-Dichloropropane	ND	0.0055		mg/Kg-dry	1	11/12/2021
cis-1,3-Dichloropropene	ND	0.0022		mg/Kg-dry	1	11/12/2021
trans-1,3-Dichloropropene	ND	0.0022		mg/Kg-dry	1	11/12/2021
Ethylbenzene	ND	0.0055		mg/Kg-dry	1	11/12/2021
2-Hexanone	ND	0.022		mg/Kg-dry	1	11/12/2021
4-Methyl-2-pentanone	ND	0.022		mg/Kg-dry	1	11/12/2021
Methylene chloride	ND	0.011		mg/Kg-dry	1	11/12/2021
Methyl tert-butyl ether	ND	0.0055		mg/Kg-dry	1	11/12/2021
Styrene	ND	0.0055		mg/Kg-dry	1	11/12/2021
1,1,2,2-Tetrachloroethane	ND	0.0055		mg/Kg-dry	1	11/12/2021
Tetrachloroethene	ND	0.0055		mg/Kg-dry	1	11/12/2021
Toluene	ND	0.0055		mg/Kg-dry	1	11/12/2021
1,1,1-Trichloroethane	ND	0.0055		mg/Kg-dry	1	11/12/2021
1,1,2-Trichloroethane	ND	0.0055		mg/Kg-dry	1	11/12/2021
Trichloroethene	ND	0.0055		mg/Kg-dry	1	11/12/2021
Vinyl chloride	ND	0.0055		mg/Kg-dry	1	11/12/2021
Xylenes, Total	ND	0.016		mg/Kg-dry	1	11/12/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Acenaphthene	ND	0.038		mg/Kg-dry	1	11/5/2021
Acenaphthylene	ND	0.038		mg/Kg-dry	1	11/5/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
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Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-005

Client Sample ID: B-9-1
Collection Date: 11/1/2021 1:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Aniline	ND	0.39		mg/Kg-dry	1	11/5/2021
Anthracene	ND	0.038		mg/Kg-dry	1	11/5/2021
Benz(a)anthracene	0.074	0.038		mg/Kg-dry	1	11/5/2021
Benzidine	ND	0.38		mg/Kg-dry	1	11/5/2021
Benzo(a)pyrene	0.059	0.038		mg/Kg-dry	1	11/5/2021
Benzo(b)fluoranthene	0.053	0.038		mg/Kg-dry	1	11/5/2021
Benzo(g,h,i)perylene	ND	0.038		mg/Kg-dry	1	11/5/2021
Benzo(k)fluoranthene	0.069	0.038		mg/Kg-dry	1	11/5/2021
Benzoic acid	ND	0.97		mg/Kg-dry	1	11/5/2021
Benzyl alcohol	ND	0.20		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethoxy)methane	ND	0.20		mg/Kg-dry	1	11/5/2021
Bis(2-chloroethyl)ether	ND	0.20		mg/Kg-dry	1	11/5/2021
Bis(2-ethylhexyl)phthalate	ND	0.97		mg/Kg-dry	1	11/5/2021
4-Bromophenyl phenyl ether	ND	0.20		mg/Kg-dry	1	11/5/2021
Butyl benzyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
Carbazole	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Chloroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Chloro-3-methylphenol	ND	0.38		mg/Kg-dry	1	11/5/2021
2-Chloronaphthalene	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Chlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Chlorophenyl phenyl ether	ND	0.20		mg/Kg-dry	1	11/5/2021
Chrysene	0.068	0.038		mg/Kg-dry	1	11/5/2021
Dibenz(a,h)anthracene	ND	0.038		mg/Kg-dry	1	11/5/2021
Dibenzofuran	ND	0.20		mg/Kg-dry	1	11/5/2021
1,2-Dichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
1,3-Dichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
1,4-Dichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
3,3´-Dichlorobenzidine	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4-Dichlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Diethyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4-Dimethylphenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Dimethyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
4,6-Dinitro-2-methylphenol	ND	0.38		mg/Kg-dry	1	11/5/2021
2,4-Dinitrophenol	ND	0.97		mg/Kg-dry	1	11/5/2021
2,4-Dinitrotoluene	ND	0.038		mg/Kg-dry	1	11/5/2021
2,6-Dinitrotoluene	ND	0.038		mg/Kg-dry	1	11/5/2021
Di-n-butyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021
Di-n-octyl phthalate	ND	0.20		mg/Kg-dry	1	11/5/2021

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-005

Client Sample ID: B-9-1
Collection Date: 11/1/2021 1:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/4/2021**		Analyst: **TEM**
Fluoranthene	0.16	0.038		mg/Kg-dry	1	11/5/2021
Fluorene	ND	0.038		mg/Kg-dry	1	11/5/2021
Hexachlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
Hexachlorobutadiene	ND	0.20		mg/Kg-dry	1	11/5/2021
Hexachlorocyclopentadiene	ND	0.20		mg/Kg-dry	1	11/5/2021
Hexachloroethane	ND	0.20		mg/Kg-dry	1	11/5/2021
Indeno(1,2,3-cd)pyrene	0.042	0.038		mg/Kg-dry	1	11/5/2021
Isophorone	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Methylnaphthalene	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Methylphenol	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Methylphenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Naphthalene	ND	0.038		mg/Kg-dry	1	11/5/2021
2-Nitroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
3-Nitroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Nitroaniline	ND	0.20		mg/Kg-dry	1	11/5/2021
2-Nitrophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
4-Nitrophenol	ND	0.38		mg/Kg-dry	1	11/5/2021
Nitrobenzene	ND	0.038		mg/Kg-dry	1	11/5/2021
N-Nitrosodi-n-propylamine	ND	0.038		mg/Kg-dry	1	11/5/2021
N-Nitrosodimethylamine	ND	0.20		mg/Kg-dry	1	11/5/2021
N-Nitrosodiphenylamine	ND	0.038		mg/Kg-dry	1	11/5/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.20		mg/Kg-dry	1	11/5/2021
Pentachlorophenol	ND	0.038		mg/Kg-dry	1	11/5/2021
Phenanthrene	0.079	0.038		mg/Kg-dry	1	11/5/2021
Phenol	ND	0.20		mg/Kg-dry	1	11/5/2021
Pyrene	0.12	0.038		mg/Kg-dry	1	11/5/2021
Pyridine	ND	0.78		mg/Kg-dry	1	11/5/2021
1,2,4-Trichlorobenzene	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4,5-Trichlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
2,4,6-Trichlorophenol	ND	0.20		mg/Kg-dry	1	11/5/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1221	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1232	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1242	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1248	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1254	ND	0.094		mg/Kg-dry	1	11/2/2021
Aroclor 1260	ND	0.094		mg/Kg-dry	1	11/2/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-005

Client Sample ID: B-9-1
Collection Date: 11/1/2021 1:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/2/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0019		mg/Kg-dry	1	11/2/2021
4,4´-DDE	ND	0.0019		mg/Kg-dry	1	11/2/2021
4,4´-DDT	ND	0.0019		mg/Kg-dry	1	11/2/2021
Aldrin	ND	0.0019		mg/Kg-dry	1	11/2/2021
alpha-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
alpha-Chlordane	ND	0.0019		mg/Kg-dry	1	11/2/2021
beta-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
Chlordane	ND	0.019		mg/Kg-dry	1	11/2/2021
delta-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
Dieldrin	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endosulfan I	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endosulfan II	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endosulfan sulfate	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endrin	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endrin aldehyde	ND	0.0019		mg/Kg-dry	1	11/2/2021
Endrin ketone	ND	0.0019		mg/Kg-dry	1	11/2/2021
gamma-BHC	ND	0.0019		mg/Kg-dry	1	11/2/2021
gamma-Chlordane	ND	0.0019		mg/Kg-dry	1	11/2/2021
Heptachlor	ND	0.0019		mg/Kg-dry	1	11/2/2021
Heptachlor epoxide	ND	0.0019		mg/Kg-dry	1	11/2/2021
Methoxychlor	ND	0.0019		mg/Kg-dry	1	11/2/2021
Toxaphene	ND	0.039		mg/Kg-dry	1	11/2/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Aluminum	4700	21		mg/Kg-dry	10	11/8/2021
Antimony	ND	2.1		mg/Kg-dry	10	11/8/2021
Arsenic	8.4	1.0		mg/Kg-dry	10	11/8/2021
Barium	47	1.0		mg/Kg-dry	10	11/8/2021
Beryllium	ND	0.52		mg/Kg-dry	10	11/8/2021
Cadmium	0.80	0.52		mg/Kg-dry	10	11/8/2021
Calcium	31000	63		mg/Kg-dry	10	11/8/2021
Chromium	11	1.0		mg/Kg-dry	10	11/8/2021
Cobalt	88	1.0		mg/Kg-dry	10	11/8/2021
Copper	23	2.6		mg/Kg-dry	10	11/8/2021
Iron	14000	31		mg/Kg-dry	10	11/8/2021
Lead	29	0.52		mg/Kg-dry	10	11/8/2021
Magnesium	12000	31		mg/Kg-dry	10	11/8/2021
Manganese	350	1.0		mg/Kg-dry	10	11/8/2021
Nickel	15	1.0		mg/Kg-dry	10	11/8/2021

Qualifiers:

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J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 16, 2021
Date Printed: November 16, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110018 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110018-005

Client Sample ID: B-9-1
Collection Date: 11/1/2021 1:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/8/2021**		Analyst: **JG**
Potassium	860	31		mg/Kg-dry	10	11/8/2021
Selenium	ND	1.0		mg/Kg-dry	10	11/8/2021
Silver	8.9	1.0		mg/Kg-dry	10	11/8/2021
Sodium	400	63		mg/Kg-dry	10	11/8/2021
Thallium	ND	1.0		mg/Kg-dry	10	11/8/2021
Vanadium	17	1.0		mg/Kg-dry	10	11/8/2021
Zinc	67	5.2		mg/Kg-dry	10	11/8/2021
Mercury	**SW7471B**			Prep Date: **11/5/2021**		Analyst: **LB**
Mercury	0.045	0.018		mg/Kg-dry	1	11/9/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/3/2021**		Analyst: **MD**
Cyanide	ND	0.59		mg/Kg-dry	1	11/4/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/12/2021**		Analyst: **RW**
pH	10.8			pH Units	1	11/12/2021
Percent Moisture	**D2974**			Prep Date: **11/5/2021**		Analyst: **HYM**
Percent Moisture	14.9	0.2	*	wt%	1	11/5/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

Nº: 930319

Page: 1 **of** 1

Company: GSG Consultants Inc
Project Number:
Client Tracking No.:
Project Name: State & Lake
Project Location: Chicago
Sampler(s): James Bravo
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants.c
QC Level: 1 ____ 2 ____ 3 ____ 4 ____

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 [✓ 5 - 7] 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	Target Compound List													Additional Information:	Lab No.:
B-1-1	11/1/202	0930	S		X		4	X														001
B-2-1	↑	1015	↑		X		4	X														002
B-3-1		1100			X		4	X														003
B-4-1	↓	1230	↓		X		4	X														004
B-9-1	11/1/2021	1330	S		X		4	X														005

Relinquished by: (Signature) Date/Time: 11/1/21
Received by: (Signature) Date/Time: 11/1/21 1531
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments:

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110018

Received on Ice: Yes ☑ No ☐

Temperature: On Ice °C

STAT Analysis Corporation

Sample Receipt Checklist

Client Name GSG

Work Order Number 21110018

Date and Time Received: 11/1/2021 3:31:00 PM

Received by: NAP

Checklist completed by: Signature | Date 11/1/21

Reviewed by: Initials | Date 11/2/21

Matrix:

Carrier name: Client Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels/containers?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container or Temp Blank temperature in compliance?	Yes ☑	No ☐	Temperature On Ice °C
Water - VOA vials have zero headspace?	No VOA vials submitted ☐	Yes ☐	No ☐
Water - Samples pH checked?	Yes ☐	No ☐	Checked by:
Water - Samples properly preserved?	Yes ☐	No ☐	pH Adjusted?

Any No response must be detailed in the comments section below.

Comments:

Client / Person contacted:

Date contacted:

Contacted by:

Response:

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditations: IEPA ELAP 100445; ORELAP IL300001; AIHA-LAP, LLC 101160; NVLAP LabCode 101202-0

November 17, 2021

GSG Consultants, Inc.
2942 W. Van Buren St.
Chicago, IL 60612
Telephone: (312) 733-6262
Fax: (312) 733-5612

Analytical Report for STAT Work Order: 21110192 Revision 0

RE: State & Lake, Chicago

Dear GSG Consultants, Inc.:

STAT Analysis received 6 samples for the referenced project on 11/4/2021 5:30:00 PM. The analytical results are presented in the following report.

All analyses were performed in accordance with the requirements of 35 IAC Part 186 / NELAP standards. Analyses were performed in accordance with methods as referenced on the analytical report. Those analytical results expressed on a dry weight basis are also noted on the analytical report.

All analyses were performed within established holding time criteria, and all Quality Control criteria met EPA or laboratory specifications except when noted in the Case Narrative or Analytical Report. If required, an estimate of uncertainty for the analyses can be provided. A listing of accredited methods/parameters can also be provided.

Thank you for the opportunity to serve you and I look forward to working with you in the future. If you have any questions regarding the enclosed materials, please contact me at (312) 733-0551.

Sincerely,

Justice Kwateng
Project Manager

Client: GSG Consultants, Inc.
Project: State & Lake, Chicago
Work Order: 21110192 Revision 0

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Tag Number	Collection Date	Date Received
21110192-001A	B-2-2		11/4/2021 12:15:00 PM	11/4/2021
21110192-001B	B-2-2		11/4/2021 12:15:00 PM	11/4/2021
21110192-002A	B-3-2		11/4/2021 12:30:00 PM	11/4/2021
21110192-002B	B-3-2		11/4/2021 12:30:00 PM	11/4/2021
21110192-003A	B-5-1		11/4/2021 1:40:00 PM	11/4/2021
21110192-003B	B-5-1		11/4/2021 1:40:00 PM	11/4/2021
21110192-004A	B-10-1		11/4/2021 1:50:00 PM	11/4/2021
21110192-004B	B-10-1		11/4/2021 1:50:00 PM	11/4/2021
21110192-005A	B-2-3		11/4/2021 2:00:00 PM	11/4/2021
21110192-005B	B-2-3		11/4/2021 2:00:00 PM	11/4/2021
21110192-006A	B-3-3		11/4/2021 2:15:00 PM	11/4/2021
21110192-006B	B-3-3		11/4/2021 2:15:00 PM	11/4/2021

CLIENT: GSG Consultants, Inc.
Project: State & Lake, Chicago
Work Order: 21110192 Revision 0

CASE NARRATIVE

The Total Metals Continuing Calibration Verification (CCV) had recovery of Antimony outside of control limits (88%, 87% recovery, QC limits 90-110%).

Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-001

Client Sample ID: B-2-2
Collection Date: 11/4/2021 12:15:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Acenaphthene	ND	0.041		mg/Kg-dry	1	11/9/2021
Acenaphthylene	ND	0.041		mg/Kg-dry	1	11/9/2021
Anthracene	ND	0.041		mg/Kg-dry	1	11/9/2021
Benz(a)anthracene	ND	0.041		mg/Kg-dry	1	11/9/2021
Benzo(a)pyrene	ND	0.041		mg/Kg-dry	1	11/9/2021
Benzo(b)fluoranthene	ND	0.041		mg/Kg-dry	1	11/9/2021
Benzo(g,h,i)perylene	ND	0.041		mg/Kg-dry	1	11/9/2021
Benzo(k)fluoranthene	ND	0.041		mg/Kg-dry	1	11/9/2021
Chrysene	ND	0.041		mg/Kg-dry	1	11/9/2021
Dibenz(a,h)anthracene	ND	0.041		mg/Kg-dry	1	11/9/2021
Fluoranthene	ND	0.041		mg/Kg-dry	1	11/9/2021
Fluorene	ND	0.041		mg/Kg-dry	1	11/9/2021
Indeno(1,2,3-cd)pyrene	ND	0.041		mg/Kg-dry	1	11/9/2021
Naphthalene	ND	0.041		mg/Kg-dry	1	11/9/2021
Phenanthrene	ND	0.041		mg/Kg-dry	1	11/9/2021
Pyrene	ND	0.041		mg/Kg-dry	1	11/9/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/10/2021**		Analyst: **JG**
Arsenic	3.7	1.2		mg/Kg-dry	10	11/10/2021
Barium	20	1.2		mg/Kg-dry	10	11/10/2021
Cadmium	ND	0.59		mg/Kg-dry	10	11/10/2021
Chromium	9.4	1.2		mg/Kg-dry	10	11/10/2021
Lead	6.3	0.59		mg/Kg-dry	10	11/10/2021
Selenium	ND	1.2		mg/Kg-dry	10	11/10/2021
Silver	ND	1.2		mg/Kg-dry	10	11/10/2021
Mercury	**SW7471B**			Prep Date: **11/10/2021**		Analyst: **LB**
Mercury	0.031	0.021		mg/Kg-dry	1	11/10/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/15/2021**		Analyst: **RW**
pH	8.79			pH Units	1	11/15/2021
Percent Moisture	**D2974**			Prep Date: **11/10/2021**		Analyst: **HYM**
Percent Moisture	18.8	0.2	*	wt%	1	11/11/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-002

Client Sample ID: B-3-2
Collection Date: 11/4/2021 12:30:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Acenaphthene	ND	0.039		mg/Kg-dry	1	11/9/2021
Acenaphthylene	ND	0.039		mg/Kg-dry	1	11/9/2021
Anthracene	ND	0.039		mg/Kg-dry	1	11/9/2021
Benz(a)anthracene	ND	0.039		mg/Kg-dry	1	11/9/2021
Benzo(a)pyrene	ND	0.039		mg/Kg-dry	1	11/9/2021
Benzo(b)fluoranthene	ND	0.039		mg/Kg-dry	1	11/9/2021
Benzo(g,h,i)perylene	ND	0.039		mg/Kg-dry	1	11/9/2021
Benzo(k)fluoranthene	ND	0.039		mg/Kg-dry	1	11/9/2021
Chrysene	ND	0.039		mg/Kg-dry	1	11/9/2021
Dibenz(a,h)anthracene	ND	0.039		mg/Kg-dry	1	11/9/2021
Fluoranthene	ND	0.039		mg/Kg-dry	1	11/9/2021
Fluorene	ND	0.039		mg/Kg-dry	1	11/9/2021
Indeno(1,2,3-cd)pyrene	ND	0.039		mg/Kg-dry	1	11/9/2021
Naphthalene	ND	0.039		mg/Kg-dry	1	11/9/2021
Phenanthrene	ND	0.039		mg/Kg-dry	1	11/9/2021
Pyrene	ND	0.039		mg/Kg-dry	1	11/9/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/10/2021**		Analyst: **JG**
Arsenic	3.0	1.1		mg/Kg-dry	10	11/10/2021
Barium	11	1.1		mg/Kg-dry	10	11/10/2021
Cadmium	ND	0.57		mg/Kg-dry	10	11/10/2021
Chromium	7.9	1.1		mg/Kg-dry	10	11/10/2021
Lead	6.0	0.57		mg/Kg-dry	10	11/10/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/10/2021
Silver	ND	1.1		mg/Kg-dry	10	11/10/2021
Mercury	**SW7471B**			Prep Date: **11/10/2021**		Analyst: **LB**
Mercury	ND	0.018		mg/Kg-dry	1	11/10/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/15/2021**		Analyst: **RW**
pH	8.38			pH Units	1	11/15/2021
Percent Moisture	**D2974**			Prep Date: **11/10/2021**		Analyst: **HYM**
Percent Moisture	15.0	0.2	*	wt%	1	11/11/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-003

Client Sample ID: B-5-1
Collection Date: 11/4/2021 1:40:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/5/2021**		Analyst: **TMB**
Acetone	ND	0.078		mg/Kg-dry	1	11/17/2021
Benzene	ND	0.0052		mg/Kg-dry	1	11/17/2021
Bromodichloromethane	ND	0.0052		mg/Kg-dry	1	11/17/2021
Bromoform	ND	0.0052		mg/Kg-dry	1	11/17/2021
Bromomethane	ND	0.010		mg/Kg-dry	1	11/17/2021
2-Butanone	ND	0.078		mg/Kg-dry	1	11/17/2021
Carbon disulfide	ND	0.052		mg/Kg-dry	1	11/17/2021
Carbon tetrachloride	ND	0.0052		mg/Kg-dry	1	11/17/2021
Chlorobenzene	ND	0.0052		mg/Kg-dry	1	11/17/2021
Chloroethane	ND	0.010		mg/Kg-dry	1	11/17/2021
Chloroform	ND	0.0052		mg/Kg-dry	1	11/17/2021
Chloromethane	ND	0.010		mg/Kg-dry	1	11/17/2021
Dibromochloromethane	ND	0.0052		mg/Kg-dry	1	11/17/2021
1,1-Dichloroethane	ND	0.0052		mg/Kg-dry	1	11/17/2021
1,2-Dichloroethane	ND	0.0052		mg/Kg-dry	1	11/17/2021
1,1-Dichloroethene	ND	0.0052		mg/Kg-dry	1	11/17/2021
cis-1,2-Dichloroethene	ND	0.0052		mg/Kg-dry	1	11/17/2021
trans-1,2-Dichloroethene	ND	0.0052		mg/Kg-dry	1	11/17/2021
1,2-Dichloropropane	ND	0.0052		mg/Kg-dry	1	11/17/2021
cis-1,3-Dichloropropene	ND	0.0021		mg/Kg-dry	1	11/17/2021
trans-1,3-Dichloropropene	ND	0.0021		mg/Kg-dry	1	11/17/2021
Ethylbenzene	ND	0.0052		mg/Kg-dry	1	11/17/2021
2-Hexanone	ND	0.021		mg/Kg-dry	1	11/17/2021
4-Methyl-2-pentanone	ND	0.021		mg/Kg-dry	1	11/17/2021
Methylene chloride	ND	0.010		mg/Kg-dry	1	11/17/2021
Methyl tert-butyl ether	ND	0.0052		mg/Kg-dry	1	11/17/2021
Styrene	ND	0.0052		mg/Kg-dry	1	11/17/2021
1,1,2,2-Tetrachloroethane	ND	0.0052		mg/Kg-dry	1	11/17/2021
Tetrachloroethene	ND	0.0052		mg/Kg-dry	1	11/17/2021
Toluene	ND	0.0052		mg/Kg-dry	1	11/17/2021
1,1,1-Trichloroethane	ND	0.0052		mg/Kg-dry	1	11/17/2021
1,1,2-Trichloroethane	ND	0.0052		mg/Kg-dry	1	11/17/2021
Trichloroethene	ND	0.0052		mg/Kg-dry	1	11/17/2021
Vinyl chloride	ND	0.0052		mg/Kg-dry	1	11/17/2021
Xylenes, Total	ND	0.016		mg/Kg-dry	1	11/17/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Acenaphthene	0.10	0.037		mg/Kg-dry	1	11/9/2021
Acenaphthylene	0.16	0.037		mg/Kg-dry	1	11/9/2021

Qualifiers:

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HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
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H - Holding time exceeded

Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-003

Client Sample ID: B-5-1
Collection Date: 11/4/2021 1:40:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Aniline	ND	0.37		mg/Kg-dry	1	11/9/2021
Anthracene	0.40	0.037		mg/Kg-dry	1	11/9/2021
Benz(a)anthracene	1.8	0.037		mg/Kg-dry	1	11/9/2021
Benzidine	ND	0.37		mg/Kg-dry	1	11/9/2021
Benzo(a)pyrene	1.6	0.037		mg/Kg-dry	1	11/9/2021
Benzo(b)fluoranthene	1.3	0.037		mg/Kg-dry	1	11/9/2021
Benzo(g,h,i)perylene	0.81	0.037		mg/Kg-dry	1	11/9/2021
Benzo(k)fluoranthene	1.3	0.037		mg/Kg-dry	1	11/9/2021
Benzoic acid	ND	0.93		mg/Kg-dry	1	11/9/2021
Benzyl alcohol	ND	0.19		mg/Kg-dry	1	11/9/2021
Bis(2-chloroethoxy)methane	ND	0.19		mg/Kg-dry	1	11/9/2021
Bis(2-chloroethyl)ether	ND	0.19		mg/Kg-dry	1	11/9/2021
Bis(2-ethylhexyl)phthalate	ND	0.93		mg/Kg-dry	1	11/9/2021
4-Bromophenyl phenyl ether	ND	0.19		mg/Kg-dry	1	11/9/2021
Butyl benzyl phthalate	ND	0.19		mg/Kg-dry	1	11/9/2021
Carbazole	ND	0.19		mg/Kg-dry	1	11/9/2021
4-Chloroaniline	ND	0.19		mg/Kg-dry	1	11/9/2021
4-Chloro-3-methylphenol	ND	0.37		mg/Kg-dry	1	11/9/2021
2-Chloronaphthalene	ND	0.19		mg/Kg-dry	1	11/9/2021
2-Chlorophenol	ND	0.19		mg/Kg-dry	1	11/9/2021
4-Chlorophenyl phenyl ether	ND	0.19		mg/Kg-dry	1	11/9/2021
Chrysene	1.5	0.037		mg/Kg-dry	1	11/9/2021
Dibenz(a,h)anthracene	0.52	0.037		mg/Kg-dry	1	11/9/2021
Dibenzofuran	ND	0.19		mg/Kg-dry	1	11/9/2021
1,2-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/9/2021
1,3-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/9/2021
1,4-Dichlorobenzene	ND	0.19		mg/Kg-dry	1	11/9/2021
3,3´-Dichlorobenzidine	ND	0.19		mg/Kg-dry	1	11/9/2021
2,4-Dichlorophenol	ND	0.19		mg/Kg-dry	1	11/9/2021
Diethyl phthalate	ND	0.19		mg/Kg-dry	1	11/9/2021
2,4-Dimethylphenol	ND	0.19		mg/Kg-dry	1	11/9/2021
Dimethyl phthalate	ND	0.19		mg/Kg-dry	1	11/9/2021
4,6-Dinitro-2-methylphenol	ND	0.37		mg/Kg-dry	1	11/9/2021
2,4-Dinitrophenol	ND	0.93		mg/Kg-dry	1	11/9/2021
2,4-Dinitrotoluene	ND	0.037		mg/Kg-dry	1	11/9/2021
2,6-Dinitrotoluene	ND	0.037		mg/Kg-dry	1	11/9/2021
Di-n-butyl phthalate	ND	0.19		mg/Kg-dry	1	11/9/2021
Di-n-octyl phthalate	ND	0.19		mg/Kg-dry	1	11/9/2021

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Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-003

Client Sample ID: B-5-1
Collection Date: 11/4/2021 1:40:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Fluoranthene	2.5	0.037		mg/Kg-dry	1	11/9/2021
Fluorene	0.078	0.037		mg/Kg-dry	1	11/9/2021
Hexachlorobenzene	ND	0.19		mg/Kg-dry	1	11/9/2021
Hexachlorobutadiene	ND	0.19		mg/Kg-dry	1	11/9/2021
Hexachlorocyclopentadiene	ND	0.19		mg/Kg-dry	1	11/9/2021
Hexachloroethane	ND	0.19		mg/Kg-dry	1	11/9/2021
Indeno(1,2,3-cd)pyrene	0.79	0.037		mg/Kg-dry	1	11/9/2021
Isophorone	ND	0.19		mg/Kg-dry	1	11/9/2021
2-Methylnaphthalene	ND	0.19		mg/Kg-dry	1	11/9/2021
2-Methylphenol	ND	0.19		mg/Kg-dry	1	11/9/2021
4-Methylphenol	ND	0.19		mg/Kg-dry	1	11/9/2021
Naphthalene	0.12	0.037		mg/Kg-dry	1	11/9/2021
2-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/9/2021
3-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/9/2021
4-Nitroaniline	ND	0.19		mg/Kg-dry	1	11/9/2021
2-Nitrophenol	ND	0.19		mg/Kg-dry	1	11/9/2021
4-Nitrophenol	ND	0.37		mg/Kg-dry	1	11/9/2021
Nitrobenzene	ND	0.037		mg/Kg-dry	1	11/9/2021
N-Nitrosodi-n-propylamine	ND	0.037		mg/Kg-dry	1	11/9/2021
N-Nitrosodimethylamine	ND	0.19		mg/Kg-dry	1	11/9/2021
N-Nitrosodiphenylamine	ND	0.037		mg/Kg-dry	1	11/9/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.19		mg/Kg-dry	1	11/9/2021
Pentachlorophenol	ND	0.037		mg/Kg-dry	1	11/9/2021
Phenanthrene	1.0	0.037		mg/Kg-dry	1	11/9/2021
Phenol	ND	0.19		mg/Kg-dry	1	11/9/2021
Pyrene	2.4	0.037		mg/Kg-dry	1	11/9/2021
Pyridine	ND	0.75		mg/Kg-dry	1	11/9/2021
1,2,4-Trichlorobenzene	ND	0.19		mg/Kg-dry	1	11/9/2021
2,4,5-Trichlorophenol	ND	0.19		mg/Kg-dry	1	11/9/2021
2,4,6-Trichlorophenol	ND	0.19		mg/Kg-dry	1	11/9/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/9/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.090		mg/Kg-dry	1	11/9/2021
Aroclor 1221	ND	0.090		mg/Kg-dry	1	11/9/2021
Aroclor 1232	ND	0.090		mg/Kg-dry	1	11/9/2021
Aroclor 1242	ND	0.090		mg/Kg-dry	1	11/9/2021
Aroclor 1248	ND	0.090		mg/Kg-dry	1	11/9/2021
Aroclor 1254	ND	0.090		mg/Kg-dry	1	11/9/2021
Aroclor 1260	ND	0.090		mg/Kg-dry	1	11/9/2021

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Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-003

Client Sample ID: B-5-1
Collection Date: 11/4/2021 1:40:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/9/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0018		mg/Kg-dry	1	11/9/2021
4,4´-DDE	ND	0.0018		mg/Kg-dry	1	11/9/2021
4,4´-DDT	ND	0.0018		mg/Kg-dry	1	11/9/2021
Aldrin	ND	0.0018		mg/Kg-dry	1	11/9/2021
alpha-BHC	ND	0.0018		mg/Kg-dry	1	11/9/2021
alpha-Chlordane	ND	0.0018		mg/Kg-dry	1	11/9/2021
beta-BHC	ND	0.0018		mg/Kg-dry	1	11/9/2021
Chlordane	ND	0.018		mg/Kg-dry	1	11/9/2021
delta-BHC	ND	0.0018		mg/Kg-dry	1	11/9/2021
Dieldrin	ND	0.0018		mg/Kg-dry	1	11/9/2021
Endosulfan I	ND	0.0018		mg/Kg-dry	1	11/9/2021
Endosulfan II	ND	0.0018		mg/Kg-dry	1	11/9/2021
Endosulfan sulfate	ND	0.0018		mg/Kg-dry	1	11/9/2021
Endrin	ND	0.0018		mg/Kg-dry	1	11/9/2021
Endrin aldehyde	ND	0.0018		mg/Kg-dry	1	11/9/2021
Endrin ketone	ND	0.0018		mg/Kg-dry	1	11/9/2021
gamma-BHC	ND	0.0018		mg/Kg-dry	1	11/9/2021
gamma-Chlordane	ND	0.0018		mg/Kg-dry	1	11/9/2021
Heptachlor	ND	0.0018		mg/Kg-dry	1	11/9/2021
Heptachlor epoxide	ND	0.0018		mg/Kg-dry	1	11/9/2021
Methoxychlor	ND	0.0018		mg/Kg-dry	1	11/9/2021
Toxaphene	ND	0.037		mg/Kg-dry	1	11/9/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/10/2021**		Analyst: **JG**
Aluminum	3600	21		mg/Kg-dry	10	11/10/2021
Antimony	2.8	2.1		mg/Kg-dry	10	11/10/2021
Arsenic	5.4	1.1		mg/Kg-dry	10	11/10/2021
Barium	78	1.1		mg/Kg-dry	10	11/10/2021
Beryllium	ND	0.54		mg/Kg-dry	10	11/10/2021
Cadmium	ND	0.54		mg/Kg-dry	10	11/10/2021
Calcium	77000	64		mg/Kg-dry	10	11/10/2021
Chromium	8.5	1.1		mg/Kg-dry	10	11/10/2021
Cobalt	5.1	1.1		mg/Kg-dry	10	11/10/2021
Copper	54	2.7		mg/Kg-dry	10	11/10/2021
Iron	11000	32		mg/Kg-dry	10	11/10/2021
Lead	440	0.54		mg/Kg-dry	10	11/10/2021
Magnesium	35000	32		mg/Kg-dry	10	11/10/2021
Manganese	430	1.1		mg/Kg-dry	10	11/10/2021
Nickel	9.2	1.1		mg/Kg-dry	10	11/10/2021

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HT - Sample received past holding time	E - Value above quantitation range
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Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-003

Client Sample ID: B-5-1
Collection Date: 11/4/2021 1:40:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/10/2021**		Analyst: **JG**
Potassium	810	32		mg/Kg-dry	10	11/10/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/10/2021
Silver	ND	1.1		mg/Kg-dry	10	11/10/2021
Sodium	2300	64		mg/Kg-dry	10	11/10/2021
Thallium	ND	1.1		mg/Kg-dry	10	11/10/2021
Vanadium	15	1.1		mg/Kg-dry	10	11/10/2021
Zinc	270	5.4		mg/Kg-dry	10	11/10/2021
Mercury	**SW7471B**			Prep Date: **11/10/2021**		Analyst: **LB**
Mercury	0.43	0.022		mg/Kg-dry	1	11/10/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/12/2021**		Analyst: **MD**
Cyanide	ND	0.56		mg/Kg-dry	1	11/12/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/15/2021**		Analyst: **RW**
pH	9.62			pH Units	1	11/15/2021
Percent Moisture	**D2974**			Prep Date: **11/10/2021**		Analyst: **HYM**
Percent Moisture	10.9	0.2	*	wt%	1	11/11/2021

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Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-004

Client Sample ID: B-10-1
Collection Date: 11/4/2021 1:50:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/5/2021**		Analyst: **TMB**
Acetone	ND	0.093		mg/Kg-dry	1	11/17/2021
Benzene	ND	0.0062		mg/Kg-dry	1	11/17/2021
Bromodichloromethane	ND	0.0062		mg/Kg-dry	1	11/17/2021
Bromoform	ND	0.0062		mg/Kg-dry	1	11/17/2021
Bromomethane	ND	0.012		mg/Kg-dry	1	11/17/2021
2-Butanone	ND	0.093		mg/Kg-dry	1	11/17/2021
Carbon disulfide	ND	0.062		mg/Kg-dry	1	11/17/2021
Carbon tetrachloride	ND	0.0062		mg/Kg-dry	1	11/17/2021
Chlorobenzene	ND	0.0062		mg/Kg-dry	1	11/17/2021
Chloroethane	ND	0.012		mg/Kg-dry	1	11/17/2021
Chloroform	ND	0.0062		mg/Kg-dry	1	11/17/2021
Chloromethane	ND	0.012		mg/Kg-dry	1	11/17/2021
Dibromochloromethane	ND	0.0062		mg/Kg-dry	1	11/17/2021
1,1-Dichloroethane	ND	0.0062		mg/Kg-dry	1	11/17/2021
1,2-Dichloroethane	ND	0.0062		mg/Kg-dry	1	11/17/2021
1,1-Dichloroethene	ND	0.0062		mg/Kg-dry	1	11/17/2021
cis-1,2-Dichloroethene	ND	0.0062		mg/Kg-dry	1	11/17/2021
trans-1,2-Dichloroethene	ND	0.0062		mg/Kg-dry	1	11/17/2021
1,2-Dichloropropane	ND	0.0062		mg/Kg-dry	1	11/17/2021
cis-1,3-Dichloropropene	ND	0.0025		mg/Kg-dry	1	11/17/2021
trans-1,3-Dichloropropene	ND	0.0025		mg/Kg-dry	1	11/17/2021
Ethylbenzene	ND	0.0062		mg/Kg-dry	1	11/17/2021
2-Hexanone	ND	0.025		mg/Kg-dry	1	11/17/2021
4-Methyl-2-pentanone	ND	0.025		mg/Kg-dry	1	11/17/2021
Methylene chloride	ND	0.012		mg/Kg-dry	1	11/17/2021
Methyl tert-butyl ether	ND	0.0062		mg/Kg-dry	1	11/17/2021
Styrene	ND	0.0062		mg/Kg-dry	1	11/17/2021
1,1,2,2-Tetrachloroethane	ND	0.0062		mg/Kg-dry	1	11/17/2021
Tetrachloroethene	ND	0.0062		mg/Kg-dry	1	11/17/2021
Toluene	ND	0.0062		mg/Kg-dry	1	11/17/2021
1,1,1-Trichloroethane	ND	0.0062		mg/Kg-dry	1	11/17/2021
1,1,2-Trichloroethane	ND	0.0062		mg/Kg-dry	1	11/17/2021
Trichloroethene	ND	0.0062		mg/Kg-dry	1	11/17/2021
Vinyl chloride	ND	0.0062		mg/Kg-dry	1	11/17/2021
Xylenes, Total	ND	0.019		mg/Kg-dry	1	11/17/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Acenaphthene	ND	0.034		mg/Kg-dry	1	11/10/2021
Acenaphthylene	ND	0.034		mg/Kg-dry	1	11/10/2021

Qualifiers:

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* - Non-accredited parameter

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Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-004

Client Sample ID: B-10-1
Collection Date: 11/4/2021 1:50:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Aniline	ND	0.35		mg/Kg-dry	1	11/10/2021
Anthracene	0.069	0.034		mg/Kg-dry	1	11/10/2021
Benz(a)anthracene	0.26	0.034		mg/Kg-dry	1	11/10/2021
Benzidine	ND	0.34		mg/Kg-dry	1	11/10/2021
Benzo(a)pyrene	0.18	0.034		mg/Kg-dry	1	11/10/2021
Benzo(b)fluoranthene	0.19	0.034		mg/Kg-dry	1	11/10/2021
Benzo(g,h,i)perylene	0.12	0.034		mg/Kg-dry	1	11/10/2021
Benzo(k)fluoranthene	0.16	0.034		mg/Kg-dry	1	11/10/2021
Benzoic acid	ND	0.85		mg/Kg-dry	1	11/10/2021
Benzyl alcohol	ND	0.18		mg/Kg-dry	1	11/10/2021
Bis(2-chloroethoxy)methane	ND	0.18		mg/Kg-dry	1	11/10/2021
Bis(2-chloroethyl)ether	ND	0.18		mg/Kg-dry	1	11/10/2021
Bis(2-ethylhexyl)phthalate	ND	0.85		mg/Kg-dry	1	11/10/2021
4-Bromophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/10/2021
Butyl benzyl phthalate	ND	0.18		mg/Kg-dry	1	11/10/2021
Carbazole	ND	0.18		mg/Kg-dry	1	11/10/2021
4-Chloroaniline	ND	0.18		mg/Kg-dry	1	11/10/2021
4-Chloro-3-methylphenol	ND	0.34		mg/Kg-dry	1	11/10/2021
2-Chloronaphthalene	ND	0.18		mg/Kg-dry	1	11/10/2021
2-Chlorophenol	ND	0.18		mg/Kg-dry	1	11/10/2021
4-Chlorophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/10/2021
Chrysene	0.23	0.034		mg/Kg-dry	1	11/10/2021
Dibenz(a,h)anthracene	0.078	0.034		mg/Kg-dry	1	11/10/2021
Dibenzofuran	ND	0.18		mg/Kg-dry	1	11/10/2021
1,2-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/10/2021
1,3-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/10/2021
1,4-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/10/2021
3,3´-Dichlorobenzidine	ND	0.18		mg/Kg-dry	1	11/10/2021
2,4-Dichlorophenol	ND	0.18		mg/Kg-dry	1	11/10/2021
Diethyl phthalate	ND	0.18		mg/Kg-dry	1	11/10/2021
2,4-Dimethylphenol	ND	0.18		mg/Kg-dry	1	11/10/2021
Dimethyl phthalate	ND	0.18		mg/Kg-dry	1	11/10/2021
4,6-Dinitro-2-methylphenol	ND	0.34		mg/Kg-dry	1	11/10/2021
2,4-Dinitrophenol	ND	0.85		mg/Kg-dry	1	11/10/2021
2,4-Dinitrotoluene	ND	0.034		mg/Kg-dry	1	11/10/2021
2,6-Dinitrotoluene	ND	0.034		mg/Kg-dry	1	11/10/2021
Di-n-butyl phthalate	ND	0.18		mg/Kg-dry	1	11/10/2021
Di-n-octyl phthalate	ND	0.18		mg/Kg-dry	1	11/10/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-004

Client Sample ID: B-10-1
Collection Date: 11/4/2021 1:50:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/8/2021**		Analyst: **TEM**
Fluoranthene	0.43	0.034		mg/Kg-dry	1	11/10/2021
Fluorene	ND	0.034		mg/Kg-dry	1	11/10/2021
Hexachlorobenzene	ND	0.18		mg/Kg-dry	1	11/10/2021
Hexachlorobutadiene	ND	0.18		mg/Kg-dry	1	11/10/2021
Hexachlorocyclopentadiene	ND	0.18		mg/Kg-dry	1	11/10/2021
Hexachloroethane	ND	0.18		mg/Kg-dry	1	11/10/2021
Indeno(1,2,3-cd)pyrene	0.10	0.034		mg/Kg-dry	1	11/10/2021
Isophorone	ND	0.18		mg/Kg-dry	1	11/10/2021
2-Methylnaphthalene	ND	0.18		mg/Kg-dry	1	11/10/2021
2-Methylphenol	ND	0.18		mg/Kg-dry	1	11/10/2021
4-Methylphenol	ND	0.18		mg/Kg-dry	1	11/10/2021
Naphthalene	ND	0.034		mg/Kg-dry	1	11/10/2021
2-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/10/2021
3-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/10/2021
4-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/10/2021
2-Nitrophenol	ND	0.18		mg/Kg-dry	1	11/10/2021
4-Nitrophenol	ND	0.34		mg/Kg-dry	1	11/10/2021
Nitrobenzene	ND	0.034		mg/Kg-dry	1	11/10/2021
N-Nitrosodi-n-propylamine	ND	0.034		mg/Kg-dry	1	11/10/2021
N-Nitrosodimethylamine	ND	0.18		mg/Kg-dry	1	11/10/2021
N-Nitrosodiphenylamine	ND	0.034		mg/Kg-dry	1	11/10/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.18		mg/Kg-dry	1	11/10/2021
Pentachlorophenol	ND	0.034		mg/Kg-dry	1	11/10/2021
Phenanthrene	0.22	0.034		mg/Kg-dry	1	11/10/2021
Phenol	ND	0.18		mg/Kg-dry	1	11/10/2021
Pyrene	0.38	0.034		mg/Kg-dry	1	11/10/2021
Pyridine	ND	0.68		mg/Kg-dry	1	11/10/2021
1,2,4-Trichlorobenzene	ND	0.18		mg/Kg-dry	1	11/10/2021
2,4,5-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/10/2021
2,4,6-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/10/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/9/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.084		mg/Kg-dry	1	11/9/2021
Aroclor 1221	ND	0.084		mg/Kg-dry	1	11/9/2021
Aroclor 1232	ND	0.084		mg/Kg-dry	1	11/9/2021
Aroclor 1242	ND	0.084		mg/Kg-dry	1	11/9/2021
Aroclor 1248	ND	0.084		mg/Kg-dry	1	11/9/2021
Aroclor 1254	ND	0.084		mg/Kg-dry	1	11/9/2021
Aroclor 1260	ND	0.084		mg/Kg-dry	1	11/9/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-004

Client Sample ID: B-10-1
Collection Date: 11/4/2021 1:50:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/9/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0017		mg/Kg-dry	1	11/9/2021
4,4´-DDE	ND	0.0017		mg/Kg-dry	1	11/9/2021
4,4´-DDT	ND	0.0017		mg/Kg-dry	1	11/9/2021
Aldrin	ND	0.0017		mg/Kg-dry	1	11/9/2021
alpha-BHC	ND	0.0017		mg/Kg-dry	1	11/9/2021
alpha-Chlordane	ND	0.0017		mg/Kg-dry	1	11/9/2021
beta-BHC	ND	0.0017		mg/Kg-dry	1	11/9/2021
Chlordane	ND	0.017		mg/Kg-dry	1	11/9/2021
delta-BHC	ND	0.0017		mg/Kg-dry	1	11/9/2021
Dieldrin	ND	0.0017		mg/Kg-dry	1	11/9/2021
Endosulfan I	ND	0.0017		mg/Kg-dry	1	11/9/2021
Endosulfan II	ND	0.0017		mg/Kg-dry	1	11/9/2021
Endosulfan sulfate	ND	0.0017		mg/Kg-dry	1	11/9/2021
Endrin	ND	0.0017		mg/Kg-dry	1	11/9/2021
Endrin aldehyde	ND	0.0017		mg/Kg-dry	1	11/9/2021
Endrin ketone	ND	0.0017		mg/Kg-dry	1	11/9/2021
gamma-BHC	ND	0.0017		mg/Kg-dry	1	11/9/2021
gamma-Chlordane	ND	0.0017		mg/Kg-dry	1	11/9/2021
Heptachlor	ND	0.0017		mg/Kg-dry	1	11/9/2021
Heptachlor epoxide	ND	0.0017		mg/Kg-dry	1	11/9/2021
Methoxychlor	ND	0.0017		mg/Kg-dry	1	11/9/2021
Toxaphene	ND	0.035		mg/Kg-dry	1	11/9/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/10/2021**		Analyst: **JG**
Aluminum	1100	20		mg/Kg-dry	10	11/10/2021
Antimony	ND	2.0		mg/Kg-dry	10	11/10/2021
Arsenic	2.6	1.0		mg/Kg-dry	10	11/10/2021
Barium	6.7	1.0		mg/Kg-dry	10	11/10/2021
Beryllium	ND	0.51		mg/Kg-dry	10	11/10/2021
Cadmium	ND	0.51		mg/Kg-dry	10	11/10/2021
Calcium	43000	61		mg/Kg-dry	10	11/10/2021
Chromium	3.2	1.0		mg/Kg-dry	10	11/10/2021
Cobalt	2.3	1.0		mg/Kg-dry	10	11/10/2021
Copper	4.9	2.5		mg/Kg-dry	10	11/10/2021
Iron	5200	31		mg/Kg-dry	10	11/10/2021
Lead	140	0.51		mg/Kg-dry	10	11/10/2021
Magnesium	24000	31		mg/Kg-dry	10	11/10/2021
Manganese	180	1.0		mg/Kg-dry	10	11/10/2021
Nickel	3.4	1.0		mg/Kg-dry	10	11/10/2021

Qualifiers:

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J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 17, 2021
Date Printed: November 17, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110192 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110192-004

Client Sample ID: B-10-1
Collection Date: 11/4/2021 1:50:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/10/2021**		Analyst: **JG**
Potassium	270	31		mg/Kg-dry	10	11/10/2021
Selenium	ND	1.0		mg/Kg-dry	10	11/10/2021
Silver	ND	1.0		mg/Kg-dry	10	11/10/2021
Sodium	230	61		mg/Kg-dry	10	11/10/2021
Thallium	ND	1.0		mg/Kg-dry	10	11/10/2021
Vanadium	5.7	1.0		mg/Kg-dry	10	11/10/2021
Zinc	20	5.1		mg/Kg-dry	10	11/10/2021
Mercury	**SW7471B**			Prep Date: **11/10/2021**		Analyst: **LB**
Mercury	0.049	0.020		mg/Kg-dry	1	11/10/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/12/2021**		Analyst: **MD**
Cyanide	ND	0.53		mg/Kg-dry	1	11/12/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/15/2021**		Analyst: **RW**
pH	9.67			pH Units	1	11/15/2021
Percent Moisture	**D2974**			Prep Date: **11/10/2021**		Analyst: **HYM**
Percent Moisture	4.8	0.2	*	wt%	1	11/11/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

Nº: 930318

Page : 1 **of** 2

Company: GSG Consultants
Project Number:
Client Tracking No.:
Project Name: State & Lake
Project Location: Chicago
Sampler(s): James Beard
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants.c
QC Level: 1 ____ 2 ____ 3 ____ 4 ____

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 [✓ 5-7] 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	RCRA Metals	PNAs	pH	TCL	Additional Information:	Lab No.:
B-2-2	11/4/21	0015	S		X		4	X	X	X			001
~~[illegible]~~ JTB B-3-2	↑	0030	S		X		4	X	X	X			002
B-5-1	↓	0140	S		X		4			X	X		003
B-10-1	11/4/21	0150	S		X		4			X	X		004

Relinquished by: (Signature) Date/Time: 11/4/21
Received by: (Signature) Date/Time: 11/4/21 1730
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments:

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110192

Received on Ice: Yes ☒ No ☐

Temperature: 3.2 °C

STAT Analysis Corporation
2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD **Nº:** 930317 **Page:** 2 **of** 2

Company: GSG Consultants Inc
Project Number: Client Tracking No.:
Project Name: State & Lake
Project Location: Chicago
Sampler(s): James Bacu
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants...
QC Level: 1___ 2___ 3___ 4___

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 5-7 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	Additional Information:	Lab No.:
B-2-3	11/4/21	0200	S		X		4		005
B-3-3	11/4/21	0215	S		X		4		006

Relinquished by: (Signature) Date/Time: 11/4/21
Received by: (Signature) Date/Time: 11/4/21 1730
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments: Hold

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110192

Received on Ice: Yes [✓] No ☐

Temperature: 3.2 °C

STAT Analysis Corporation

Sample Receipt Checklist

Client Name **GSG**

Work Order Number **21110192**

Date and Time Received: **11/4/2021 5:30:00 PM**

Received by: ID

Checklist completed by: ______ Signature 11/4/21 Date

Reviewed by: ______ Initials 11/5/21 Date

Matrix:

Carrier name Client Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels/containers?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container or Temp Blank temperature in compliance?	Yes ☑	No ☐	Temperature 3.2 °C
Water - VOA vials have zero headspace?	No VOA vials submitted ☐	Yes ☐	No ☐
Water - Samples pH checked?	Yes ☐	No ☐	Checked by: ______
Water - Samples properly preserved?	Yes ☐	No ☐	pH Adjusted? ______

Any No response must be detailed in the comments section below.

Comments: ______

Client / Person contacted: ______

Date contacted: ______

Contacted by: ______

Response: ______

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditations: IEPA ELAP 100445; ORELAP IL300001; AIHA-LAP, LLC 101160; NVLAP LabCode 101202-0

November 22, 2021

GSG Consultants, Inc.
2942 W. Van Buren St.
Chicago, IL 60612
Telephone: (312) 733-6262
Fax: (312) 733-5612

Analytical Report for STAT Work Order: 21110358 Revision 0

RE: CTA State & Lake, Chicago

Dear GSG Consultants, Inc.:

STAT Analysis received 7 samples for the referenced project on 11/9/2021 5:40:00 PM. The analytical results are presented in the following report.

All analyses were performed in accordance with the requirements of 35 IAC Part 186 / NELAP standards. Analyses were performed in accordance with methods as referenced on the analytical report. Those analytical results expressed on a dry weight basis are also noted on the analytical report.

All analyses were performed within established holding time criteria, and all Quality Control criteria met EPA or laboratory specifications except when noted in the Case Narrative or Analytical Report. If required, an estimate of uncertainty for the analyses can be provided. A listing of accredited methods/parameters can also be provided.

Thank you for the opportunity to serve you and I look forward to working with you in the future. If you have any questions regarding the enclosed materials, please contact me at (312) 733-0551.

Sincerely,

Justice Kwateng
Project Manager

Client: GSG Consultants, Inc.
Project: CTA State & Lake, Chicago
Work Order: 21110358 Revision 0

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Tag Number	Collection Date	Date Received
21110358-001A	B-1-2		11/8/2021 9:45:00 AM	11/9/2021
21110358-001B	B-1-2		11/8/2021 9:45:00 AM	11/9/2021
21110358-002A	B-4-2		11/8/2021 9:00:00 AM	11/9/2021
21110358-002B	B-4-2		11/8/2021 9:00:00 AM	11/9/2021
21110358-003A	B-6-1		11/8/2021 11:45:00 AM	11/9/2021
21110358-003B	B-6-1		11/8/2021 11:45:00 AM	11/9/2021
21110358-004A	B-6-2		11/8/2021 11:50:00 AM	11/9/2021
21110358-004B	B-6-2		11/8/2021 11:50:00 AM	11/9/2021
21110358-005A	B-1-3		11/8/2021 9:50:00 AM	11/9/2021
21110358-005B	B-1-3		11/8/2021 9:50:00 AM	11/9/2021
21110358-006A	B-4-3		11/8/2021 9:00:00 AM	11/9/2021
21110358-006B	B-4-3		11/8/2021 9:00:00 AM	11/9/2021
21110358-007A	B-6-3		11/9/2021 1:00:00 PM	11/9/2021
21110358-007B	B-6-3		11/9/2021 1:00:00 PM	11/9/2021

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-001

Client Sample ID: B-1-2
Collection Date: 11/8/2021 9:45:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/10/2021**		Analyst: **TEM**
Acenaphthene	ND	0.039		mg/Kg-dry	1	11/11/2021
Acenaphthylene	0.088	0.039		mg/Kg-dry	1	11/11/2021
Anthracene	0.16	0.039		mg/Kg-dry	1	11/11/2021
Benz(a)anthracene	0.63	0.039		mg/Kg-dry	1	11/11/2021
Benzo(a)pyrene	0.55	0.039		mg/Kg-dry	1	11/11/2021
Benzo(b)fluoranthene	0.45	0.039		mg/Kg-dry	1	11/11/2021
Benzo(g,h,i)perylene	0.26	0.039		mg/Kg-dry	1	11/11/2021
Benzo(k)fluoranthene	0.48	0.039		mg/Kg-dry	1	11/11/2021
Chrysene	0.57	0.039		mg/Kg-dry	1	11/11/2021
Dibenz(a,h)anthracene	0.17	0.039		mg/Kg-dry	1	11/11/2021
Fluoranthene	1.1	0.039		mg/Kg-dry	1	11/11/2021
Fluorene	0.040	0.039		mg/Kg-dry	1	11/11/2021
Indeno(1,2,3-cd)pyrene	0.26	0.039		mg/Kg-dry	1	11/11/2021
Naphthalene	ND	0.039		mg/Kg-dry	1	11/11/2021
Phenanthrene	0.56	0.039		mg/Kg-dry	1	11/11/2021
Pyrene	1.0	0.039		mg/Kg-dry	1	11/11/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/12/2021**		Analyst: **JG**
Arsenic	5.7	1.1		mg/Kg-dry	10	11/12/2021
Barium	46	1.1		mg/Kg-dry	10	11/12/2021
Cadmium	ND	0.57		mg/Kg-dry	10	11/12/2021
Chromium	21	1.1		mg/Kg-dry	10	11/12/2021
Lead	14	0.57		mg/Kg-dry	10	11/12/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/12/2021
Silver	ND	1.1		mg/Kg-dry	10	11/12/2021
Mercury	**SW7471B**			Prep Date: **11/13/2021**		Analyst: **LB**
Mercury	0.078	0.022		mg/Kg-dry	1	11/15/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/16/2021**		Analyst: **RW**
pH	9.04			pH Units	1	11/16/2021
Percent Moisture	**D2974**			Prep Date: **11/17/2021**		Analyst: **HYM**
Percent Moisture	16.3	0.2	*	wt%	1	11/18/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-002

Client Sample ID: B-4-2
Collection Date: 11/8/2021 9:00:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/10/2021**		Analyst: **TEM**
Acenaphthene	ND	0.043		mg/Kg-dry	1	11/11/2021
Acenaphthylene	ND	0.043		mg/Kg-dry	1	11/11/2021
Anthracene	ND	0.043		mg/Kg-dry	1	11/11/2021
Benz(a)anthracene	ND	0.043		mg/Kg-dry	1	11/11/2021
Benzo(a)pyrene	ND	0.043		mg/Kg-dry	1	11/11/2021
Benzo(b)fluoranthene	ND	0.043		mg/Kg-dry	1	11/11/2021
Benzo(g,h,i)perylene	ND	0.043		mg/Kg-dry	1	11/11/2021
Benzo(k)fluoranthene	ND	0.043		mg/Kg-dry	1	11/11/2021
Chrysene	ND	0.043		mg/Kg-dry	1	11/11/2021
Dibenz(a,h)anthracene	ND	0.043		mg/Kg-dry	1	11/11/2021
Fluoranthene	ND	0.043		mg/Kg-dry	1	11/11/2021
Fluorene	ND	0.043		mg/Kg-dry	1	11/11/2021
Indeno(1,2,3-cd)pyrene	ND	0.043		mg/Kg-dry	1	11/11/2021
Naphthalene	ND	0.043		mg/Kg-dry	1	11/11/2021
Phenanthrene	0.046	0.043		mg/Kg-dry	1	11/11/2021
Pyrene	ND	0.043		mg/Kg-dry	1	11/11/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/12/2021**		Analyst: **JG**
Arsenic	2.8	1.2		mg/Kg-dry	10	11/12/2021
Barium	20	1.2		mg/Kg-dry	10	11/12/2021
Cadmium	ND	0.60		mg/Kg-dry	10	11/12/2021
Chromium	8.3	1.2		mg/Kg-dry	10	11/12/2021
Lead	12	0.60		mg/Kg-dry	10	11/12/2021
Selenium	ND	1.2		mg/Kg-dry	10	11/12/2021
Silver	ND	1.2		mg/Kg-dry	10	11/12/2021
Mercury	**SW7471B**			Prep Date: **11/13/2021**		Analyst: **LB**
Mercury	ND	0.023		mg/Kg-dry	1	11/15/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/16/2021**		Analyst: **RW**
pH	8.98			pH Units	1	11/16/2021
Percent Moisture	**D2974**			Prep Date: **11/17/2021**		Analyst: **HYM**
Percent Moisture	24.8	0.2	*	wt%	1	11/18/2021

Qualifiers:		
	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-003

Client Sample ID: B-6-1
Collection Date: 11/8/2021 11:45:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/10/2021**		Analyst: **CBG**
Acetone	ND	0.065		mg/Kg-dry	1	11/19/2021
Benzene	ND	0.0043		mg/Kg-dry	1	11/19/2021
Bromodichloromethane	ND	0.0043		mg/Kg-dry	1	11/19/2021
Bromoform	ND	0.0043		mg/Kg-dry	1	11/19/2021
Bromomethane	ND	0.0086		mg/Kg-dry	1	11/19/2021
2-Butanone	ND	0.065		mg/Kg-dry	1	11/19/2021
Carbon disulfide	ND	0.043		mg/Kg-dry	1	11/19/2021
Carbon tetrachloride	ND	0.0043		mg/Kg-dry	1	11/19/2021
Chlorobenzene	ND	0.0043		mg/Kg-dry	1	11/19/2021
Chloroethane	ND	0.0086		mg/Kg-dry	1	11/19/2021
Chloroform	ND	0.0043		mg/Kg-dry	1	11/19/2021
Chloromethane	ND	0.0086		mg/Kg-dry	1	11/19/2021
Dibromochloromethane	ND	0.0043		mg/Kg-dry	1	11/19/2021
1,1-Dichloroethane	ND	0.0043		mg/Kg-dry	1	11/19/2021
1,2-Dichloroethane	ND	0.0043		mg/Kg-dry	1	11/19/2021
1,1-Dichloroethene	ND	0.0043		mg/Kg-dry	1	11/19/2021
cis-1,2-Dichloroethene	ND	0.0043		mg/Kg-dry	1	11/19/2021
trans-1,2-Dichloroethene	ND	0.0043		mg/Kg-dry	1	11/19/2021
1,2-Dichloropropane	ND	0.0043		mg/Kg-dry	1	11/19/2021
cis-1,3-Dichloropropene	ND	0.0017		mg/Kg-dry	1	11/19/2021
trans-1,3-Dichloropropene	ND	0.0017		mg/Kg-dry	1	11/19/2021
Ethylbenzene	ND	0.0043		mg/Kg-dry	1	11/19/2021
2-Hexanone	ND	0.017		mg/Kg-dry	1	11/19/2021
4-Methyl-2-pentanone	ND	0.017		mg/Kg-dry	1	11/19/2021
Methylene chloride	ND	0.0086		mg/Kg-dry	1	11/19/2021
Methyl tert-butyl ether	ND	0.0043		mg/Kg-dry	1	11/19/2021
Styrene	ND	0.0043		mg/Kg-dry	1	11/19/2021
1,1,2,2-Tetrachloroethane	ND	0.0043		mg/Kg-dry	1	11/19/2021
Tetrachloroethene	ND	0.0043		mg/Kg-dry	1	11/19/2021
Toluene	ND	0.0043		mg/Kg-dry	1	11/19/2021
1,1,1-Trichloroethane	ND	0.0043		mg/Kg-dry	1	11/19/2021
1,1,2-Trichloroethane	ND	0.0043		mg/Kg-dry	1	11/19/2021
Trichloroethene	ND	0.0043		mg/Kg-dry	1	11/19/2021
Vinyl chloride	ND	0.0043		mg/Kg-dry	1	11/19/2021
Xylenes, Total	ND	0.013		mg/Kg-dry	1	11/19/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/10/2021**		Analyst: **TEM**
Acenaphthene	ND	0.035		mg/Kg-dry	1	11/11/2021
Acenaphthylene	ND	0.035		mg/Kg-dry	1	11/11/2021

Qualifiers:		
	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-003

Client Sample ID: B-6-1
Collection Date: 11/8/2021 11:45:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/10/2021**		Analyst: **TEM**
Aniline	ND	0.35		mg/Kg-dry	1	11/11/2021
Anthracene	ND	0.035		mg/Kg-dry	1	11/11/2021
Benz(a)anthracene	ND	0.035		mg/Kg-dry	1	11/11/2021
Benzidine	ND	0.35		mg/Kg-dry	1	11/11/2021
Benzo(a)pyrene	ND	0.035		mg/Kg-dry	1	11/11/2021
Benzo(b)fluoranthene	ND	0.035		mg/Kg-dry	1	11/11/2021
Benzo(g,h,i)perylene	ND	0.035		mg/Kg-dry	1	11/11/2021
Benzo(k)fluoranthene	ND	0.035		mg/Kg-dry	1	11/11/2021
Benzoic acid	ND	0.88		mg/Kg-dry	1	11/11/2021
Benzyl alcohol	ND	0.18		mg/Kg-dry	1	11/11/2021
Bis(2-chloroethoxy)methane	ND	0.18		mg/Kg-dry	1	11/11/2021
Bis(2-chloroethyl)ether	ND	0.18		mg/Kg-dry	1	11/11/2021
Bis(2-ethylhexyl)phthalate	ND	0.88		mg/Kg-dry	1	11/11/2021
4-Bromophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/11/2021
Butyl benzyl phthalate	ND	0.18		mg/Kg-dry	1	11/11/2021
Carbazole	ND	0.18		mg/Kg-dry	1	11/11/2021
4-Chloroaniline	ND	0.18		mg/Kg-dry	1	11/11/2021
4-Chloro-3-methylphenol	ND	0.35		mg/Kg-dry	1	11/11/2021
2-Chloronaphthalene	ND	0.18		mg/Kg-dry	1	11/11/2021
2-Chlorophenol	ND	0.18		mg/Kg-dry	1	11/11/2021
4-Chlorophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/11/2021
Chrysene	ND	0.035		mg/Kg-dry	1	11/11/2021
Dibenz(a,h)anthracene	ND	0.035		mg/Kg-dry	1	11/11/2021
Dibenzofuran	ND	0.18		mg/Kg-dry	1	11/11/2021
1,2-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/11/2021
1,3-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/11/2021
1,4-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/11/2021
3,3´-Dichlorobenzidine	ND	0.18		mg/Kg-dry	1	11/11/2021
2,4-Dichlorophenol	ND	0.18		mg/Kg-dry	1	11/11/2021
Diethyl phthalate	ND	0.18		mg/Kg-dry	1	11/11/2021
2,4-Dimethylphenol	ND	0.18		mg/Kg-dry	1	11/11/2021
Dimethyl phthalate	ND	0.18		mg/Kg-dry	1	11/11/2021
4,6-Dinitro-2-methylphenol	ND	0.35		mg/Kg-dry	1	11/11/2021
2,4-Dinitrophenol	ND	0.88		mg/Kg-dry	1	11/11/2021
2,4-Dinitrotoluene	ND	0.035		mg/Kg-dry	1	11/11/2021
2,6-Dinitrotoluene	ND	0.035		mg/Kg-dry	1	11/11/2021
Di-n-butyl phthalate	ND	0.18		mg/Kg-dry	1	11/11/2021
Di-n-octyl phthalate	ND	0.18		mg/Kg-dry	1	11/11/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
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* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-003

Client Sample ID: B-6-1
Collection Date: 11/8/2021 11:45:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/10/2021**		Analyst: **TEM**
Fluoranthene	ND	0.035		mg/Kg-dry	1	11/11/2021
Fluorene	ND	0.035		mg/Kg-dry	1	11/11/2021
Hexachlorobenzene	ND	0.18		mg/Kg-dry	1	11/11/2021
Hexachlorobutadiene	ND	0.18		mg/Kg-dry	1	11/11/2021
Hexachlorocyclopentadiene	ND	0.18		mg/Kg-dry	1	11/11/2021
Hexachloroethane	ND	0.18		mg/Kg-dry	1	11/11/2021
Indeno(1,2,3-cd)pyrene	ND	0.035		mg/Kg-dry	1	11/11/2021
Isophorone	ND	0.18		mg/Kg-dry	1	11/11/2021
2-Methylnaphthalene	ND	0.18		mg/Kg-dry	1	11/11/2021
2-Methylphenol	ND	0.18		mg/Kg-dry	1	11/11/2021
4-Methylphenol	ND	0.18		mg/Kg-dry	1	11/11/2021
Naphthalene	ND	0.035		mg/Kg-dry	1	11/11/2021
2-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/11/2021
3-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/11/2021
4-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/11/2021
2-Nitrophenol	ND	0.18		mg/Kg-dry	1	11/11/2021
4-Nitrophenol	ND	0.35		mg/Kg-dry	1	11/11/2021
Nitrobenzene	ND	0.035		mg/Kg-dry	1	11/11/2021
N-Nitrosodi-n-propylamine	ND	0.035		mg/Kg-dry	1	11/11/2021
N-Nitrosodimethylamine	ND	0.18		mg/Kg-dry	1	11/11/2021
N-Nitrosodiphenylamine	ND	0.035		mg/Kg-dry	1	11/11/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.18		mg/Kg-dry	1	11/11/2021
Pentachlorophenol	ND	0.035		mg/Kg-dry	1	11/11/2021
Phenanthrene	ND	0.035		mg/Kg-dry	1	11/11/2021
Phenol	ND	0.18		mg/Kg-dry	1	11/11/2021
Pyrene	ND	0.035		mg/Kg-dry	1	11/11/2021
Pyridine	ND	0.71		mg/Kg-dry	1	11/11/2021
1,2,4-Trichlorobenzene	ND	0.18		mg/Kg-dry	1	11/11/2021
2,4,5-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/11/2021
2,4,6-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/11/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/10/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.084		mg/Kg-dry	1	11/10/2021
Aroclor 1221	ND	0.084		mg/Kg-dry	1	11/10/2021
Aroclor 1232	ND	0.084		mg/Kg-dry	1	11/10/2021
Aroclor 1242	ND	0.084		mg/Kg-dry	1	11/10/2021
Aroclor 1248	ND	0.084		mg/Kg-dry	1	11/10/2021
Aroclor 1254	ND	0.084		mg/Kg-dry	1	11/10/2021
Aroclor 1260	ND	0.084		mg/Kg-dry	1	11/10/2021

Qualifiers:

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S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-003

Client Sample ID: B-6-1
Collection Date: 11/8/2021 11:45:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/10/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0017		mg/Kg-dry	1	11/10/2021
4,4´-DDE	ND	0.0017		mg/Kg-dry	1	11/10/2021
4,4´-DDT	ND	0.0017		mg/Kg-dry	1	11/10/2021
Aldrin	ND	0.0017		mg/Kg-dry	1	11/10/2021
alpha-BHC	ND	0.0017		mg/Kg-dry	1	11/10/2021
alpha-Chlordane	ND	0.0017		mg/Kg-dry	1	11/10/2021
beta-BHC	ND	0.0017		mg/Kg-dry	1	11/10/2021
Chlordane	ND	0.017		mg/Kg-dry	1	11/10/2021
delta-BHC	ND	0.0017		mg/Kg-dry	1	11/10/2021
Dieldrin	ND	0.0017		mg/Kg-dry	1	11/10/2021
Endosulfan I	ND	0.0017		mg/Kg-dry	1	11/10/2021
Endosulfan II	ND	0.0017		mg/Kg-dry	1	11/10/2021
Endosulfan sulfate	ND	0.0017		mg/Kg-dry	1	11/10/2021
Endrin	ND	0.0017		mg/Kg-dry	1	11/10/2021
Endrin aldehyde	ND	0.0017		mg/Kg-dry	1	11/10/2021
Endrin ketone	ND	0.0017		mg/Kg-dry	1	11/10/2021
gamma-BHC	ND	0.0017		mg/Kg-dry	1	11/10/2021
gamma-Chlordane	ND	0.0017		mg/Kg-dry	1	11/10/2021
Heptachlor	ND	0.0017		mg/Kg-dry	1	11/10/2021
Heptachlor epoxide	ND	0.0017		mg/Kg-dry	1	11/10/2021
Methoxychlor	ND	0.0017		mg/Kg-dry	1	11/10/2021
Toxaphene	ND	0.035		mg/Kg-dry	1	11/10/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/15/2021**		Analyst: **JG**
Aluminum	990	20		mg/Kg-dry	10	11/16/2021
Antimony	ND	2.0		mg/Kg-dry	10	11/16/2021
Arsenic	ND	1.0		mg/Kg-dry	10	11/16/2021
Barium	3.2	1.0		mg/Kg-dry	10	11/16/2021
Beryllium	ND	0.51		mg/Kg-dry	10	11/16/2021
Cadmium	ND	0.51		mg/Kg-dry	10	11/16/2021
Calcium	19000	62		mg/Kg-dry	10	11/17/2021
Chromium	2.6	1.0		mg/Kg-dry	10	11/16/2021
Cobalt	1.2	1.0		mg/Kg-dry	10	11/16/2021
Copper	ND	2.5		mg/Kg-dry	10	11/16/2021
Iron	2300	31		mg/Kg-dry	10	11/16/2021
Lead	1.7	0.51		mg/Kg-dry	10	11/16/2021
Magnesium	12000	31		mg/Kg-dry	10	11/17/2021
Manganese	110	1.0		mg/Kg-dry	10	11/16/2021
Nickel	2.6	1.0		mg/Kg-dry	10	11/16/2021

Qualifiers:

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HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-003

Client Sample ID: B-6-1
Collection Date: 11/8/2021 11:45:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/15/2021**		Analyst: **JG**
Potassium	750	31		mg/Kg-dry	10	11/16/2021
Selenium	ND	1.0		mg/Kg-dry	10	11/16/2021
Silver	ND	1.0		mg/Kg-dry	10	11/16/2021
Sodium	250	82		mg/Kg-dry	10	11/16/2021
Thallium	ND	1.0		mg/Kg-dry	10	11/16/2021
Vanadium	2.6	1.0		mg/Kg-dry	10	11/16/2021
Zinc	ND	5.1		mg/Kg-dry	10	11/16/2021
Mercury	**SW7471B**			Prep Date: **11/13/2021**		Analyst: **LB**
Mercury	ND	0.020		mg/Kg-dry	1	11/15/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/17/2021**		Analyst: **MD**
Cyanide	ND	0.53		mg/Kg-dry	1	11/17/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/16/2021**		Analyst: **RW**
pH	9.02			pH Units	1	11/16/2021
Percent Moisture	**D2974**			Prep Date: **11/17/2021**		Analyst: **HYM**
Percent Moisture	5.8	0.2	*	wt%	1	11/18/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 22, 2021
Date Printed: November 22, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110358 Revision 0
Project: CTA State & Lake, Chicago
Lab ID: 21110358-004

Client Sample ID: B-6-2
Collection Date: 11/8/2021 11:50:00 AM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS **SW8270C (SW3550B)**				Prep Date: **11/10/2021**		Analyst: **DM**
Acenaphthene	ND	0.041		mg/Kg-dry	1	11/11/2021
Acenaphthylene	ND	0.041		mg/Kg-dry	1	11/11/2021
Anthracene	ND	0.041		mg/Kg-dry	1	11/11/2021
Benz(a)anthracene	ND	0.041		mg/Kg-dry	1	11/11/2021
Benzo(a)pyrene	ND	0.041		mg/Kg-dry	1	11/11/2021
Benzo(b)fluoranthene	ND	0.041		mg/Kg-dry	1	11/11/2021
Benzo(g,h,i)perylene	ND	0.041		mg/Kg-dry	1	11/11/2021
Benzo(k)fluoranthene	ND	0.041		mg/Kg-dry	1	11/11/2021
Chrysene	ND	0.041		mg/Kg-dry	1	11/11/2021
Dibenz(a,h)anthracene	ND	0.041		mg/Kg-dry	1	11/11/2021
Fluoranthene	ND	0.041		mg/Kg-dry	1	11/11/2021
Fluorene	ND	0.041		mg/Kg-dry	1	11/11/2021
Indeno(1,2,3-cd)pyrene	ND	0.041		mg/Kg-dry	1	11/11/2021
Naphthalene	ND	0.041		mg/Kg-dry	1	11/11/2021
Phenanthrene	0.11	0.041		mg/Kg-dry	1	11/11/2021
Pyrene	ND	0.041		mg/Kg-dry	1	11/11/2021
Metals by ICP/MS **SW6020A (SW3050B)**				Prep Date: **11/12/2021**		Analyst: **JG**
Arsenic	9.2	1.1		mg/Kg-dry	10	11/12/2021
Barium	49	1.1		mg/Kg-dry	10	11/12/2021
Cadmium	ND	0.56		mg/Kg-dry	10	11/12/2021
Chromium	21	1.1		mg/Kg-dry	10	11/12/2021
Lead	17	0.56		mg/Kg-dry	10	11/12/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/12/2021
Silver	ND	1.1		mg/Kg-dry	10	11/12/2021
Mercury **SW7471B**				Prep Date: **11/13/2021**		Analyst: **LB**
Mercury	ND	0.023		mg/Kg-dry	1	11/15/2021
pH (25 °C) **SW9045C**				Prep Date: **11/16/2021**		Analyst: **RW**
pH	8.26			pH Units	1	11/16/2021
Percent Moisture **D2974**				Prep Date: **11/17/2021**		Analyst: **HYM**
Percent Moisture	20.2	0.2	*	wt%	1	11/18/2021

	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
Qualifiers:	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

No.: 930315

Page : 1 **of** 2

Company: GSG Consultants Inc
Project Number:
Client Tracking No.:
Project Name: CTA State & Lake
Project Location: Chicago
Sampler(s): James Beaco
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants
QC Level: 1 ___ 2 ___ 3 ___ 4 ___

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 [✓ 5-7] 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	TCL	RCRA Mtls	PNAs	pH	Additional Information:	Lab No.:
B-1-2	11/8/21	0945	S		X		4		X	X	X		001
B-4-2	↑	0900	S		X		4		X	X	X		002
B-6-1	↓	1145	S		X		4	X			X		003
B-6-2	11/8/21	1150	S		X		4		X	X	X		004

Relinquished by: (Signature)	Date/Time:
Received by: (Signature)	Date/Time: 11/9/21 1740
Relinquished by: (Signature)	Date/Time:
Received by: (Signature)	Date/Time:
Relinquished by: (Signature)	Date/Time:
Received by: (Signature)	Date/Time:

Comments:

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110350

Received on Ice: Yes ☒ No ☐

Temperature: 3.2 °C

STAT Analysis Corporation
2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

No.: 930314

Page: 2 **of** 2

Company: GSG Consultants Inc
Project Number:
Client Tracking No.:
Project Name: CTA State ; Lake
Project Location:
Sampler(s): James Broco
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants
QC Level: 1 ____ 2 ____ 3 ____ 4 ____

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 5-7 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	Additional Information:	Lab No.:
B-1-3	11/8/21	0950	S		X		4		005
B-4-3	11/8/21	0900	S		X		4		006
B-6-3	11/9/21	0100	S		X		4		007

Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time: 11/9/21 1740
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments:
Hold

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110358

Received on Ice: Yes ☒ No ☐

Temperature: 3.2 °C

STAT Analysis Corporation

Sample Receipt Checklist

Client Name GSG

Work Order Number 21110358

Date and Time Received: 11/9/2021 5:40:00 PM

Received by: ID

Checklist completed by: Signature Date 11/9/21

Reviewed by: CB Initials 11/10/21 Date

Matrix:

Carrier name Client Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels/containers?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container or [✓ Temp Blank] temperature in compliance?	Yes ☑	No ☐	Temperature 3.2 °C
Water - VOA vials have zero headspace?	No VOA vials submitted ☐	Yes ☐	No ☐
Water - Samples pH checked?	Yes ☐	No ☐	Checked by:
Water - Samples properly preserved?	Yes ☐	No ☐	pH Adjusted?

Any No response must be detailed in the comments section below.

Comments:

Client / Person contacted:

Date contacted:

Contacted by:

Response:

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditations: IEPA ELAP 100445; ORELAP IL300001; AIHA-LAP, LLC 101160; NVLAP LabCode 101202-0

November 19, 2021

GSG Consultants, Inc.
2942 W. Van Buren St.
Chicago, IL 60612
Telephone: (312) 733-6262
Fax: (312) 733-5612

Analytical Report for STAT Work Order: 21110415 Revision 0

RE: State & Lake, Chicago

Dear GSG Consultants, Inc.:

STAT Analysis received 2 samples for the referenced project on 11/10/2021 5:25:00 PM. The analytical results are presented in the following report.

All analyses were performed in accordance with the requirements of 35 IAC Part 186 / NELAP standards. Analyses were performed in accordance with methods as referenced on the analytical report. Those analytical results expressed on a dry weight basis are also noted on the analytical report.

All analyses were performed within established holding time criteria, and all Quality Control criteria met EPA or laboratory specifications except when noted in the Case Narrative or Analytical Report. If required, an estimate of uncertainty for the analyses can be provided. A listing of accredited methods/parameters can also be provided.

Thank you for the opportunity to serve you and I look forward to working with you in the future. If you have any questions regarding the enclosed materials, please contact me at (312) 733-0551.

Sincerely,

Justice Kwateng
Project Manager

Client: GSG Consultants, Inc.
Project: State & Lake, Chicago
Work Order: 21110415 Revision 0

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Tag Number	Collection Date	Date Received
21110415-001A	B-10-2		11/10/2021 3:00:00 PM	11/10/2021
21110415-001B	B-10-2		11/10/2021 3:00:00 PM	11/10/2021
21110415-002A	B-10-3		11/10/2021 3:09:00 PM	11/10/2021
21110415-002B	B-10-3		11/10/2021 3:09:00 PM	11/10/2021

Date Reported: November 19, 2021
Date Printed: November 19, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110415 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110415-001

Client Sample ID: B-10-2
Collection Date: 11/10/2021 3:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/12/2021**		Analyst: **DM**
Acenaphthene	ND	0.042		mg/Kg-dry	1	11/15/2021
Acenaphthylene	ND	0.042		mg/Kg-dry	1	11/15/2021
Anthracene	ND	0.042		mg/Kg-dry	1	11/15/2021
Benz(a)anthracene	ND	0.042		mg/Kg-dry	1	11/15/2021
Benzo(a)pyrene	ND	0.042		mg/Kg-dry	1	11/15/2021
Benzo(b)fluoranthene	0.048	0.042		mg/Kg-dry	1	11/15/2021
Benzo(g,h,i)perylene	0.062	0.042		mg/Kg-dry	1	11/15/2021
Benzo(k)fluoranthene	0.045	0.042		mg/Kg-dry	1	11/15/2021
Chrysene	ND	0.042		mg/Kg-dry	1	11/15/2021
Dibenz(a,h)anthracene	0.061	0.042		mg/Kg-dry	1	11/15/2021
Fluoranthene	ND	0.042		mg/Kg-dry	1	11/15/2021
Fluorene	ND	0.042		mg/Kg-dry	1	11/15/2021
Indeno(1,2,3-cd)pyrene	ND	0.042		mg/Kg-dry	1	11/15/2021
Naphthalene	ND	0.042		mg/Kg-dry	1	11/15/2021
Phenanthrene	ND	0.042		mg/Kg-dry	1	11/15/2021
Pyrene	ND	0.042		mg/Kg-dry	1	11/15/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/16/2021**		Analyst: **JG**
Arsenic	9.2	1.2		mg/Kg-dry	10	11/16/2021
Barium	52	1.2		mg/Kg-dry	10	11/16/2021
Cadmium	ND	0.60		mg/Kg-dry	10	11/16/2021
Chromium	20	1.2		mg/Kg-dry	10	11/16/2021
Lead	16	0.60		mg/Kg-dry	10	11/16/2021
Selenium	ND	1.2		mg/Kg-dry	10	11/16/2021
Silver	ND	1.2		mg/Kg-dry	10	11/16/2021
Mercury	**SW7471B**			Prep Date: **11/15/2021**		Analyst: **LB**
Mercury	ND	0.023		mg/Kg-dry	1	11/16/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/19/2021**		Analyst: **RW**
pH	9.49			pH Units	1	11/19/2021
Percent Moisture	**D2974**			Prep Date: **11/17/2021**		Analyst: **HYM**
Percent Moisture	21.8	0.2	*	wt%	1	11/17/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

STAT Analysis Corporation
2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

Nº: 930313

Page : 1 **of** 2

Company: CSG Consultants Inc
Project Number:
Client Tracking No.:
Project Name: State & Lake
Project Location: Chicago
Sampler(s): James Burd
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@csg-consult
QC Level: 1 ____ 2 ____ 3 ____ 4 ____

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 [✓ 5-7] 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	RCRA metals	PNAs	pH	Additional Information:	Lab No.:
B-10-2	11/10/21	0300	S		X		4	X	X	X		001

Relinquished by: (Signature) Date/Time: 11/10/21 1725
Received by: (Signature) Date/Time: 11/10/21 1725
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments:

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110415

Received on Ice: Yes ☒ No ☐

Temperature: On Ice °C

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD **Nº:** 930312 **Page:** 2 **of** 2

Company: GSG Consultants Inc
Project Number:
Client Tracking No.:
Project Name: State & Lake
Project Location: Chicago
Sampler(s): James Baw
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants
QC Level: 1 ___ 2 ___ 3 ___ 4 ___

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 5-7 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	Additional Information:	Lab No.:
B-10-3	11/10/21	0309	S		X		4		002

Relinquished by: (Signature) Date/Time: 11/10/21 1725
Received by: (Signature) Date/Time: 11/10/21 1725
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments:
Hold

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110415

Received on Ice: Yes ☒ No ☐

Temperature: On Ice °C

STAT Analysis Corporation

Sample Receipt Checklist

Client Name GSG

Work Order Number 21110415

Date and Time Received: 11/10/2021 5:25:00 PM

Received by: ID

Checklist completed by: Signature Date 11/10/21

Reviewed by: Initials Date 11/11/21

Matrix:

Carrier name Client Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels/containers?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container or Temp Blank temperature in compliance?	Yes ☑	No ☐	Temperature On Ice °C
Water - VOA vials have zero headspace?	No VOA vials submitted ☐	Yes ☐	No ☐
Water - Samples pH checked?	Yes ☐	No ☐	Checked by:
Water - Samples properly preserved?	Yes ☐	No ☐	pH Adjusted?

Any No response must be detailed in the comments section below.

Comments:

Client / Person contacted:

Date contacted:

Contacted by:

Response:

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditations: IEPA ELAP 100445; ORELAP IL300001; AIHA-LAP, LLC 101160; NVLAP LabCode 101202-0

November 24, 2021

GSG Consultants, Inc.
2942 W. Van Buren St.
Chicago, IL 60612
Telephone: (312) 733-6262
Fax: (312) 733-5612

Analytical Report for STAT Work Order: 21110507 Revision 0

RE: State & Lake, Chicago

Dear GSG Consultants, Inc.:

STAT Analysis received 5 samples for the referenced project on 11/12/2021 5:15:00 PM. The analytical results are presented in the following report.

All analyses were performed in accordance with the requirements of 35 IAC Part 186 / NELAP standards. Analyses were performed in accordance with methods as referenced on the analytical report. Those analytical results expressed on a dry weight basis are also noted on the analytical report.

All analyses were performed within established holding time criteria, and all Quality Control criteria met EPA or laboratory specifications except when noted in the Case Narrative or Analytical Report. If required, an estimate of uncertainty for the analyses can be provided. A listing of accredited methods/parameters can also be provided.

Thank you for the opportunity to serve you and I look forward to working with you in the future. If you have any questions regarding the enclosed materials, please contact me at (312) 733-0551.

Sincerely,

Justice Kwateng
Project Manager

Client: GSG Consultants, Inc.
Project: State & Lake, Chicago
Work Order: 21110507 Revision 0

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Tag Number	Collection Date	Date Received
21110507-001A	B-5-2		11/12/2021 2:15:00 PM	11/12/2021
21110507-001B	B-5-2		11/12/2021 2:15:00 PM	11/12/2021
21110507-002A	B-8-1		11/12/2021 2:00:00 PM	11/12/2021
21110507-002B	B-8-1		11/12/2021 2:00:00 PM	11/12/2021
21110507-003A	B-8-2		11/12/2021 2:50:00 PM	11/12/2021
21110507-003B	B-8-2		11/12/2021 2:50:00 PM	11/12/2021
21110507-004A	B-5-3		11/12/2021 3:20:00 PM	11/12/2021
21110507-004B	B-5-3		11/12/2021 3:20:00 PM	11/12/2021
21110507-005A	B-8-3		11/12/2021 3:00:00 PM	11/12/2021
21110507-005B	B-8-3		11/12/2021 3:00:00 PM	11/12/2021

CASE NARRATIVE

The Total Metals Continuing Calibration Verification (CCV) had recovery of Antimony outside of control (89%, 85% recovery, QC limits 90-110%). This CCV is associated with sample B-8-1 (21110507-002).

The metals Laboratory Control Sample (LCS) (preparation batch 137779) had recovery for Sodium outside of control limits (207% recovery, QC Limits 80-120%). Recovery in the Laboratory Control Sample Duplicate (LCSD) and Raletive Percent Difference (RPD) between the LCS and LCSD were within control limits.

Date Reported: November 24, 2021
Date Printed: November 24, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110507 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110507-001

Client Sample ID: B-5-2
Collection Date: 11/12/2021 2:15:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Acenaphthene	ND	0.042		mg/Kg-dry	1	11/17/2021
Acenaphthylene	ND	0.042		mg/Kg-dry	1	11/17/2021
Anthracene	ND	0.042		mg/Kg-dry	1	11/17/2021
Benz(a)anthracene	ND	0.042		mg/Kg-dry	1	11/17/2021
Benzo(a)pyrene	ND	0.042		mg/Kg-dry	1	11/17/2021
Benzo(b)fluoranthene	ND	0.042		mg/Kg-dry	1	11/17/2021
Benzo(g,h,i)perylene	ND	0.042		mg/Kg-dry	1	11/17/2021
Benzo(k)fluoranthene	ND	0.042		mg/Kg-dry	1	11/17/2021
Chrysene	ND	0.042		mg/Kg-dry	1	11/17/2021
Dibenz(a,h)anthracene	ND	0.042		mg/Kg-dry	1	11/17/2021
Fluoranthene	ND	0.042		mg/Kg-dry	1	11/17/2021
Fluorene	ND	0.042		mg/Kg-dry	1	11/17/2021
Indeno(1,2,3-cd)pyrene	ND	0.042		mg/Kg-dry	1	11/17/2021
Naphthalene	ND	0.042		mg/Kg-dry	1	11/17/2021
Phenanthrene	0.067	0.042		mg/Kg-dry	1	11/17/2021
Pyrene	ND	0.042		mg/Kg-dry	1	11/17/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/17/2021**		Analyst: **JG**
Arsenic	9.3	1.2		mg/Kg-dry	10	11/17/2021
Barium	51	1.2		mg/Kg-dry	10	11/17/2021
Cadmium	ND	0.60		mg/Kg-dry	10	11/17/2021
Chromium	24	1.2		mg/Kg-dry	10	11/17/2021
Lead	19	0.60		mg/Kg-dry	10	11/17/2021
Selenium	ND	1.2		mg/Kg-dry	10	11/17/2021
Silver	ND	1.2		mg/Kg-dry	10	11/17/2021
Mercury	**SW7471B**			Prep Date: **11/23/2021**		Analyst: **LB**
Mercury	0.027	0.023		mg/Kg-dry	1	11/24/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/22/2021**		Analyst: **RW**
pH	8.34			pH Units	1	11/22/2021
Percent Moisture	**D2974**			Prep Date: **11/19/2021**		Analyst: **HYM**
Percent Moisture	22.2	0.2	*	wt%	1	11/19/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 24, 2021
Date Printed: November 24, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110507 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110507-002

Client Sample ID: B-8-1
Collection Date: 11/12/2021 2:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/14/2021**		Analyst: **TMB**
Acetone	ND	0.088		mg/Kg-dry	1	11/24/2021
Benzene	ND	0.0059		mg/Kg-dry	1	11/24/2021
Bromodichloromethane	ND	0.0059		mg/Kg-dry	1	11/24/2021
Bromoform	ND	0.0059		mg/Kg-dry	1	11/24/2021
Bromomethane	ND	0.012		mg/Kg-dry	1	11/24/2021
2-Butanone	ND	0.088		mg/Kg-dry	1	11/24/2021
Carbon disulfide	ND	0.059		mg/Kg-dry	1	11/24/2021
Carbon tetrachloride	ND	0.0059		mg/Kg-dry	1	11/24/2021
Chlorobenzene	ND	0.0059		mg/Kg-dry	1	11/24/2021
Chloroethane	ND	0.012		mg/Kg-dry	1	11/24/2021
Chloroform	ND	0.0059		mg/Kg-dry	1	11/24/2021
Chloromethane	ND	0.012		mg/Kg-dry	1	11/24/2021
Dibromochloromethane	ND	0.0059		mg/Kg-dry	1	11/24/2021
1,1-Dichloroethane	ND	0.0059		mg/Kg-dry	1	11/24/2021
1,2-Dichloroethane	ND	0.0059		mg/Kg-dry	1	11/24/2021
1,1-Dichloroethene	ND	0.0059		mg/Kg-dry	1	11/24/2021
cis-1,2-Dichloroethene	ND	0.0059		mg/Kg-dry	1	11/24/2021
trans-1,2-Dichloroethene	ND	0.0059		mg/Kg-dry	1	11/24/2021
1,2-Dichloropropane	ND	0.0059		mg/Kg-dry	1	11/24/2021
cis-1,3-Dichloropropene	ND	0.0023		mg/Kg-dry	1	11/24/2021
trans-1,3-Dichloropropene	ND	0.0023		mg/Kg-dry	1	11/24/2021
Ethylbenzene	ND	0.0059		mg/Kg-dry	1	11/24/2021
2-Hexanone	ND	0.023		mg/Kg-dry	1	11/24/2021
4-Methyl-2-pentanone	ND	0.023		mg/Kg-dry	1	11/24/2021
Methylene chloride	ND	0.012		mg/Kg-dry	1	11/24/2021
Methyl tert-butyl ether	ND	0.0059		mg/Kg-dry	1	11/24/2021
Styrene	ND	0.0059		mg/Kg-dry	1	11/24/2021
1,1,2,2-Tetrachloroethane	ND	0.0059		mg/Kg-dry	1	11/24/2021
Tetrachloroethene	ND	0.0059		mg/Kg-dry	1	11/24/2021
Toluene	ND	0.0059		mg/Kg-dry	1	11/24/2021
1,1,1-Trichloroethane	ND	0.0059		mg/Kg-dry	1	11/24/2021
1,1,2-Trichloroethane	ND	0.0059		mg/Kg-dry	1	11/24/2021
Trichloroethene	ND	0.0059		mg/Kg-dry	1	11/24/2021
Vinyl chloride	ND	0.0059		mg/Kg-dry	1	11/24/2021
Xylenes, Total	ND	0.018		mg/Kg-dry	1	11/24/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Acenaphthene	ND	0.044		mg/Kg-dry	1	11/17/2021
Acenaphthylene	ND	0.044		mg/Kg-dry	1	11/17/2021

Qualifiers:

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J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 24, 2021
Date Printed: November 24, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110507 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110507-002

Client Sample ID: B-8-1
Collection Date: 11/12/2021 2:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Aniline	ND	0.44		mg/Kg-dry	1	11/17/2021
Anthracene	ND	0.044		mg/Kg-dry	1	11/17/2021
Benz(a)anthracene	0.052	0.044		mg/Kg-dry	1	11/17/2021
Benzidine	ND	0.44		mg/Kg-dry	1	11/17/2021
Benzo(a)pyrene	0.060	0.044		mg/Kg-dry	1	11/17/2021
Benzo(b)fluoranthene	0.052	0.044		mg/Kg-dry	1	11/17/2021
Benzo(g,h,i)perylene	ND	0.044		mg/Kg-dry	1	11/17/2021
Benzo(k)fluoranthene	0.056	0.044		mg/Kg-dry	1	11/17/2021
Benzoic acid	ND	1.1		mg/Kg-dry	1	11/17/2021
Benzyl alcohol	ND	0.23		mg/Kg-dry	1	11/17/2021
Bis(2-chloroethoxy)methane	ND	0.23		mg/Kg-dry	1	11/17/2021
Bis(2-chloroethyl)ether	ND	0.23		mg/Kg-dry	1	11/17/2021
Bis(2-ethylhexyl)phthalate	ND	1.1		mg/Kg-dry	1	11/17/2021
4-Bromophenyl phenyl ether	ND	0.23		mg/Kg-dry	1	11/17/2021
Butyl benzyl phthalate	ND	0.23		mg/Kg-dry	1	11/17/2021
Carbazole	ND	0.23		mg/Kg-dry	1	11/17/2021
4-Chloroaniline	ND	0.23		mg/Kg-dry	1	11/17/2021
4-Chloro-3-methylphenol	ND	0.44		mg/Kg-dry	1	11/17/2021
2-Chloronaphthalene	ND	0.23		mg/Kg-dry	1	11/17/2021
2-Chlorophenol	ND	0.23		mg/Kg-dry	1	11/17/2021
4-Chlorophenyl phenyl ether	ND	0.23		mg/Kg-dry	1	11/17/2021
Chrysene	0.057	0.044		mg/Kg-dry	1	11/17/2021
Dibenz(a,h)anthracene	ND	0.044		mg/Kg-dry	1	11/17/2021
Dibenzofuran	ND	0.23		mg/Kg-dry	1	11/17/2021
1,2-Dichlorobenzene	ND	0.23		mg/Kg-dry	1	11/17/2021
1,3-Dichlorobenzene	ND	0.23		mg/Kg-dry	1	11/17/2021
1,4-Dichlorobenzene	ND	0.23		mg/Kg-dry	1	11/17/2021
3,3´-Dichlorobenzidine	ND	0.23		mg/Kg-dry	1	11/17/2021
2,4-Dichlorophenol	ND	0.23		mg/Kg-dry	1	11/17/2021
Diethyl phthalate	ND	0.23		mg/Kg-dry	1	11/17/2021
2,4-Dimethylphenol	ND	0.23		mg/Kg-dry	1	11/17/2021
Dimethyl phthalate	ND	0.23		mg/Kg-dry	1	11/17/2021
4,6-Dinitro-2-methylphenol	ND	0.44		mg/Kg-dry	1	11/17/2021
2,4-Dinitrophenol	ND	1.1		mg/Kg-dry	1	11/17/2021
2,4-Dinitrotoluene	ND	0.044		mg/Kg-dry	1	11/17/2021
2,6-Dinitrotoluene	ND	0.044		mg/Kg-dry	1	11/17/2021
Di-n-butyl phthalate	ND	0.23		mg/Kg-dry	1	11/17/2021
Di-n-octyl phthalate	ND	0.23		mg/Kg-dry	1	11/17/2021

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S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
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Date Reported: November 24, 2021
Date Printed: November 24, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110507 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110507-002

Client Sample ID: B-8-1
Collection Date: 11/12/2021 2:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Fluoranthene	0.086	0.044		mg/Kg-dry	1	11/17/2021
Fluorene	ND	0.044		mg/Kg-dry	1	11/17/2021
Hexachlorobenzene	ND	0.23		mg/Kg-dry	1	11/17/2021
Hexachlorobutadiene	ND	0.23		mg/Kg-dry	1	11/17/2021
Hexachlorocyclopentadiene	ND	0.23		mg/Kg-dry	1	11/17/2021
Hexachloroethane	ND	0.23		mg/Kg-dry	1	11/17/2021
Indeno(1,2,3-cd)pyrene	ND	0.044		mg/Kg-dry	1	11/17/2021
Isophorone	ND	0.23		mg/Kg-dry	1	11/17/2021
2-Methylnaphthalene	ND	0.23		mg/Kg-dry	1	11/17/2021
2-Methylphenol	ND	0.23		mg/Kg-dry	1	11/17/2021
4-Methylphenol	ND	0.23		mg/Kg-dry	1	11/17/2021
Naphthalene	ND	0.044		mg/Kg-dry	1	11/17/2021
2-Nitroaniline	ND	0.23		mg/Kg-dry	1	11/17/2021
3-Nitroaniline	ND	0.23		mg/Kg-dry	1	11/17/2021
4-Nitroaniline	ND	0.23		mg/Kg-dry	1	11/17/2021
2-Nitrophenol	ND	0.23		mg/Kg-dry	1	11/17/2021
4-Nitrophenol	ND	0.44		mg/Kg-dry	1	11/17/2021
Nitrobenzene	ND	0.044		mg/Kg-dry	1	11/17/2021
N-Nitrosodi-n-propylamine	ND	0.044		mg/Kg-dry	1	11/17/2021
N-Nitrosodimethylamine	ND	0.23		mg/Kg-dry	1	11/17/2021
N-Nitrosodiphenylamine	ND	0.044		mg/Kg-dry	1	11/17/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.23		mg/Kg-dry	1	11/17/2021
Pentachlorophenol	ND	0.044		mg/Kg-dry	1	11/17/2021
Phenanthrene	0.071	0.044		mg/Kg-dry	1	11/17/2021
Phenol	ND	0.23		mg/Kg-dry	1	11/17/2021
Pyrene	0.066	0.044		mg/Kg-dry	1	11/17/2021
Pyridine	ND	0.89		mg/Kg-dry	1	11/17/2021
1,2,4-Trichlorobenzene	ND	0.23		mg/Kg-dry	1	11/17/2021
2,4,5-Trichlorophenol	ND	0.23		mg/Kg-dry	1	11/17/2021
2,4,6-Trichlorophenol	ND	0.23		mg/Kg-dry	1	11/17/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.11		mg/Kg-dry	1	11/17/2021
Aroclor 1221	ND	0.11		mg/Kg-dry	1	11/17/2021
Aroclor 1232	ND	0.11		mg/Kg-dry	1	11/17/2021
Aroclor 1242	ND	0.11		mg/Kg-dry	1	11/17/2021
Aroclor 1248	ND	0.11		mg/Kg-dry	1	11/17/2021
Aroclor 1254	ND	0.11		mg/Kg-dry	1	11/17/2021
Aroclor 1260	ND	0.11		mg/Kg-dry	1	11/17/2021

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B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 24, 2021
Date Printed: November 24, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110507 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110507-002

Client Sample ID: B-8-1
Collection Date: 11/12/2021 2:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0021		mg/Kg-dry	1	11/17/2021
4,4´-DDE	ND	0.0021		mg/Kg-dry	1	11/17/2021
4,4´-DDT	ND	0.0021		mg/Kg-dry	1	11/17/2021
Aldrin	ND	0.0021		mg/Kg-dry	1	11/17/2021
alpha-BHC	ND	0.0021		mg/Kg-dry	1	11/17/2021
alpha-Chlordane	ND	0.0021		mg/Kg-dry	1	11/17/2021
beta-BHC	ND	0.0021		mg/Kg-dry	1	11/17/2021
Chlordane	ND	0.021		mg/Kg-dry	1	11/17/2021
delta-BHC	ND	0.0021		mg/Kg-dry	1	11/17/2021
Dieldrin	ND	0.0021		mg/Kg-dry	1	11/17/2021
Endosulfan I	ND	0.0021		mg/Kg-dry	1	11/17/2021
Endosulfan II	ND	0.0021		mg/Kg-dry	1	11/17/2021
Endosulfan sulfate	ND	0.0021		mg/Kg-dry	1	11/17/2021
Endrin	ND	0.0021		mg/Kg-dry	1	11/17/2021
Endrin aldehyde	ND	0.0021		mg/Kg-dry	1	11/17/2021
Endrin ketone	ND	0.0021		mg/Kg-dry	1	11/17/2021
gamma-BHC	ND	0.0021		mg/Kg-dry	1	11/17/2021
gamma-Chlordane	ND	0.0021		mg/Kg-dry	1	11/17/2021
Heptachlor	ND	0.0021		mg/Kg-dry	1	11/17/2021
Heptachlor epoxide	ND	0.0021		mg/Kg-dry	1	11/17/2021
Methoxychlor	ND	0.0021		mg/Kg-dry	1	11/17/2021
Toxaphene	ND	0.044		mg/Kg-dry	1	11/17/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/17/2021**		Analyst: **JG**
Aluminum	15000	24		mg/Kg-dry	10	11/17/2021
Antimony	ND	2.4		mg/Kg-dry	10	11/19/2021
Arsenic	8.2	1.2		mg/Kg-dry	10	11/17/2021
Barium	50	1.2		mg/Kg-dry	10	11/17/2021
Beryllium	0.86	0.60		mg/Kg-dry	10	11/17/2021
Cadmium	ND	0.60		mg/Kg-dry	10	11/17/2021
Calcium	48000	72		mg/Kg-dry	10	11/17/2021
Chromium	25	1.2		mg/Kg-dry	10	11/17/2021
Cobalt	14	1.2		mg/Kg-dry	10	11/17/2021
Copper	34	3.1		mg/Kg-dry	10	11/17/2021
Iron	27000	36		mg/Kg-dry	10	11/17/2021
Lead	16	0.60		mg/Kg-dry	10	11/17/2021
Magnesium	25000	36		mg/Kg-dry	10	11/17/2021
Manganese	420	1.2		mg/Kg-dry	10	11/17/2021
Nickel	39	1.2		mg/Kg-dry	10	11/17/2021

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S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 24, 2021
Date Printed: November 24, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110507 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110507-002

Client Sample ID: B-8-1
Collection Date: 11/12/2021 2:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/17/2021**		Analyst: **JG**
Potassium	3800	36		mg/Kg-dry	10	11/17/2021
Selenium	ND	1.2		mg/Kg-dry	10	11/17/2021
Silver	ND	1.2		mg/Kg-dry	10	11/17/2021
Sodium	1700	72		mg/Kg-dry	10	11/19/2021
Thallium	ND	1.2		mg/Kg-dry	10	11/17/2021
Vanadium	26	1.2		mg/Kg-dry	10	11/17/2021
Zinc	62	6.0		mg/Kg-dry	10	11/17/2021
Mercury	**SW7471B**			Prep Date: **11/23/2021**		Analyst: **LB**
Mercury	0.60	0.024		mg/Kg-dry	1	11/24/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/18/2021**		Analyst: **MD**
Cyanide	ND	0.67		mg/Kg-dry	1	11/18/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/22/2021**		Analyst: **RW**
pH	8.32			pH Units	1	11/22/2021
Percent Moisture	**D2974**			Prep Date: **11/19/2021**		Analyst: **HYM**
Percent Moisture	24.9	0.2	*	wt%	1	11/19/2021

Qualifiers:

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HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 24, 2021
Date Printed: November 24, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110507 Revision 0
Project: State & Lake, Chicago
Lab ID: 21110507-003

Client Sample ID: B-8-2
Collection Date: 11/12/2021 2:50:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Acenaphthene	ND	0.043		mg/Kg-dry	1	11/17/2021
Acenaphthylene	ND	0.043		mg/Kg-dry	1	11/17/2021
Anthracene	ND	0.043		mg/Kg-dry	1	11/17/2021
Benz(a)anthracene	ND	0.043		mg/Kg-dry	1	11/17/2021
Benzo(a)pyrene	ND	0.043		mg/Kg-dry	1	11/17/2021
Benzo(b)fluoranthene	ND	0.043		mg/Kg-dry	1	11/17/2021
Benzo(g,h,i)perylene	ND	0.043		mg/Kg-dry	1	11/17/2021
Benzo(k)fluoranthene	ND	0.043		mg/Kg-dry	1	11/17/2021
Chrysene	ND	0.043		mg/Kg-dry	1	11/17/2021
Dibenz(a,h)anthracene	ND	0.043		mg/Kg-dry	1	11/17/2021
Fluoranthene	ND	0.043		mg/Kg-dry	1	11/17/2021
Fluorene	ND	0.043		mg/Kg-dry	1	11/17/2021
Indeno(1,2,3-cd)pyrene	ND	0.043		mg/Kg-dry	1	11/17/2021
Naphthalene	ND	0.043		mg/Kg-dry	1	11/17/2021
Phenanthrene	ND	0.043		mg/Kg-dry	1	11/17/2021
Pyrene	ND	0.043		mg/Kg-dry	1	11/17/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/17/2021**		Analyst: **JG**
Arsenic	9.2	1.3		mg/Kg-dry	10	11/17/2021
Barium	37	1.3		mg/Kg-dry	10	11/17/2021
Cadmium	ND	0.64		mg/Kg-dry	10	11/17/2021
Chromium	30	1.3		mg/Kg-dry	10	11/17/2021
Lead	18	0.64		mg/Kg-dry	10	11/17/2021
Selenium	ND	1.3		mg/Kg-dry	10	11/17/2021
Silver	ND	1.3		mg/Kg-dry	10	11/17/2021
Mercury	**SW7471B**			Prep Date: **11/23/2021**		Analyst: **LB**
Mercury	0.027	0.023		mg/Kg-dry	1	11/24/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/22/2021**		Analyst: **RW**
pH	8.11			pH Units	1	11/22/2021
Percent Moisture	**D2974**			Prep Date: **11/19/2021**		Analyst: **HYM**
Percent Moisture	23.6	0.2	*	wt%	1	11/19/2021

Qualifiers:

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J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

Nº: 932580

Page : 1 **of** 2

Company: GSG Consultants Inc

Project Number:

Client Tracking No.:

Project Name: State & Lake

Project Location: Chicago

Sampler(s): Jones Bravo

Report To: Ted Cagney

Phone:

Fax:

e-mail: tcagney@gsg-consultants

QC Level: 1 ____ 2 ____ 3 ____ 4 ____

Quote No.:

P.O. No.:

Turn Around Time (Days): 1 2 3 4 [✓ 5 - 7] 10

Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	TCL	RCRA metals	PNAs	pH										Additional Information:	Lab No.:
B-S-2	11/12/21	0015	S		X		4		X	X	X											001
B-S-1	↕	0200	S		\		4	X			X											002
B-S-2	11/12/21	0250	S		X		4		∧	∧	X											003

Relinquished by: (Signature)	Date/Time: 11/12/21
Received by: (Signature)	Date/Time: 11/12/21 1705
Relinquished by: (Signature)	Date/Time:
Received by: (Signature)	Date/Time:
Relinquished by: (Signature)	Date/Time:
Received by: (Signature)	Date/Time:

Comments:

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 2110507

Received on Ice: Yes ☑ No ☐

Temperature: on Ice °C

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

Nº: 932581

Page : 2 **of** 2

Company: GSG Consultants Inc
Project Number:
Client Tracking No.:
Project Name: State & Lake
Project Location: Chicago
Sampler(s): James Banco
Report To: Ted Cagney
Phone:
Fax:
QC Level: 1 ____ 2 ____ 3 ____ 4 ____
e-mail: tcagney@gsg-consultants

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 5-7 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	Additional Information:	Lab No.:
B-S-3	11/12/21	0020	S		X		4		004
B-8-3	11/12/21	0300	S		X		4		005

Relinquished by: (Signature) Date/Time: 11/12/21
Received by: (Signature) Date/Time: 11/12/21 17:45
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments: Hold

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110507

Received on Ice: Yes ☑ No ☐

Temperature: On Ice °C

STAT Analysis Corporation

Sample Receipt Checklist

Client Name GSG

Date and Time Received: 11/12/2021 5:15:00 PM

Work Order Number 21110507

Received by: NAP

Checklist completed by: Signature Date 11/12/21

Reviewed by: Initials Date 11/15/21

Matrix:

Carrier name: Client Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
Chain of custody present?	Yes ☑	No ☐	
Chain of custody signed when relinquished and received?	Yes ☑	No ☐	
Chain of custody agrees with sample labels/containers?	Yes ☑	No ☐	
Samples in proper container/bottle?	Yes ☑	No ☐	
Sample containers intact?	Yes ☑	No ☐	
Sufficient sample volume for indicated test?	Yes ☑	No ☐	
All samples received within holding time?	Yes ☑	No ☐	
Container or Temp Blank temperature in compliance?	Yes ☑	No ☐	Temperature On Ice °C
Water - VOA vials have zero headspace?	No VOA vials submitted ☐	Yes ☐	No ☐
Water - Samples pH checked?	Yes ☐	No ☐	Checked by:
Water - Samples properly preserved?	Yes ☐	No ☐	pH Adjusted?

Any No response must be detailed in the comments section below.

Comments:

Client / Person contacted:

Date contacted:

Contacted by:

Response:

STAT Analysis Corporation
2242 West Harrison St., Suite 200, Chicago, IL 60612-3766
Tel: (312) 733-0551 Fax: (312) 733-2386 STATinfo@STATAnalysis.com
Accreditations: IEPA ELAP 100445; ORELAP IL300001; AIHA-LAP, LLC 101160; NVLAP LabCode 101202-0

November 26, 2021

GSG Consultants, Inc.
2942 W. Van Buren St.
Chicago, IL 60612
Telephone: (312) 733-6262
Fax: (312) 733-5612

Analytical Report for STAT Work Order: 21110510 Revision 0

RE: State & Lake

Dear GSG Consultants, Inc.:

STAT Analysis received 3 samples for the referenced project on 11/15/2021 9:29:00 AM. The analytical results are presented in the following report.

All analyses were performed in accordance with the requirements of 35 IAC Part 186 / NELAP standards. Analyses were performed in accordance with methods as referenced on the analytical report. Those analytical results expressed on a dry weight basis are also noted on the analytical report.

All analyses were performed within established holding time criteria, and all Quality Control criteria met EPA or laboratory specifications except when noted in the Case Narrative or Analytical Report. If required, an estimate of uncertainty for the analyses can be provided. A listing of accredited methods/parameters can also be provided.

Thank you for the opportunity to serve you and I look forward to working with you in the future. If you have any questions regarding the enclosed materials, please contact me at (312) 733-0551.

Sincerely,

Justice Kwateng
Project Manager

Client: GSG Consultants, Inc.
Project: State & Lake
Work Order: 21110510 Revision 0

Work Order Sample Summary

Lab Sample ID	Client Sample ID	Tag Number	Collection Date	Date Received
21110510-001A	B-9-1		11/14/2021 7:00:00 PM	11/15/2021
21110510-001B	B-9-1		11/14/2021 7:00:00 PM	11/15/2021
21110510-002A	B-9-2		11/14/2021 7:10:00 PM	11/15/2021
21110510-002B	B-9-2		11/14/2021 7:10:00 PM	11/15/2021
21110510-003A	B-9-3		11/14/2021 7:30:00 PM	11/15/2021
21110510-003B	B-9-3		11/14/2021 7:30:00 PM	11/15/2021

CLIENT: GSG Consultants, Inc.
Project: State & Lake
Work Order: 21110510 Revision 0

CASE NARRATIVE

The Total Metals Continuing Calibration Verification (CCV) had recovery of Antimony outside of control (85%/86% recovery, QC limits 90-110%). This CCV is associated with the following sample: B-9-1 (21110510-001)

The metals Laboratory Control Sample (LCS) (preparation batch 137779) had recovery outside of control limits for Sodium (207% recovery, QC Limits 80-120%).

Date Reported: November 26, 2021
Date Printed: November 26, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110510 Revision 0
Project: State & Lake
Lab ID: 21110510-001

Client Sample ID: B-9-1
Collection Date: 11/14/2021 7:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Volatile Organic Compounds by GC/MS	**SW5035/8260B**			Prep Date: **11/15/2021**		Analyst: **KWV**
Acetone	ND	0.099		mg/Kg-dry	1	11/24/2021
Benzene	ND	0.0066		mg/Kg-dry	1	11/24/2021
Bromodichloromethane	ND	0.0066		mg/Kg-dry	1	11/24/2021
Bromoform	ND	0.0066		mg/Kg-dry	1	11/24/2021
Bromomethane	ND	0.013		mg/Kg-dry	1	11/24/2021
2-Butanone	ND	0.099		mg/Kg-dry	1	11/24/2021
Carbon disulfide	ND	0.066		mg/Kg-dry	1	11/24/2021
Carbon tetrachloride	ND	0.0066		mg/Kg-dry	1	11/24/2021
Chlorobenzene	ND	0.0066		mg/Kg-dry	1	11/24/2021
Chloroethane	ND	0.013		mg/Kg-dry	1	11/24/2021
Chloroform	ND	0.0066		mg/Kg-dry	1	11/24/2021
Chloromethane	ND	0.013		mg/Kg-dry	1	11/24/2021
Dibromochloromethane	ND	0.0066		mg/Kg-dry	1	11/24/2021
1,1-Dichloroethane	ND	0.0066		mg/Kg-dry	1	11/24/2021
1,2-Dichloroethane	ND	0.0066		mg/Kg-dry	1	11/24/2021
1,1-Dichloroethene	ND	0.0066		mg/Kg-dry	1	11/24/2021
cis-1,2-Dichloroethene	ND	0.0066		mg/Kg-dry	1	11/24/2021
trans-1,2-Dichloroethene	ND	0.0066		mg/Kg-dry	1	11/24/2021
1,2-Dichloropropane	ND	0.0066		mg/Kg-dry	1	11/24/2021
cis-1,3-Dichloropropene	ND	0.0026		mg/Kg-dry	1	11/24/2021
trans-1,3-Dichloropropene	ND	0.0026		mg/Kg-dry	1	11/24/2021
Ethylbenzene	ND	0.0066		mg/Kg-dry	1	11/24/2021
2-Hexanone	ND	0.026		mg/Kg-dry	1	11/24/2021
4-Methyl-2-pentanone	ND	0.026		mg/Kg-dry	1	11/24/2021
Methylene chloride	ND	0.013		mg/Kg-dry	1	11/24/2021
Methyl tert-butyl ether	ND	0.0066		mg/Kg-dry	1	11/24/2021
Styrene	ND	0.0066		mg/Kg-dry	1	11/24/2021
1,1,2,2-Tetrachloroethane	ND	0.0066		mg/Kg-dry	1	11/24/2021
Tetrachloroethene	ND	0.0066		mg/Kg-dry	1	11/24/2021
Toluene	ND	0.0066		mg/Kg-dry	1	11/24/2021
1,1,1-Trichloroethane	ND	0.0066		mg/Kg-dry	1	11/24/2021
1,1,2-Trichloroethane	ND	0.0066		mg/Kg-dry	1	11/24/2021
Trichloroethene	ND	0.0066		mg/Kg-dry	1	11/24/2021
Vinyl chloride	ND	0.0066		mg/Kg-dry	1	11/24/2021
Xylenes, Total	ND	0.020		mg/Kg-dry	1	11/24/2021
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Acenaphthene	ND	0.036		mg/Kg-dry	1	11/17/2021
Acenaphthylene	ND	0.036		mg/Kg-dry	1	11/17/2021

Qualifiers:		
	ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
	J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
	B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
	HT - Sample received past holding time	E - Value above quantitation range
	* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 26, 2021
Date Printed: November 26, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110510 Revision 0
Project: State & Lake
Lab ID: 21110510-001

Client Sample ID: B-9-1
Collection Date: 11/14/2021 7:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Aniline	ND	0.36		mg/Kg-dry	1	11/17/2021
Anthracene	ND	0.036		mg/Kg-dry	1	11/17/2021
Benz(a)anthracene	0.057	0.036		mg/Kg-dry	1	11/17/2021
Benzidine	ND	0.36		mg/Kg-dry	1	11/17/2021
Benzo(a)pyrene	0.049	0.036		mg/Kg-dry	1	11/17/2021
Benzo(b)fluoranthene	0.059	0.036		mg/Kg-dry	1	11/17/2021
Benzo(g,h,i)perylene	0.046	0.036		mg/Kg-dry	1	11/17/2021
Benzo(k)fluoranthene	0.049	0.036		mg/Kg-dry	1	11/17/2021
Benzoic acid	ND	0.90		mg/Kg-dry	1	11/17/2021
Benzyl alcohol	ND	0.18		mg/Kg-dry	1	11/17/2021
Bis(2-chloroethoxy)methane	ND	0.18		mg/Kg-dry	1	11/17/2021
Bis(2-chloroethyl)ether	ND	0.18		mg/Kg-dry	1	11/17/2021
Bis(2-ethylhexyl)phthalate	ND	0.90		mg/Kg-dry	1	11/17/2021
4-Bromophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/17/2021
Butyl benzyl phthalate	ND	0.18		mg/Kg-dry	1	11/17/2021
Carbazole	ND	0.18		mg/Kg-dry	1	11/17/2021
4-Chloroaniline	ND	0.18		mg/Kg-dry	1	11/17/2021
4-Chloro-3-methylphenol	ND	0.36		mg/Kg-dry	1	11/17/2021
2-Chloronaphthalene	ND	0.18		mg/Kg-dry	1	11/17/2021
2-Chlorophenol	ND	0.18		mg/Kg-dry	1	11/17/2021
4-Chlorophenyl phenyl ether	ND	0.18		mg/Kg-dry	1	11/17/2021
Chrysene	0.064	0.036		mg/Kg-dry	1	11/17/2021
Dibenz(a,h)anthracene	ND	0.036		mg/Kg-dry	1	11/17/2021
Dibenzofuran	ND	0.18		mg/Kg-dry	1	11/17/2021
1,2-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/17/2021
1,3-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/17/2021
1,4-Dichlorobenzene	ND	0.18		mg/Kg-dry	1	11/17/2021
3,3´-Dichlorobenzidine	ND	0.18		mg/Kg-dry	1	11/17/2021
2,4-Dichlorophenol	ND	0.18		mg/Kg-dry	1	11/17/2021
Diethyl phthalate	ND	0.18		mg/Kg-dry	1	11/17/2021
2,4-Dimethylphenol	ND	0.18		mg/Kg-dry	1	11/17/2021
Dimethyl phthalate	ND	0.18		mg/Kg-dry	1	11/17/2021
4,6-Dinitro-2-methylphenol	ND	0.36		mg/Kg-dry	1	11/17/2021
2,4-Dinitrophenol	ND	0.90		mg/Kg-dry	1	11/17/2021
2,4-Dinitrotoluene	ND	0.036		mg/Kg-dry	1	11/17/2021
2,6-Dinitrotoluene	ND	0.036		mg/Kg-dry	1	11/17/2021
Di-n-butyl phthalate	ND	0.18		mg/Kg-dry	1	11/17/2021
Di-n-octyl phthalate	ND	0.18		mg/Kg-dry	1	11/17/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 26, 2021
Date Printed: November 26, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110510 Revision 0
Project: State & Lake
Lab ID: 21110510-001

Client Sample ID: B-9-1
Collection Date: 11/14/2021 7:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Semivolatile Organic Compounds by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Fluoranthene	0.079	0.036		mg/Kg-dry	1	11/17/2021
Fluorene	ND	0.036		mg/Kg-dry	1	11/17/2021
Hexachlorobenzene	ND	0.18		mg/Kg-dry	1	11/17/2021
Hexachlorobutadiene	ND	0.18		mg/Kg-dry	1	11/17/2021
Hexachlorocyclopentadiene	ND	0.18		mg/Kg-dry	1	11/17/2021
Hexachloroethane	ND	0.18		mg/Kg-dry	1	11/17/2021
Indeno(1,2,3-cd)pyrene	ND	0.036		mg/Kg-dry	1	11/17/2021
Isophorone	ND	0.18		mg/Kg-dry	1	11/17/2021
2-Methylnaphthalene	ND	0.18		mg/Kg-dry	1	11/17/2021
2-Methylphenol	ND	0.18		mg/Kg-dry	1	11/17/2021
4-Methylphenol	ND	0.18		mg/Kg-dry	1	11/17/2021
Naphthalene	ND	0.036		mg/Kg-dry	1	11/17/2021
2-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/17/2021
3-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/17/2021
4-Nitroaniline	ND	0.18		mg/Kg-dry	1	11/17/2021
2-Nitrophenol	ND	0.18		mg/Kg-dry	1	11/17/2021
4-Nitrophenol	ND	0.36		mg/Kg-dry	1	11/17/2021
Nitrobenzene	ND	0.036		mg/Kg-dry	1	11/17/2021
N-Nitrosodi-n-propylamine	ND	0.036		mg/Kg-dry	1	11/17/2021
N-Nitrosodimethylamine	ND	0.18		mg/Kg-dry	1	11/17/2021
N-Nitrosodiphenylamine	ND	0.036		mg/Kg-dry	1	11/17/2021
2, 2'-oxybis(1-Chloropropane)	ND	0.18		mg/Kg-dry	1	11/17/2021
Pentachlorophenol	ND	0.036		mg/Kg-dry	1	11/17/2021
Phenanthrene	0.057	0.036		mg/Kg-dry	1	11/17/2021
Phenol	ND	0.18		mg/Kg-dry	1	11/17/2021
Pyrene	0.083	0.036		mg/Kg-dry	1	11/17/2021
Pyridine	ND	0.72		mg/Kg-dry	1	11/17/2021
1,2,4-Trichlorobenzene	ND	0.18		mg/Kg-dry	1	11/17/2021
2,4,5-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/17/2021
2,4,6-Trichlorophenol	ND	0.18		mg/Kg-dry	1	11/17/2021
PCBs	**SW8082A (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **GVC**
Aroclor 1016	ND	0.086		mg/Kg-dry	1	11/17/2021
Aroclor 1221	ND	0.086		mg/Kg-dry	1	11/17/2021
Aroclor 1232	ND	0.086		mg/Kg-dry	1	11/17/2021
Aroclor 1242	ND	0.086		mg/Kg-dry	1	11/17/2021
Aroclor 1248	ND	0.086		mg/Kg-dry	1	11/17/2021
Aroclor 1254	ND	0.086		mg/Kg-dry	1	11/17/2021
Aroclor 1260	ND	0.086		mg/Kg-dry	1	11/17/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
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HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 26, 2021
Date Printed: November 26, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110510 Revision 0
Project: State & Lake
Lab ID: 21110510-001

Client Sample ID: B-9-1
Collection Date: 11/14/2021 7:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Pesticides	**SW8081B (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **GVC**
4,4´-DDD	ND	0.0017		mg/Kg-dry	1	11/17/2021
4,4´-DDE	ND	0.0017		mg/Kg-dry	1	11/17/2021
4,4´-DDT	ND	0.0017		mg/Kg-dry	1	11/17/2021
Aldrin	ND	0.0017		mg/Kg-dry	1	11/17/2021
alpha-BHC	ND	0.0017		mg/Kg-dry	1	11/17/2021
alpha-Chlordane	ND	0.0017		mg/Kg-dry	1	11/17/2021
beta-BHC	ND	0.0017		mg/Kg-dry	1	11/17/2021
Chlordane	ND	0.017		mg/Kg-dry	1	11/17/2021
delta-BHC	ND	0.0017		mg/Kg-dry	1	11/17/2021
Dieldrin	ND	0.0017		mg/Kg-dry	1	11/17/2021
Endosulfan I	ND	0.0017		mg/Kg-dry	1	11/17/2021
Endosulfan II	ND	0.0017		mg/Kg-dry	1	11/17/2021
Endosulfan sulfate	ND	0.0017		mg/Kg-dry	1	11/17/2021
Endrin	ND	0.0017		mg/Kg-dry	1	11/17/2021
Endrin aldehyde	ND	0.0017		mg/Kg-dry	1	11/17/2021
Endrin ketone	ND	0.0017		mg/Kg-dry	1	11/17/2021
gamma-BHC	ND	0.0017		mg/Kg-dry	1	11/17/2021
gamma-Chlordane	ND	0.0017		mg/Kg-dry	1	11/17/2021
Heptachlor	ND	0.0017		mg/Kg-dry	1	11/17/2021
Heptachlor epoxide	ND	0.0017		mg/Kg-dry	1	11/17/2021
Methoxychlor	ND	0.0017		mg/Kg-dry	1	11/17/2021
Toxaphene	ND	0.036		mg/Kg-dry	1	11/17/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/17/2021**		Analyst: **JG**
Aluminum	1900	20		mg/Kg-dry	10	11/17/2021
Antimony	ND	2.0		mg/Kg-dry	10	11/19/2021
Arsenic	3.4	1.0		mg/Kg-dry	10	11/17/2021
Barium	21	1.0		mg/Kg-dry	10	11/17/2021
Beryllium	ND	0.51		mg/Kg-dry	10	11/17/2021
Cadmium	ND	0.51		mg/Kg-dry	10	11/17/2021
Calcium	35000	82		mg/Kg-dry	10	11/17/2021
Chromium	5.6	1.0		mg/Kg-dry	10	11/17/2021
Cobalt	2.0	1.0		mg/Kg-dry	10	11/17/2021
Copper	16	2.5		mg/Kg-dry	10	11/17/2021
Iron	5900	31		mg/Kg-dry	10	11/17/2021
Lead	84	0.51		mg/Kg-dry	10	11/17/2021
Magnesium	13000	31		mg/Kg-dry	10	11/17/2021
Manganese	110	1.0		mg/Kg-dry	10	11/17/2021
Nickel	5.4	1.0		mg/Kg-dry	10	11/17/2021

Qualifiers:

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J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter

RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

Date Reported: November 26, 2021
Date Printed: November 26, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110510 Revision 0
Project: State & Lake
Lab ID: 21110510-001

Client Sample ID: B-9-1
Collection Date: 11/14/2021 7:00:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/17/2021**		Analyst: **JG**
Potassium	640	31		mg/Kg-dry	10	11/17/2021
Selenium	ND	1.0		mg/Kg-dry	10	11/17/2021
Silver	ND	1.0		mg/Kg-dry	10	11/17/2021
Sodium	330	61		mg/Kg-dry	10	11/19/2021
Thallium	ND	1.0		mg/Kg-dry	10	11/17/2021
Vanadium	7.4	1.0		mg/Kg-dry	10	11/17/2021
Zinc	72	5.1		mg/Kg-dry	10	11/17/2021
Mercury	**SW7471B**			Prep Date: **11/23/2021**		Analyst: **LB**
Mercury	0.071	0.019		mg/Kg-dry	1	11/24/2021
Cyanide, Total	**SW9012A**			Prep Date: **11/19/2021**		Analyst: **MD**
Cyanide	ND	0.54		mg/Kg-dry	1	11/19/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/22/2021**		Analyst: **RW**
pH	9.63			pH Units	1	11/22/2021
Percent Moisture	**D2974**			Prep Date: **11/19/2021**		Analyst: **HYM**
Percent Moisture	7.3	0.2	*	wt%	1	11/19/2021

Qualifiers:

ND - Not Detected at the Reporting Limit	RL - Reporting / Quantitation Limit for the analysis
J - Analyte detected below quantitation limits	S - Spike Recovery outside accepted recovery limits
B - Analyte detected in the associated Method Blank	R - RPD outside accepted recovery limits
HT - Sample received past holding time	E - Value above quantitation range
* - Non-accredited parameter	H - Holding time exceeded

Date Reported: November 26, 2021
Date Printed: November 26, 2021

ANALYTICAL RESULTS

Client: GSG Consultants, Inc.
Work Order: 21110510 Revision 0
Project: State & Lake
Lab ID: 21110510-002

Client Sample ID: B-9-2
Collection Date: 11/14/2021 7:10:00 PM
Matrix: Soil

Analyses	Result	RL	Qualifier	Units	DF	Date Analyzed
Polynuclear Aromatic Hydrocarbons by GC/MS	**SW8270C (SW3550B)**			Prep Date: **11/16/2021**		Analyst: **TEM**
Acenaphthene	ND	0.040		mg/Kg-dry	1	11/17/2021
Acenaphthylene	ND	0.040		mg/Kg-dry	1	11/17/2021
Anthracene	ND	0.040		mg/Kg-dry	1	11/17/2021
Benz(a)anthracene	ND	0.040		mg/Kg-dry	1	11/17/2021
Benzo(a)pyrene	ND	0.040		mg/Kg-dry	1	11/17/2021
Benzo(b)fluoranthene	ND	0.040		mg/Kg-dry	1	11/17/2021
Benzo(g,h,i)perylene	ND	0.040		mg/Kg-dry	1	11/17/2021
Benzo(k)fluoranthene	ND	0.040		mg/Kg-dry	1	11/17/2021
Chrysene	ND	0.040		mg/Kg-dry	1	11/17/2021
Dibenz(a,h)anthracene	ND	0.040		mg/Kg-dry	1	11/17/2021
Fluoranthene	ND	0.040		mg/Kg-dry	1	11/17/2021
Fluorene	ND	0.040		mg/Kg-dry	1	11/17/2021
Indeno(1,2,3-cd)pyrene	ND	0.040		mg/Kg-dry	1	11/17/2021
Naphthalene	ND	0.040		mg/Kg-dry	1	11/17/2021
Phenanthrene	0.052	0.040		mg/Kg-dry	1	11/17/2021
Pyrene	ND	0.040		mg/Kg-dry	1	11/17/2021
Metals by ICP/MS	**SW6020A (SW3050B)**			Prep Date: **11/17/2021**		Analyst: **JG**
Arsenic	10	1.1		mg/Kg-dry	10	11/17/2021
Barium	38	1.1		mg/Kg-dry	10	11/17/2021
Cadmium	ND	0.58		mg/Kg-dry	10	11/17/2021
Chromium	22	1.1		mg/Kg-dry	10	11/17/2021
Lead	16	0.58		mg/Kg-dry	10	11/17/2021
Selenium	ND	1.1		mg/Kg-dry	10	11/17/2021
Silver	ND	1.1		mg/Kg-dry	10	11/17/2021
Mercury	**SW7471B**			Prep Date: **11/23/2021**		Analyst: **LB**
Mercury	0.023	0.022		mg/Kg-dry	1	11/24/2021
pH (25 °C)	**SW9045C**			Prep Date: **11/22/2021**		Analyst: **RW**
pH	8.20			pH Units	1	11/22/2021
Percent Moisture	**D2974**			Prep Date: **11/19/2021**		Analyst: **HYM**
Percent Moisture	20.5	0.2	*	wt%	1	11/19/2021

Qualifiers:

ND - Not Detected at the Reporting Limit
J - Analyte detected below quantitation limits
B - Analyte detected in the associated Method Blank
HT - Sample received past holding time
* - Non-accredited parameter
RL - Reporting / Quantitation Limit for the analysis
S - Spike Recovery outside accepted recovery limits
R - RPD outside accepted recovery limits
E - Value above quantitation range
H - Holding time exceeded

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF COUSTODY RECORD

Nº: 930310 **Page:** 1 **of** 2

Company: GSG Consultants Inc
Project Number:
Client Tracking No.:
Project Name: State & Lake
Project Location: Chicago
Sampler(s): James Benco
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants.com
QC Level: 1 ____ 2 ____ 3 ____ 4 ____

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 [✓ 5 - 7] 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	TCL	RCRA metals	PNAs	pH	Additional Information:	Lab No.:
B-9-1	11/14/21	1900	S		X		4	X			X		001
B-9-2	11/14/21	1910	S		X		4		X	X	X		002

Relinquished by: (Signature)		Date/Time: 11/15/21 0920
Received by: (Signature)		Date/Time: 11/15/21 9:20
Relinquished by: (Signature)		Date/Time:
Received by: (Signature)		Date/Time:
Relinquished by: (Signature)		Date/Time:
Received by: (Signature)		Date/Time:

Comments:

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110516

Received on Ice: Yes ☑ No ☐

Temperature: 3.1 °C

STAT Analysis Corporation

2242 W. Harrison Suite 200, Chicago, Illinois 60612 Phone: (312) 733-0551 Fax: (312) 733-2386
e-mail address: STATinfo@STATAnalysis.com

CHAIN OF CUSTODY RECORD

No.: 930311

Page: 2 of 2

Company: GSG Consultants. Inc
Project Number:
Client Tracking No.:
Project Name: State ; Lake
Project Location: Chicago
Sampler(s): James Benco
Report To: Ted Cagney
Phone:
Fax:
e-mail: tcagney@gsg-consultants.com
QC Level: 1 ____ 2 ____ 3 ____ 4 ____

Quote No.:
P.O. No.:
Turn Around Time (Days): 1 2 3 4 5-7 10
Results Needed: / / am/pm

Client Sample Number/Description:	Date Taken	Time Taken	Matrix	Comp.	Grab	Preserv.	No. of Containers	Additional Information:	Lab No.:
B-9-3	11/14/21	1930	S		X		4		003

Relinquished by: (Signature) Date/Time: 11/15/21 0930
Received by: (Signature) Date/Time: 11/15/21 928
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:
Relinquished by: (Signature) Date/Time:
Received by: (Signature) Date/Time:

Comments: Hold

Preservation Code: A = None B = HNO_3 C = NaOH D = H_2SO_4 E = HCl F = 5035/EnCore G = Other

Laboratory Work Order No.: 21110510

Received on Ice: Yes ☒ No ☐

Temperature: 3.1 °C

STAT Analysis Corporation

Sample Receipt Checklist

Client Name GSG

Work Order Number 21110510

Date and Time Received: 11/15/2021 9:29:00 AM

Received by: NAP

Checklist completed by: Signature 11/15/21 Date

Reviewed by: Initials 11/16/21 Date

Matrix:

Carrier name Client Delivered

Shipping container/cooler in good condition?	Yes ☑	No ☐	Not Present ☐	
Custody seals intact on shippping container/cooler?	Yes ☐	No ☐	Not Present ☑	
Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑	
Chain of custody present?	Yes ☑	No ☐		
Chain of custody signed when relinquished and received?	Yes ☑	No ☐		
Chain of custody agrees with sample labels/containers?	Yes ☑	No ☐		
Samples in proper container/bottle?	Yes ☑	No ☐		
Sample containers intact?	Yes ☑	No ☐		
Sufficient sample volume for indicated test?	Yes ☑	No ☐		
All samples received within holding time?	Yes ☑	No ☐		
Container or [✓ Temp Blank] temperature in compliance?	Yes ☑	No ☐	Temperature	3.1 °C
Water - VOA vials have zero headspace?	No VOA vials submitted ☐	Yes ☐	No ☐	
Water - Samples pH checked?	Yes ☐	No ☐	Checked by:	
Water - Samples properly preserved?	Yes ☐	No ☐	pH Adjusted?	

Any No response must be detailed in the comments section below.

Comments:

Client / Person contacted:

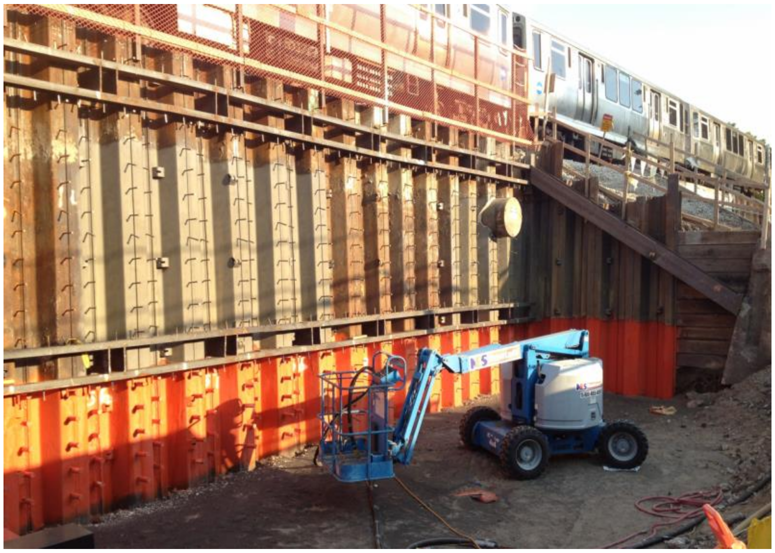
Date contacted:

Contacted by:

Response:

APPENDIX D

CHICAGO TRANSIT AUTHORITY ADJACENT CONSTRUCTION MANUAL



Adjacent Construction Manual

Infrastructure Division

Prepared by

Structural Engineering

Revision 01
March 2022

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Approved by: James P. Harper Date: 4/18/2022

Chief Engineer

James Harper

Approved by: William Polacek Date: 4/19/2022

General Manager, Construction

William Polacek

Approved by: TaNesheha Marshall Date: 4/19/22

Vice President, Construction

TaNesheha Marshall

Approved by: William Mooney Digitally signed by William Mooney
Date: 2022.04.15 16:10:40 -05'00' Date: 4/15/22

Chief Infrastructure Officer

William R. Mooney

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REVISION SUMMARY

The following provide highlight of changes to major updates in Revision 1 of Adjacent Construction Manual.

SECTION 1: INTRODUCTION

(1) Manual update cycle added.
(2) Basic Safety Envelope definition updated.
(3) Add various new definitions related to rail operations and flagging.
(4) CTA nearby construction website link updated.

SECTION 2: COORDINATION FLOWCHART AND SUBMITTAL REQUIREMENTS

(1) Section 2.7 Construction Process Plan (CPP) requirements updated.
(2) Section 2.8 Construction Verification new requirements added.

SECTION 3: BASIC CONSTRUCTION AND EXCAVATION REQUIREMENTS

(1) Section 3 name revised and updated to ensure this section governs the overall construction requirements.
(2) Various underground utility location assumptions, field verifications requirements added.
(3) Guidelines added for construction impacting CTA Rail Operation related to flagging, slow zone, and line cuts, etc.
(4) Construction equipment requirements added in Section 3.9.1.
(5) Handrails and walkways requirements added in Section 3.11.

SECTION 4: OWNER/CONTRACTOR-DESIGNED TEMPORARY SHORING REQUIREMENT

(1) The use of various shoring types redefined in Section 4.2 and Section 4.3.
(2) New Jack and Bore Construction requirements added in Section 4.4.
(3) New Horizontal Directional Drilling Construction requirements added in Section 4.5.

SECTION 5: LOADING ON TEMPORARY SHORING SYSTEM

(1) No major changes in this section.

SECTION 6: RAPID TRANSIT LIVE LOAD SURCHARGE

(1) Added Variance Request for existing CTA retaining wall stability check when factor of safety against overturning and sliding cannot achieve as required in Section 7.

SECTION 7: SHORING ANALYSIS METHODOLOGIES

(1) Added requirements about welding.

SECTION 8: MATERIAL PROPERTIES AND ALLOWABLE STRESSES

(1) No major changes in this section.

SECTION 9: SPECIAL CONDITIONS

(1) Minor updates and clarifications regarding dewatering.
(2) Clarifications added for global stability in Section 9.4.

SECTION 10: TRACK, STRUCTURE, AND SHORING MONITORING

(1) Added baseline reading requirements for Jack and Bore construction and Horizontal Directional Drilling construction monitoring.
(2) Supplemental monitoring requirements added for micropile installation within CTA Zone of Influence.

Section 11: OTHER TYPES OF ADJACENT CONSTRUCTION

(1) Added special requirements for drilled shaft installation.
(2) Added special requirements for micropile installation.
(3) Added swing stage requirements.
(4) Added small unmanned aircraft system requirements.
(5) Added requirements on miscellaneous elements mounted on CTA elevated track structures.
(6) Section 11.5 restructured to Existing CTA Facilities.

Appendix A – SUBMITTAL CHECKLISTS

(1) Various new checklists added.

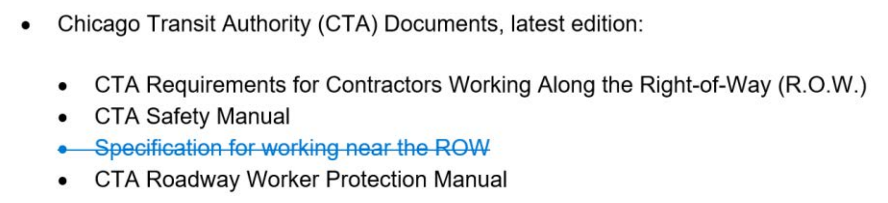
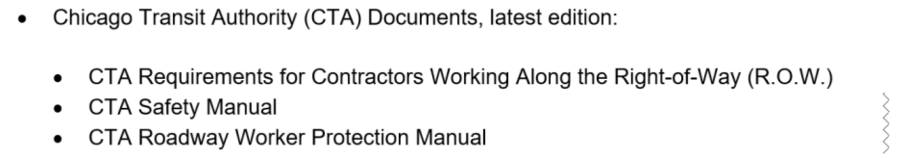
Appendix B to Appendix H:

(1) No major changes.

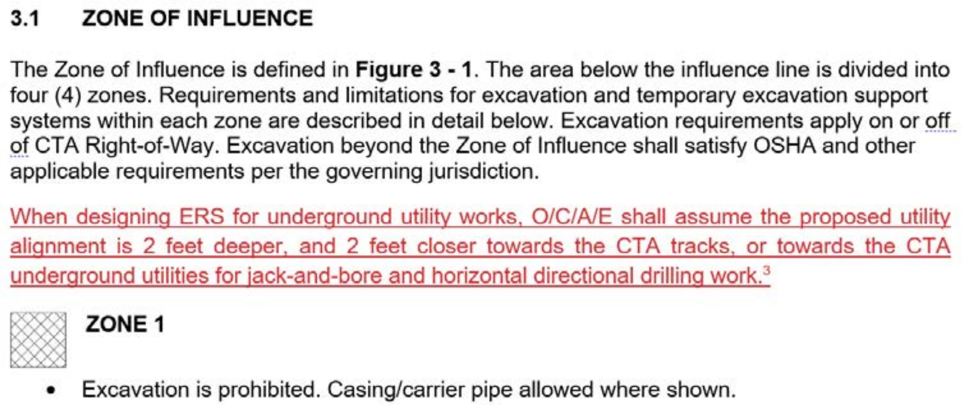
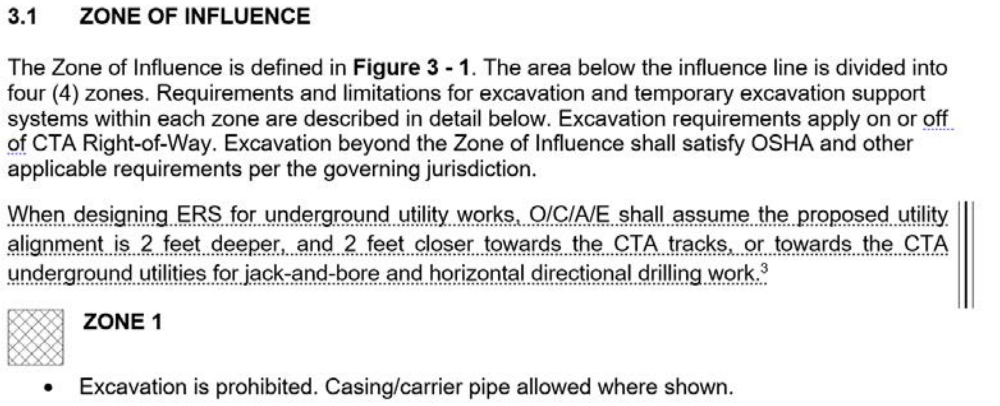
REVISION GUIDE

In an effort to ensure a clean final version is released, the “track-change” feature is turned off. However, different types of revision marks have been developed to assist users understanding what type of changes have been made in the course of reading the new version of ACM.

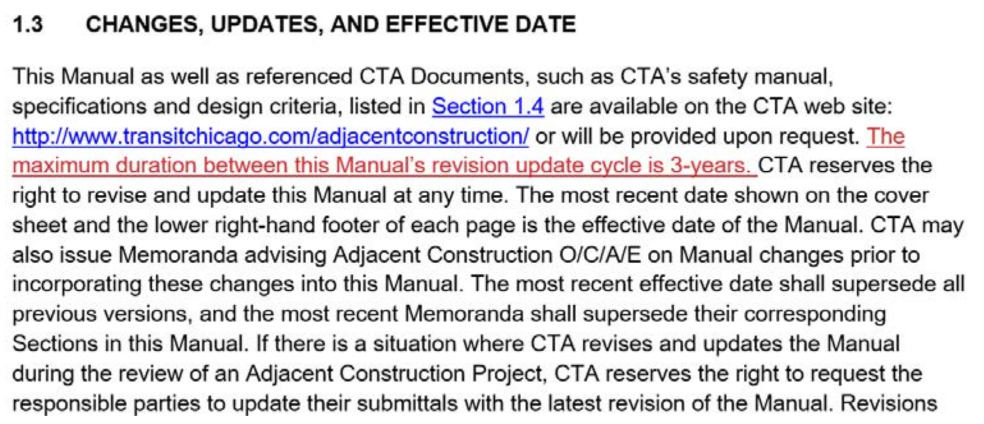
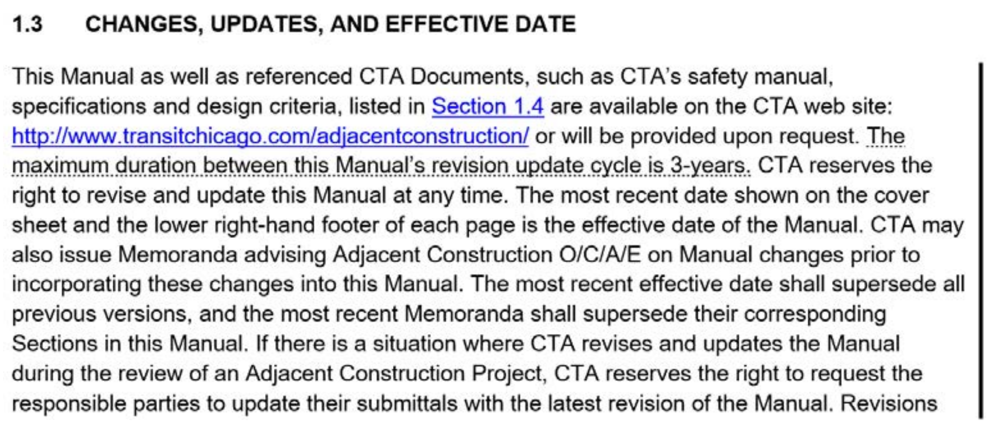
Deletion: This revision mark is only shown when deletion occurred without any other changes.

Track-Change On No Revision Mark	 • Chicago Transit Authority (CTA) Documents, latest edition: • CTA Requirements for Contractors Working Along the Right-of-Way (R.O.W.) • CTA Safety Manual • ~~Specification for working near the ROW~~ • CTA Roadway Worker Protection Manual
Track-Change Off Revision Mark Shown in the Final Version	 • Chicago Transit Authority (CTA) Documents, latest edition: • CTA Requirements for Contractors Working Along the Right-of-Way (R.O.W.) • CTA Safety Manual • CTA Roadway Worker Protection Manual

Insertion: This revision mark is only shown when insertion of new content occurred and the new content is underlined with dotted line.

Track-Change On No Revision Mark	 **3.1 ZONE OF INFLUENCE** The Zone of Influence is defined in **Figure 3 - 1**. The area below the influence line is divided into four (4) zones. Requirements and limitations for excavation and temporary excavation support systems within each zone are described in detail below. Excavation requirements apply on or off of CTA Right-of-Way. Excavation beyond the Zone of Influence shall satisfy OSHA and other applicable requirements per the governing jurisdiction. When designing ERS for underground utility works, O/C/A/E shall assume the proposed utility alignment is 2 feet deeper, and 2 feet closer towards the CTA tracks, or towards the CTA underground utilities for jack-and-bore and horizontal directional drilling work.[3] ▨ **ZONE 1** • Excavation is prohibited. Casing/carrier pipe allowed where shown.
Track-Change Off Revision Mark Shown in the Final Version	 **3.1 ZONE OF INFLUENCE** The Zone of Influence is defined in **Figure 3 - 1**. The area below the influence line is divided into four (4) zones. Requirements and limitations for excavation and temporary excavation support systems within each zone are described in detail below. Excavation requirements apply on or off of CTA Right-of-Way. Excavation beyond the Zone of Influence shall satisfy OSHA and other applicable requirements per the governing jurisdiction. When designing ERS for underground utility works, O/C/A/E shall assume the proposed utility alignment is 2 feet deeper, and 2 feet closer towards the CTA tracks, or towards the CTA underground utilities for jack-and-bore and horizontal directional drilling work.[3] ▨ **ZONE 1** • Excavation is prohibited. Casing/carrier pipe allowed where shown.

Revised Content: This revision mark applies when there are content changes occurred within a paragraph, and the revised content is underlined with dotted line.

Track-Change On No Revision Mark	**1.3 CHANGES, UPDATES, AND EFFECTIVE DATE** This Manual as well as referenced CTA Documents, such as CTA's safety manual, specifications and design criteria, listed in Section 1.4 are available on the CTA web site: http://www.transitchicago.com/adjacentconstruction/ or will be provided upon request. The maximum duration between this Manual's revision update cycle is 3-years. CTA reserves the right to revise and update this Manual at any time. The most recent date shown on the cover sheet and the lower right-hand footer of each page is the effective date of the Manual. CTA may also issue Memoranda advising Adjacent Construction O/C/A/E on Manual changes prior to incorporating these changes into this Manual. The most recent effective date shall supersede all previous versions, and the most recent Memoranda shall supersede their corresponding Sections in this Manual. If there is a situation where CTA revises and updates the Manual during the review of an Adjacent Construction Project, CTA reserves the right to request the responsible parties to update their submittals with the latest revision of the Manual. Revisions
Track-Change Off Revision Mark Shown in the Final Version	**1.3 CHANGES, UPDATES, AND EFFECTIVE DATE** This Manual as well as referenced CTA Documents, such as CTA's safety manual, specifications and design criteria, listed in Section 1.4 are available on the CTA web site: http://www.transitchicago.com/adjacentconstruction/ or will be provided upon request. The maximum duration between this Manual's revision update cycle is 3-years. CTA reserves the right to revise and update this Manual at any time. The most recent date shown on the cover sheet and the lower right-hand footer of each page is the effective date of the Manual. CTA may also issue Memoranda advising Adjacent Construction O/C/A/E on Manual changes prior to incorporating these changes into this Manual. The most recent effective date shall supersede all previous versions, and the most recent Memoranda shall supersede their corresponding Sections in this Manual. If there is a situation where CTA revises and updates the Manual during the review of an Adjacent Construction Project, CTA reserves the right to request the responsible parties to update their submittals with the latest revision of the Manual. Revisions

Exceptions:

1. Footnote number sequential changes due to inserting a new footnote was not marked with revision marks.

TABLE OF CONTENTS

TABLE OF FIGURES

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OPEN LETTER TO OWNER OF PROPOSED CONSTRUCTION ADJACENT TO CTA INFRASTRUCTURE

Dear Owner,

Working adjacent to CTA infrastructure can be challenging. Adjacent, from CTA's perspective, refers to activities occurring in the "Basic Safety Envelope", as defined on page 29. When working inside of the CTA defined Basic Safety envelope, CTA has a variety of requirements enforced by our various stakeholder departments. This manual attempts to consolidate these requirements by either direct incorporation into this document or otherwise referencing their locations. The requirements in this manual are intended to safeguard CTA's infrastructure, and in turn, its employees, passengers, and general public. It is our goal that this manual will ease the planning, design, and construction of your project by comprehensively delineating our requirements; while also guiding CTA staff during review of adjacent work activities. This manual does not address requirements or review processes for adjacent construction that affects CTA Bus Operations solely.

As the Owner of property adjacent to the CTA, you are the entity that hires the team of Architects, Engineers, or Contractors for the proposed work adjacent to CTA infrastructure. The CTA expects you to take the leadership role in ensuring your team's compliance with this Manual, either by owning the responsibility yourself or by delegating it to your team. Depending on how your project team is organized and how you delegate responsibilities, each may be responsible for different issues and it may change from project to project. As such, it is in both of our best interests that you understand the requirements in this Manual and delegate responsibilities appropriately. You will find that by clearly defining roles and responsibilities and communicating them with CTA we will be able to provide you with clear direction, which will in turn allow us to keep your project on schedule. As each project is unique, CTA requirements may vary on a case-by-case basis, but this Manual should be valuable guidance for your project.

The remaining pages of this preface provide quick reference guides for work adjacent to the three most common track conditions, elevated, on-grade and subway, as well as a table that delineates requirements by work activity. Section 2 provides process flowcharts and timelines. All project correspondence should be routed to adjconstruction@transitchicago.com.

We sincerely hope that we are able to provide you not only smooth rides on our transit system, but also on your adjacent construction project.

Sincerely,

Chicago Transit Authority Infrastructure Division

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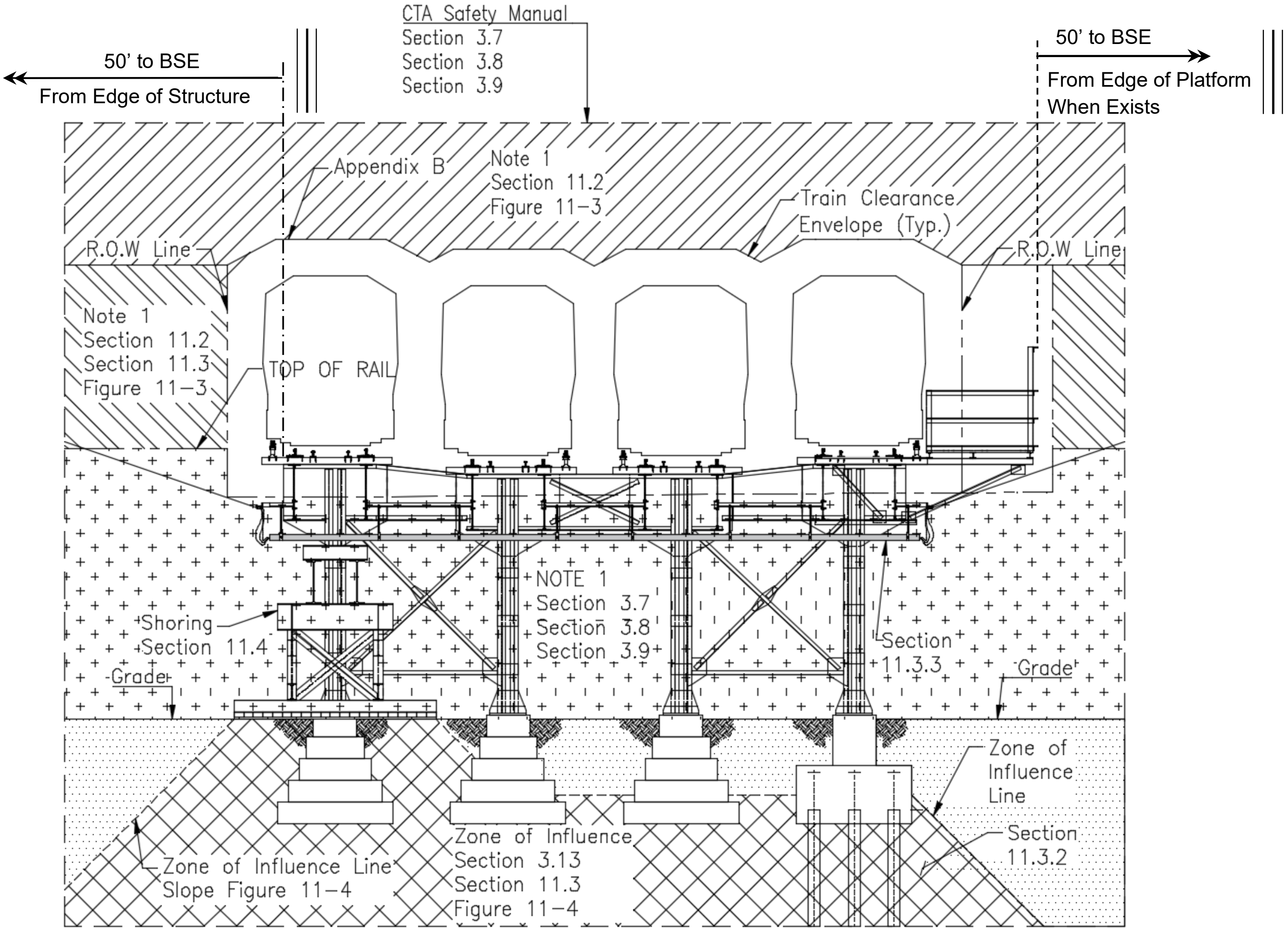
DIAGRAM CASES FOR ADJACENT CONSTRUCTION WORK

The following three diagrams are provided for the users of this Manual to easily locate the starting point of different types of Adjacent Construction Projects. However, it is the users' responsibility to fully familiarize themselves with this Manual for the coordination processes, design, construction and monitoring requirements. All hatched areas below grade in diagrams define the zone of influence affecting CTA structures and Earth Retention Systems will need to be designed with surcharge loadings from the CTA tracks/structures, or for underground structures. Soil unloading will need to be considered when analyzing the tunnel structures.

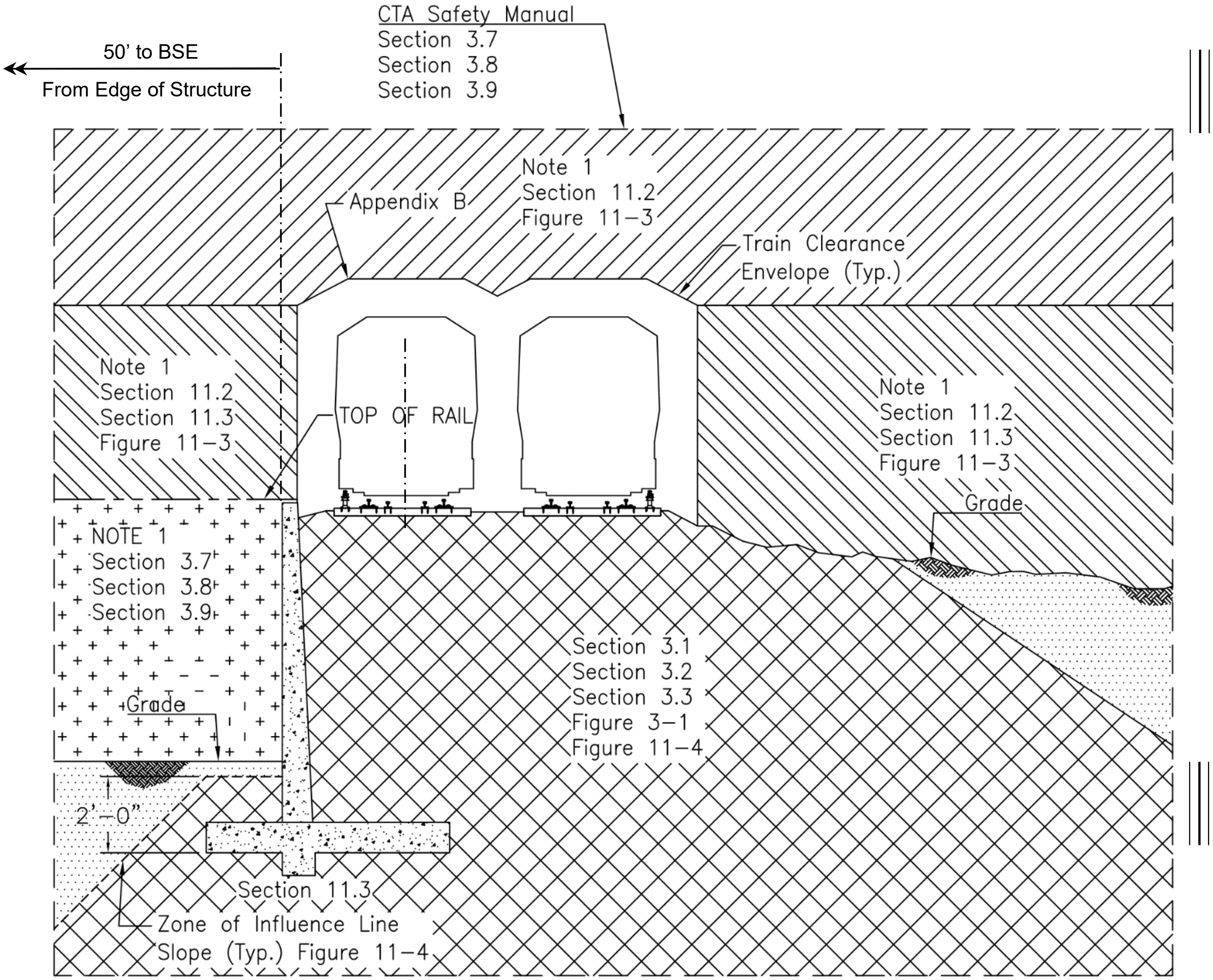
CASE 1 – ELEVATED TRACK STRUCTURES



Notes:

1. **Consult CTA Safety for requirements. Track flaggers will be required if its determined there is a risk that will extend above tracks. See Sections 3.7, 3.8, and 3.9.**

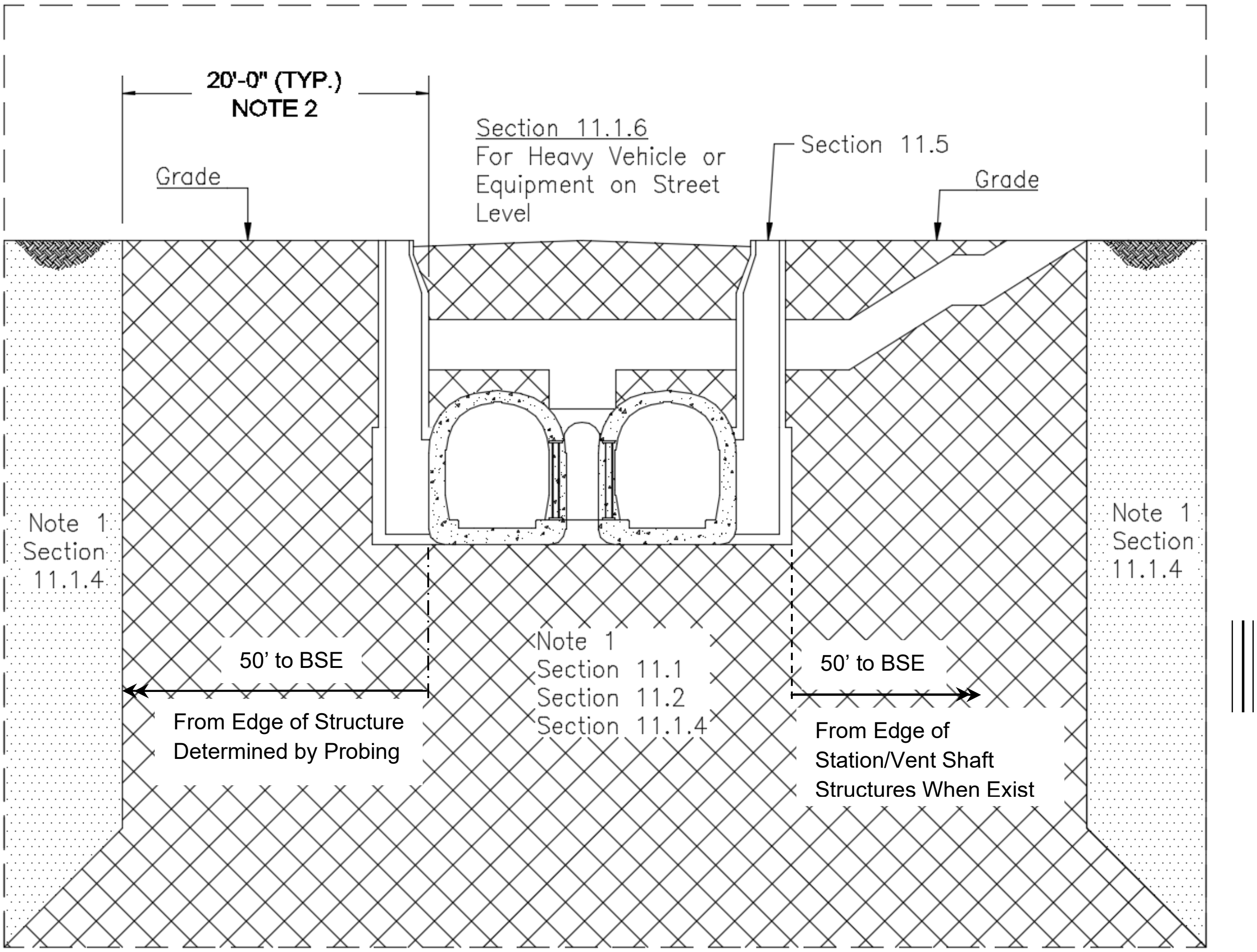
CASE 2 – ON-GRADE AND RETAINING WALL TRACKS



Notes:

1. Consult CTA Safety for requirements. Track flaggers will be required if its determined there is a risk that will extend into train clearance envelop. See Sections 3.7, 3.8, and 3.9.

CASE 3 – UNDERGROUND STRUCTURES, STATIONS, AND AUXILIARY STRUCTURES



Notes:

1. Consult CTA Safety for requirements. Track flaggers will be required if its determined there is a risk that will extend into train clearance envelop. See Sections 3.7, 3.8, and 3.9.

2. From drilled probe that clears the outer tunnel edge (typical each side).

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REFERENCE TABLE BASED ON TYPE OF WORK

Type of Work	Sections
Soil boring	5.2.1 for soil investigation 5.3 for ground water investigation
Determine right-of-way ownership	3.5
Determine existing utilities	3.6 with additional requirements in 4.4 and 4.5 for Jack-and-Bore Construction
Excavation adjacent to on-grade tracks	3.1, 3.2
Track protection fences, handrails, and walkways	3.10, 3.11, Appendix G
Minor excavation adjacent to on-grade tracks (shallow utilizes, poles, etc.)	3.3
Excavation adjacent to subway structures	11.1.1, 11.1.2, 11.1.3
Drilled, augered, driven, and vibrated penetration construction adjacent to subway structures	11.1.4
Heavy vehicle or equipment on street level over subway structures	11.1.6
Minor excavation above subway structures (shallow utilities, roadway reconstruction, etc.)	11.1.5
Bridge construction over tracks	11.2.1, 11.2.2, 11.2.3, 11.2.5
Miscellaneous temporary structure adjacent to CTA tracks (scaffold, man lift, etc.)	11.2.6
Tower crane over CTA tracks	11.2.7
Overhead wire line crossings	11.2.4
Wire line crossings mounted on elevated track structure	11.3.4
Miscellaneous element mounted on elevated track structure (lightings, drip pan, etc.)	11.3.5
Excavation adjacent to structure foundations	11.3
Direct shoring of track structures	11.4
Sidewalk reconstruction adjacent to subway vent shaft grating structures	11.5
Jack-and-bore construction	4.4
Directional drilling construction	4.5

Type of Work	**Sections**
Dewatering	9.2
Testing for tiebacks	9.5
General construction requirements and Contractor operating restrictions	3.8, 3.9
Track monitoring	10
Shoring removal	3.13
Safety	3.4 and 3.5

SECTION 1 INTRODUCTION

1.1 PURPOSE

The Chicago Transit Authority's Adjacent Construction Manual (CTA ACM) is prepared in the interest and for the guidance of those who may contemplate construction activities adjacent to, beneath, on, or over existing CTA property, facilities, and/or operating Right-of-Way, also known as the Basic Safety Envelope, as defined on page 25. This Manual provides the minimum requirements for excavations, monitoring, and temporary excavation support. The design of permanent retaining walls and other systems of permanent earth retention adjacent to CTA operating Right-of-Way are addressed in the CTA Infrastructure Design Criteria Manual. All temporary structures anticipated to be in service for more than a one year period are considered permanent structures and may not be entirely governed by this Manual.[1]

For CTA projects, this Manual shall also apply to CTA hired Design Consultants and Contractors as modified in the project Specifications.

This Manual outlines the design criteria that must be followed and the process for submitting project information to CTA. It also outlines requirements for constructing a project in the vicinity of, or impacting CTA systems and facilities. As a policy of CTA, projects are reviewed to ensure that no adverse impacts will occur to CTA operations, systems, and facilities and to assure the safe operation of the CTA system. Given the risks associated with construction and excavation adjacent to an active rapid transit track, the design requirements and construction limitations specified herein are conservative and may be more restrictive than those commonly required by other agencies, for example, excavations adjacent to a highway structure. Specialized requirements and recommended design practices for excavation and excavation support contained in this Manual are intended to improve safety of excavation adjacent to active rapid transit tracks for operations, the traveling public, and Contractor personnel and reduce delays and impacts to CTA operations.

For Adjacent Construction projects in the planning and design phase, the flow chart provided in Section 2 provides an overview of tasks to be done and the expected time to complete them in order to receive permission from CTA to proceed with construction activities. **It is recommended that 10 feet clearance be provided for all new development to the adjacent CTA structures to ensure future abilities to inspect and maintain both structures.** Proposed deviations or variances from the provisions of this Manual must be presented to CTA for review following the process given in Section 2.2. CTA's Chief Engineer has the lead responsibility to review, approve, and oversee implementation for compliance with CTA requirements for all construction adjacent to and/or impacting CTA interests.

1.2 LIMITATIONS, RESPONSIBILITIES AND DISCLAIMERS

This Manual is not intended for use as a textbook, and shall not be used as a substitute for engineering knowledge, experience, or judgment. The criteria, information, and analysis

---

[1] See Section 1 Commentary

methodologies presented in this Manual have been developed in accordance with recognized engineering principles and in accordance with railroad industry practice. Good design practice will always require a combination of basic engineering principles, experience, and judgment in order to furnish the best possible structure, within reasonable economic limitations, to suit an individual site. **CTA does not warrant the accuracy or completeness of this Manual, nor that this Manual is free from errors and omissions.** Users of this Manual shall independently validate and verify the information contained herein and should promptly notify CTA of any discrepancies or inconsistencies discovered in the course of utilizing this Manual**. Users of this Manual are strongly recommended to read the Commentary section to better understand the intent and concerns of certain requirements in this Manual. Commentary is located in Appendix F.**

Design of temporary shoring systems for excavation support shall be prepared by a licensed Illinois Structural Engineer who shall be solely responsible for verifying the accuracy, suitability, and applicability of the information contained in this Manual for any specific project. The same licensed Illinois Structural Engineer is to field verify the installation complies with the design and provide a letter to CTA confirming as such.

Review and acceptance of submittals by CTA shall not relieve the Contractor and Engineer in Responsible Charge of responsibility for the design and construction of the temporary shoring system, including responsibility for errors and omissions in submittals, and construction deviations from accepted design plans. Excavation safety shall be the responsibility of the Contractor.

CTA is not responsible or liable for any noise and vibration generated which may impact the new structures built adjacent to existing CTA Rapid Transit structures.

For information regarding additional limitations, restrictions, insurance and bond requirements, letter of commitment, deposit requirements, and rail safety training, please refer to the CTA Requirements for Contractors Working Along the Right-of-Way (R.O.W.) document available on the CTA Adjacent Construction web site:

http://www.transitchicago.com/nearbyconstruction/

1.3 CHANGES, UPDATES, AND EFFECTIVE DATE

This Manual as well as referenced CTA Documents, such as CTA's safety manual, specifications and design criteria, listed in Section 1.4 are available on the CTA web site: http://www.transitchicago.com/nearbyconstruction/ or will be provided upon request. The maximum duration between this Manual's revision update cycle is 3-years. CTA reserves the right to revise and update this Manual at any time. The most recent date shown on the cover sheet and the lower right-hand footer of each page is the effective date of the Manual. CTA may also issue Memoranda advising Adjacent Construction O/C/A/E on Manual changes prior to incorporating these changes into this Manual. The most recent effective date shall supersede all previous versions, and the most recent Memoranda shall supersede their corresponding Sections in this Manual. If there is a situation where CTA revises and updates the Manual during the review of an Adjacent Construction Project, CTA reserves the right to request the responsible parties to update their submittals with the latest revision of the Manual. Revisions and updates to this Manual will be posted on the web site. Users of this Manual shall be solely responsible for checking the web site for updates and utilizing the latest version. Forward any proposed changes or updates to this Manual to the CTA Infrastructure Division for consideration. The Contact information is as followed:

Adjacent Construction Oversight
Attention: Structural Engineering
Email Address: adjconstruction@transitchicago.com

1.4 REFERENCES

The following documents are referenced in this Manual:

- Chicago Transit Authority (CTA) Documents, latest edition:
  - CTA Requirements for Contractors Working Along the Right-of-Way (R.O.W.)
  - CTA Safety Manual
  - CTA Roadway Worker Protection Manual
  - Master CTA Spec for IDOT Projects – CTA Flagging and Coordination
  - Flagman Requirements
- American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineer, latest edition.
- State of Illinois Department of Transportation (IDOT), Standard Specifications for Road and Bridge Construction, latest edition.
- American Welding Society (AWS), D1.1, Structural Welding Code – Steel, latest edition.
- Federal Highway Administration (FHWA), Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored System, FHWA-IF-99-015, June 1999.
- Federal Highway Administration (FHWA), Geotechnical Engineering Circular No. 7, Soil Nail Walls, FHWA-IF-03-017, March 2003.
- South California Regional Rail Authority (SCRRA) Metrolink Excavation Support Guidelines, July 2009
- "*Trenching and Shoring Manual*" by State of California, Department of Transportation, Issued by Offices of Structure Construction, Copyright © 2011 California Department of Transportation. All rights reserved.

- Massachusetts Bay Transportation Authority Guidelines and Procedures for Construction on MBTA Railroad Property, April 2001.
- United States Steel (USS) Steel Sheet Piling Design Manual, 1984.
- Naval Facilities Engineering Command DM-7.02 Foundations and Earth Structures, September 1986
- NHI Publication No. FHWA-NHI-15-044 Engineering for Structural Stability in Bridge Construction
- 765 ILCS 140 – Adjacent Landowner Excavation Protection Act (Illinois Compiled Statutes)
- Post-Tension Manual by Post Tensioning Institute (PTI)
- Guidelines for the Design of Buried Steel Pipe by American Lifelines Alliance, July 2001 with addenda through February 2005.
- AWPA U1: Use Category System – User Specification for Treated Wood by American Wood Protection Association, latest edition.
- Metra Guidelines for Utility Installations Part 1 – Wire Lines and Communications Cables, September 2007
- ComEd System Standard Clearance for Conductors or Poles to Railroad Tracks and Rail Cars (Reference NESC 2341), December 2014
- Interim Guidelines for Horizontal Directional Drilling (HDD) Under Union Pacific Railroad Right-of-Way
- National Design Specification (NDS) for Wood Construction by American Wood Council

1.5 DEFINITIONS

A. General (Not in alphabetic order)

Shall, must	Terms “shall” and “must” indicate mandatory conditions; the user of this Manual will make every practical effort to follow the criteria. If it is impractical to follow the “shall” or “must” criteria, the user of this Manual needs to obtain CTA approval through Variance Request outlined in Section 2.2 and document the decision made. Lack of

	compliance with “shall” or “must” requirements may result in rejection of proposal.
Should	Term “should” is an advisory condition; the user of this Manual is recommended, not mandated, to follow the criteria. For situations where it is impractical to follow the “should” criteria, the user of this Manual needs to obtain CTA approval and document the decision made.
May	Term “may” is a permissive condition; it is recommended that the user of this Manual make reasonable efforts to follow the design criteria. For situations where it is impractical to follow the “may” criteria, the user of this Manual does not need authorization for design variances.

B. Railroad Terminology

Basic Safety Envelope (BSE)	The area within fifty (50) feet horizontally of edge of track structures or edge of wayside/station platforms, or twenty-five (25) feet outside the property line, whichever is greater. The pair of imaginary lines, which define the outside boundaries of the Basic Safety Envelope, extend vertically up and down infinitely. For the purpose of this Manual, all construction activities within these boundaries will be considered to have the potential to affect the track or CTA operations and will be constrained as necessary by the CTA Employee-in-Charge/Flagger.
Construction Process Plan (CPP)	A program, plan, and schedule prepared, and submitted by the Contractor and accepted by CTA that accurately describes and illustrates the manner in which work within the Basic Safety Envelope will be accomplished, the potential impacts on elements of the Operating System and the manner and methods by which these elements will be protected from any potential impact, and/or the manner in which work will be accomplished.
Contractor	The individual, firm, partnership, corporation, joint venture, or combination thereof that has entered into a construction contract with the legal entity for which the work is being performed. For purpose of this Manual, Contractor also includes any sub-contractor, supplier, agent, or other individual entering the CTA Right-of-Way during performance of the work.
CTA Inspector	CTA Inspector can include: personnel from Chicago Transit Authority Engineering, Construction, Safety, Rail Operations, etc.

	And CTA hired construction service construction managers (CM) or project managers.
Engineer in Responsible Charge	The Licensed Structural Engineer in responsible charge of structural design as required in this Manual, whose seal and signature shall be affixed to the Drawings, Specifications, calculations, and other documents used in the design and construction. For the purposes of this Manual, the Engineer in Responsible Charge also includes other people designated by the licensed Structural Engineer in responsible charge and working at his/her direction.
Flagger	An employee designated to control the movement of trains by display of hand signals, flags or lights.
Flag Zone	A segment of track with definite boundaries.
Flag Zone Index	A chart identifying each flag zone by the 1) Flag Zone number; 2) location (limits of the Flag Zone); 3) number of tracks; 4) track characteristics/special conditions; 5) rail stations within the Flag Zone; and 6) Flagger Requirements.
Flag Zone Map	A map of areas of a rail line illustrating the limits of Flag Zones.
Line Cut	A temporary cessation of all service on a transit line; meaning total stoppage of transit service on all tracks and at all stations within the closure zone to facilitate access for a Contractor(s) to perform work on or near the CTA Right-of-Way. If CTA or CTA's Contractors) request Line Cut operations along the same line concurrently with the Adjacent Construction Contractor, CTA shall have the exclusive authority to determine which request shall be granted.
Manual	For the purpose of this document, Manual shall be considered this document (CTA Adjacent Construction Project Manual) in part or in its entirety. Other documents may be referred to as guidelines and shall not mean this document.
Operating System	Includes, but is not limited to, the tracks on which trains and "on-track" equipment operate or may potentially operate, and in addition any facilities closely related to the operation of the CTA system including, but not limited to, signal, power, communications, bridges, poles, cables and houses, underground structures, culverts, access roads, ramps, highway-rail grade crossings and station platforms.

Public Agency	The federal government and any agencies, departments, or subdivisions thereof; the State of Illinois; and any county, city, city and county district, public authority, joint powers agency, municipal corporation, or any other political subdivision or public corporation therein, responsible for sponsoring a project.
Right-of-Way	A strip of land, real estate, or property of interest, under the ownership or operating jurisdiction of CTA or other Public Agencies on which railroad tracks, other structures, and facilities are constructed.
Service Bulletin	An instructional bulletin that is used for planned irregular train operation – format used for removal of a track from service.
Single-Track	A temporary operation established by operating trains bi-directionally on one track while the adjacent track is taken out-of-service. A Single-Track can only be established between track crossovers in the proper configuration for the required train movements. Only one Single-Track at a time can be set up on a line and only for very limited time periods. If CTA or CTA's Contractors) request single track operations along the same line concurrently with the Adjacent Construction Contractor, CTA shall have the exclusive authority to determine which request shall be granted.
Slow Zone	A series of signs establishing a segment of track where trains must operate at a reduced speed due to workers on the Right-of-Way, track and structure conditions, or other reasons that trains must operate at a reduced speed.
Third Party	An individual, firm, partnership, or corporation, or combination thereof, private, or public, participating, sponsoring, or affected by a project. Government agencies and utilities may be considered a Third Party.
Zone of Influence	The zone within which shored excavation is required and the shoring system is required to be designed for CTA rapid transit and/or railroad live load surcharge. **It does not mean open cut is permitted outside the Zone of Influence line.** See **Figure 3 - 1: Zone of Influence**, **Figure 11 - 2: CTA Underground Structure Zone of Influence**, and **Figure 11 - 4: Elevated Track Structure Footing Zone of Influence**.

C. Shoring Terminology

Deep Soil Mix Wall	An augured, cement grout soil improvement technique, incorporating soldier reinforcement, whereby in-situ soils are mixed

	in place with cement grout to form a row of overlapped soil-cement columns. These overlapped soil-cement columns are used for both groundwater cutoff and, with soldier piles, as a reinforced-soil diaphragm-type shoring wall.
Diaphragm Wall	A continuous shoring wall comprised of concrete or a mixture of cement soil (usually with embedded vertical steel members) that is drilled or excavated in place prior to excavation in order to support lateral loads from retained soil and water. Examples of diaphragm walls include deep soil mix walls, secant walls, tangent walls, and slurry walls.
Grouting	Injection of fluid materials into the ground to improve the strength of ground, decrease permeability and prevent water inflows, and/or compensate for ground settlements and movements. Types of grouting include permeation grouting (cement, micro-cement, chemical, etc.), jet grouting, and compacting grouting.
Lagging	Timber boards, planking or sheathing, reinforced concrete planks, or steel plate secured between adjacent soldier piles.
Packing	Steel, wood, concrete or non-shrink grout used to fill gaps and transfer load between the shoring wall and bracing elements.
Preloading	Placement of initial loads in bracing members by jacking and shimming or wedging to assure adequate bearing of connected shoring elements and to reduce ground movements.
Secant Wall	A continuous shoring wall formed by a series of overlapped, concrete-filled drilled piers (otherwise commonly referred to as drilled shafts, caissons, or cast-in-drilled-hole [CIDH] piles). A minimum of every other pier is reinforced to span vertically.
Sheet Piling	Vertical steel shapes that are driven into the ground and interlocked with each other to form a continuous wall in order to support lateral loads from retained soil and water.
Shoring Deadman	A buried or partially buried structure that is utilized as an anchorage for tension rods that restrain a shoring wall. Deadman anchorage may be provided by soldier piles, sheet piling, or concrete blocks or walls.
Slurry Wall	Continuous, reinforced concrete wall constructed by filling a series of discrete trenches with tremie concrete. Tremie concrete displaces bentonite or polymer slurry that is in the trench. The slurry is used to prevent collapse of the trench during excavation for slurry wall placement. The resulting concrete barrier wall retains

	soil and ground water on the exterior side of the slurry wall, and permits excavation and removal of soil on the interior side of the wall. Walls may be reinforced or non-reinforced.
Soil Nailing	A system in which soil nails are typically grouted, untensioned rebars that are installed in drilled holes in order to form a reinforced soil mass. Reinforced shotcrete is applied to the face of the excavation. Shotcreting and nail installation proceed in a top down manner as excavation proceeds.
Soldier Piles	Vertical steel shapes (typically wide flange or HP) installed to support lateral loads from retained soil (and water if part of a sealed shoring system).
Strut	A brace (compression member) that resists thrust in the direction of its own length. The connection from a strut to a soldier pile or waler shall not be a single gusset plate.[2]
Tangent Wall	A shoring wall formed by a series of concrete-filled drilled piers (otherwise commonly referred to as drilled shafts, caissons, or cast-in-drilled-hole [CIDH] piles) that are installed tangent to each other and do not overlap. A minimum of every other pier is reinforced to span vertically.
Tieback (Soil Anchor)	A tension element utilized to restrain a shoring wall. A tieback consists of a steel tendon (bar or strands) installed in a drilled hole. The tendon is bonded to the soil over its anchorage bond length with cement grout. The tendon is tensioned to provide positive restraint to the shoring wall and to reduce wall deflections.
Tremie Concrete	Concrete deposited under water or slurry by means of tremie equipment. The concrete displaces the water or slurry as the concrete is deposited.
Trench Shield or Or Trench Box	Pre-fabricated structure that is commonly installed to support lateral earth loads for utility installation, and whose walls commonly have no embedment into the soils below excavation subgrade. Trench shields are typically installed within pre-excavated slots and/or pushed into the ground as the excavation proceeds.
Waler	Horizontal beam used to brace vertical excavation shoring elements.

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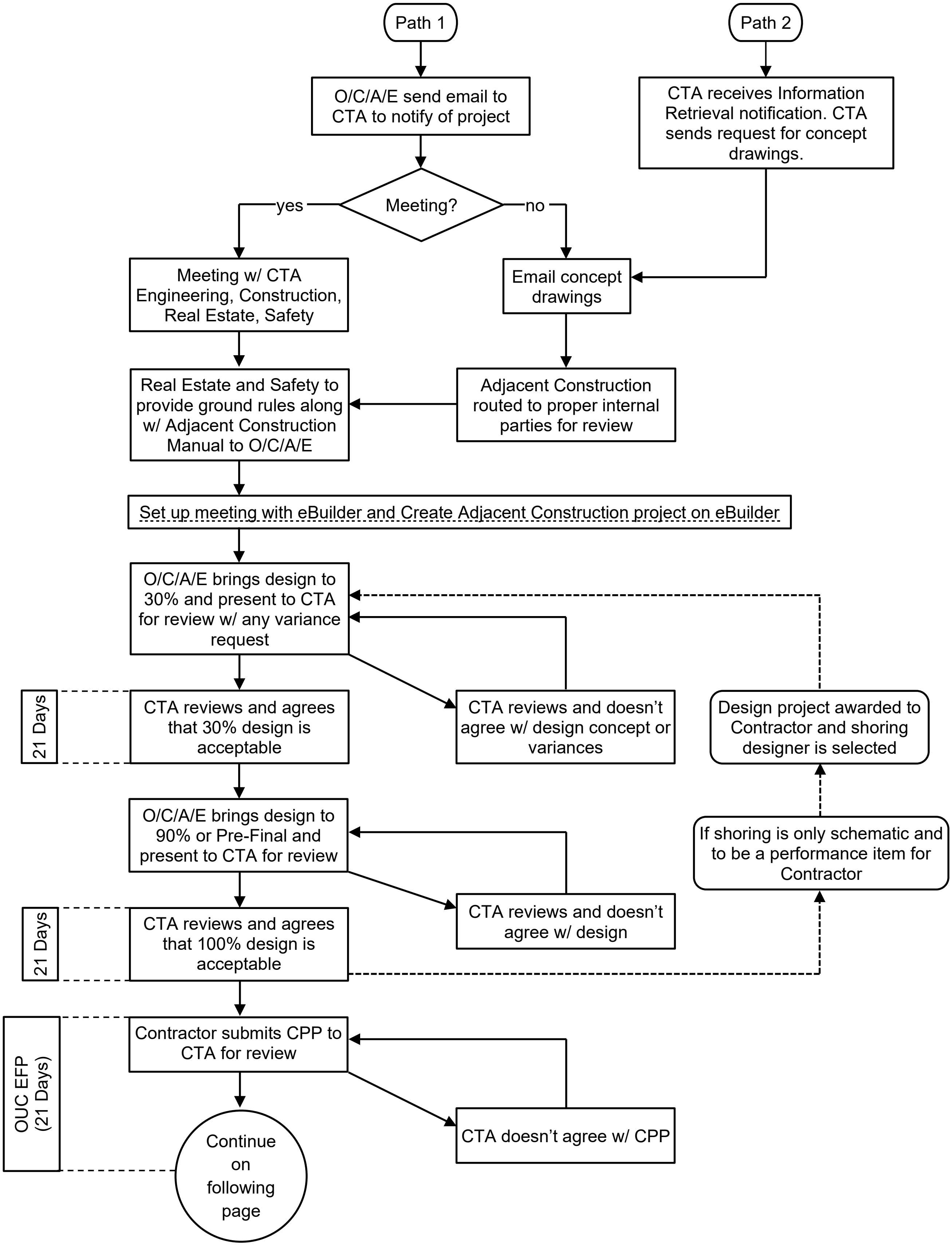
[2] See Section 1 Commentary

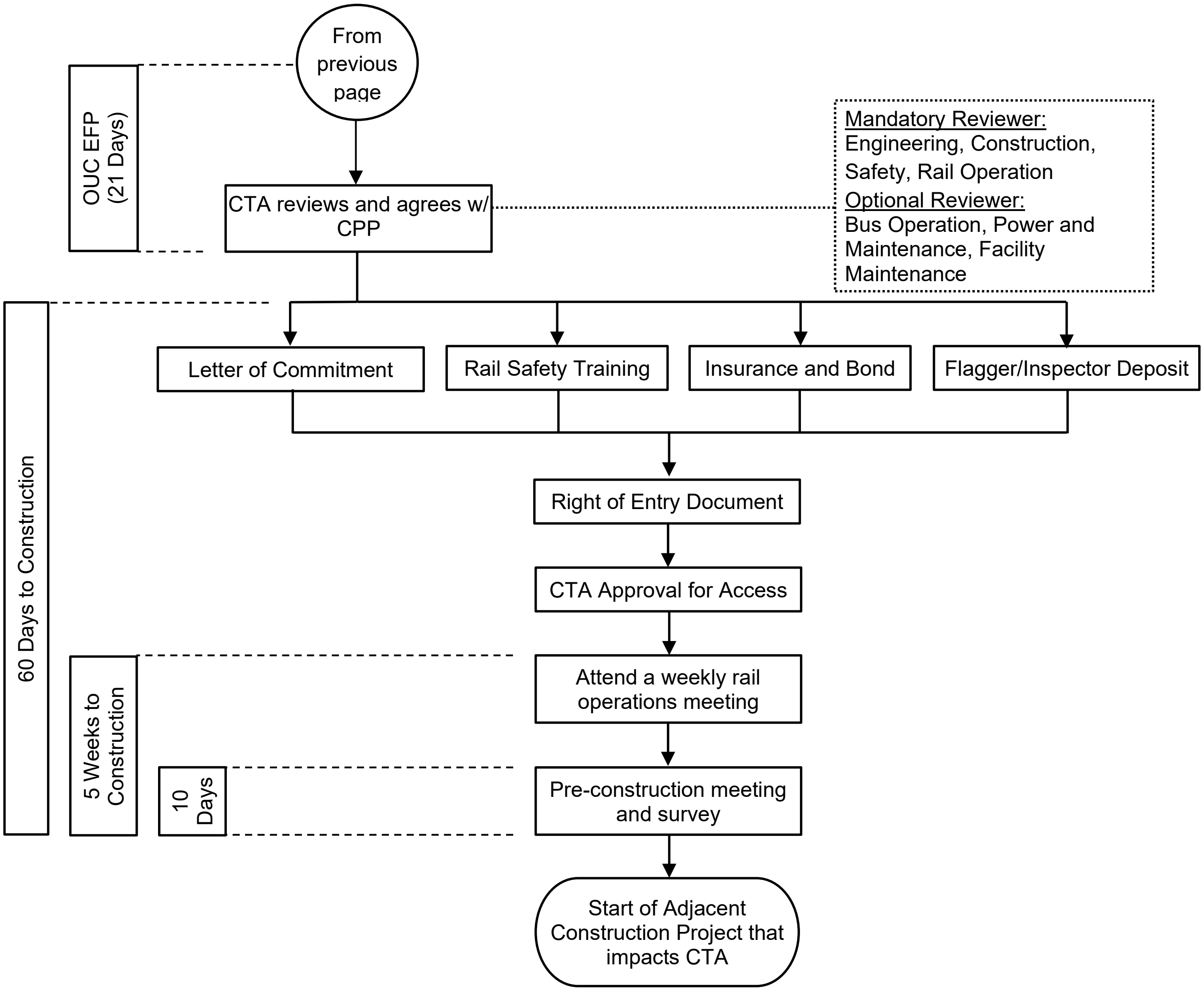
1.6 ACRONYMS

The following acronyms are used in this document:

ANSI	American National Standards Institute
AREMA	American Railway Engineering and Maintenance of Way Association
ASTM	American Society for Testing and Materials
CADD	Computer-Aided Drafting and Design
CDOT	Chicago Department of Transportation
CFR	Code of Federal Regulations
CPP	Construction Process Plan
CTA	Chicago Transit Authority
EFP	Equivalent Fluid Pressure
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
GPR	Ground Penetrating Radar
HDD	Horizontal Directional Drilling
IC	Illinois Central Railroad
IDOT	Illinois Department of Transportation
JULIE	Joint Utility Locating Information for Exactors
LOCID	CTA Location Identifier
MOM	Ministry of Manpower
NAVFAC	Naval Facilities Engineering Command
NHI	National Highway Institute
O/C/A/E	Owner/Contractor/Architect/Engineer
OSHA	Occupational Safety and Health Administration
OUC	Office of Underground Coordination
QA/QC	Quality Assurance / Quality Control
R.O.W	Right-of-Way
SCRRA	South California Regional Rail Authority
USS	United States Steel

SECTION 2 COORDINATION FLOWCHART AND SUBMITTAL REQUIREMENTS





Note:
Items shown in the above flowchart may overlap.

2.1 GENERAL

All drawings and calculations for the Adjacent Construction Project that impacts CTA shall be prepared, sealed, and signed by a Structural Engineer currently licensed in the State of Illinois who has previous experience in the design of temporary shoring systems of the type being submitted (preferably ten years). Preferably, temporary shoring systems will be designed by a team composed of a railroad structural engineer who is experienced, knowledgeable and competent in design, construction, operations and maintenance parameters for commuter/passenger and freight railroad systems, and a licensed structural engineer who is experienced, knowledgeable and competent in the design and construction of shored excavations adjacent to railroad tracks.

The designer will be responsible for the accuracy of all controlling dimensions as well as the selection of soil design values that accurately reflect the actual field conditions. No shoring installation or excavation within the Zone of Influence will be allowed until the drawings and calculations are reviewed and accepted by CTA. CTA will NOT approve signed and sealed submittals. Accepted submittals are treated as “Received for Record”.

Forms, drawings, and calculations shall be submitted to CTA for review in electronic format transmitted by email, ftp, or mail (with CD-R or DVD-R properly labeled) as means to notify CTA of the Adjacent Construction. After the initial coordination with CTA, a project coordination website will be created by CTA and all submittals and CPP’s must be uploaded to the appointed project website. Any documents not uploaded to the project website will not be considered as received by CTA. User Instructions for the project website will be provided by Adjacent Construction team or CTA’s Adjacent Construction CM. Files shall be Bluebeam and Adobe PDF compatible. Each separate document shall be a separate PDF file (drawings, specifications, calculations, forms, etc.). Files shall be named using the following guidelines:

- “ADJ” indicating Adjacent Construction;
- A LOCID may be assigned by CTA Engineering after first coordination occurs;
- CTA Project Number (YYYY-NNNNN.NN) - If the project is in design phase, CTA Adjacent Construction will assign a project number and it shall be included in the file name;
- Date submitted
- Document type (DW – drawings; SP – Specifications; CA – Calculations; PP – Construction Process Plan; etc.);
- If the project is under OUC review, there should be an OUC number (OUCID) already assigned. The 8-digit OUCID shall be included in the file name;
- Brief descriptions of the submittal;

A file name example: ADJ_LOCID_YYYY-NNNNN.NN_ YYYYMMDD_ Document type_ OUCID_Description

All submittals, design calculations, specifications and drawings shall be prepared in accordance with a QA/QC process. The QA/QC process may follow the established program of a Public

Agency, Engineer in Responsible Charge firm, or Contractor. The QA/QC process used shall be made available to CTA at their request.

It is required by CTA Engineering that the QA/QC process consists of an independent check of design calculations and an independent QC review of the drawings and specifications prior to submittal to CTA by qualified individuals. Documentation of the QA/QC process, including names and contact information of independent reviewers, shall be made available to CTA at their request if the independent check and QC review is implemented.

A minimum of twenty-one (21) calendar days should be allowed for CTA's review, provided that all required submittal materials are included and properly identified.

2.2 EXCEPTIONS, WAIVERS, AND VARIANCES

The current practice for all Adjacent Projects in the City of Chicago is for them to be submitted and reviewed under the OUC review process during the construction phase. This can create prolonged review times, impacts to the scope of the Adjacent Construction Projects and many other complications when exceptions, waivers, and/or variances cannot be granted. Given the risks associated with construction and excavation adjacent to an active rapid transit track, it is essential that the Adjacent Project Team familiarize themselves with this Manual and coordinate with CTA in the planning or early design phase.

Any deviations from the requirements outlined in this Manual, and/or any Sections where Variance Request is specifically required, must follow these procedures.

Variance Request Procedure

1. For projects under design, variance requests should be submitted at the Concept or 30% review levels for consideration by CTA after the Adjacent Construction Project is first introduced to CTA through the OUC Information Retrieval Process. Concept level variance requests are preferred. Design should not be advanced prior to receiving a decision on a variance request.

2. Submit the variance request to CTA Adjacent Construction using the Variance Request Form in Appendix H. This should be a separate submittal from any design review submittal. The request should be signed and sealed by the Engineer in Responsible Charge. It is imperative that the following specific information be included on the form or as an attachment:

    a. Exact location of the proposed work (attach maps and/or figures) and include the following:
        i. GPS coordinates
        ii. North arrow
    b. Identify the exact provision of the Guidelines for which the exception, waiver or variance is requested.
    c. Complete description of the proposed work

   d. Proposed limits of excavation, plan area and depth
   e. Proposed type(s) of shoring including track protection fences, handrails, walkways, or other means of protection for CTA track workers, normal operations, emergency evacuation, and operations personnel working adjacent to track
   f. Proof of concept drawings and calculations
   g. Proposed duration for installation and removal of shoring systems
   h. Proposed duration of shoring system and means for ensuring track is not displaced while system is in place
   i. Description of alternates that conform to this Manual and brief evaluation to show that any other alternate conforming to this Manual is not practical.

3. CTA will review the request and return a decision within twenty-one (21) calendar days.

4. If the variance request is accepted by CTA, the applicant agrees to follow all conditions imposed by CTA. For shoring within Zone 2, complete owner-designed shoring, and details per Section 4.1 should be included in the plans at the 90% level. Design conditions and requirements in this Manual for any Contractor-designed alternate shoring system shall be included in the plans and specifications. CPP shall be prepared and submitted by the Contractor during the OUC Existing Facility Protection Process.

5. For projects already under construction when this Manual is first posted on the web site, CTA's coordination and review will occur during the OUC review process.

2.3 DRAWINGS

The drawings for Adjacent Construction Project that impacts CTA must be complete and shall accurately describe the nature of the work. Drawings shall be to scale.

At a minimum, the drawings shall include the following:

a. Plan view that includes the following information and meets the following criteria:
   - GPS coordinates
   - North arrow
   - All pertinent topographic information
   - All Operating System elements and facilities
   - All overhead and underground utilities
   - All of the proposed excavations and distances from centerline of the track(s) to the face of the excavation and temporary shoring at relevant locations
   - Proposed types and locations of equipment used to install the temporary shoring
   - The drawing shall be in U.S. units with a scale no less than 1" = 10'. Acceptable scales include 1" = 10', 1/8" = 1'-0", and 1/4" = 1'-0".

b. Section view normal to the track(s) showing the temporary shoring system relative to the centerline of the track(s). The section shall show elevations of the track(s), the existing ground surface, excavation lines at each stage as applicable, and bracing elements. Protective dividers, fences, handrail, and walkway shall be shown as applicable. Minimum horizontal clearances from centerline of track to nearest obstruction at top of rail elevation and above shall be provided. The section shall also show shoring wall embedment depth and approximate groundwater depth.

c. Arrangement and sizes of shoring elements and details of all connections.

d. Specifications for materials and requirements for shoring fabrication and installation.

e. Construction sequence(s) detailing all steps in the shoring installation, excavation, and shoring removal. The Construction sequence(s) must be described specific enough for an inspector to verify the construction is installed properly in sequence.

f. Track monitoring requirements (types, locations, reading schedule, etc.). See Section 10 for requirements. Inclinometer may be required.

2.4 CALCULATIONS

Design calculations shall be provided for all elements of the shoring system.

The calculations shall consider each stage of excavation and support removal.

The calculations shall include estimates of shoring deflection, demonstrating that the proposed system will not cause excessive settlement of the tracks. See Section 10.2 for settlement limitations.

A summary of the soil parameters used in the design shall be included in the calculations, and the source reference for these parameters shall be identified and provided. Include a copy of the geotechnical report.

Input and output from computer programs used for analysis and design of temporary shoring shall be accompanied by hand calculations verifying the input and results. In cases where the analysis methods used by the program are not shown in the output, appropriate documentation of the program’s calculations shall be provided.

Loading diagrams from all sources (soil, Rapid Transit surcharge, equipment surcharge, water, etc.) shall be included for each stage and final stage of excavation, for both hand calculations and/or computer program calculations.

2.5 DESIGN CHECKLIST

The shoring designer shall complete, seal, and sign a copy of the Submittal Checklist included in Appendix A of these Guidelines. The independent QA/QC reviewer shall use the form completed by the shoring designer as a review checklist. The completed checklist shall accompany the shoring submittal. All revisions of the checklist and any additional review comments shall be included with clear revision numbers shown. Only the final approved revision of the structural Calculations and Drawings shall be submitted, however, all changes must be clouded and identified clearly with revision marks.

2.6 PROPRIETARY SYSTEMS

Use of proprietary systems, such as formwork, trench boxes or slide rail shoring, require that a Structural Engineer licensed in the state of Illinois confirm that the systems components are satisfactory for site-specific conditions. Manufacturers or suppliers cut sheets must be submitted, listing serial numbers of frames or boxes proposed for use on the project. Such cut sheets must clearly state the maximum loading and depths for which the system has been designed. These cut sheets must be stamped by the Structural Engineer (licensed in Illinois) who is approving the use of such system.

The structural engineer licensed in Illinois, as part of the calculation package shall provide documentation explaining that he/she has reviewed the analysis and/or testing verification done by the manufacturer and understand that he/she, by signing and sealing the calculation package with the proprietary products, are liable for any failure.

2.7 CONSTRUCTION PROCESS PLAN (CPP)

The construction of all shoring and all other construction activities within the Basic Safety Envelope and the Zone of Influence will require the Contractor to submit a Construction Process Plan (CPP). Adjacent Construction shall not commence without an approved CPP. Prior to starting the work, Contractor shall conduct a CPP briefing/pre-activity meeting with the crew and ensure all parties are familiarized with the approved CPP. The briefing points will be provided as comments by CTA Engineering upon review of the CPP.

The CPP is to include:

a. Contact list with company names, direct phone numbers, and email addresses for all Adjacent Construction team members, including project manager(s), superintendent(s), Engineer(s) in responsible charge, etc.

b. General project information includes project name, location, process plan activity, etc.

c. A table of contents with PDF bookmarks created for all sections.

d. Contingency plans that include any potential field changes anticipated by the Contractor that may occur on site which deviates from the submitted CPP seeking approval, such as equipment changes due to availability, shoring member size/material changes due to material availability, or shoring installation sequence deviations due to underground obstructions etc. If no deviation is anticipated, it shall clearly state no deviations from the approved CPP are anticipated on site.

e. A summary that includes possible conflicts/issues with actions required. Note that if any unforeseen condition/conflict is encountered on site, CTA Inspectors shall be notified and consensus between CTA representative and Contractor’s Engineer in Responsible Charge must be reached before work can resume.

f. Contain a description of any proposed temporary changes to the Operating System.

g. Describe the activities necessary to perform specific work within the Basic Safety Envelope and the Zone of Influence.

h. Include a detailed schedule that indicates the expected hourly progress of each activity that has a duration of one hour or longer. The schedule shall include the time at which all activities planned under the CPP will be completed.

i. Show each activity and where and how it affects the normal operation on the Operating System.

j. Include all materials and equipment required to complete each activity in the CPP within the allotted time period. Show anticipated locations where equipment may be placed, especially equipment that has the potential to foul the tracks.

k. Detailed Construction sequence(s) showing all steps in the shoring installation, excavation, and shoring removal based on the sequence(s) shown on the drawings.

l. Detailed quality Control Plan that includes inspection and testing requirements, including any certificates such as welder’s certificates and welding specification procedures, etc. Coordinate with item (m) and item (o).

m. Form letter(s) from the shoring designer that confirms, for each stage of the construction or deconstruction, that installed shoring either in a temporary condition or a final condition, per his field review, conforms with the design intent. A signed and sealed version of these letters for each stage is to be delivered to CTA prior to the contractor progressing to the next stage of construction. Coordinate with item (o).

n. Provide descriptions on how the embedment depth of ERS vertical components (sheet piles, soldier piles, etc) are measured.

o. Provide hold point(s) for Construction Verification outlined in Section 2.8.

p. Detailed monitoring requirements per Section 10. As an alternative, the monitoring plan can be included in a separate CPP submitted for review.

q. Include contingency plans for putting the Operating System back in operation in case of emergency or in case the Contractor fails to perform and complete the work on time. Contingency plans shall address the various stages of construction and may require redundant equipment and personnel.

r. A detailed job hazard analysis.

s. Attach CTA approved Variance Requests associated with the work.

t. Include all required checklists in Appendix A where applicable to the work in the submitted CPP. The Construction Process Plan Checklist shall be attached for all CPP submitted to CTA for review.

u. Detailed methods on how to identify underground utilities for any Adjacent Construction with excavation including boring construction.

v. For CPP revisions, include a list of comments and detailed responses.

w. Safety Related:

   1) Provide Name and Driving Directions to Nearest Hospital Location

   2) Provide a Site Evacuation Plan

   3) Provide the Weather Limitations and Contingency Plan for the project.

   4) Provide a Fall Protection Plan for working from Articulating Lift.

   5) PPE must be worn by all Tradespersons while working on project (including Mask /Face-coverings and gloves, as applicable)

   6) Plan must include actions being taken by construction personnel to address and mitigate an event or occurrence of Contagious Diseases / Outbreaks (i.e. COVID-19)

   7) Tradespersons must have valid CTA Rail Safety Training Cards with them for work. Random CTA audits are conducted.

   8) CTA Rail Safety Trained Personnel required for Slow Zone setup

   9) CTA Flaggers must be positioned with portable track trip system is in place prior to activities.

   10) Verification of inspection for all equipment and operator certification.

   11) Safety Briefing must be conducted together with all Tradespersons / CTA Personnel prior to the start of work and documented.

   12) Communication with the CTA Flaggers is vital during this operation. Maintain / adhere to communication with Flaggers; Flaggers will sound horn when train approaches, contractor to stop work, lower equipment and when train clears Flaggers will sound horn to proceed / continue with work

   13) No work shall be performed while Train Service proceeds through work zone. Materials must be secured.

   14) Ladders used for access to the ROW must be constructed from non-conductive material and have dual access rungs for use on both sides of the A-frame or shop made with safe extension of the side rails for Tradespersons to step-through.

15) All required information for the construction equipment per Section 3.9.1.

Based on the Coordination Flowchart, the CPP shall be submitted to CTA eighty-one (81) days prior to the start of the work within the Basic Safety Envelope. However, items shown in the Coordination Flowchart may overlap and the minimum days CPP must be submitted to CTA for review is twenty-one (21) prior to the start of the work.

The Contractor's construction activities shall minimize impact to the CTA Operating System.

2.8 CONSTRUCTION VERIFICATION

Temporary Shoring

The temporary shoring Engineer in Responsible Charge (or his/her authorized designee) shall visit the site and review the as-built shoring system to verify that the system is constructed in accordance with the shoring plans that have been reviewed and accepted by CTA. The Engineer in Responsible Charge shall prepare a letter that shall be submitted to CTA confirming that the shoring system has been reviewed and verified, which includes, but not limit to, overall condition, critical dimensions such as excavation depth, material, welds, etc. Any field changes shall be listed in the letter and the effect of those changes shall be evaluated by the Engineer in Responsible Charge. Any deficiencies noted by the Engineer in Responsible Charge shall be corrected by the Contractor. Deficiencies and corrections shall be noted in the letter with verification of adequate correction by the Engineer in Responsible Charge. If the shoring system is a pre-manufactured product, manufacturer shall provide a letter to confirm the correct product is installed.

The number of site visits and the stage or stages of construction at which they shall be performed can be suggested by the Shoring Designer, but will be specified by CTA as a condition of acceptance of the temporary shoring design. The intent will be to have the temporary shoring installation verified by the Engineer in Responsible Charge at critical construction stages. The confirmation letter required above shall be made for each construction stage.

Contractor shall provide evidence that ERS vertical components (sheet piles, soldier piles, etc) have achieved the design depth to Engineer in Responsible Charge and CTA.

Potholing Utilities

When potholing is required to verify existing CTA utilities per Section 3.6, Section 4.4, and Section 4.5, Contractor shall submit a confirmation letter and provide evidence that existing CTA utilities have been located before commencing the proposed Adjacent Construction work. Evidence shall include:

- Photos during the potholing process
- Photos showing the existing CTA utilities after discovered, if visible.
- Photos showing the depth measurement process

- Updated drawings with the field verified existing CTA utility locations and clearance dimensions to the proposed work

Welding

Contractor shall have a Certified Welding Inspector/Quality Representative on site to visually inspect all field welding and randomly select 15% of the field welds to measure lengths and throat thickness, except for the welds done per AWS D1.5 shall be 100% inspected to measure lengths, throat thickness, and overall weld quality. Contractor's Certified Welding Inspector shall document and record types and locations of all defects found in the work and confirm the measures taken to correct these defects.

Concrete Formwork

When potential failure of formwork poses a risk to CTA, as determined by same, the "Concrete Pre-Pour Checklist" as attached in Appendix A must be filled and submitted to CTA for record.

Micropile Installation

When micropile installation is within CTA track structure spread footing and based on the soil boring log, weak soil layers are expected within the Zone of Influence, the micropile design Engineer in Responsible Charge shall visit the site when the drilling occurs within the Zone of Influence and weak soil layers to monitor the installation process, verify if external flushing occurred, and provide necessary guidance when obstructions are encountered that casing can no longer advance without auger extending beyond the bottom edge of the casing.

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SECTION 3 BASIC CONSTRUCTION AND EXCAVATION REQUIREMENTS

3.1 ZONE OF INFLUENCE

The Zone of Influence is defined in **Figure 3 - 1**. The area below the influence line is divided into four (4) zones. Requirements and limitations for excavation and temporary excavation support systems within each zone are described in detail below. Excavation requirements apply on or off of CTA Right-of-Way. Excavation beyond the Zone of Influence shall satisfy OSHA and other applicable requirements per the governing jurisdiction.

When designing ERS for underground utility works, O/C/A/E shall assume the proposed utility alignment is two (2) feet deeper, and two (2) feet closer towards the CTA tracks, or towards the CTA underground utilities for jack-and-bore and horizontal directional drilling work.[3]

▩ **ZONE 1**

- Excavation is prohibited. Casing/carrier pipe allowed where shown.

▧ **ZONE 2**

- **No excavation or temporary shoring installation will be allowed without the special written permission of CTA.** Requirements for requesting a variance are provided in Section 2.2.
- Dimension 5’-7” provides the very minimum clearance for the CTA train envelope for an installed ERS structure. However, installation procedures usually encroach into train envelope which may require track out of service if approved. The preferred and recommended clearance from face of the excavation to the centerline of track is 7’-2” which should be followed.
- If CTA grants a variance to allow excavation, vertical excavation with continuous shoring walls is required. Shoring installation shall be complete prior to any excavation. Design of the shoring system shall include lateral surcharge due to rapid transit live load.
- Examples of continuous shoring wall types include interlocked sheet piling or diaphragm walls. Sheet piling shall not cantilever in height exceeding four (4) feet in the final condition or during excavation stage before anchor/brace system can be installed[4]. Diaphragm wall types include deep soil mix walls, secant pile walls, and tangent pile walls. Soldier piles and lagging are not allowed if excavation is necessary to install lagging.
- Excavation shall have a length parallel to the track no greater than one-hundred (100) feet.

▨ **ZONE 3:**

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[3] See Section 3 Commentary
[4] See Section 3 Commentary

- **Excavation requires temporary shoring.** Vertical excavation with continuous shoring walls is required. Shoring installation shall be complete prior to any excavation. Design of the shoring system shall include lateral surcharge due to rapid transit live load.

- Examples of continuous shoring wall types are the same as Zone 2, only in Zone 3 soldier piles and lagging may be allowed. Cantilevered soldier piles and lagging (and sheet piling) shall not exceed six (6) feet in height in final condition or during excavation stage before anchor/brace system can be installed.[5] Maximum excavation lifts shall be as directed by the Geotechnical Engineer depending on the soil type but shall not be more than five (5) feet for each stage of excavation for soldier pile and lagging walls or any other type of shoring that requires excavation of an open soil face prior to installing continuous support elements. Grouting is required behind the lagging to fill the voids.

░ **ZONE 4:**

- **Excavation requires temporary shoring.** Excavations shall be vertical. Continuous shoring walls installed prior to any excavation are preferred. Maximum excavation lifts shall be as directed by the Geotechnical Engineer depending on the soil type but shall not be more than five (5) feet for each stage of excavation for soldier pile and lagging walls or any other type of shoring that requires excavation of an open soil face prior to installing continuous support elements.
- The excavation shall be provided with a shoring system that actively supports the sides of the excavation and prevents the excavation faces from unraveling or moving. Sloped excavations are not permitted.
- Hydraulic and mechanical trench shores with sheeting, trench shields, and timber shoring may be utilized.

EXCAVATIONS BEYOND INFLUENCE LINE:

- Lateral surcharge due to rapid transit live load need not be considered in the shoring design. **It does not mean open cut is permitted outside the Zone of Influence line.**
- Shored vertical excavations are preferred. Sloped excavations are discouraged. CTA will require slope stability analysis and monitoring per Section 10 and Section 10.5.
- Excavation and temporary shoring shall comply with OSHA and other applicable requirements per the governing jurisdiction.

GENERAL REQUIREMENTS OF EXCAVATIONS IN ALL ZONES:

- Finished excavation surfaces shall be in uniform planes, with no abrupt breaks.
- Positive drainage shall be maintained away from the tracks and track subgrade at all times.
- Backfilling materials, procedures, placement, and performance criteria shall meet the requirements IDOT Standard Specification including aggregate base sub-ballast. Coordinate with CTA Engineering.

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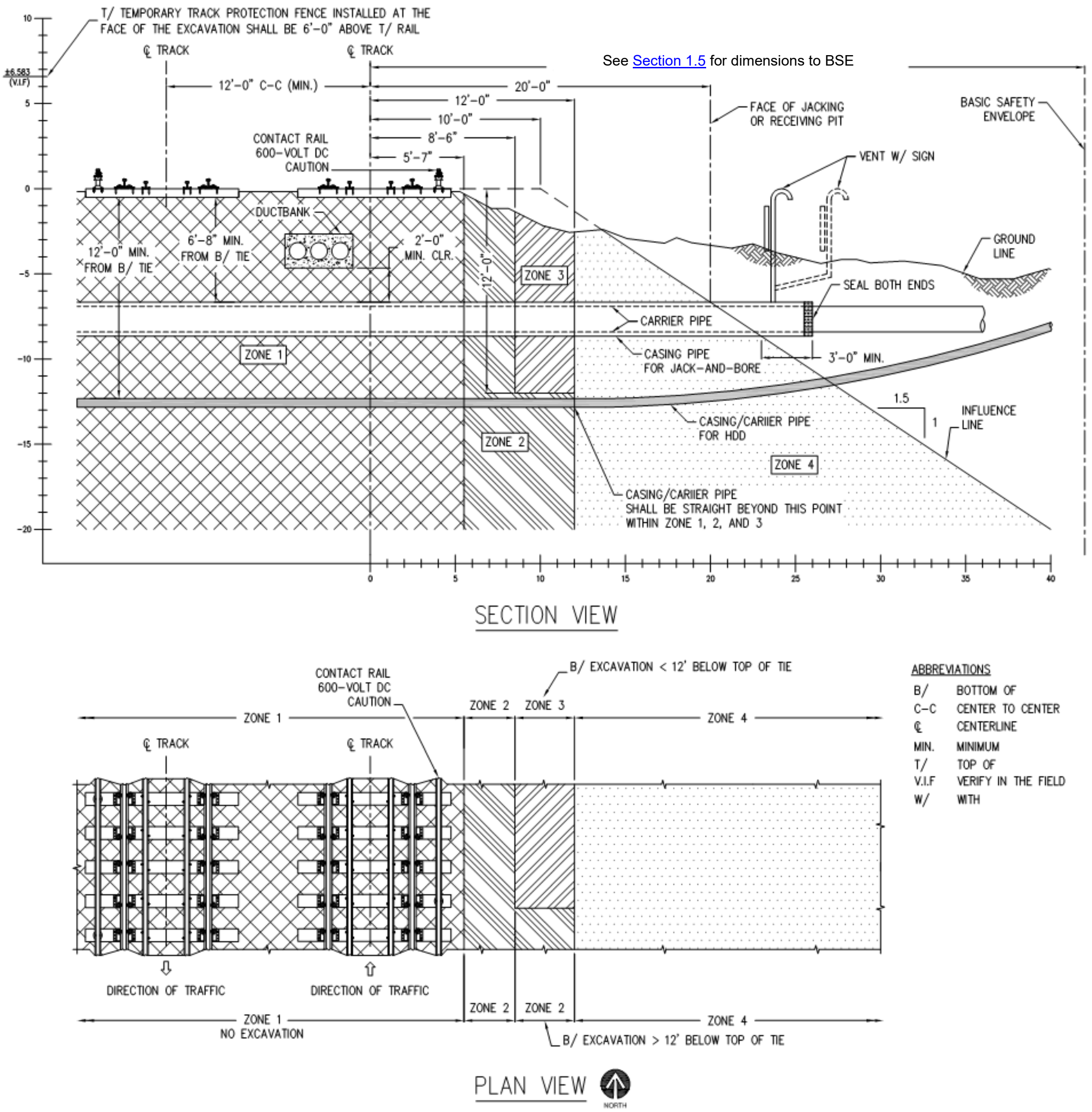
[5] See Section 3 Commentary

- When top of shoring wall is below the bottom of cross ties, existing ballast shall not be disturbed. If any disturbance to the ballast occurs, correction must be made immediately. The ballast shoulder width measured from the end of the cross tie to the point when ballast starts to slope shall be twelve (12) inches minimum[6].
- Refer to Section 10.3 for monitoring frequency requirement in all Zones.

SPECIAL REQUIREMENTS FOR JACK-AND-BORE CONSTRUCTION:

- Refer to Section 4.4 and 4.5 for additional design and construction requirements.



See Section 1.5 for dimensions to BSE

Figure 3 - 1: Zone of Influence

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[6] See Section 3 Commentary

3.2 VARIANCES

CTA prohibits excavation in Zone 1 (with the exception of jack and bore construction as shown in **Figure 3 - 1**) and does not allow excavation in Zone 2 without special written permission. Variances for allowing excavation within Zone 2 may be granted on a case-by-case basis by CTA at its sole discretion. Planning, design, and bidding shall not be based on the assumption that a variance will be granted to allow shored excavation. Therefore, it is required by CTA for Adjacent Project Owner, Designers and/or Contractors to follow the procedures outlined in Section 2.2.

3.3 EXCEPTIONS FOR MINOR CONSTRUCTION

CTA may permit unshored excavation within Zone 3 and Zone 4 provided that the excavation has a limited plan area and is no greater than five (5) feet in depth from top of tie. Further, excavation and backfilling must be completed during a single, uninterrupted period of time during which no train movements will occur on the adjacent track. Planning and bidding shall not be based on the assumption that an exception to the Zone of Influence shoring requirements will be granted.

Unshored excavation adjacent to a track will only be allowed in soil conditions that will permit the work to be performed without disturbing the adjacent track and/or the materials supporting the track.

Localized shallow trenching for utility installation and excavations for the installation of precast foundations (such as signal foundations) are examples of cases where exceptions may be granted. Exceptions will be granted on a case-by-case basis by CTA at its sole discretion. Factors CTA will consider when assessing whether or not to grant an exception include: the length of time required to complete the excavation and backfilling, the available time between train movements on the adjacent track, and local soil conditions.

3.4 RAIL SAFETY TRAINING

All Contractor/Subcontractor/Consultant personnel assigned to work on, under, above, or adjacent to the CTA Right-of-Way and inside Rail Maintenance Facilities adjacent to six-hundred (600) VDC, are required to successfully complete a one-day (8-hour) Rail Safety Training Course administered by CTA in order to qualify for a Rail Right-of-Way Safety Card. The course identifies the dangers that exist on the Rail System, including moving trains and the 600-volt DC Traction Power Distribution System.

For application, associated fees, and scheduling procedures, please refer to CTA Requirements for Contractors Working Along the Right-of-Way (R.O.W.) document available on the CTA Adjacent Construction Website: http://www.transitchicago.com/nearbyconstruction/.

3.5 RIGHT-OF-WAY

Rapid Transit Right-of-Way, in many cases, is owned and maintained by CTA. However, in some cases, CTA shares Right-of-Way with private railroad owners. For example, on sections of Midway Orange Line and Harlem Green Line, at embankments, CTA shares Right-of-Way with Railroads. The Contractor and/or Engineer in Responsible Charge shall coordinate with CTA Real Estate and Railroad for Right-of-Way ownership information. In order to perform work on their Right-of-Way, approval shall be obtained from Railroad. Design and construction of the earth retention system shall satisfy Railroad requirements and this Manual, whichever is stricter.

3.6 UTILITIES

In the City of Chicago, existing utilities shall be located prior to commencing any excavation. The Office of Underground Coordination (OUC) is the distribution agency within the Chicago Department of Transportation, Division of Infrastructure Management, for all requests regarding existing utility information and the review/approval of construction work in or adjacent to the Public Way. Proposed projects for new construction and installation work must be processed through the OUC Information Retrieval process to procure CTA infrastructure drawings. CTA is a member of OUC. Acceptance of the project by CTA does not constitute a representation as to the accuracy or completeness of location of the existence or non-existence of any utilities or structures within the limits of the project. For locating CTA existing utilities within the Basic Safety Envelope as defined in Section 1.5, such as duct banks for signal cables, traction power cables, etc., it is required by CTA that Ground-Penetrating Radar (GPR) be used for any work that contains the scope of soil removal, i.e., excavation, boring, etc. For locating CTA existing utilities outside the Basic Safety Envelope, GPR shall also be used when the proposed work is within ten (10) feet clear distance from the faces of CTA existing utilities. In certain instances, CTA forces may provide assistance for locating CTA's underground utilities. GPR must be done by a qualified company that has successfully located utilities on railroad tracks (ballast can result in additional noise for GPR and is different from pavement). CTA would also recommend GPR be used to locate all other utilities. Refer to Section 4.4 for additional potholing requirements for locating utilities for Jack-and-Bore Construction and Horizontal Directional Drilling Construction.

When locating non-CTA utilities outside the City of Chicago, follow the standard operating procedures of the local municipalities. At a minimum, coordinate with JULIE for underground utilities identification.

Other agencies utilities or assets that are located within CTA's Right-of-Way or property, Right of Entry shall be obtained before entering CTA's property for maintenances.

If any utilities are discovered on site that are not shown in the Information Retrieval documents, Contractor shall attempt to determine the possible owner of the utilities to determine the course of action. CTA Inspectors shall be notified with the coordination process and results. Adjacent Construction work shall not resume until the utilities have been identified and consensus between the Contractor and utility owner is reached, reviewed and agreed by CTA Engineering. If the discovered utilities have been abandoned, Contractor's Engineer in Responsible Charge shall determine the negative effect to the adjacent CTA structures if the proposed work require a full or partial removal of the abandoned utilities and submit to CTA Engineering for review and approval.

3.7 SAFETY REGULATIONS

Specific safety regulations of CTA are provided in the CTA Safety Manual. Construction shall also conform to the OSHA Standards, as well as any other applicable government agency safety regulations.

The entire CTA Rail System has been divided into 198 Flag Zones. These Flag Zones are based upon which Rail Terminal has the responsibility of providing flaggers. The Flag Zone numbers emulate train run numbers assigned to the Terminal supplying the Flaggers (except for the loop). For easy identification, all Flag Zones are listed on a Flag Zone Index chart.

CTA Inspectors will assist Contractor to determine the number of flaggers required for the work based on the address of the worksite and means and methods in the process plan. Consult the "Flag Zone Guide" in the CTA's Flagger Requirements document to determine the minimum number of flaggers required. If work is performed in two or more flag zones, the flag zone shall govern the minimum number of flagger ordered with the highest/largest number of flaggers. Taking a track out of service with a Service Bulletin may reduce the total number of flaggers required. If the proposed Adjacent Construction work is deemed to be of higher risk to the CTA services, or unusual site constraints exist, a pre-activity meeting shall be held with the Contractor, CTA Inspectors, CTA Safety, and CTA Route Transportation Manger to review the proposed activities and site constraints to determine the required number of flaggers.

Once all of the R.O.W requirements have been met which includes Letter of Commitment, Deposit, RRP Insurance, Rail Safety Training, and an Approved CPP, the CTA Project Manager will notify the Contractor and send a blank flagger request spreadsheet. Contractor shall fill out and return the spreadsheet no later than noon on the Wednesday one week before the proposed work activities. After the flagger request is entered into the Rail Operations Personnel Request website, CTA Inspectors will receive a notification before the end of the day Friday in the same week if the request has been approved or denied. These procedures/timelines may change without notice in the ACM based on Rail Operations. Ensure to coordinate with Rail Operations for the most up-to-date flagger ordering procedures and timelines.

Refer to CTA's Flagger Requirements for additional information and refer to Section 3.9 for more information on Single Track/Reroute.

Refer to Section 2.7 for safety related Construction Process Plan (CPP) submittal requirements.

3.8 CONSTRUCTION

Construction of excavations or temporary shoring system within the Basic Safety Envelope and Zone of Influence, or with the potential of entering the Basic Safety Envelope and Zone of Influence requires a Construction Process Plan (CPP). See Section 2.7 for CPP submittal requirements. Once the applicable right-of-entry requirements, safety training requirements, accepted earth retention system design and drawings, and CPP are in-place, the Contractor may proceed with construction according to the design plans, specifications, and accepted CPP. Refer to the flowchart in Section 2 for additional timeline and coordination information.

All ground penetrating structural components of the Earth Retention System shall be installed using methods proven to not impact adjacent structures.

Any damage to rails, ties, structures, embankments, Third Party property, signal, and communications equipment, or any other facilities during construction shall be repaired, at the expense of the Public Agency or Contractor doing the work, to a condition equal to or better than the condition prior to entry into the Basic Safety Envelope and to a level accepted by CTA. CTA reserves the right to back charge the Contractor for the affected rapid transit operation for any and all costs and expenses incurred as a result of their work, which may result in the following:

- Unscheduled delay to trains, or interference in any manner with the operation of trains.
- Unscheduled disruption to normal rapid transit operations.
- Unreasonable inconvenience to the public or private users of the system.
- Loss of revenue.
- Alternative method of transportation for passengers.

The Public Agency and Contractor shall comply with the rules and regulations as required by the CTA Safety Department after reviewing the CPP.

3.9 CONTRACTOR OPERATING RESTRICTIONS

All construction work within the Basic Safety Envelope or Zone of Influence shall be performed in accordance with an accepted CPP.

When operating near active tracks, whether on or off CTA Right-of-Way, the Contractor's operations will be constrained as necessary to protect the Operating System. In general terms, if the Contractor's operation has the potential to interfere with the safe passage of rapid transit traffic or has the potential to damage tracks or other CTA infrastructure, restrictions will be imposed on the Contractor's operations.

When working within the Basic Safety Envelope or within the Zone of Influence, the Contractor is considered to have the potential to damage the track, regardless of the operation or equipment being used. The Contractor will still be considered as having the potential to damage the track when working outside the Basic Safety Envelope, or Zone of Influence, depending upon the operation. For example, if the Contractor operates a crane or backhoe with a boom having sufficient length to encroach Basic Safety Envelope, or if the Contractor is handling long beams or piles that could fall across a track. Such operations will be constrained. For bridge girder erection above CTA tracks, refer to Section 11.2.5 for additional requirements.

CTA has sole discretion to determine if the Contractor's work activities, and including mobilization and/or transportation of construction equipment, have the potential to impact its operations. Unless otherwise approved by CTA, the Contractor will not be permitted to perform operations that have the potential affect operations during morning or evening rush hours. Rush hour varies by lines and locations but typically it is Monday through Friday; mornings from 0500 to 0900 hours and afternoon from 1500 to 1900 hour. For rush hour on a specific line and location, coordinate with CTA Train Operation and attend the weekly rail operation meeting.

3.9.1 Construction Equipment

The construction equipment governed by this Section is defined as any powered equipment that facilitates the Adjacent Construction and has the potential to foul CTA tracks as defined above in Section 3.9 and/or the failure of the construction equipment when being operated/mobilized within CTA's Basic Safety Envelope or within the Zone of Influence that has the potential to endanger the public, public or private Right-of-Way. **Construction Equipment approved in the CPP shall not be substituted.**

The storage, handling, transportation, mobilization, and operation of construction equipment shall comply with all OSHA Regulation Standard Number 1910 Subparts N, O, and P, or any Subparts, and OSHA Standard 1926.1427 for Operator Training, Certification, and Evaluation, that will govern the use of the specific construction equipment with the following additional requirements:

- The operation manuals of the construction equipment shall be included in the Construction Process Plan submitted to CTA as a part of the requirements in Section 2.7 and all operational constraints/restrictions in the operation manual shall be highlighted.
- The manufacturer certified construction equipment load test results shall be included in the CPP.
- The maintenance and inspection log for the equipment shall be included in the CPP.
- The Contractor shall retain an Illinois licensed Structural Engineer and analyze the stability of the construction equipment in operational condition and mobilization condition. The stability check shall include overturning analysis with a factor of safety of 2.0, and sliding analysis with a factor of safety of 2.0. The analysis shall consider all of the possible equipment configurations and conditions with anticipated wind pressure, ground slope, or any forces/conditions that may affect the stability, and include both static and dynamic states. The dynamic state shall consider the worst case swing/rotational speed that can produce the worst case centrifugal forces with the least hold-down condition. If the worst case overturning or sliding factor of safety is less than 2.0 but greater than 1.5, a physical hold-down device shall be required, designed, and installed whenever the construction equipment is in the operational condition. If cribbing is used as construction equipment platform, it shall be restrained to prevent any sliding between the cribbing and soil or supporting structures below.
- A demonstration in a safe and controlled environment/site of the proposed equipment for the proposed work shall be performed to ensure the equipment is suitable for the

application, with either the restrictions from the operational manual, or further restrictions required by the SE calculations.
- The construction equipment, in its operational position, shall be on level ground within one (1) degree grade.
- Before traveling/swinging a construction equipment with load, a designated person shall be responsible for determining and controlling safety. Decisions such as position of load, boom/mast location, ground support, travel route, and speed of movement/rotation/swing shall be in accord with his/her determinations based on the operation manual and analysis.
- Construction equipment operators and their immediate supervisor shall complete a course in accident prevention and the course shall consist of instruction suited to the particular operations involved.
- No construction equipment is allowed to encroach into the CTA Train Envelope within 7'-2" distance from the centerline of the track and above the Train Envelope when a passing train is present. Refer to Appendix B for more detail. Construction Equipment operators must keep their hands and feet clear of all equipment controls while the train is passing.

Whenever a construction equipment has an overall height (highest point of the equipment) more than two times the height of the equipment main body, but the construction equipment is not categorized as a crane with manufacturer tested load tables, the following additional requirements shall apply (for example, an excavator with mast module mounted):

- The hydraulic mast foot shall be installed and engaged whenever the mast is extended. The mast foot shall bear on sound and leveled ground.
- In both the operational and mobilization states when the mast is vertically positioned, the construction equipment shall not be positioned in a way that there is no ground for mast foot to bear on.
- Before construction equipment swings or travels with load and the mast vertically positioned, mast shall be fully retracted.
- If mast is segmented, the mast shall not extend taller than what is required for the work.
- **Modifications on the equipment is not permitted.** For example, change of counterweights, undercarriage, mast, etc.

3.9.2 Slow Zones

A Slow Zone, as outlined in Transit Operations Standard Operating Procedure (SOP) No. 7041 is required when The Contractor's work is within the CTA Basic Safety Envelope or Zone of Influence, and the duration of the work is one-half hour or more. Refer to SOP No. 7041 for responsibility, set-up, standard operation and removal of the Slow Zone.

An Extended Duration Construction Slow Zone shall be required when one or more conditions as shown below are expected to occur and remain outside of the scheduled flagger/Slow Zone protected work period, or require as determined by CTA, in which case, the Infrastructure

Division Standard Operating Procedure IC-SOP-P002 shall be used in conjunction with SOP No. 7041.

- Construction activity adjoining, above, or beneath CTA tracks (within CTA Basic Safety Envelope) that has the potential for personnel, material, or equipment to accidentally intrude upon a train's clearance envelope. This would exclude ground level work activities above CTA subway tunnels.
- Excavation under or adjacent to (within the Zone of Influence) to any ballasted track or elevated, subway or earth retention structures, except minor excavations in Zone 4 of **Figure 11 - 2** above CTA subway tunnels.
- Any shoring required of an elevated track structure.

During review of Contractor Construction Process Plans, the CTA Project Manager and CTA Construction Safety shall evaluate the nature of the construction work and the manner in which it is proposed to be performed. If any of the activities or conditions on the IC-SOP-P002 checklist in Appendix A are expected to occur and remain outside of the scheduled flagger/slow zone protected work periods, the checklist shall be submitted to the CTA chief Engineer noting the anticipated conditions. Include with the checklist a full description of the work and include limits, duration and precautionary measures planned to minimize risk to the CTA's operations and property. The Chief Engineer or his Designee will determine the need and detailed requirements for a construction related slow zone during non-work hours.

At the end of each work shift and prior to releasing flaggers from a flagger protected work zone, or prior to returning track to normal service, the CTA Inspectors shall inspect the site and determine whether any conditions described on the IC-SOP-P002 Checklist in Appendix A exist which could warrant the continuation of reduced train speed. Any concerns or issues should immediately be brought to the attention of the Chief Engineer (or authorized representative) prior to releasing the flaggers and increasing allowable train speeds through work zone.

3.9.3 Single Track/Line Cut

In general, a Single Track or Line Cut is required if the Contractor's work is within the CTA Train Envelope Clearance, or when there is no way to clear the CTA Train Envelope without incurring significant train delays or risk to the Operating System as determined by CTA. In most cases power down is also requested unless the timeline or nature of the work warrants an exception. A list of common situations is provided as following to demonstrate when Single Track or Line Cut is required. Adjacent Construction scope of work should be coordinated with CTA Construction, Safety and Rail Operations in a timely manner to secure flaggers, Single Track or Line Cut.

To take a track out of service, a completed "Single Track/Reroute Request" form must be submitted to the Office of the Vice President, Rail Operations in advance of the scheduled work. Coordinate with Rail Operations for form submission requirements. The Contractor is encouraged to submit the five week lookahead schedules at the Rail Operation meeting to coordinate track access with other projects on the same route. Note that any changes to the submitted Rail Service Bulletin requests also require at least 2 weeks' notice, therefore coordination is essential to ensure the accuracy of the request submitted. Whenever possible, the person in charge should request a meeting with CTA Route Transportation Manager, Power & Way Engineering, and Signal Department. Taking a track out of service with a Service Bulletin may reduce the total number of flaggers required. For more information, refer to CTA's Flagger Requirements.

Single Track/Reroute

- Swing Stages/Tuckpointing - Only required for the portion of work within the Train Envelope
- Caissons/Earth Retention Systems - Only required if the caisson/ERS is within the Train Envelope
- Bridge Erection/Demolition - Depends on site conditions as well as the Contractor's means/methods
- Crane/Man Lift Extended Over the ROW - Depends on the nature/duration of the work - most work can be accomplished with flaggers and 3rd rail covers
- Track Work - Most cases require a single track, line cut or multiple tracks O/S. If clearances allow, construction fence / protective barriers are required when working on the ROW to delineate the work zone from any active tracks.

Line Cut

- Structural Steel Modifications - Depends on the nature of the work, but may be required for replacement of track stringers, girders, and columns
- Bridge Erection / Demolition - Depends on site conditions as well as the Contractor's means/methods
- Track Work

Debris Netting / Protective Barriers

- Swing Stages / Scaffolding - Required to prevent loose material/debris from fouling the ROW
- Mid / High Rise Construction - Required to prevent loose material/debris from fouling the ROW
- Bridge Decks - Required along the handrail to prevent loose material/debris from fouling the ROW

For IDOT projects regarding and coordination requirements, refer to Master CTA Spec for IDOT projects - CTA Flagging and Coordination.

CTA will not operate work trains, nor allow the Contractor to operate work trains, along the corridor to transport equipment and materials for the Adjacent Construction Projects, unless otherwise approved by CTA.

Contractor's activities that have the potential to affect CTA operations (active or otherwise) may be suspended during all train movements within the construction limits.

The Contractor will generally be directed by CTA flaggers and/or inspectors as to the need to suspend operations. The number of flaggers and inspectors will be determined by CTA per its review of the Contractor's CPP.

Approval of Contractor hours and activities will be determined by the CTA per its review of the Contractor’s CPP.

Refer to the CTA Safety Manual for additional details.

3.10 TRACK PROTECTION FENCES

Track protection fences shall be provided, placed, and secured a minimum of 7’-2” clear from the centerline of the nearest active track and height shall be 6’-0” above top of running rail. If CTA grants a variance to allow excavation 5’-7” from the centerline of the nearest active track, the track protection fences can be connected to and supported by shoring walls to satisfy the above 7’-2” clearance requirement. Clearance less than 7’-2” must be approved by CTA. Appendix G contains a CTA pre-approved track protection fence detail.

Refer to the CTA Safety Manual for additional details.

3.11 HANDRAILS AND WALKWAYS

If CTA grants a variance to allow excavation 5’-7” from the centerline of the nearest active track, and the track protection fences, at a distance of 7’-2” from centerline of closest track, are connected to and supported by shoring walls, adequate walkways shall be provided in accordance with OSHA requirements between the face of the shoring walls and the track protection fences. Walkway supports may be connected to and supported by shoring walls. The walkway surface shall be even with the top of shoring. Handrails may be provided independently from the track protection fences per OSHA requirements, or the track protection fences can be designed to act as handrails.

Handrails and walkways shall be designed in conformance with the requirements of Article 8.5 “Walkways and Handrails on Bridges” of the AREMA *Manual for Railway Engineering* and OSHA Standards. The walkway and support design are required to support a one-hundred (100) psf gravity live load to secure as an emergency evacuation route for the CTA passengers.

For temporary handrails/guardrails and walkways within the CTA’s Zone of Influence but not intended to act as emergency evacuation route for the CTA passengers and only required to facilitate the adjacent construction work, OSHA requirements shall govern the design.

Any handrails/guardrails and walkways within the CTA’s Zone of Influence, OSHA requirements shall govern inspection and maintenance. Adjacent Construction Contractor shall perform necessary maintenance to ensure the walking-working surfaces and guardrails are maintained free of hazards such as sharp or protruding objects, loose boards, etc. Adjacent Construction Contractor shall also ensure walking-working surfaces/guardrails are inspected regularly and as necessary, and maintained in a safe condition not only for the workers, but also to prevent any objects falling on the CTA R.O.W. When any correction or repair involves the structural integrity of the walking-working surface and guardrails, the designer of responsible charge shall evaluate the repair and qualified person shall perform or supervise the correction or repair. At the end of each shift before the construction site is shut down, a brief safety walkthrough shall be conducted to confirm the walking-working surfaces/guardrails are secure without loose boards. If high wind is anticipated by weather forecast, generally defined as: (1) wind speed equal or greater than 40 mph lasting one hour or longer, or (2) wind speed equal or greater than 58 mph for any duration, Adjacent Construction Contractor shall coordinate with the walking-working surfaces/guardrails, or any other temporary structures used to facilitate the adjacent construction designer of responsible charge to evaluate if any measures should be taken to secure said temporary structures. A more detailed safety walkthrough shall be conducted before the forecasted wind event.

3.12 CLEARANCES

All elements of the shoring system shall be placed such that they satisfy the clearance diagram per Appendix B.

3.13 SHORING REMOVAL

At the conclusion of construction, staged backfill and removal will often be necessary to safely remove bracing and connection elements of the shoring system. Unless otherwise approved by CTA, shoring walls/piles shall be mostly left in place with partial removal to elevation as required by CTA. If CTA approves to remove shoring systems, removal of these elements shall be included as part of the shoring construction sequence included in the signed and sealed design drawings and the CPP. The Contractor shall comply with removal requirements as stated on the CPP and drawings. Contractor removals shall not proceed if safety of operations is jeopardized or if CTA determines that safety could be jeopardized. Monitoring per Section 10 is to also continue through this activity.

Vertical shoring elements (sheet piles, soldier piles, and diaphragm walls) shall be mostly left in place unless otherwise approved by CTA. Vertical shoring elements shall be cut off or demolished to two (2) feet below bottom of track ties if within twelve (12) feet horizontally from centerline of track, unless otherwise directed by the CTA based on evaluation of the site on a case-by-case basis.

If the Contractor desires complete removal of vertical shoring elements for salvage or reuse, the Contractor shall submit the proposed removal procedure to CTA. The proposed removal1 procedure shall include provisions that will prevent movement or settlement of the track(s) and fill all voids that might remain after shoring removal. Complete removal of vertical shoring elements may be allowed by CTA at their sole discretion.

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SECTION 4 TEMPORARY SHORING SYSTEM

4.1 OWNER/CONTRACTOR-DESIGNED TEMPORARY SHORING REQUIREMENT

For construction projects that will require temporary shored excavation within the Zone of Influence, CTA strongly recommends that Contract Documents (plans, specifications, and estimates) include detailed design drawings and specifications for temporary shoring system. (However, temporary shored excavation as a performance item that is Contractor-Designed will also be accepted.) In addition to clarifying the required construction sequence, defining the impacts to the Operating System, and having a temporary shoring system accepted by CTA prior to the onset of construction, uncertainty regarding the time and expense required for the Contractor to prepare a temporary shoring submittal that satisfies CTA requirements may be effectively eliminated.

4.2 PERMITTED SHORING TYPES AND ELEMENTS

4.2.1 Permitted Without Restrictions

The following types of shoring are permitted by CTA for use within the Zone of Influence:

- Continuous Shoring Walls, such as sheet piling and diaphragm wall systems that are completed in place prior to any excavation are permitted in all Zones.
- Deep Soil Mix Walls and Sheet Piling: Based on other transit agency's experience that the soil mixing (drill) rig and other equipment utilized during a soil mixing operation typically pose a lesser risk than the pile driving equipment utilized to install sheet piling. Additionally, pre-drilling and vibration associated with sheet pile installation and extraction can cause track settlement. Consequently, the Contractor's operations may be somewhat less restricted if deep soil mix walls are used in lieu of sheet piling. Soil mix walls are generally used for deep excavation adjacent CTA subway structures. Refer to Section 11.1 for construction adjacent to CTA underground structures. For secant pile analysis, construction tolerances shall be considered during design. A combination of 2" offset plus 1% vertical out-of-plumb which produces the smallest overlap shall be checked against compression and shear as an arch, unless a more restrictive tolerance is proposed by the Installer. The overlap out-of-tolerance check can be waived if the secant pile size and spacing are selected so that the overlap remains a minimum of 20% pile diameter with the worst-case tolerance condition as mentioned above.
- Preloaded Bracing: Preloading of bracing elements can reduce shoring deflection and ground settlement during excavation and assure good bearing and a tight fit between shoring elements. Where feasible, struts shall be preloaded to about 50% of their design load to achieve adequate bearing between connected shoring elements and to reduce the track settlement that can occur during excavation.

4.2.2 Permitted With Restrictions or Variance Request

The following types of shoring are permitted by CTA for use within the Zone of Influence but with restrictions:

- Soldier pile and lagging systems, have lagging members installed as excavation proceeds. During the excavation process, vertical cuts (of limited extent) are required to stand unsupported until the lagging has been installed. During the time, the ground is unsupported and raveling or ground loss can result in ground settlements that negatively impact track profile and alignment. Additionally, if the lagging is not installed tight to the excavated ground, the ground will tend to move to fill the gaps, which can result in settlement behind the shoring wall that negatively impacts track profile and alignment. Therefore, this type of shoring is not permitted in Zone 2 in **Figure 3 - 1**. However, when there are underground utilities and continuous shoring walls must be interrupted locally, soldier pile and lagging systems are permitted to be used in Zone 2 in **Figure 3 - 1** locally to clear the underground utilities.

The following types of shoring are permitted to use within the Rapid Transit Zone of Influence only when Variance Request is approved by CTA.

- Tiebacks: Tiebacks shall not be utilized to shore excavations within the Rapid Transit Zone of Influence. In addition, tiebacks shall not extend into the Rapid Transit Zone of Influence from walls supporting excavations outside of the Rapid Transit Zone of Influence. If the use of tieback system is approved by CTA, refer to Section 8.1.3 and Section 9.5.

- Micropiles with Laggings: Micropiles with Laggings shall not be utilized to shore excavations within the Rapid Transit Zone of Influence. If the use of micropiles with laggings system is approved by CTA, refer to Section 8.1.6 and Section 9.7.

- Slurry Wall: Slurry walls shall not be utilized to shore excavation in Zone 2 of the Rapid Transit Zone of Influence in **Figure 3 - 1**. If the use of slurry walls is approved by CTA in other Zones, installation of slurry wall shall avoid weekday commute hours, and must work around the weeknight and weekend train traffic. Excavations shall not commence until the slurry walls achieve the design strength.

4.3 PROHIBITED SHORING TYPES AND ELEMENTS[7]

The following types of shoring are prohibited from use within the Rapid Transit Zone of Influence with no exceptions:

- Soil Nailing: Soil nailing shall not be utilized to shore excavations within the Railroad Zone of Influence. In addition, soil nails shall not extend into the Rapid Transit Zone of

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[7] See Section 4 Commentary

Influence from walls supporting excavations outside of the Rapid Transit Zone of Influence.

- Helical Screw Anchors: Helical Screw Anchors shall not be utilized to shore excavations within the Rapid Transit Zone of Influence. In addition, helical screw anchors shall not extend into the Rapid Transit Zone of Influence from walls supporting excavations outside of the Rapid Transit Zone of Influence.

4.4 JACK AND BORE CONSTRUCTION

Pipelines under or across CTA tracks on Right-of-Way shall be encased in a larger pipe or conduit called the casing pipe. Casing pipe will be required for all pipelines carrying oil, gas, petroleum products, or other flammable, highly volatile substances which, from their nature or pressure, might cause damage if escaping on or near CTA tracks or property. Unless other measures are put in place to mitigate safety concerns, to the satisfaction of CTA. For non-pressure water, sewer, or drainage crossings where the installation can be made without interference to transit operations, the casing pipe may be omitted when the pipe strength is capable of withstanding transit live loading. This type of installation must be approved by the CTA. All casing pipes, except those laid longitudinally, shall be sloped not less than 0.3%.

Pipelines perpendicular to the transit Right-of-Way shall be laid across the entire width of the Right-of-Way. Casing pipe shall extend beyond the Zone-of-Influence line shown in **Figure 3 - 1** by at least 3’-0” each end.

Pipelines laid longitudinally on transit Right-of-Way shall be located outside the Zone-of-Influence line as practicable as possible. However, if it is not practical and the pipelines are within the Zone-of-Influence, casing pipe shall be provided, unless otherwise approved by CTA.

Where practicable, pipelines shall be located to cross the tracks at approximate right angles, but preferably at not less than forty-five (45) degrees. In most cases, CTA will provide location of the existing ductbanks.

The minimum clearance from the edge of CTA existing utilities to edge of proposed pipeline shall be 2’-0” as shown in **Figure 3 - 1**. In most cases, CTA will provide the general location of the utilities upon initial coordination. However, in addition to requirements shown in Section 3.6, potholing must be performed whenever proposed infrastructure or utilities will traverse CTA utilities. Contractor must make reasonable efforts to expose the edge of existing CTA utility nearest the proposed pipeline to verify clearance. When reasonable efforts do not allow for exposure of nearest edge of existing CTA utility, CTA will require additional clearance to account for unknowns.

Pipelines shall not be placed within a culvert, under transit bridges, or closer than 45 feet to any portion of a transit bridge, station, or other facilities, except in special cases, and then by special design, as approved by the CTA.

Any replacement or modification of an existing carrier pipe and/or casing shall be considered a new installation, subject to the requirements of this Manual.

Where laws or orders of other public authority prescribe a higher degree of protection than specified herein, the higher degree so prescribed shall be deemed a part of this Manual.

Stray current from the electrified tracks must be expected and accounted for in protection of pipelines and casings. Pipelines and casings shall be suitably insulated from the stray current and any underground conduits carrying electric wire on CTA property.

For pipelines carrying flammable or hazardous materials, ANSI Codes B 31.8, and B 31.4, current at time of constructing the pipeline, shall govern the inspection and testing of the facility on CTA property, except that proof-testing of strength of carrier pipe shall be in accordance with the requirements of ANSI Code B 31.4, as applicable, for all pipelines carrying all liquefied petroleum gas, natural or manufactured gas, and other flammable substances.

Cathodic protection shall be applied to all pipelines and casings carrying flammable substances. Where casing and/or carrier pipe is cathodically protected by other than anodes, the CTA shall be notified and suitable testing shall be made. This testing shall be witnessed by the CTA to ensure that other transit structures and facilities are adequately protected from the cathodic current in accordance with the recommendations of Reports of Correlating Committee on Cathodic Protection, current issue by the National Association of Corrosion Engineers.

The Owner or its Contractor may be required to provide a non-refundable lump sum payment for “after the fact maintenance”. The determination of this amount is based on the individual situation but usually for jack-and-bore operation directly underneath the tracks with an open cut. No work will be allowed until this payment is received if the payment is requested. This payment is not to be confused with payments for items mentioned in Section 1.2, or for flagging, inspection, etc.

There are special requirements in regard to monitoring frequency during the Jack-and-Bore construction in Section 10.3, and special loading requirement for casing pipe design in Section 5.4. Users of this Manual shall pay attention to these additional requirements.

Casings for carriers of non-flammable substances shall have both ends of the casing blocked in such a way as to prevent the entrance of foreign material, but allowing leakage to pass in the event of a carrier break. Where ends of casing are at or above ground surface and above high-water level, they may be left open, provided drainage is afforded in such a manner that leakage will be conducted away from transit tracks and structures.

Casings for carriers of flammable substances shall be sealed to the outside of the carrier pipe. Details of seals shall be shown on the plans. Sealed casings for flammable substances shall be properly vented with proper signage. Vent pipes shall be of sufficient diameter, but in no case less than two (2) inches in diameter, and shall be attached near each end of the casing and project through the ground surface at Right-of-Way lines or not less than forty-five (45) feet (measured at right angles from centerline of nearest track). Vent pipes shall extend at least four (4) feet above the ground surface. Top of vent pipe shall have a down-turned elbow, properly screened, or a relief valve. Vents in locations subject to high water shall be extended above the maximum elevation of high water and shall be supported and protected in a manner approved by the CTA. When the pipeline is in a public highway, street-type vents shall be installed.

For casings for carriers of flammable substances, pipe joint shall be field welded with a single bevel groove butt weld that develops the full capacity of the intact casing pipe and shall conform to the latest AWS 1.1 by a certified welder.

Detailed method of installation shall be provided in the CPP as specified in Section 2.7 with the following requirements:

General:

- The use of water or slurry under pressure (jetting) or puddling shall not be permitted to facilitate boring, pushing, or jacking operations. Water or slurry used to lubricate the cutter and pipe is acceptable.
- Unless otherwise directed by the Geotechnical Engineer in Responsible Charge, indicated in the CPP and approved by CTA, pipe, conduit, and casing installation under tracks shall be progressed on a continuous basis without stoppage, except for adding sections, until the leading edge has reached the receiving pit, or (ten) 10 feet beyond the CTA Zone of Influence, whichever is greater.

Jacking:

- This method shall be in accordance with the AREMA Manual, Volume 1, Chapter 1, Part 4, “Earth Boring and Jacking Culvert Pipe Through Fills.” This operation shall be conducted without handmining ahead of the pipe and without the use of any type of boring, augering, or drilling equipment.
- Bracing and backstops shall be designed and jacks with sufficient rating used so that the jacking can progress without stoppage (except for adding lengths of pipe) until edge of the pipe reaches the receiving pit, or 10 feet beyond the CTA Zone of Influence, whichever is greater.
- During jacking, an earth plug 1.5 times the diameter of the casing shall be maintained at all times. Jacking operations shall be continuous on a twenty-four (24)-hour per day basis until edge of the pipe reaches the receiving pit, or ten (10) feet beyond the CTA Zone of Influence, whichever is greater.

Auger Boring:

- This method consists of pushing the casing pipe into the earth with a horizontal auger boring machine with an auger rotating within the casing pipe to remove the spoil. The front of the pipe shall be provided with mechanical arrangements or devices that prevent the auger from leading the casing so that no unsupported excavation is ahead of the casing. The auger and cutting head arrangement shall be removable from within the pipe in the event an obstruction is encountered. The over-cut by the cutting head shall not exceed the outside diameter of the casing pipe by more than one-half inch. The face of the cutting head shall be arranged to provide reasonable obstruction to the free flow or running of earth material.

Any method which employs simultaneous boring and jacking or drilling and jacking for pipes over eight (8) inches in diameter that does not adhere to the above mentioned requirements will not be permitted.

If an obstruction is encountered during the installation which stops the forward action of the pipe, and it becomes evident that it is impossible to advance the pipe, operations will cease and the pipe shall be abandoned in place and filled completely with grout. Detailed procedures for filling abandoned pipe with grout must be included in the CPP. When water is known or expected to be encountered at the site, The Owner or its Contractor shall lower and maintain the ground water level a minimum of two (2) feet below the invert of casings at all times during construction, if approved by the Geotechnical Engineer in Responsible Charge and approved by CTA. See Section 9.2 for dewatering requirements.

Requirements in Section 4.5 items 5 through 10 shall also apply to this section.

All underground utilities constructed within CTA's Zone of Influence, or abandoned in place is subject to CTA independent inspection and acceptance.

4.5 HORIZONTAL DIRECTIONAL DRILLING CONSTRUCTION

The American Railway Engineering and Maintenance-of-Way (AREMA) has assigned a working committee to develop a recommended railroad industry practice for horizontal directional drilling (HDD) under railroad right-of-way. The interim guidelines listed below are issued by the Union Pacific Railroad (UPRR) and are adopted by the CTA. Pending completion of the AREMA recommended practice, at which time CTA will review and determine whether to adopt it. Existing CTA utilities verification shall comply with Section 3.6 and Section 4.4.

This method consists of utilizing specialized drilling equipment to bore a small diameter pilot hole along the desired alignment using a mechanical cutting head with high-pressure bentonite slurry to remove the cuttings. The drill string is advanced with the bentonite slurry pumped through the string to the cutting head and then forced back along the string, carrying the cuttings back to the surface for removal. After the cutting head reaches the far side of the crossing, it is removed and a reamer (with a diameter wider than the cutting head) is attached to the lead end of the drill string. The casing is attached to the reamer and the casing is then pulled back into its final position.

1. For all liquid or gas pipelines, only steel pipe may be installed under tracks or CTA right-of-way utilizing HDD. The pipe may be used as a carrier pipe or a casing pipe. Plastic carrier pipe, if used, must be installed in a steel casing.
2. For fiber optics or electrical installations, plastic pipe may be used as a conduit.
3. For all liquid or gas installations, also see Section 4.4, with casing not exceeding sixty-three (63) inches, minimum cover (measured from bottom of tie to top of pipe) shall be

twelve (12) feet, regardless of product. For fiber optics or electrical installations, with casing/conduit nominal size of 6 inches or less, minimum cover shall be twelve (12) feet. Submittal shall include actual planned depth of pipe under each track.

4. Pipe specification must be provided and it shall satisfy AREMA recommendations and all applicable government and industry regulations.

5. Qualifications of drilling Contractor must be submitted which shall include specific instances of previous successful experience in drilling under sensitive surface facilities.

6. Construction Process Plan must be submitted per Section 2.7. The CPP shall include description of the anticipated rig capacity, the proposed equipment and the method for advancing the borehole through expected soil conditions, angles, depth, and exact location of the exit ditch, the pilot hole diameter, the proposed reaming plan, including the number and diameter of pre-reams/back-reams and diameter of the final reamed borehole, and the contingency equipment and plans for dealing with soil conditions that a Geotechnical engineer could reasonably expect to be encountered at the proposed HDD installation site. The CPP shall also address the anticipated hours of operation during the HDD borehole drilling and installation process, the minimum number of personnel, and their responsibilities on-duty and on-site during all HDD drilling operations. Installation shall follow the approved CPP with the following requirements:

    a. Excavating the soil by means of jetting of fluid or jetting of slurry are not allowed.

    b. Slurry use shall be kept to a minimum and shall only be used for head lubrication and/or spoils return. The Contractor shall calculate anticipated slurry use and monitor actual use during the boring operation in order to determine the slurry loss into the surrounding soil. The bentonite slurry shall seal the annular space between the casing and the excavated soil with a minimum return of 95%.

    c. HDD operation within the CTA Zone of Influence shall be advanced in a timely manner with minimal breaks in operation and no change in crew or operator.

7. The Contractor must provide a detailed Fracture Mitigation (frac-out) Plan including method of monitoring and capturing the return of drilling fluids with particular attention to prevention of in advertent escape of drilling fluids where they could undermine the tracks.

8. Establish a Survey Grid Line and provide a program of monitoring and documenting the actual location of the borehole during drilling operations.

9. An Authority assigned inspector and the Contractor's monitoring engineer are required to monitor the ground, ballast, and track for movement during the drilling, reaming, and pullback process per Section 10. All work within the right-of-way Basic Safety Envelope must be coordinated with the flaggers. The installation process must be immediately stopped if movement is detected. The damaged area must be immediately reported to the Authority and immediately repaired subject to Authority review and approval. The

installation process must be reviewed and modified as required before the installation may proceed.

10. Upon completion of the HDD installation work, the Contractor shall provide an accurate as-built drawings of the installed HDD segment. As-built drawings will include both horizontal and profile plan.
11. All underground utilities constructed within CTA's Zone of Influence, or abandoned in place is subject to CTA independent inspection and acceptance.

SECTION 5 LOADING ON TEMPORARY SHORING SYSTEM

5.1 GENERAL

Lateral loading from the following sources shall be considered in the design of the temporary shoring system:

- Retained Soil
- Retained Groundwater (hydrostatic pressure)
- Surcharge from all applicable sources, including, but not limited to, CTA train and/or railroad live load, equipment and vehicles, material stockpiles, structures, and improvements, etc.

Earthquake (seismic) loading need not to be considered.

Other sources of load, including centrifugal force from a train, impact loads, thermal loads, and wind loads are typically not required to be considered in the design. Such loads need only be considered in cases where they are significant. For example, centrifugal forces may need to be considered in the design of a shoring system constructed at a curve over which trains travel at high speeds.

5.2 SOIL LOADS

The following examples are located within Appendix C

Example 5.1 Develop an Active Soil Pressure Diagram
Example 5.2 Develop an Apparent Pressure Diagram
Example 5.3 Determine Passive Resistance (Cohesionless Soil)
Example 5.4 Determine Passive Resistance (Cohesive Soil)

5.2.1 Soil Types and the Determination of Soil Properties

Soil types and applicable properties shall be ascertained by taking borings and performing appropriate field and laboratory test. Sufficient geotechnical exploration shall be performed to establish an understanding of the soil profile for the subject site. Refer to **Figure 5 - 1**, **Figure 5 - 2**, **Figure 5 - 3**, for examples of an acceptable soil boring layout.

Soil borings shall be in accordance with the current issue of the AREMA *Manual for Railway Engineering* Chapter 1, Part 1, “Specifications for Test Borings”. In addition to establishing the soil profile, key soil parameters for the design of shoring to be ascertained during exploration include the unit weights and strengths for the soil [i.e., the cohesion (c), and angle of internal friction (Φ)].

Vane Shear Test is to be performed to determine the undrained shear strength (S_u) for soft clays - less than one (1) tsf bearing pressure. The peak undrained shear resistance value measured from the test shall be corrected based on the liquid limit.[8] If clay contains silt or sand, the test results become less reliable. The Geotechnical Engineer and/or the Engineer in Responsible Charge shall use caution when using the test results for analysis.

Soil boring logs shall be accompanied by a plan drawn to scale showing location of borings in relation to the tracks and the proposed shoring wall and/or pipe (for jack-and-bore construction) locations, the elevation of around surface at each boring, and the elevation of the base of running rail of the tracks. See additional requirements for drawings in Section 2.3.

The design soil properties shall be established by a Registered Geotechnical Engineer, or, alternatively, by a licensed Professional Engineer specializing in geotechnical engineering.

At a minimum, boring depth shall be 1.5 times the minimum embedment depth specified in Section 7.8.1 for excavation with Earth Retention System.

Figure 5 - 2 and **Figure 5 - 3** below are only intended for open cut if permitted by the Authority per Section 3.1. Soil under CTA tracks, especially in the case of open cut embankments can have a different soil profile than the soil under the Adjacent Facility which can have significant impact on the open cut stability analysis. Therefore, soil borings shall be done adjacent to and along CTA tracks with a maximum spacing of 100’-0”. Unlike ERS where the passive side of soil profile is more important. For slope stability analysis, since the soil along the slip surface is providing sliding resistance, it is important to better understand the soil profile in the transverse direction of centerline of tracks. Therefore, a minimum of two (2) soil borings are required per **Figure 5 - 3** and the soil boring depth shall extend below the anticipated slip surface.

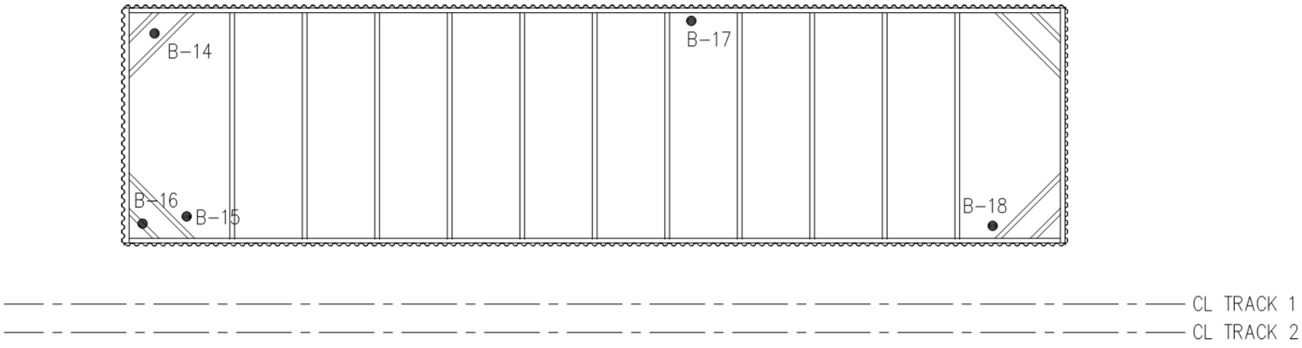

Figure 5 - 1: Typical Soil Boring Locations for ERS

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[8] See Section 5 Commentary

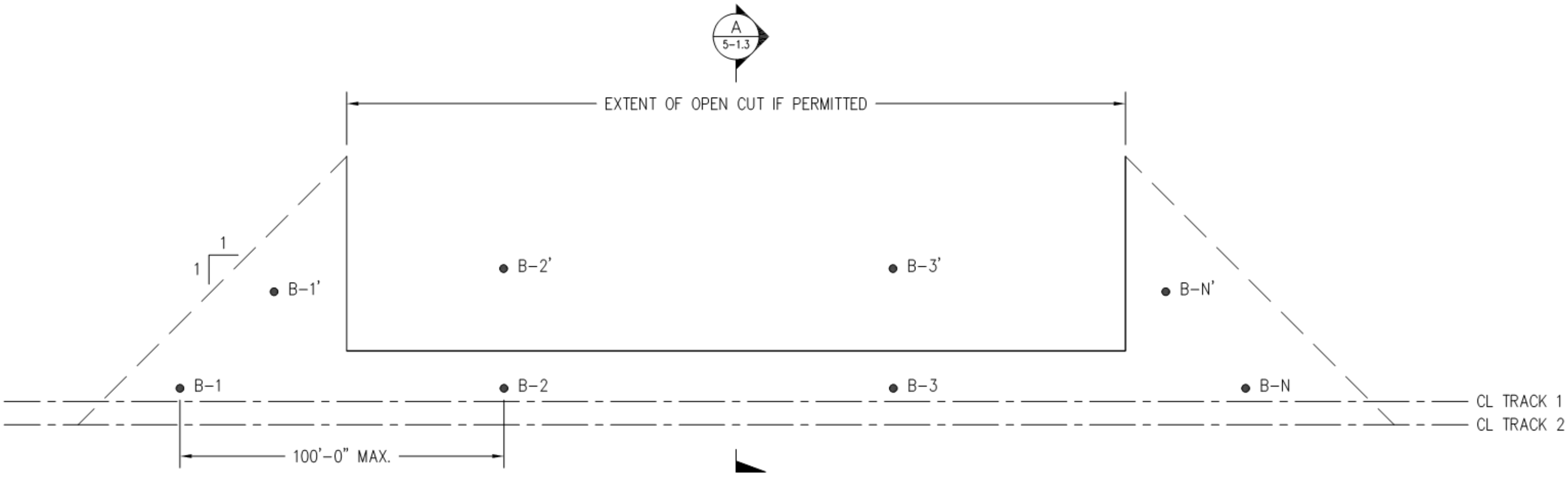

Figure 5 - 2: Typical Soil Boring Locations for Open Cut

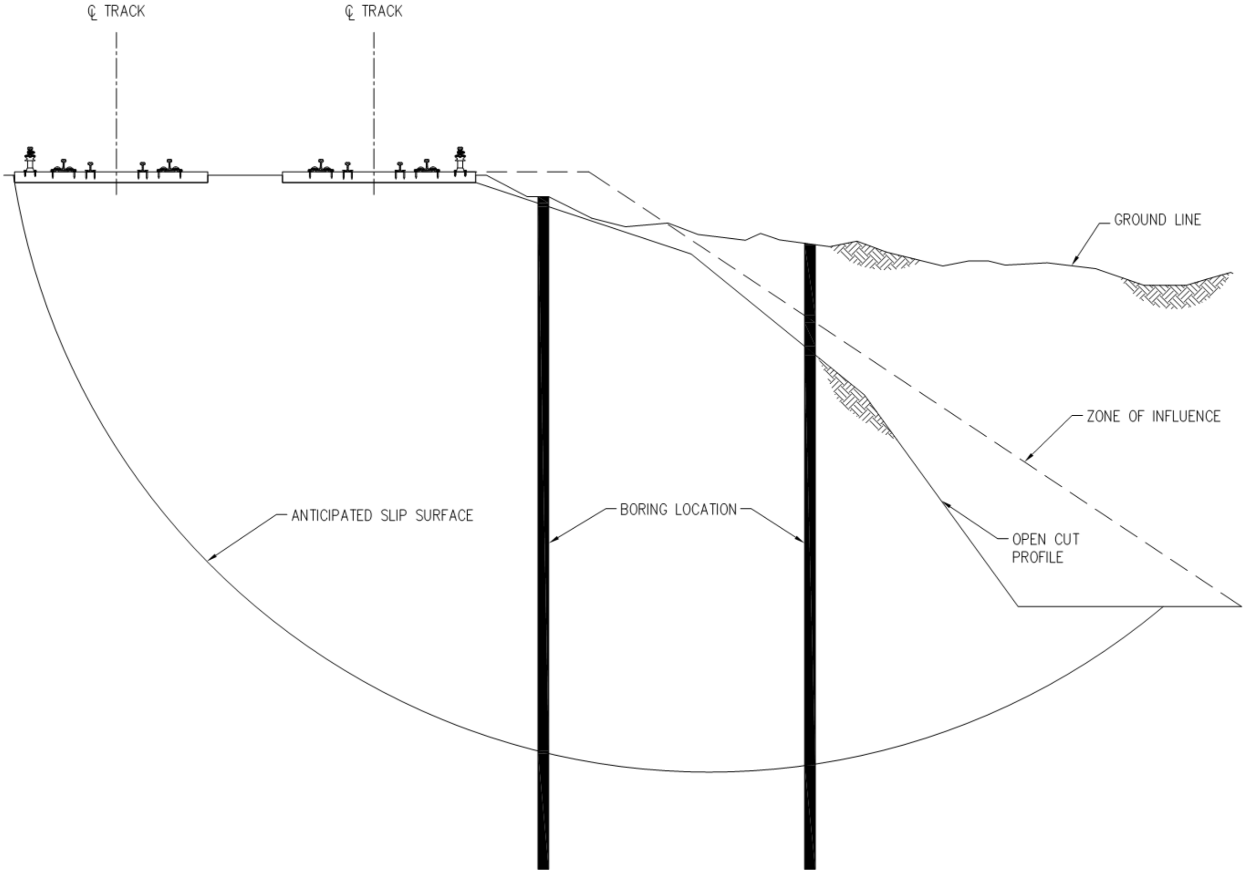

Figure 5 - 3: Section A for Open Cut

5.2.2 Loading from Retained Soil on Flexible Systems

The loading defined in this section applies to shoring systems that have some degree of flexibility. Shoring types that may be considered flexible include cantilever shoring walls and, in most cases, shoring walls supported by a single level of bracing. The active soil pressure distribution for a flexible shoring system shall be assumed to take the form of an equivalent fluid pressure (EFP); i.e., a triangularly shaped pressure distribution.

EFP values used for shoring design shall be ascertained by a Registered Geotechnical Engineer, or, alternatively, by a licensed Professional Engineer specializing in geotechnical engineering. In no case shall the design active EFP for soil above the groundwater table be less than 30 psf/ft for level retained earth when this approach is used (i.e., the active pressure at any depth shall not be less than 30(Y) psf where Y is a depth below the ground surface in feet)[9]. This minimum EFP value must be increased appropriately when the shoring system is retaining a sloped cut.

Alternatively, the retained soils may be classified as Type 3 in accordance with the soil descriptions in Table 8-5-1[10] of the AREMA Manual for Railway Engineering. Representative soil properties for Type 3 classification are given in Table 8-5-2[11] of the AREMA Manual for Railway Engineering.

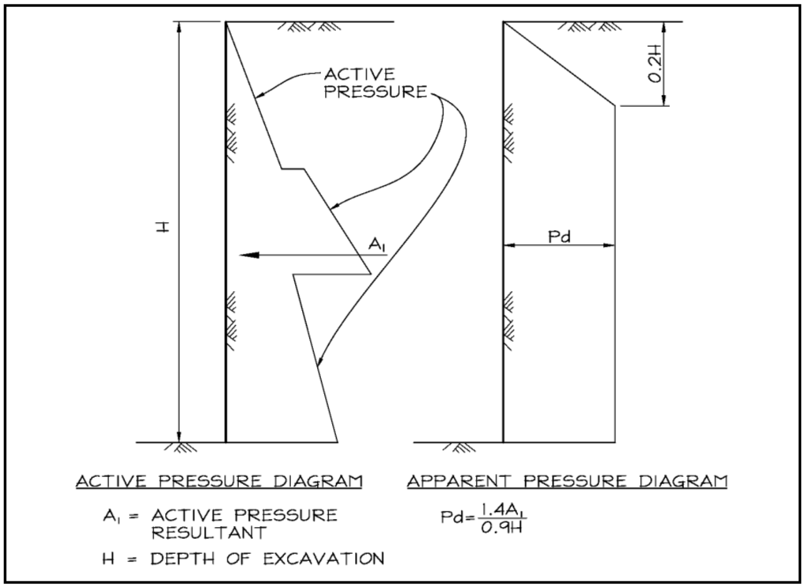

Figure 5 - 4: Construction of an Apparent Pressure Diagram

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[9] See Section 5 Commentary
[10] See Section 5 Commentary
[11] See Section 5 Commentary

5.2.3 Loading from Retained Soil on Restrained Systems

Shoring walls with multiple levels of bracing tend to restrict movements of the soil behind the wall. This restraint alters the soil pressure distribution from the anticipated pressures based on the theory of active loading. “Apparent pressure” diagrams for braced (restrained) shoring systems have been developed by numerous authors. Generalized apparent pressure diagrams suitable for use in both cohesionless and cohesive soils, as well as interlayered soil profiles, can be constructed from active pressure diagrams as shown in **Figure 5 - 4**.

Alternatively, a number of diagrams, applicable to either cohesionless or cohesive soils, or both, are presented in AREMA *Manual for Railway Engineering* Figure 8-28-2 (attached in Commentary Section for reference[12]), and in Chapter 7 of Caltrans *Trenching and Shoring Manual*[13]. These diagrams may be utilized, provided that the resulting loading magnitudes are not significantly less conservative than those determined by the procedure outlined in **Figure 5 - 4**.

When apparent pressure loading is utilized for design, active soil loading developed in accordance with Section 5.2.2 shall be assumed to act below excavation grade.

5.2.4 Passive Resistance

Cohesionless Soil[14]

The passive resistance in cohesionless ($c = 0$) soils should be determined by Rankine’s Theory. When there are underground utilities that prevent sufficient embedment depth with the passive resistance calculated with Rankine’s Theory, log-spiral theory may be used. Determination of the coefficient of passive pressure (K_p) using log-spiral theory is a function of soil friction angle (Φ) and wall interface friction angle (δ). Previous railroad design criteria have required that δ be assumed to be 0° due to dynamic train loading. However, this assumption can produce overly conservative results (with $\delta = 0°$, the calculated K_p with log-spiral theory is the same as using Rankine’s theory). In lieu of requiring $\delta = 0°$, at the shoring designer’s option, δ_{design} may be assumed to be a maximum of $\delta_{typ}/2$, where δ_{typ} is the wall friction value that would be utilized in the design of typical shoring away from railroad tracks. In no case shall δ exceed $\Phi/4$.

Coulomb’s Theory to determine the passive resistance shall not be used.

Cohesive Soil

In cohesive ($\Phi = 0°$) soil, $K_p = 1.0$, and the passive resistance is $\gamma_e z+2c$, where γ_e is the effective unit weight of the soil (i.e., the moist unit weight above the water level and the buoyant unit weight below the water level) and z is a depth below excavation grade.

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[12] See Section 5 Commentary

[13] “*Trenching and Shoring Manual*” by State of California, Department of Transportation, Issued by Offices of Structure Construction, Copyright © 2011 California Department of Transportation. All rights reserved.

[14] See Section 5 Commentary

Negative active pressures shall not be utilized to increase the available passive resistance under any circumstances. (Negative active pressures can be computed when 2c exceeds γ_eH, where H is the depth of excavation.)

Cohesive (c), and Granular (Φ) Soil

Passive pressure diagrams can be developed for c, Φ soils using more complex theoretical expressions. However, it is common to consider a soil stratum as either a purely cohesionless or cohesive soil depending on the soil's predominant physical properties and expected behavior.

Effect of Unbalanced Water Head

In cases where the shoring system will retain an unbalanced water head, available passive resistance may need to be reduced to account for upward seepage pressures.

5.2.5 Wall Rotation

When the actual estimated wall rotation is less than the value required to fully mobilize active or passive conditions, adjust the earth pressure coefficients by using the diagram on the upper right-hand corner of **Figure 5 - 5**.

5.3 GROUNDWATER LOAD

Groundwater loading acting on the shoring system shall be based upon the maximum groundwater level that can be reasonably anticipated during the life of the shored excavation.

The design groundwater table shall be established upon available historical ground water monitoring (well) data and/or boring data for the subject area. For projects where historical records are not available, the groundwater table utilized for design shall be assessed conservatively by choosing the higher elevation between the groundwater elevation when drilling (WD) and the groundwater elevation after boring (AB) plus five (5) feet. Alternatively, a groundwater monitoring well would need to be installed and collected for one year to document highest potential water elevation.

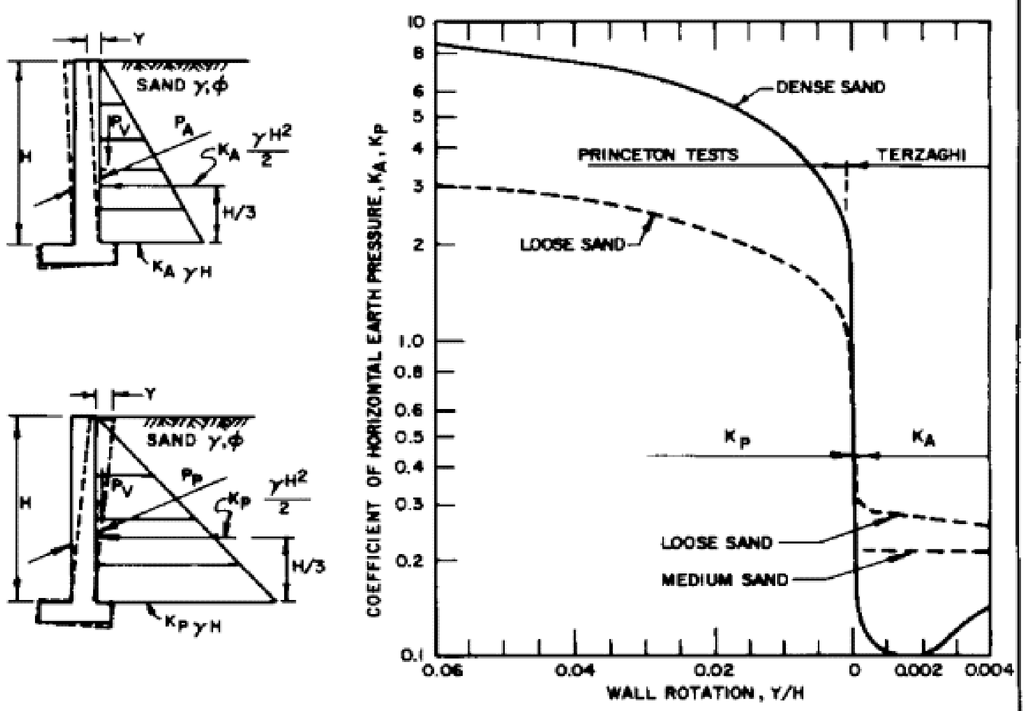
5.4 SURCHARGE LOADS

Lateral pressure acting on the temporary shoring system resulting from the following sources of surcharge loading shall be considered in the design of the shoring as appropriate:

- Rapid transit live load (see Section 6)
- Casing pipe for Jack-and-Bore construction shall be designed with an impact factor of 35% applied to the Rapid Transit live load surcharge specified in Section 6.1 if the height of soil cover is less than 10 feet.
- Track, ties, and ballast (where not included in soil loads)
- Equipment and vehicles
- Material stockpiles

- Existing structures
- Shoring tower
- Any other source of surcharge load
    - For Jack-and-Bore construction, the boring machine requires backplate or reaction piles to drive the casing. If the backplate or reaction piles are to be mounted on the ERS system, the pressure from the boring machine exerting on the ERS system shall be included in the design. The pressure used in the design shall be monitored during Jack-and-Bore construction.

Lateral pressure resulting from vertical surcharge loads shall be computed in accordance with the equations presented in Article 20.3.2 of the AREMA *Manual for Railway Engineering* Chapter 8 – Concrete Structures and Foundations.



MAGNITUDES OF WALL ROTATION TO REACH FAILURE

SOIL TYPE AND CONDITION	ROTATION Y/H*	
	ACTIVE	PASSIVE
DENSE COHESIONLESS	.0005	.002
LOOSE COHESIONLESS	.002	.006
STIFF COHESIVE	.01	.02
SOFT COHESIVE	.02	.04

* Y = HORIZONTAL DISPLACEMENT
H = HEIGHT OF THE WALL

Figure 5 - 5: Effect of Wall Movement on Wall Pressures

5.5 EARTHQUAKE (SEISMIC) LOAD

Special provisions for seismic design shall not apply.

5.6 COMBINATION OF LOADS AND LOADING CASES

All elements of the temporary shoring system shall be designed for a combination of lateral soil, groundwater, and surcharge loads acting in conjunction with vertical dead and live loads. Load combinations shall be per AREMA *Manual for Railway Engineering* Table 8-2-4 for Service Load Design, or Table 8-2-5 for Load Factor Design.

Loading conditions during all stages of excavation, support removal, and support relocation shall be analyzed. No reduction in loading from the present during the full depth excavation stage shall be assumed for the stages of support removal or relocation.

In situations where loading conditions on opposite sides of an internally braced excavation are not equal, the shoring design shall account for this unbalanced loading condition. The shoring system shall be designed for, and be compatible with, the more heavily loaded side of the excavation.

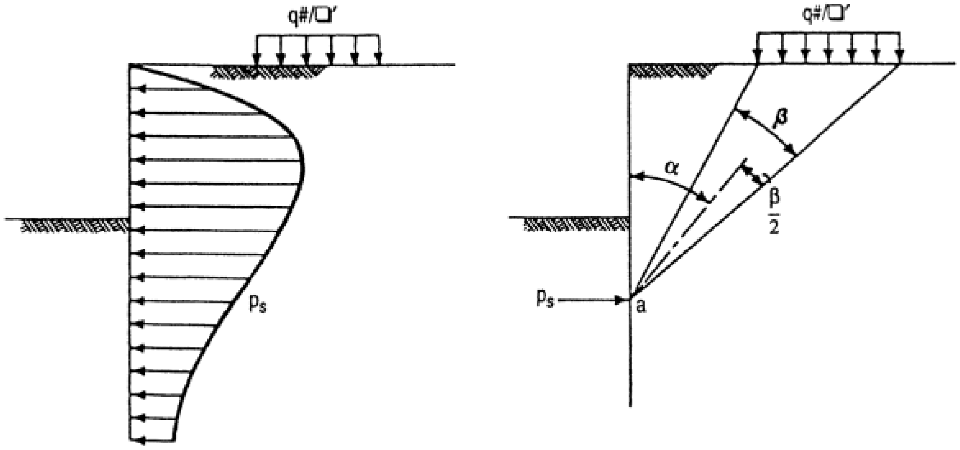
In situations where the top of shoring wall elevation on opposite sides of an internally braced excavation is not equal and the soil is re-graded, the shoring design shall account for the global stability.

SECTION 6 RAPID TRANSIT LIVE LOAD SURCHARGE

6.1 GENERAL

All temporary shoring systems supporting excavation within the Zone of Influence and sloped excavations beyond Zone of Influence (see Section 3.1) shall be designed for lateral pressure due to rapid transit live load surcharge unless otherwise approved by CTA under Section 3.3. Transit live load surcharge, specified below, shall be based on CTA Rapid Transit Axle Loads – Normal Service, unless otherwise directed by CTA to use the CTA Railbound Crane Axle Loads. In cases where CTA shares Right-of-Way with private railroad owners, the railroad live load surcharge shall be based on Cooper's E-80 live load, or as directed by the railroad owner. In no case shall the railroad live load surcharge used in the design be smaller than the CTA Rapid Transit live loads. No reduction in lateral surcharge pressure shall be allowed for "flexible" or "semi-rigid" wall behavior (i.e. 100% Boussinesq live load surcharge for "rigid" wall behavior is required for design of all shoring wall types).

Lateral surcharge pressure values for various depths below bottom of tie and distances to centerline of track computed using the Boussinesq equation are provided in **Figure 6 - 1** and are from AREMA *Manual for Railway Engineering* Chapter 8 – Concrete Structures and Foundations Part 20 Flexible Sheet Pile Bulkheads Article 20.3.2.2 Strip Load q.



$$p_s = \frac{2q}{\pi}(\beta + \sin\beta \sin^2\alpha - \sin\beta \cos^2\alpha)$$

Figure 6 - 1: Pressure Distribution for Strip Load

Where, strip load q for CTA Rapid Transit Axle Loads – Normal Service is[15]:

---

[15] See Section 6 Commentary

$$q_{normal} = 491psf$$

Strip load q for CTA Railbound Crane Axle Loads is[16]:

$$q_{crane} = 606psf$$

Strip load for Cooper's E-80 live load can be calculated as:

$$q_{E-80} = 80{,}000/(5 \cdot 9) = 1779psf$$

For stability check for old existing retaining walls supporting CTA tracks built prior to 1970, if the factor of safety for overturning and sliding cannot achieve the requirements as shown in SECTION 7, submit a Variance Request with the calculations showing factors of safety cannot achieve the requirements within this Manual for review and additional considerations as shown in the Commentary[17].

The values shown above were calculated by the dividing axle loads by the product of tie length (standard 9 ft tie) and shortest axle spacing (i.e. the strip load width shall be 9.0 feet). The values developed for the standard concrete tie length of 8.25 feet are not meaningfully different from those presented above. Note that the provided values apply only for situations where the top of shoring is at or above the elevation of the bottom of railroad ties.

The values shown above do not contain weight of track system and it shall be included in the design. The weights of different track types are shown below, there shall be no reduction in the retained soil for the volume of ties. Pressures can be obtained by dividing the values by the standard long 9 ft ties.

Tangent Track	460 lbs. / ft. / track
Curved Track without Restraining Rail	500 lbs. / ft. / track
Curved Track with Restraining Rail	570 lbs. / ft. / track

The following examples are located in Appendix C.

Example 6.1 Rapid Transit Live Load Surcharge from Two Tracks
Example 6.2 Rapid Transit Live Load Surcharge from Three Tracks
Example 6.3 "Simplified" Rapid Transit Live Load Surcharge from Four Tracks
Example 6.4 Construct the Actual Rapid Transit Surcharge Pressure

6.2 SURCHARGE FROM MULTIPLE TRACKS

Surcharge loading from multiple tracks shall be considered as follows:

- Two tracks – Full surcharge from both tracks.
- Three tracks – Full surcharge from two closest tracks combined with 50% surcharge from third track.

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[16] See Section 6 Commentary
[17] See Section 6 Commentary

- Four or tracks – Full surcharge from two closest tracks combined with 50% surcharge from third track and 25% surcharge from fourth track.

Only surcharge from those tracks for which the shored excavation is within the Zone of Influence need be considered.[18]

6.3 SIMPLIFIED SURCHARGE PRESSURE DISTRIBUTION

In lieu of using the detailed Boussinesq pressure distribution, railroad live load surcharge pressures may be simplified to have a rectangular distribution with a magnitude equal to 80% of the maximum Boussinesq pressure as simplified surcharge pressure distribution. The simplified surcharge pressure distribution is permitted in braced condition in all Zones and cantilevered condition in Zone 4. Further, the simplified surcharge pressure distribution will be permitted in the cantilevered condition for sheet piling in Zone 2, and the cantilevered condition for soldier piles (and sheet piling) in Zone 3 provided the maximum cantilevered height limits are satisfied. For multiple level braced shoring wall, before the second level of bracing can be installed, this condition may be the critical condition for the design. The Designer in Responsible Charge shall evaluate if simplified surcharge pressure can be used to calculate the stage 1 bracing reaction. In no cases shall the simplified surcharge pressure distribution result in lower demands in any structural elements in a shoring wall system.

6.4 APPLICATION OF SURCHARGE PRESSURE

Railroad live load surcharge pressures shall be assumed to act over the full height of the temporary shoring wall. Where the top of the shoring wall is at or above the bottom of railroad tie elevation, the vertical surcharge pressure (q) used in the Boussinesq distribution shall be the pressure under the ties and shall be applied starting at the bottom of crosstie elevation. Where the top of the shoring wall is below the bottom of railroad tie elevation, the vertical surcharge pressure used in the Boussinesq distribution shall be an equivalent pressure at the top of the shoring wall. The equivalent vertical surcharge pressure shall be distributed over a length equal to the tie length plus the vertical distance from bottom of tie to top of wall (1H:2V distribution outward from each end of the tie). The magnitude of the equivalent vertical surcharge (q) will be equal to the pressure under the tie multiplied by the ratio of the tie length to the equivalent distributed length.

6.5 SURCHARGE FOR PERPENDICULAR SHORING WALLS IN ZONE 1

Temporary shoring walls proposed to be installed perpendicular to and across tracks (or used as temporary bridge abutments) will not be allowed, unless otherwise specially permitted by CTA. If special permission is granted by CTA, the design railroad live load surcharge acting on such walls shall be computed in accordance with Chapter 8, Article 5.3.1 of the AREMA *Manual for Railway Engineering*.

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[18] See Section 6 Commentary

6.6 COMBINATION WITH SURCHARGE FROM OTHER SOURCES

Surcharge from other sources (e.g., heavy equipment, existing structures, etc.) shall be considered in the design of temporary shoring systems for excavation support as appropriate. Surcharges from other sources shall be added to the railroad live load surcharge if the surcharge loads can act concurrently. An example of combined surcharges may be Contractor cranes, trucks, or material stockpiles above an excavation concurrent with a passing train. The minimum construction surcharge shall be 240 psf unless a heavier equipment is anticipated.

SECTION 7 SHORING ANALYSIS METHODOLOGIES

Classic shoring analysis methodologies are summarized in Section 7 and should be considered minimum analysis requirements for temporary shoring design. Computer programs and more advanced soil-structure interaction analyses may be utilized for design, but shall be accompanied by verified hand calculations showing significant agreement with the classic methodologies presented herein. The Engineer in Responsible Charge shall be solely responsible for input and results of computer programs utilized for shoring analysis and design. See Section 2.4 for additional information on submittal of computer program output as part of the design calculations.

Typical temporary shoring applications may not require stability analysis beyond determining the minimum embedment. The factor of safety against sliding, overturning and global slope stability shall be calculated as applicable to the particular temporary shoring system. The minimum factor of safety for stability, including sliding, overturning and global slope stability, shall be 1.5. No reduction for factor of safety is allowed for temporary condition. See Section 9.4 for global stability analysis requirements.

The following example is provided in Appendix C:

Example 7.1 Cantilever Soldier Pile and Lagging Shoring Wall

The following examples will be provided in future revisions:

Example 7.2	Sheet Pile Shoring Wall, One Level of Bracing (Free Earth Support Method)
Example 7.3	Sheet Pile Shoring Wall, One Level of Bracing (Fixed Earth Support Method)
Example 7.4	Analysis of a Diaphragm Shoring Wall with Three Levels of Bracing

7.1 CONTINUOUS SHORING WALLS

Continuous shoring walls, such as steel sheet piling and diaphragm walls, are typically analyzed on a longitudinal per-foot-of-wall (unit) basis for the lateral pressures computed in accordance with Sections 5 and Section 6 of this Manual. The wall is designed for the unit bending moments and shears resulting from the lateral pressures acting on the wall. When the shoring wall is designed to support vertical loads, these loads must be considered in the design as well.

In the case of sheet piling, the structural strength of the wall is provided by sheets themselves. Wide flange sections installed in deep soil mix, secant, tangent, or slurry walls are the primary structural elements for these systems. Rebar reinforced slurry walls are designed as a continuous vertically reinforced concrete wall.

7.2 SOLDIER PILE SHORING WALLS

Soldier pile and lagging walls are analyzed in a somewhat different manner than continuous shoring walls. Soldier pile and lagging walls are not continuous below excavation grade, and the loading acting on the active and passive sides of the wall for the embedded portion of the wall must be constructed to reflect the discontinuous nature of the wall. The “effective width” of the embedded portion of the soldier pile (for both active and passive loading)[19] shall follow the requirements per AREMA *Manual for Railway Engineering* Chapter 8 Part 28 Article 28.5.3.2 where it requires the equivalent width shall be assumed to equal the width of the soldier pile multiplied by a factor of 3 for granular soils and a factor of 2 for cohesive soils. The width of the soldier piles shall be taken as the width of the flange or diameter for driven sections and the diameter of the concrete-filled hole for sections encased in concrete. When determining the passive pressure distribution on the soldier piles, a depth of 1.5 times the width of the soldier pile in soil shall not be considered in providing passive lateral support. As with continuous walls, lateral pressures utilized to construct the loading diagrams shall be computed in accordance with Sections 5 and Section 6 of this Manual.

Soldier piles are designed as vertical beams to resist the bending moments and shears resulting from the lateral loads acting on the piles. Vertical loading (if any) shall be considered in the soldier pile design.

7.3 ANALYSIS OF CANTILEVER WALLS

Cantilever shoring walls shall be designed using the “Conventional Methods” of analysis. A schematic figure showing the resulting active and passive pressures is provided in Figure 8-28-1 in AREMA *Manual for Railway Engineering* for cohesionless soil, as shown below. The rotation of the length of vertical wall element shall be considered as the soil will be mobilized below the point of rotation on the retained soil side of the ERS wall (i.e., Pp2 as passive pressure, Pa2 as active pressure.)

Alternatively, cantilever walls may be designed using the “simplified” method where the rotation of the length of vertical wall element is ignored (i.e., Pp2 and Pa2 are ignored). If this method is used, the computed embedment depth (referred to as “D – Z” in the above referenced Figure 8-28-1) shall be increased by 20 percent to determine the minimum theoretical embedment depth.[20]

A factor of safety for the cantilever wall embedment shall be provided. When the theoretical embedment depth is computed based on the “unreduced” passive resistance (factor of safety equals to 1.0), this theoretical embedment depth shall be increased by a minimum of 40% to determine the design embedment depth (i.e. minimum factor of safety on theoretical embedment depth of 1.4)[21]. This 40% increase is provided in addition to the 20% increase required if the “simplified” method of analysis has been utilized.

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[19] See Section 7 Commentary
[20] See Section 7 Commentary
[21] See Section 7 Commentary

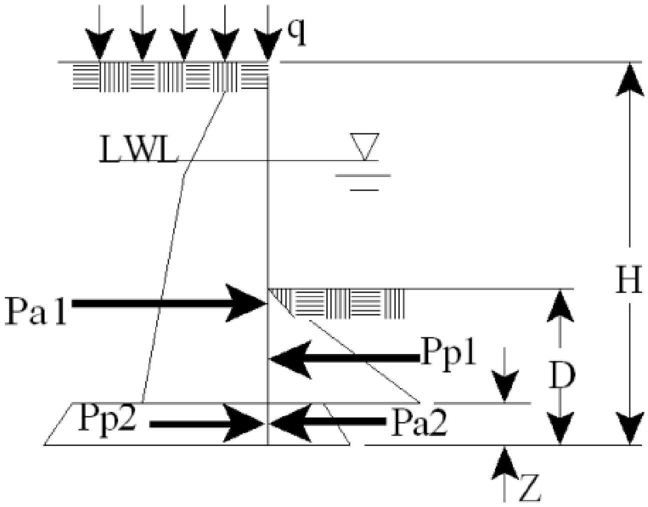

Figure 8-28-1. Lateral Earth Pressure - Granular Soil

Embedment depths computed based on passive resistance that has been reduced by a factor of safety of 2 will also be acceptable, provided that the resulting embedment depth is not significantly less than that computed using the nominal 40% increase in embedment depth discussed above.

Analysis utilizing "unreduced" passive resistance should be applied with caution when the shoring wall is embedded in stiff to hard clays, because the computed embedment may be unrealistically short. See Section 7.8.1 for minimum embedment depths.[22]

7.4 ANALYSIS OF WALLS WITH A SINGLE LEVEL OF BRACING

Walls supported by a single level of bracing may be analyzed using the Free Earth Support or Fixed Earth Support Method at the shoring designer's option. Each of these methods is outlined below.

7.4.1 Free Earth Support Method

This method is based on the assumption that the shoring wall is embedded far enough to assure stability, but that the available passive resistance is incapable of restraining the shoring wall sufficiently to induce negative moment in the wall (i.e., there is no reversal of moment below excavation subgrade). The theoretical embedment required for stability is determined by statics. The theoretical depth of embedment required is determined by summing moments due to all pressures acting on the shoring wall about the bracing level. The embedment depth is adjusted until the sum of the moments about the bracing level is zero. Moments and shears in the shoring wall and the bracing reaction may be computed after the embedment depth is determined.

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[22] See Section 7 Commentary

7.4.2 Fixed Earth Support Method

This method is based on the assumption that the shoring wall is embedded sufficiently to provide effective “fixity” at the bottom of the shoring wall (i.e., the deflected shape of the shoring wall is such that the wall reverses curvature over its embedded length and becomes vertical at its bottom). Unlike the Free Earth Support Method, moment reversal takes place over the embedded portion of the shoring wall. In comparison to the Free Earth Support Method, the embedment computed using the Fixed Earth Support Method would be longer; however, pile moment demand, pile deflection, and the bracing reaction will typically be reduced.

Hand calculating the required embedment depth for the Fixed Earth Support Method is not a trivial matter. However, through the use of commonly available structural analysis software, determining the depth of embedment required to produce the appropriate deflected shape of the shoring wall (i.e., effective fixity) is just a matter of iterating the depth of embedment. As for the Free Earth Support Method, moments and shears in the pile, and the bracing reaction may be computed after the theoretical embedment depth is determined.

7.4.3 Factor of Safety for Shoring Wall Embedment Depth

A factor of safety for the shoring wall embedment depth must be provided when either the Free Earth Support Method or Fixed Earth Support Method is used. The requirement shall be the same as outlined in Section 7.3.

In Appendix C, Example 6.2 illustrates the Free Earth Support Method and Example 6.3 illustrates the Fixed Earth Support Method for the same excavation geometry in the same soil conditions for comparison purposes. (Examples will be provided in the future revision).

7.5 ANALYSIS OF WALLS WITH MULTIPLE LEVELS OF BRACING

7.5.1 Embedment Depth

The required depth of penetration for a shoring wall supported by two or more levels of bracing shall be determined by one of the following methods (See Section 7.8.1 for minimum embedment depths.):

1. The theoretical embedment may be calculated by balancing moments due to all soil, hydrostatic, lateral surcharge, and “unreduced” passive pressures (factor of safety equal to 1.0) acting below the lowest bracing level about the lowest bracing level. The moment capacity of the shoring wall shall be conservatively neglected in this analysis. The depth of penetration is adjusted until the sum of the moments equals zero. The computed theoretical embedment depth shall be increased by a minimum of 50% to determine the design embedment depth. (This method should be used with caution when stiff to hard clays provide passive resistance, because the computed embedment depth may be unrealistically short.)

2. The embedment depth may be computed by summing moments as noted above, using passive resistance values that have been reduced by dividing them by a factor of safety of 2.0. No increase in embedment is required when this method is used. This method will be acceptable provided that the resulting embedment depth is not significantly less than that computed using the nominal 50% increase in embedment depth discussed above.

7.5.2 Analysis of Shoring Wall

Moments and shears in the shoring wall shall be computed using beam analysis, assuming that the shoring wall is hinged at all bracing levels except the uppermost.[23] Analysis of the portion of the shoring wall below the lowest bracing level shall be based on statics, including a consideration of all loads acting on the embedded portion of the shoring wall. A fictitious support at or below subgrade shall not be assumed for analysis purposes.

No redistribution of loads or reduction in the demand on the shoring wall due to soil arching shall be assumed.

7.5.3 Determination of Bracing Loads

Bracing loads shall be determined by beam analysis assuming that the shoring wall is hinged at all the bracing levels except the uppermost.

The load on the lowest bracing level shall be determined by statics, including a consideration of all loads acting on the embedded portion of the shoring wall. A fictitious support at or below subgrade shall not be assumed for analysis purposes.

7.6 ANALYSIS BRACING SYSTEMS

Unit (per foot) reactions at each bracing level are determined during the analysis of the shoring wall. For shoring walls with soldier piles (e.g., soldier pile and lagging walls, deep soil mix walls, and secant walls) point loads from each pile are computed by multiplying the pile spacing by the unit bracing reactions. Bracing loads for sheet piling may be assumed as a horizontal uniform load equal to the unit reactions.

Internal (cross-lot) bracing systems consisting of wales and struts shall be designed to resist the computed bracing loads. Moments, shears, and axial loads in the bracing members shall be computed using standard methods of structural analysis.

Tieback is a prohibited shoring type per Section 4.3. However, when permitted to use, tieback or deadman systems that are used to restrain the shoring walls shall be designed to resist the computed bracing loads.

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[23] See Section 7 Commentary

No redistribution of loads or reduction in the demand on bracing elements due to soil arching shall be assumed.

7.7 LAGGING ANALYSIS

Lagging may be designed for a load equal to two third of the shoring design load (soil and surcharge pressures) to account for soil arching when arching action can form in the soil behind the lagging (e.g., in granular or stiff cohesive soils where there is sufficient space to permit the in-place soil to arch and the back side of the soldier piles bear directly against the soil). The lagging members shall be designed as horizontal beams spanning between soldier piles.

In cases where soil arching cannot develop, reduced lagging loads shall not be considered.

Tabulated lagging thicknesses (such as FHWA *Lateral Support Systems and Underpinning RD 75-128* Table 4 – Recommended Thicknesses of Wood Lagging) shall not be utilized.

7.8 GENERAL SHORING REQUIREMENTS

7.8.1 Minimum Embedment Depth

Computed embedment depths shall be compared with the following minimum values. In cases where the computed embedment depth is less than that specified below, the minimum embedment depth specified below shall be utilized:

- Cantilever walls: Embedment depth shall not be less than the height of the retained cut.[22]
- Braced walls less than 20 feet high: Embedment depth shall not be less than 6 feet.[24]
- Braced walls 20 feet high or more: Embedment depth shall not be less than 8 feet.[24]

7.8.2 Secondary Bracing

Primary elements of the shoring system shall be provided with secondary bracing as required for stability. The secondary bracing elements shall be designed for an axial load equal to 2.5% of the axial load in the braced member.[25]

7.8.3 Connections

Connections between the various elements of the shoring system shall be designed for tension and shear loads equal to at least 10% of the design compression load transferred through the connection. If the actual shear or tension at a connection is larger than this 10% value, then the actual shear or tension load shall be utilized for design.

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[20] See Section 7 Commentary
[24] See Section 7 Commentary
[25] See Section 7 Commentary

The connection from a strut to a soldier pile or waler shall not be a single gusset/knife plate.[2]

7.8.4 Stiffeners

Stiffeners shall be provided at shoring member connections per AREMA *Manual for Railway Engineering* Chapter 15 Article 1.7.7 – Stiffeners at Points of Bearing. Stiffener thickness shall not be less than 3/8".

7.8.5 Splices

Splice of steel members shall have a strength not less than the capacity of the member being spliced.

7.8.6 Welding

All field welding on the earth retention structures within the Zone of Influence shall comply with AWS D1.1, unless otherwise noted for any shoring structures directly supporting CTA track structures and CTA train loadings, which AREMA and AWS D1.5 shall be used, especially those members in tension designated as Fracture Critical Members. Welder's Qualification and Certificates, and all Welding Procedure Specifications for the welds used in the field for the temporary structures mentioned above, shall be submitted, and included in the Construction Process Plan for review and record.

7.9 SHORING DEFLECTION AND SETTLEMENT

All shoring designs within the Zone of Influence shall include an estimate of shoring deflection and retained earth settlement. Maximum permissible deflection shall enable the horizontal and vertical movement of the track to be limited to the requirements of Section 10.2. The amount of settlement that occurs will depend upon the soil type, the size of the excavation, the construction methods and quality of workmanship, and the design of the shoring system (including the stiffness of the shoring wall and bracing systems).

Elastic analyses of the shoring system should be performed for the various stages of support installation and removal in order to estimate lateral shoring deflection, which should then be used to make settlement estimates. It is important to understand that the shoring system deflections in different stages are additive (i.e., stage 1 deflection can be added to stage 2 deflections to estimate the overall final deflection, and waler deflection at the mid span can also contribute to the deflection of the overall system and affect the settlement.)[26]

Unless structural analysis show a greater elastic deflection of the shoring wall will not cause excessive ground settlement, the following shoring wall deflection limit shall be used for design:

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[2] See Section 1 Commentary
[26] See Section 7 Commentary

1. For shoring wall in Zone 2 and Zone 3 of **Figure 3 - 1**, maximum deflection at top of the shoring wall shall be 1/4".

2. For shoring wall in Zone 4:

    a. Horizontal distance from shoring wall to center line of track measured at a right angle from track is greater than 12’ but smaller than 18’, maximum deflection at top of shoring wall shall be 3/8”.[27]
    b. Horizontal distance from shoring wall to center line of track measured at a right angle from track is greater than 18’, maximum deflection at top of shoring wall shall be 1/2”.[27]

When excavation is in soft to medium clays, bottom heave must be considered per Section 9.3.2. In addition to the shoring wall elastic deflection calculation, lateral wall movement shall also be determined using **Figure 7 - 1** as a comparison and the greater deflection shall be used for the ground settlement analysis.

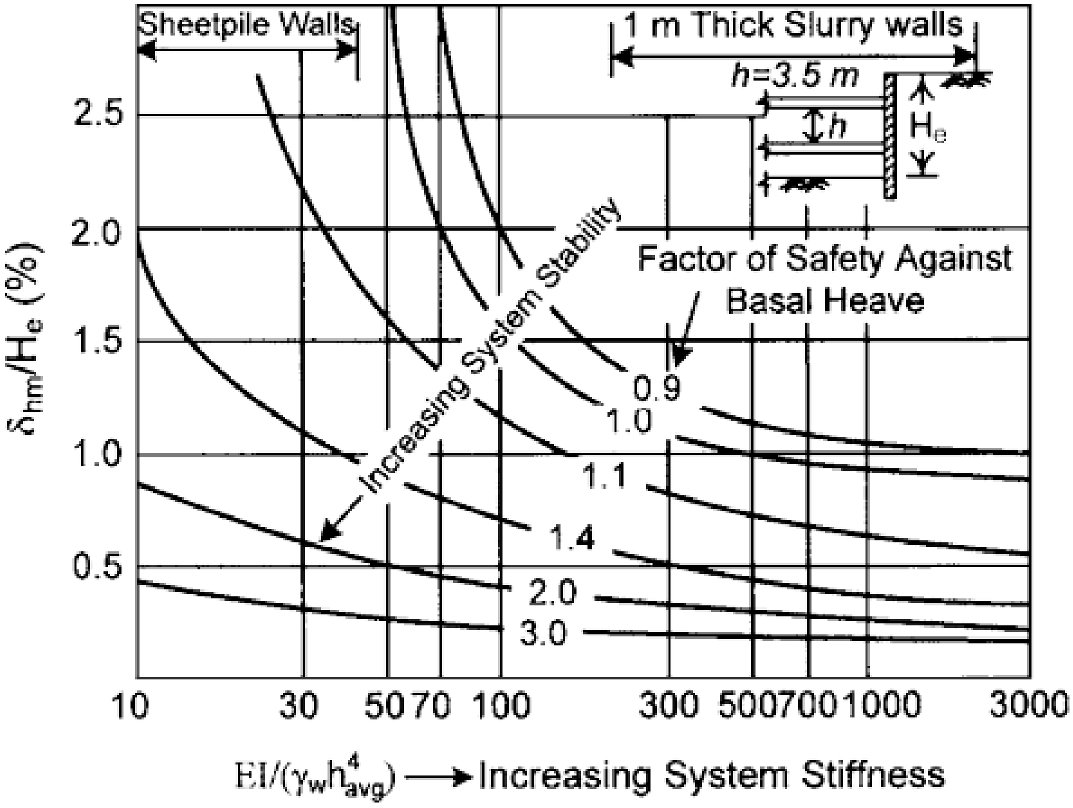

Figure 7 - 1: Design Curves for Maximum Lateral Wall Movement for Excavations in Soft to Medium Clays (Clough and O’Rourke 1990)

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[27] See Section 7 Commentary

SECTION 8 MATERIAL PROPERTIES AND ALLOWABLE STRESSES

The following examples are provided in Appendix C:

Example 8.1 Wide Flange Waler Design
Example 8.2 Pipe Strut Design
Example 8.3 Shoring Wall Design
Example 8.4 Wood Lagging Design

8.1 STEEL

Steel may be used material, provided that is free from any strength impairing defects or contain permanent deformations.

8.1.1 Structural Steel

Allowable stresses for steel shall conform to the AREMA *Manual for Railway Engineering* Table 15-1-11, latest edition, with the following additional constraints for struts or any members stressed primarily in axial compression:

- Axial stress shall not exceed 12 ksi.[28]
- Round HSS members will be allowed even though they are not included in the AREMA *Manual for Railway Engineering.* Round HSS members used as struts shall be designed per AREMA and AISC as shown in Example 8.2 in Appendix C.

Structural steel design, including bolted and welded connections design shall conform to the AREMA *Manual for Railway Engineering* Chapter 15 Steel Structures Part 1 Design, except for the provisions for fatigue requirements.

No overstress shall be permitted.

Structural steel for which mill certificates are not available (unidentified steel) shall be designed for allowable stresses no greater than those allowed for ASTM A36 steel.

The design wall thickness shall be taken to 0.93 times the nominal wall thickness for ASTM A500 shapes, regardless the welding process.

Preferred Material Specification – American Society for Testing and Materials (ASTM)

- ASTM A6 “Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling”

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[28] See Section 8 Commentary

- ASTM A36 “Standard Specification for Carbon Structural Steel” for all shapes other than W and HP
- ASTM A572 “Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel” Grade 50 for HP shape
- ASTM A992 “Standard Specification for Structural Steel Shapes” for W shape used as structural components for earth retention system (i.e., soldier piles, walers, struts)
- ASTM A709 “Standard Specification for Structural Steel for Bridges” for W shape used as structural components for elevated track supporting temporary shoring structures as governed by Section 11.4
- ASTM A500 “Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes” Grade B for HSS shapes
- ASTM A252 “Standard Specification for Welded and Seamless Steel Pipe Plies” Grade 2 or better for HSS shapes.
    - If the casing is to be welded for splicing, the carbon equivalency (CE) as defined in AWS D1.1, Section XI 5.1, shall not exceed 0.45, and the sulfur content shall not exceed 0.05 percent.
    - The design wall thickness shall be taken to 0.93 times the nominal wall thickness for ASTM A252, regardless the welding process.

8.1.2 Steel Sheet Piling

The maximum allowable flexural stress in sheet piling shall not exceed 65% of the yield strength of the steel and overstress shall not be permitted.[29]

Hot-rolled sheet piling is preferred than cold-rolled sheet piling. If cold-rolled sheet piling is used for the shoring wall, the section property shall be reduced by 10% for design.[30] (Refer to Example 8.3)

Preferred Material Specification – American Society for Testing and Materials (ASTM)

- ASTM A328 “Standard Specification for Steel Sheet Piling” Grade 50 or ASTM A572 Grade 50 for hot rolled steel sheet piling
- ASTM A572 Grade 50 for cold-rolled sheet piling

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[29] See Section 8 Commentary
[30] See Section 8 Commentary

8.1.3 Prestressed Strand or Rod

If prestressed strands or rod are used as tieback tendons (special CTA approval required, refer to Section 4.3) or as tie rods to a deadman, the allowable working stress shall not exceed 40% of the guaranteed ultimate tensile strength. All tiebacks shall be load tested, refer to Section 9.5 for tie back testing requirements.

If the strands or rod are used for purposes other than those specified above, the allowable working stress shall not exceed 60% of guaranteed ultimate tensile strength.

The shoring designer shall evaluate the potential effects of corrosion on strands and rods and take necessary cross section reduction in design, and provide corrosion protection suitable for the installation environment and anticipated service life.

Preferred Material Specification – American Society for Testing and Materials (ASTM)

- ASTM A416 “Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete”
- ASTM A722 “Standard Specification for High-Strength Steel Bars for Prestressed Concrete”

8.1.4 Wire Rope Cable and Chain

Wire rope cables and chains shall not be used.[31]

8.1.5 Casing Pipe

For Jack and bore carrier pipe carrying flammable material and other hazardous material, casing pipe and joints shall be of metal and of leakproof construction.

The minimum yield strength for steel pipe will be 35 ksi. Smooth wall pipes with a nominal diameter greater than 70 inches require special approval by the CTA. See Appendix D for Table of Minimal Wall Thickness for Steel Casing Pipe.

Preferred Material Specification – American Society for Testing and Materials (ASTM)

- ASTM A252 “Standard Specification for Welded and Seamless Steel Pipe Piles” Grade 2 or better

8.1.6 Micropile Casing Pipe[32]

Micropile casing pipe shall have physical properties conform to one of the following:

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[31] See Section 8 Commentary
[32] See Section 8 Commentary

Preferred Material Specification:

- API 5CT Grade N80 or better. Casings shall not be spliced with welded joints.

8.2 CONCRETE[33]

Reinforced and plain (unreinforced) concrete shall be designed using the Service Load Design in accordance with AREMA *Manual for Railway Engineering* Chapter 8 Part 2 Article 2.25 through Article 2.29. Service Load Design load combinations shall be used in Table 8-2-4 in AREMA *Manual for Railway Engineering.*

Load Factor Design in accordance AREMA *Manual for Railway Engineering* Chapter 8 Part 2 Article 2.30 through Article 2.39 is also accepted provided all applicable loads are factored per Table 8-2-5 in AREMA *Manual for Railway Engineering.*

No stress increases or load factor reductions shall be allowed.

8.2.1 Non-Shrink Grout

A mixture of Portland Cement, admixture, and water. Grout must have a 28-day strength of 5,000 psi when tested in accordance with ASTM C109. The grout must consist of a neat cement or sand cement mixture of Type II, III or V Portland cement conforming to Section 1020 of the IDOT Standard Specifications.

8.3 WOOD

All wood shoring elements shall be Douglas Fir, No. 2 or better if below allowable stresses are used. Other species and grades are also acceptable. The allowable stresses shall be determined based on NDS.

All wood that will remain in place permanently, if permitted by CTA, shall be pressure treated for ground contact use in accordance with AWPA U1, User Category UC4B or UC4C.

Allowable stresses shall be as follows:

Compression perpendicular to the grain = 450 psi

Compression parallel to the grain = $480{,}000(L/d)^2 \leq 1600$ psi, where,

L = unbraced length of member
D = lesser cross-sectional dimension of member
(L and d to have consistent units)

Flexural stress = 1700 psi

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[33] See Section 8 Commentary

(reduced to 1500 psi for members with a nominal depth of 8 inches or less)

Horizontal shear = 140 psi

8.4 OTHER MATERIALS

Allowable stresses for materials other than listed in this manual will be reviewed by CTA Engineering on a case-by-case basis. Typically, industry-accepted allowable stresses or load factors (with no overstress allowances) may be acceptable.

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SECTION 9 SPECIAL CONDITIONS

9.1 SEALED SHORING

Under certain conditions, excavation below the groundwater table will require that a sealed shoring system be utilized. Examples of situations where sealed shoring is needed include, but are not limited to:

- Excavations in permeable soils where dewatering is infeasible or where the quantity of water to be handled and disposed of would be excessive.
- Locations where the groundwater is contaminated.
- Locations where dewatering would result in unacceptable settlement of the surrounding area.

Relatively watertight shoring is most commonly provided using interlocked sheet piling or diaphragm walls.

Where possible, groundwater flow around the bottom of the shoring wall should be prevented by extending the wall into an underlying low permeability soil layer (such as a clay layer). If a low permeability cut off layer is not present, or if it is at such a great depth that penetrating it is not feasible or cost effective, a tremie concrete or grouted seal slab should be considered for the base of the excavation.

In cases where a positive bottom seal is not provided, the potential for piping must be evaluated. See Section 9.3.

9.2 DEWATERING

Dewatering can be an effective means of reducing shoring loading and improving shoring stability and constructability. In some cases, it may also be required to allow construction of proposed project elements.

In cases where dewatering is not precluded by other factors (see Section 9.1), CTA will consider allowing dewatering, provided that it won’t cause problematic settlement to tracks or other infrastructures. Pumps of sufficient capacity shall be provided and maintained at the site, and continually attended on a twenty-four (24)-hour basis, until in the sole judgement of CTA, their operation can be safely halted. The potential for problematic track settlement to occur will be a function of the site soil profile and the depth to which the site needs to be dewatered. Track settlement in excess of that specified in Section 10.1 may be acceptable if it can be shown that differential settlements resulting from dewatering will be minimal (i.e., settlements will occur over a broad area). Engineering calculations demonstrating that excessive differential settlement will not occur will be required.

When dewatering, close observation per accepted monitoring plan shall be maintained to detect any settlement or displacement of transit embankment, tracks, and facilities. Proposed methods of dewatering must be submitted to the CTA for approval prior to implementation. The discharge from the dewatering operations in the Basic Safety Envelope shall be carefully monitored. The discharge from the dewatering operations in the vicinity of the CTA Zone of Influence shall be carefully monitored. If in the opinion of the CTA, there is an excessive loss of fine soil particles at any time during the dewatering process, the dewatering will be halted immediately. The dewatering operation cannot resume until the unsatisfactory condition is remedied to the satisfaction of the CTA.

In cases where the performance of the temporary shoring system depends upon the functionality of the dewatering system, the dewatering system shall be fail-safe. Elements such as an uninterrupted power supply, back-up pumps, and failure alarm signals will be required to guarantee that the dewatering system will never shut down for a period of time that could compromise the stability of the shored excavation.

Dewatering system design shall be performed by a Professional Engineer registered in the State of Illinois with previous experience in the design of the specific type of dewatering system being proposed. Removed water shall not be drained along the tracks, but shall be drained off the Right-of-Way in accordance with environmental restrictions. Unless otherwise specified by the Professional Engineer, dewatering shall be limited to a total of approximately 900 gallons.

9.3 BOTTOM STABILITY

9.3.1 Piping

For excavations in pervious materials, the possibility of piping must be evaluated. Piping occurs when an unbalanced hydrostatic head causes large upward seepage pressures in the soil at and below the bottom of the excavation. The upward seepage pressure reduces the effective weight of the soil below the bottom of the excavation. As a result, the ability of the soil to laterally support the embedded portion of the shoring wall (i.e., passive resistance) is reduced. In the extreme, a quick condition can develop at the bottom of the excavation and large quantities of soil can be transported rapidly from outside to inside the excavation, thereby causing large ground settlements, and possibly even shoring system collapse.

Piping can be controlled by dewatering outside the shoring walls (where allowed) or by making the shoring walls deeper in order to reduce the upward hydraulic gradient. Alternatively, a tremie or grouted slab can be used as a bottom seal.

The potential for piping may be evaluated using published procedures[34]. The minimum acceptable factor of safety against piping shall be 1.5. Additionally, a reduction in the available passive resistance due to upward seepage pressures shall be taken as appropriate.

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[34] See Section 9 Commentary

9.3.2 Bottom Heave

In cases where excavations are made in soft (and sometimes medium) clays the potential for bottom heave must be evaluated. Bottom heave occurs when the depth of excavation is sufficient to cause upward movement of material in the bottom of the excavation and corresponding downward displacement of material surrounding the excavation. Heave can result in excessive settlement of the ground retained by the shoring system, and distress or failure of the shoring.

The possibility for heave should be evaluated further in cases when the Stability Number (N_o) exceeds 4, where:

$N_o = (\gamma H+q)/c$, and
γ = unit weight of soil
H = depth of excavation
q = vertical surcharge pressure
c = cohesive strength of soil

When N_o exceeds 4, the factor of safety against bottom heave should be computed using procedures outlined in the Caltrans "*Trenching and Shoring Manual*". The minimum acceptable factor of safety against bottom heave shall be 1.5. A factor of safety of 2 and greater is preferred since bottom heave also contributes to the lateral wall movement. Refer to Section 7.9 for lateral wall movement for excavations in soft to medium clays.

9.4 GLOBAL STABILITY

Typical shoring applications may not require global slope stability analysis. The Engineer in Responsible Charge shall determine if global stability calculations are warranted. However, CTA Engineering reserves the right to require global stability calculations at their sole discretion. As an example, when ERS is proposed outside the Zone of Influence in **Figure 3 - 1** with existing building demolished, global stability can be affected when the soil is soft or medium clay.[35]

If applicable and/or required by CTA, temporary shoring systems and sloped excavations shall be demonstrated to be safe using limit equilibrium analyses with appropriate potential failure surfaces (A potential failure mode is mentioned in Section 5.6). Slope stability analyses shall consider the presence of rapid transit live loading, applicable railroad live loading such as Cooper's E-80 on active tracks, and/or construction equipment.

The minimum factor of safety against failure of the whole, or any portion of, shored or sloped cuts shall be 1.5.

9.5 TIEBACKS

Per Section 4.3, shoring wall with tiebacks is a prohibited shoring type, unless otherwise approved by CTA. The approval of utilizing tiebacks will be reviewed by CTA Engineering on a

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[35] See Section 9 Commentary

case-by-case basis at their sole discretion. If tiebacks are permitted they must be installed using a method in which the drilled holes for the tiebacks will be stable and open at all times. In some soil types, this will necessitate fully cased holes beneath active tracks. Tiebacks shall be located a minimum of five (5) feet below top of rail.

Tiebacks shall be designed in accordance with the procedures and criteria outlined in the Post-Tensioning Institute (PTI), Recommendations for Prestressed Rock and Soil Anchors, with the exception that the allowable stresses for the tieback tendons shall be limited to those values specified in Section 8.1 of this Manual. A minimum factor of safety of 2.0 shall be used.

All tiebacks shall be load tested. The tieback load testing procedure, schedule, and acceptance criteria shall be developed by the qualified Engineer in Responsible Charge. At a minimum procedures and acceptance criteria for performance and proof testing shall conform to the following, unless otherwise directed by the qualified Engineer in Responsible Charge. The Engineer in Responsible Charge shall witness one proof test and one performance test. The first three (3) tiebacks installed and a minimum of 10% of the remaining tiebacks shall be performance tested. All remaining tiebacks shall be proof tested.

- Proof test shall be made by incrementally loading consist of Alignment Load, 20%, 50%, 75%, 100%, 120%, and 133% of Design Load. Lock off at 100% Design Load.
- Performance test shall be made by incrementally loading per the proof test load schedule shown above, but unload to Alignment Load at every proof test level. Lock off at 100% Design Load.
- The maximum test load in the proof and performance test shall be held for 10 minutes. The tieback movement with respect to a fixed reference shall be measured and recorded at 1 minute, 2, 3, 4, 5, 6, and 10 minutes. If tieback movement between 1 minute and 10 minutes exceeds 0.04 inches, the maximum test load shall be held for an additional 50 minutes, 20, 25, 30, 45, and 60 minutes. The total movement if the load hold is extended, shall not exceed 0.08 inches. The load hold time shall begin when the pump starts to raise the load from the 120% Design Load increment to the 133% Design Load increment.
- The minimum apparent free length at the test load, as calculated on the basis of elastic movement, shall be equivalent to not less than 80% of the designed free tieback length plus the jack length.
- If tieback is unacceptable after the test, the Contractor has the option to post-grout the tieback, up to two additional times, or until 300 psi is observed at the grout pump, and perform the test again. If tieback is again unacceptable, notify the qualified Engineer in Responsible Charge.

When tiebacks are bonded in fine-grained soils, creep testing shall be done in lieu of performance testing. Creep testing procedures and acceptance criteria shall conform to those given for temporary anchors in the Post-Tensioning Institute (PTI), Recommendations for Prestressed Rock and Soil Anchors.

In addition to the PTI Recommendations for Prestressed Rock and Soil Anchors, the designer may also reference FHWA Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored Systems, FHWA-IF-99-015.

9.6 DEADMEN

Under the appropriate conditions (where any other alternate is not practical) CTA may allow temporary shoring walls to be supported using deadmen located on the opposite side of the tracks from the shored excavation. The proposed location(s) for deadman anchorage will require review and acceptance by CTA and any Third-Party property owners as appropriate.

Deadman anchorage may be provided by soldier piles, sheet piling, or concrete blocks or walls. Deadman anchors shall be designed to provide a minimum factor of safety of 2.0 against failure.

In order to minimize the deflection of the shoring, deadman anchors shall be prestressed to remove the slack in the system and to mobilize the passive resistance. A portion of the final design load shall be locked off.

Tie rods that pass under the tracks must be electrically isolated from the track. Details of proposed system of electrical isolation shall be submitted for review.

9.7 MICROPILES

If warranted by low headroom clearance, Micropiles with Lagging type of shoring wall may be permitted.

Wall thickness reduction in design shall be in accordance with Section 8.1.1. Threaded joint design/detail shall be in accordance with Section 4 Commentary[7]. When threaded joint cannot provide the required bending capacity, it is acceptable to provide an inner casing extending beyond each side of the threaded joint as reinforcement. The inner casing can either be designed to fully resist the bending demand, or resist the bending demand minus the bending capacity threaded joint can provide.

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SECTION 10 TRACK, STRUCTURE, AND SHORING MONITORING

10.1 PURPOSE

CTA requires monitoring of the excavation, temporary shoring system and adjacent track(s) and structures throughout the duration of shoring installation, excavation, construction, removal and backfill. The monitoring procedures specified below are intended to confirm that shoring systems are performing in a satisfactory manner and to identify locations of excessive ground movement so that they can be controlled and corrected in a timely manner with the pre-approved contingency plans. The frequency of monitoring is previously mentioned in Section 3.1 Zone of Influence and will be further discussed in this Section.

The Contractor's field instrumentation specialist shall be responsible for purchasing, installing, and obtaining data for the ground instrumentation and the structural instrumentation. The field instrumentation specialist shall be a registered Professional Engineer in the State of Illinois and have demonstrated previous successful experience on a minimum of two (2) projects in installation and monitoring of the types of instrumentation specified herein. The field instrumentation specialist shall have supervised instrumentation programs similar in magnitude and similar in subsurface conditions on at least one (1) project. The instrumentation specialist shall be on-site and supervise at least the first five (5) installations of each type of instrument; supervise and establish the formal initial reading for each instrument installed; and, supervise the interpretation of all instrumentation data. The Contractor shall be responsible for providing access to instrument locations throughout construction.

10.2 LIMITATION ON TRACK MOVEMENT

CTA requires that track settlement or track heave associated with all aspects of shoring and excavation shall not exceed the Limiting Value vertical change. Track movement shall not exceed Limiting Value horizontal change due to temporary shoring and excavation. Track resurfacing (i.e. track tamping) or other remedial measures will be required if these limits are exceeded. In addition to Limit Values, minimum Warning Values are also implemented and required by CTA to ensure a sufficient time window can be provided to implement contingency plans as specified for stopping further movement.

- Responses required when the change in vertical and horizontal location of the running rail exceeds the: **Limiting Value of 1/4 inches.**
    - Suspend all construction activities in the affected area and notify CTA immediately.
    - Within 24 hours of reducing instrumentation data indicating that a Limiting Value has been reached, implement contingency plans per the Contractor’s CPP for stopping further movement.
    - Perform a detailed evaluation of construction procedures and submit to CTA the evaluation and recommended procedures to reduce movement. Furnish and

install additional instruments if they are needed to further define the magnitude of the indicated problem. Obtain approval of the Authority prior to restarting work.

- Responses required when the change in vertical and horizontal location of the running rail exceeds the: **Warning Value of 3/16 inches.**
    - Notify CTA immediately. CTA Engineering may require the Contractor to suspend activities in the affected area with the exception of those actions necessary to avoid reaching the Limiting Value.
    - Increase frequency of monitoring readings. See Section 10.3.
    - Supplemental readings will be required. See Section 10.4.

10.3 MINIMUM MONITORING REQUIREMENTS

The excavation and temporary shoring system shall be visually inspected at least daily by a qualified field instrumentation specialist or the appointed qualified personnel to check for obvious movements or changes that were unplanned or that may be detrimental to transit operations or safety. Visual monitoring should be performed more often during the performance of critical activities, such as excavation or foundation installation immediately adjacent to shoring or after moderate to severe rain events.

CTA requires that tracks adjacent to excavations and above Jack-and-Bore/ Horizontal Directional Drilling Construction within the Zone of Influence be monitored for movement and settlement. At a minimum, track monitoring shall consist of the following:

- Survey points shall be established along all tracks for which the excavation is within the Zone of Influence. It is recommended to establish the survey points on the crossties adjacent to the running rails.[36] The maximum spacing and minimum extent of these points shall be as shown on **Figure 10 - 1**. A minimum of three (3) control points shall be established in areas that will not be subject to possible disturbance due to construction activities or railroad operations. CTA recommends that baseline readings be done over three (3) days and the average of readings be used as the baseline.
- The horizontal coordinates and elevation of both rails shall be measured at each survey point location in accordance with the following schedule and frequency:
    a. Prior to starting any work associated with installation of the shoring system, a baseline reading of horizontal coordinates, elevations, temperature, and dynamic rail movement (see Section 10.4) shall be taken at each survey point identified. In cases where track maintenance activities are performed to correct movements, a new baseline shall be established and its relationship to the

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[36] See Section 10 Commentary

previous baseline documented. CTA recommends that baseline readings be done over three (3) days and the average of all readings be used as baseline.[37]

b. From the time at which shoring installation commences until excavation reaches the design elevation and the shoring system is in its final design condition, readings at each survey point of the horizontal coordinates and elevations shall be taken on a daily basis before and after each work shift for all Zones shown in **Figure 3 - 1**. Supplemental readings will be required if excessive or unanticipated settlements are recorded more than the Warning Value.

c. For seven (7) consecutive days after excavation reaches to the design elevation and the shoring system is in its final design condition., a minimum frequency of one reading of horizontal and vertical coordinates per day shall be performed for each monitoring point.

d. After seven (7) days of one (1) reading of horizontal and vertical coordinates per day, bi-daily readings shall be performed for each monitoring point or instrumentation during the construction but prior to shoring removal.

e. Monitoring frequency will return to once daily basis if conditions warrant. Conditions include: modifications are made to shoring structures that change the load path or stiffness, weather condition changes such as heavy rain, freezing temperature and thawing temperature, readings that hit the warning limits and others as directed at the sole discretion of CTA.

f. If permitted, from the time at which shoring removal commences until excavation is backfilled to the grade elevation, readings shall be taken on a daily basis for all Zones shown in **Figure 3 - 1**.

g. After shoring removal has been completed and excavation has been backfilled, readings shall continue on a once weekly basis for a minimum of four weeks.

h. Other monitoring instruments, such as inclinometers, and reading frequency of these instruments, may be requested by CTA, or recommended by instrumentation specialist based on cases by case basis. See Section 10.5.

i. For Jack-and-Bore Construction, follow above requirement (a) to set up baseline reading prior to starting any work. The Contractor shall monitor the track and ground/ballast movement immediately after the Jack-and-Bore operation comes to a stopping point such as splicing a new casing, obstruction encountered, or breaks, etc.

j. For Horizontal Direction Drilling Construction, follow above requirement (a) to set up baseline reading prior to starting any work. The Contractor shall monitor the

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[37] See Section 10 Commentary

track and ground/ballast movement immediately after drilling, reaming, and pullback operations.

Raw survey data shall be made available to CTA within one working day of the readings are made. The field instrumentation specialist will reduce and interpret the data and make the reduced data and interpretations available to the Contractor and CTA as soon as practicable, but no more than one (1) week after the readings are taken, and shall be provided on a form similar to that shown in Appendix E.

Neither CTA nor their representatives are in any way responsible for the safety and serviceability of the work. The Contractor shall not disclose instrumentation data to third parties, and shall not publish data without prior approval of the CTA.

Monitoring of the shoring structure is required since movement in the structure may precede and predict potential movement in the track.

Monitoring of the open-cut excavation is required since movement in the excavation may precede and predict potential movement in the track.

10.4 SUPPLEMENTAL MONITORING

Supplemental monitoring will be required when Warning Value is reached, and may be required by CTA in the case of movement less than the Warning Value as CTA deems necessary. Supplemental monitoring consists of the following:

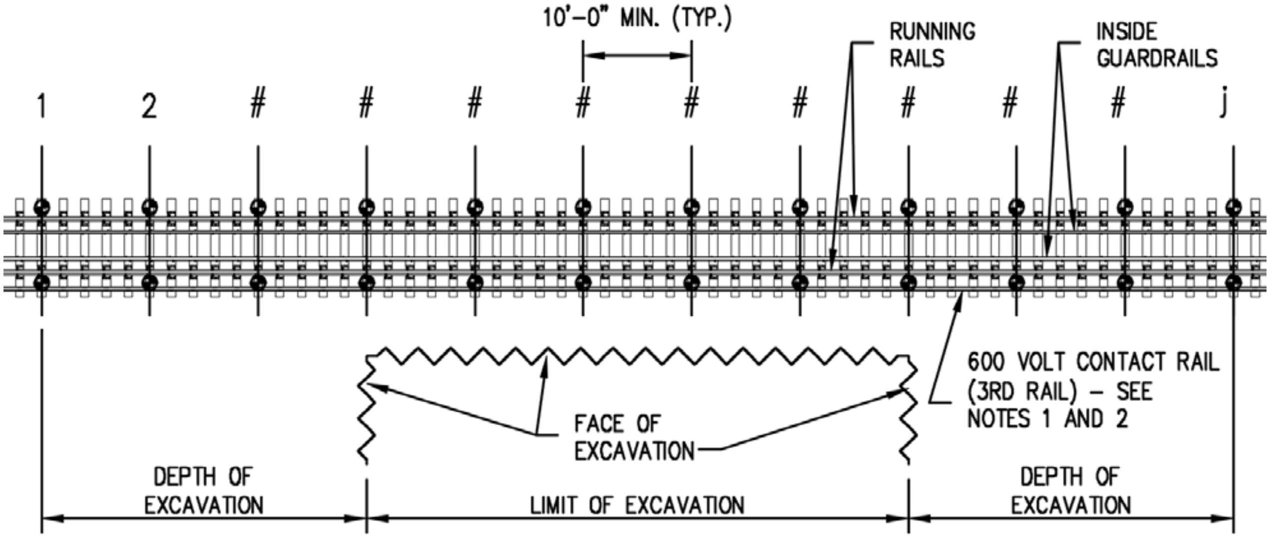
- Measurement of rail movements under load using a dynamic voidmeter. Measurements shall be taken at the same locations as the survey points that reached Warning Value for both running rails.
- More frequent survey measurements of static top of running rail elevations and coordinates, and dynamic running rail movements and cross-slope. Monitoring frequency must be increased to twice per day (before and after a day shift) until corrections have been executed and CTA infrastructure is deemed stable.
- Provide CTA static and dynamic survey data, in a form similar to Appendix E, immediately following the survey.
- More frequent monitoring measurements of shoring structure.

The following Supplemental Monitoring and Actions are required for Micropile installation is within the CTA's Zone of Influence:

- Once the 3/16" Warning Value is reached, stop drilling and continuously monitor settlement until no further settlement is detected for at least ten (10) minutes. Wait for CTA representatives to arrive on site and confer prior to restart of drilling, and if no further settlement is detected, perform continuous settlement monitoring until micropile casing has reached competent soil layer such as hard clay.
- If settlement reaches the 1/4" Limiting Value, stop drilling and have flaggers hold trains on the nearest track. Continuously monitor for additional settlement. If no further

settlement occurs within thirty (30) minutes, request flaggers to release trains under six (6) mph speed restriction. Begin to install shoring and stabilizing micropile hole such as grouting.

- If additional settlement occurs beyond the 1/4" Limiting Value, halt all further train movements on nearest track. Begin to make provisions for emergency single track and installation of shoring. Contact the temporary shoring Engineer in Responsible Charge and request assessment of stability of the settled track structure. In parallel, contact CTA representatives to inspect the trackwork for deformation and/or discontinuity. Restore train service on nearest track if there is consensus between CTA representative and temporary shoring Engineer in Responsible Charge that track and structure is stable. Impose the six (6) mph speed restriction until such time the temporary shoring is fully engage.
- If the final settlement is equal or greater than 3/8", correction measures shall be taken to bring the track structure/rail elevation back to the baseline measurements. Refer to Section 11.3.2 for additional requirements.



⊕ MONITORING POINT – TWO PER TIE (ONE FOR EACH RUNNING RAIL)

NOTES:

1. THE CONTRACTOR SHALL USE EXTREME CAUTION WHEN WORKING NEAR THE 600 VOLT CONTACT RAIL. ADEQUATE PERSONAL PROTECTIVE EQUIPMENT AND INSULATING 3RD RAIL COVERS MUST BE UTILIZED AT ALL TIMES.
2. LOCATION OF 3RD RAILS ALONG TRACKS WILL VARY – STATION AREAS VS NON-STATION AREAS.

Figure 10 - 1: Minimum Monitoring Requirements

10.5 SPECIAL MONITORING

CTA reserves the right to require that special monitoring be done for large, atypical, or long-lived shoring projects. Special monitoring may include the use of inclinometers, piezometers, tiltmeters, or other types of monitoring instrumentation. CTA will address this issue on a project-specific basis.

If open-cut adjacent to CTA tracks or track structures are permitted by CTA with Variance Request Form, inclinometers will be required to monitor the slope stability.

10.6 ACCESS AND FLAGGING

Access and flagging for establishing and reading survey points and monitoring instrumentation shall be coordinated with CTA Construction, Safety and Rail Operations.

SECTION 11 OTHER TYPES OF ADJACENT CONSTRUCTION

All sections of this Manual shall apply to this Section 11, where applicable, unless specifically modified within this Section.

11.1 CONSTRUCTION ADJACENT TO CTA UNDERGROUND STRUCTURES

11.1.1 General

The structural response and safety of underground Structures affected by Adjacent Construction activities has been a primary concern and CTA has attempted to establish criteria to restrict ground movements to be induced. However, most criteria adopted by other agencies are mostly arbitrary because of the lack of research and case study, and the complicated nature of this topic. Currently this concern is primarily addressed by monitoring movement and vibration with equipment such as inclinometer, tiltmeter, crack monitor, and survey. Therefore, Special Monitoring required in Section 10.5 will be requested when the Adjacent Construction is adjacent to or over existing CTA underground structures and/or structures and will be handled on a case-by-case basis depending on the existing condition of the underground structures after initial inspection, existing soil condition, excavation size, tunnel alignment in relation to the excavation (direction of ground movement), etc. **Figure 11 - 1** demonstrates an example on how the damage potential would depend on tunnel alignment in relation to the excavation (direction of ground movement).

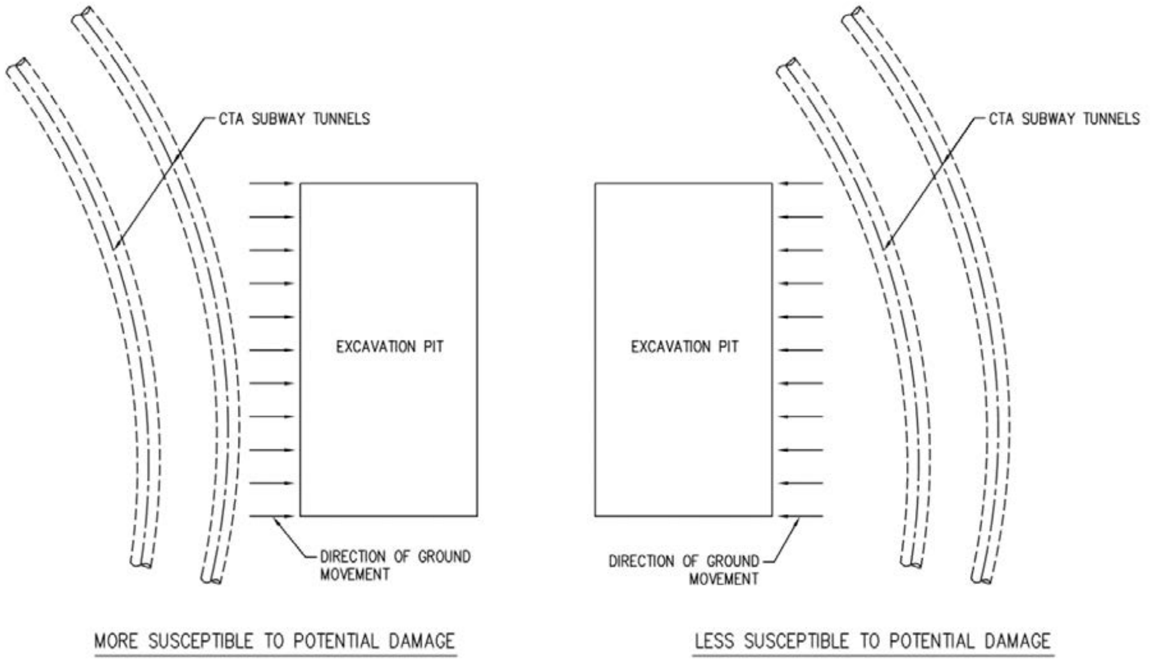
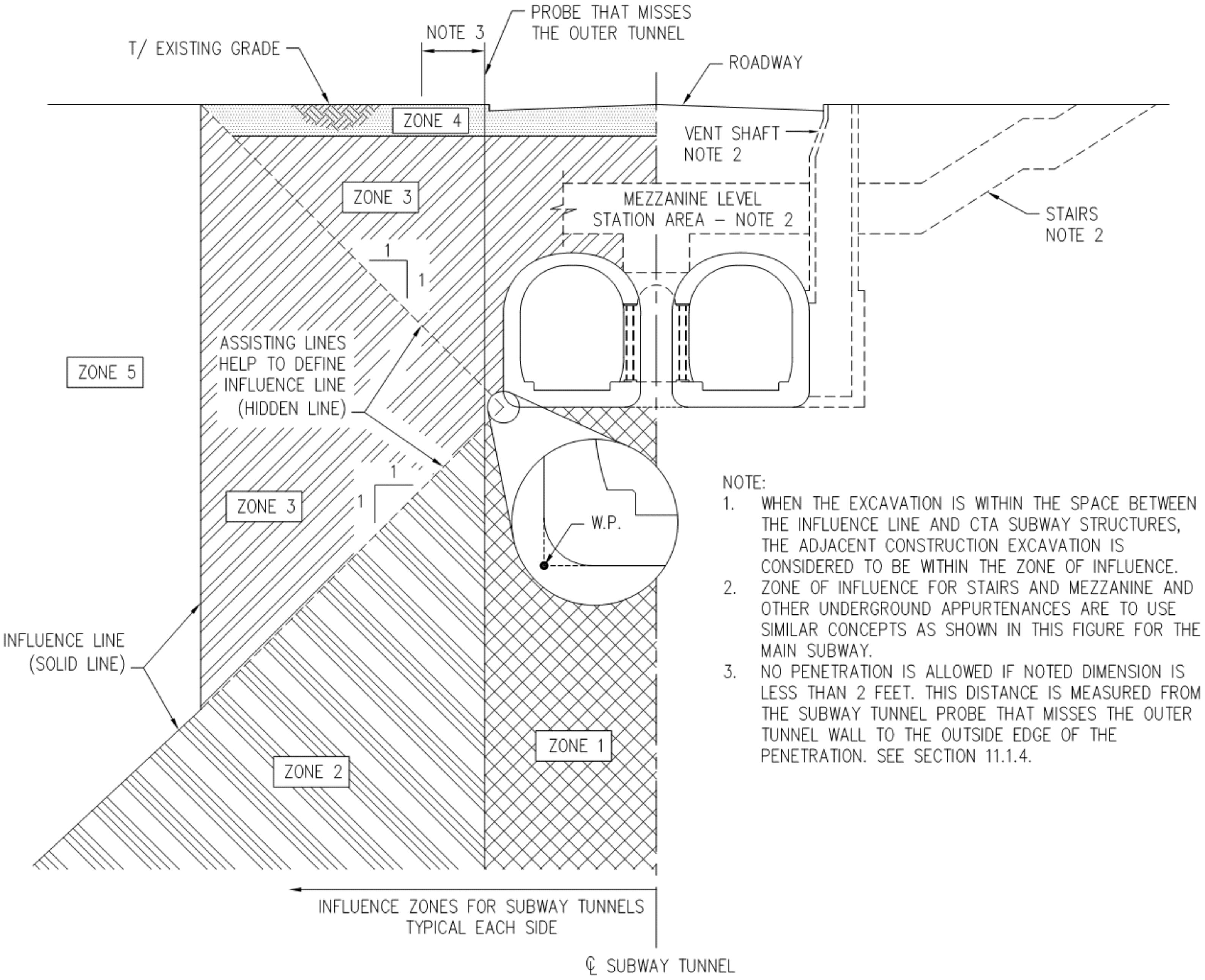


Figure 11 - 1: Tunnel Alignment in Relation to the Excavation

11.1.2 CTA Underground Structure Zone of Influence

In general, CTA requires all CTA underground structures including underground structures, subway station structures, and vent shafts to be fully re-evaluated for the effects caused by the Adjacent Construction, except for the cases shown later in this Section. The Zone of Influence diagram for CTA underground structures is shown in **Figure 11 - 2**. Refer to SECTION 4 through SECTION 9 for ERS design requirements.



NOTE:

1. WHEN THE EXCAVATION IS WITHIN THE SPACE BETWEEN THE INFLUENCE LINE AND CTA SUBWAY STRUCTURES, THE ADJACENT CONSTRUCTION EXCAVATION IS CONSIDERED TO BE WITHIN THE ZONE OF INFLUENCE.
2. ZONE OF INFLUENCE FOR STAIRS AND MEZZANINE AND OTHER UNDERGROUND APPURTENANCES ARE TO USE SIMILAR CONCEPTS AS SHOWN IN THIS FIGURE FOR THE MAIN SUBWAY.
3. NO PENETRATION IS ALLOWED IF NOTED DIMENSION IS LESS THAN 2 FEET. THIS DISTANCE IS MEASURED FROM THE SUBWAY TUNNEL PROBE THAT MISSES THE OUTER TUNNEL WALL TO THE OUTSIDE EDGE OF THE PENETRATION. SEE SECTION 11.1.4.

Figure 11 - 2: CTA Underground Structure Zone of Influence

▩ **Zone 1:**

- **Excavation is prohibited.**

▧ **Zone 2:**

- **No excavation or temporary shoring installation will be allowed without the special written permission of CTA.** Requirements for requesting a variance are provided in Section 2.2.
    - If CTA grants a variance to allow excavation, a rigid/stiff support of excavation system with slurry walls, tangent piles, or secant piles shall be used. For design, the at rest earth pressure shall be used on the retained soil side. All brace levels shall be preloaded to control ground movements.
    - CTA tunnel structures shall be analyzed with the consideration of soil unloading.
    - Shoring installation shall be completed prior to any excavation.
    - Any other flexible ERS system, if a prior approval of CTA is obtained, may have to be designed for a higher stiffness factor and requirements, based on a case by case basis. When the ground conditions warrant, use of ground stabilization with flexible support of excavation, in lieu of rigid support of excavation may be approved by CTA at its sole discretion. If fixable support of excavation is used, underpinning of the CTA underground structures/structures may be required.
    - If underpinning is requested, the underpinning structure must receive the support at least five (5) feet below the Line of Influence shown in **Figure 11 - 2**.

▨ **Zone 3:**

- All requirements in Zone 2 shall apply with the exception that flexible ERS system is permitted without a Variance Request.

░ **Zone 4:**

- Minor excavation over CTA underground structures for underground utility work may not require the complete tunnel analysis outlined in Section 11.1.3 depending on the size of the excavation. Generally, the excavation is considered minor if depth of excavation is less than 5 feet, length of excavation is less than twenty-five (25) feet, and width of excavation is less than twenty-five (25) feet. However, structure movement monitoring may be required by CTA based on a case by case basis, at the sole discretion of CTA.

□ **Zone 5:**

- Excavation may be shored or slope cut and no impact to CTA underground structures.

CTA subway mezzanine level and vent shaft structures are usually structurally supported by the subway tubes and do not require bearing on soil for vertical support. When excavations in Zone 3 expose the mezzanine level and vent shaft structures, coordinate with CTA for additional requirements for temporary support for the mezzanine structures.

CTA subway station auxiliary stairs usually do not have footings and soil bearing is required for vertical support. When excavations in Zone 3 expose the stairs, shoring will be required.

11.1.3 Tunnel Analysis Criteria

All existing underground structures shall be considered to be already under the long-term loads. Any changes in the loading (additional loads and/or soil unloading), due to adjacent excavation and construction, on the tunnel should be applied to these existing long-term loads for analysis. The users of this Manual can assume all CTA underground structures are cut and cover.[38]

- For CTA cut and cover structures:
    - If new construction is adjacent to or over existing CTA cut and cover structures, establish the short term and long-term loading conditions that will result from the adjacent construction and compare with the existing CTA cut and cover structure loading condition.
    - If any of the short term or long-term pressures due to the adjacent excavation and construction fall outside of the original range/limits of the design pressure, for which the existing CTA structure was designed, a structural analysis shall be conducted on the CTA structure to determine its adequacy to withstand the anticipated earth pressures and construction loads without overstress or cracking. The analysis shall be submitted for CTA review.
- The structural check of existing CTA cut and cover structures must include calculations for the following:
    - Stresses in the tunnel structure/liner.
    - Tunnel section distortion.
    - Lateral shift of tunnel.
    - Opening of the joints and possibility of water leakage at bolted joints. Bolt stresses shall be calculated.
- A computer analysis shall be performed to determine the effect of the new construction will have on the tunnel support system (liner). The tunnel liners may be modeled as straight members continuously joined together. For circular liners, the joints shall be taken at no more than ten (10)-degree angle subtended at the center. Radial soil-spring supports, at all joints are recommended to achieve a proper loading regime. Spring

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[38] See Section 11 Commentary

properties should correctly simulate the soil or rock modulus correlated with the soil data and soil properties given in the site specific geotechnical report.

- In lieu of a more complete analysis, the following procedure may be used to determine the effects on CTA tunnel liners. Joint loads should be determined by first assuming a one-foot length of tunnel liner and then calculating the tributary area at each joint. The resultant value should then be multiplied by the corresponding ordinate of the pressure diagram to arrive at the joint load. Radial, compression springs representing the modulus of subgrade reaction should be considered at each joint. Member properties and spring properties should be calculated per foot length of the liner, for the computer input data.

- When the computer model is run, the springs should be released to eliminate spring-tensions until springs are only acting in compression. The plot of the deflected liner should be compared with the assumed spring-releases, and trial runs should be made until the deflected shape corresponds with the spring-releases. Alternatively, a computer program that automatically eliminates the tension spring until convergence is achieved could be used. Selective checks using hand calculations should be performed to establish the accuracy of the computer analysis.

11.1.4 Drilled, Augered, Driven and Vibrated Penetration Construction Protocol

This section applies to penetrations **adjacent to and within twenty (20) feet but no less than two (2) feet to underground CTA Structures** including installation of slurry walls, tangent piles, secant piles, and drilled shafts/caissons, including probing operation, or any other type of substructures that require penetrating the soil, such as Geopiers, etc. Distances are measured from the underground structures probe that misses the outer tunnel wall to the outside edge of the penetration (not the final penetration size) at the underground structures elevation. The maximum out of plumb and layout for the center point must be considered.

A pre-inspection, a post inspection, and a Damage Letter are required for all depths.

The following requirements shall apply unless otherwise approved by CTA through the variance request outlined in Section 2.2 at the sole discretion of CTA:

- General

  The project's structural drawings shall show the underground structures in plan and cross section.

  The underground structures shall be located from the north/south and east/west coordinates of the right-of-way lines and from adjacent penetrations.

To verify the actual location, depth, and profile of the underground structures, probing may be required on a case-by-case basis based on location[39] when any proposed penetration is within a minimum horizontal distance of twenty (20) feet at curved section of tunnel and ten (10) feet at straight section of tunnel as measured from the outside edge of the theoretical tunnel wall or within a vertical distance of ten (10) feet as measured from the theoretical outside top of the underground structure to the bottom of the penetration. (Probing may be required to determine the appropriate course of action to allow a penetration to proceed above, adjacent to, and beyond the underground structures.)

If probing cannot be performed due to the availability of the site or interference from existing structures, or utilities, the underground structures shall be surveyed from within the interior of the underground structures. The thickness of the underground structures walls shall be considered twenty-four (24) inches, or as otherwise shown in as-built drawings. A precautionary twenty-four (24) inches wide safety zone shall be added to adjust for the outer limit of the tunnel wall(s).

For determining the placement of a penetration (after probing is complete) adjacent to the underground structures, the outer limits of the underground structures shall be considered to be the probe that does not touch the outside wall of the underground structures and exceeds the depth of the underside of the underground structures floor by a minimum of ten (10) feet.

Prior to proceeding with any penetration above, including probing, adjacent to, and beyond the underground structures, a Structural or Professional Engineer licensed in State of Illinois shall inspect and document both by photograph(s) and videotape the existing conditions and structural integrity of the underground structures. The owner of the property or its representative at its sole cost shall employ the services of a licensed State of Illinois Engineering Firm. All inspections shall be done in the presence of CTA. The right of way lines and excavation locations shall be clearly identified at grade level by use of monuments and marked as approved by CTA. Within thirty (30) days after the completion of all penetrations the licensed State of Illinois Structural or Professional Engineer shall schedule a final tunnel inspection with CTA. A final inspection report signed and stamped by the licensed State of Illinois Structural or Professional Engineer shall be submitted within thirty (30) days after the final inspection. Based on the type, depth, and location of the penetration; CTA will determine the distance from the underground structures to the penetration that will require a pre and post inspection. The minimum required distances are twenty (20) feet.

The Contractor or Subcontractor shall provide a CPP including the procedures, means, and methods for performing the underground structures probes and/or penetrations above, adjacent to, and beyond the underground structures. Soil boring reports are to

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[39] See Section 11 Commentary

accompany all requests for underground structures probing and/or penetrations above, adjacent to, or beyond the underground structures. Elevations and soil profiles shall be referenced by depth and the City of Chicago Datum (CCD). The procedures shall be submitted prior to CTA issuing its authorization to the OUC. The maximum allowable out of plumb and layout for the center point for penetrations shall be noted on the procedures. Procedures for monitoring plumb and layout for the center point shall be included. Procedures are to include a repair procedure if the underground structures are penetrated or damaged during probing.

To prevent damage to the existing underground structures drilling shall cease immediately if an obstruction is encountered within five (5) feet of the underground structure.

If the underground structure is penetrated or damaged during probing, or by any other penetration, all operations are to cease and CTA is to be notified immediately. The Contractor shall not remove the casing, drill bit, auger, rods or etc. from the borehole or shaft. A repair procedure approved by CTA shall be implemented. Upon completion of the repair work a licensed State of Illinois Structural Engineer shall inspect and approve the repairs to the interior of the tunnel liner and provide photographs and documentation of the final repairs to CTA.

The Contractor shall notify CTA that they will resume the approved construction activity above, adjacent to, and beyond the underground structures.

Field personnel performing the penetrations shall be fully knowledgeable of the elevations and locations of the underground structures.

- Underground structures Probing

Probing operations shall commence with the drilling of a temporary casing to a suitable clay layer, at various CCD elevations, as determined by the soil borings.

A minimum of four (4) probes will be required to determine the location, depth, and profile of the underground structures. A minimum of two (2) groups of probes are required for each straight section of tunnel. A minimum of three (3) groups of probes are required for each curved section of tunnel. The first probe to be drilled shall be the furthest from the underground structures; the remaining probes shall be advanced toward the underground structures.

The probe hole to the underground structures will be drilled to within a caution distance of approximately fifteen (15) inches of the calculated probing length. Drilling operations shall stop at the calculated caution distance to prepare for possible contact with the underground structures or for sound level monitoring from within the underground structures. The approximate drill bit location shall be estimated from sound monitoring within the underground structures. The underground structures shall not be penetrated during probing procedures. Upon encountering the underground structures, the location of the probe, the angle of the probe (if any), and the depth of the probe from existing grade to the underground structures shall be recorded.

During withdrawal of the drill bit and extension rods, the entire cavity, annular space, and voids caused by the displaced soil shall be completely filled with a bentonite-cement grout.

If the underground structure is penetrated or damaged during probing all operations are to cease and CTA is to be notified immediately. The Contractor shall not remove the casing, drill bit, auger, or rods from the borehole.

Within fifteen (15) days after the completion of the underground structures probing the owner or his representative shall provide CTA with a detailed drawing prepared and stamped by a licensed State of Illinois Structural or Professional Engineer indicating the location of the probes. The detail drawing at a minimum shall include the locations from the north/south and east/west coordinates of the right-of-way lines; the depth of penetration; the distance between probes; and the outside limits of the underground structures walls.

- Special Inspection and Monitoring

When drilling operations occur within ten (10) feet of straight portion and twenty (20) feet of curved portion of underground structures, CTA will assign, on a full-time basis, a minimum of one inspector in the underground structures, along with required number of flaggers, and one inspector at surface level with the drilling operator. In cases where there are multiple tunnels affected by operations additional inspectors will be assigned as needed. Inspections shall begin prior to any construction activities proceeding adjacent to the underground structures to obtain a baseline condition of the tunnel.

- Calculation Submittals

Calculations by a licensed State of Illinois Structural or Professional Engineer shall be provided to CTA demonstrating the hydrostatic pressure from the wet concrete, slurry, or from driven piles will not induce additional stresses and cause failure to the underground structures. The allowable stresses on the underground structures shall be in accordance with current American Concrete Institute Building Code Requirements. If the stresses will affect the structural integrity of the underground structures a permanent steel casing is required. The preliminary compressive strength of the concrete of the underground structure shall be assumed to be 2000 psi. In lieu of this calculation submittal the contractor can chose to provide permanent casing as described below for caissons/drill shafts.

- Special Requirements for Caissons/Drilled Shafts

A permanent steel casing is required from five (5) feet above the top of the underground structure to five (5) feet below the underside of the underground structure floor, however, the soil profile may require that the permanent steel casing be placed above and below these limits. For example, when soil profiles show soft to medium clay with unconfined compressive strength not able to satisfy the following equation:

Q_u required (tsf) ≤ H (ft) / 50, where H is the depth of excavation

Removal of soil within the casing shall not be advanced beyond the limits of the permanent casing, two (2) feet of unexcavated soil shall be maintained at all times in the casing.

At CTA's discretion, based on soil and underground structures conditions:

- The excavation may be performed under a slurry head. Excavate to five (5) feet above the top of the underground structures; fill the excavation with a slurry to the existing grade; excavate to five (5) feet below the underside of the underground structures floor and insert the permanent casing.
- The excavation may proceed to five (5) feet below the underside of the underground structures floor without the permanent casing being in place. After obtaining the required depth, grout shall be poured from the bottom of the excavation to five (5) feet above the top of the underground structures. The permanent casing shall be inserted in the wet grout to the bottom of the excavation. Once the grout has obtained its initial set, excavation may proceed through the grout and the remaining soil.

CPP Requirements for Caissons: For all caissons within the 10 ft/20 ft rule, provide cross section of caisson with soil profile, relative top, bottom, and side distances to CTA structure, casing information, and each step in the drilling process.

Once the excavation has started for an adjacent caisson/drilled shaft beyond the bottom of the casing, the work of that caisson shall be carried on continuously, twenty-four (24) hours a day, including Saturday, Sundays, and Holidays, until the caisson has been completed. If any time, work on any adjacent caisson is not continuous for any reason, it shall be backgrouted immediately.

When there is a line of caissons/drilled shafts longitudinally adjacent to the CTA underground structures and/or structures, including secant walls, shaft installation shall be one at a time. Under no circumstances shall there be more than one shaft open.

- Special Requirements for Micropiles

Flaggers are always required for micropile installation. **When micropile installation is adjacent to CTA substructures within the zone of influence, the installation method shall be Rotary Duplex Drilling method**. Drill bit shall not extend beyond the casing in weak soil layers such as sand, very soft to soft clay, etc. Especially when it is within the Zone of Influence. Soil boring logs shall be submitted with the micropile installation process plan for reference.

The drilling operation shall avoid external flushing as practicable as possible. Measures may include but not limited to:

- Provide continuously monitoring of the flushing fluid/air pressure.
- Limiting the maximum distance that drill bit can extend beyond the casing in competent soil.

Special Supplemental Monitoring is required for Micropile installation. Refer to Section 10.4 for additional monitoring requirements.

11.1.5 Heavy Vehicles/Equipment Above CTA Underground Structures and Structures

Any heavy vehicles or equipment with axle loads greater than axle loads for the AASHTO design truck (HS20-44 or HL-93), that would impose loads on CTA underground structures and/or structures, shall require structural analysis to verify CTA structures will not be impacted. For stationed equipment with outriggers, crane mat shall be provided at outriggers to ensure the distributed maximum outrigger force will not exceed 240 psf on the street level. Submit signed and sealed IL Structural Engineer drawings and calculations to CTA for review.

11.2 CONSTRUCTION ABOVE AND ADJACENT TO CTA TRACK AND FACILITIES

11.2.1 General

Structures shall be designed per the requirements of the local jurisdictional codes. Structures MUST satisfy the CTA train clearance envelope as shown in Appendix B. Bridge structures over CTA tracks and facilities shall incorporate protective measures to guard against objects or debris from entering CTA Right-of-Way.

11.2.2 Pier/Foundation Wall Protection Adjacent to CTA Tracks

When bridge piers, building foundation walls or other structural elements are within the Basic Safety Envelope and are potentially in the path of a derailed train, they are to be designed per AREMA *Manual for Railway Engineering* Chapter 8 Part 2 Article 2.1.5.1.

Crash walls for piers from twelve (12) to twenty-five (25) feet clear from the center line of track shall have a minimum height of six (6) feet above the top of rail. Piers less than twelve (12) feet clear from the centerline of track shall have a minimum crash wall height of twelve (12) feet above the top of rail.

The crash wall shall be at least 2’-6” thick and at least twelve (12) feet long. When two or more columns compose a pier, the crash wall shall connect the columns and extend at least one (1) foot beyond the outermost columns parallel to the track. The crash wall shall be anchored to the footings and columns, if applicable, with adequate reinforcing steel and shall extend to at least four (4) feet below the lowest surrounding grade.

Alternatively, CTA may consider the use of installing restraining rail to limit lateral movement. Contact CTA for details.

Consideration may be given by CTA, at its sole discretion, to providing protection for bridge piers or building foundation walls over twenty-five (25) feet from the centerline of track as conditions warrant. In making this determination, such factors as horizontal and vertical alignment of the track, embankment height, and an assessment of the consequences of serious damage in the case of a collision will also be considered.

11.2.3 Pier/Foundation Wall Formwork

When bridge piers or building foundation walls are in close proximity to CTA tracks and/or facilities and their formwork failure could potentially damage CTA tracks and structures interrupting CTA normal operations, formwork shall be designed by a structural engineer licensed in Illinois and formwork calculations and shop drawings shall be signed and sealed by the Illinois licensed structural engineer. Formwork shall be designed per ACI 347 – Guide to formwork for Concrete. Actual mix design, actual concrete temperature (or colder temperature to be conservative), and actual pour rate (or faster pour rate to be conservative) needs to be used to calculate the pressure on formwork.

Immediately prior to the Contractor pouring concrete into the forms, the IL SE that provided the design is to visit the site to confirm the installation complies with the drawings and calculations and the mix pour rate and mix design complies. The IL SE must provide verbal confirmation to CTA inspector on site and is to follow with a signed and sealed letter formalizing the verbal confirmation.

In such cases where formwork or accessories are proprietary, Section 2.6 of this Manual shall apply.

11.2.4 Overhead Wire Line Crossings

This section is developed based on Metra Guidelines for Utility Installations and ComEd System Standard and shall apply to overhead electric power lines and non-electrified wire lines over CTA Rapid Transit Right-of-Way. The poles or towers supporting the line shall preferably be outside CTA’s Right-of-Way. However, when an overhead wire line crossing over CTA tracks is required, the requirements illustrated in **Figure 11 - 3** apply.

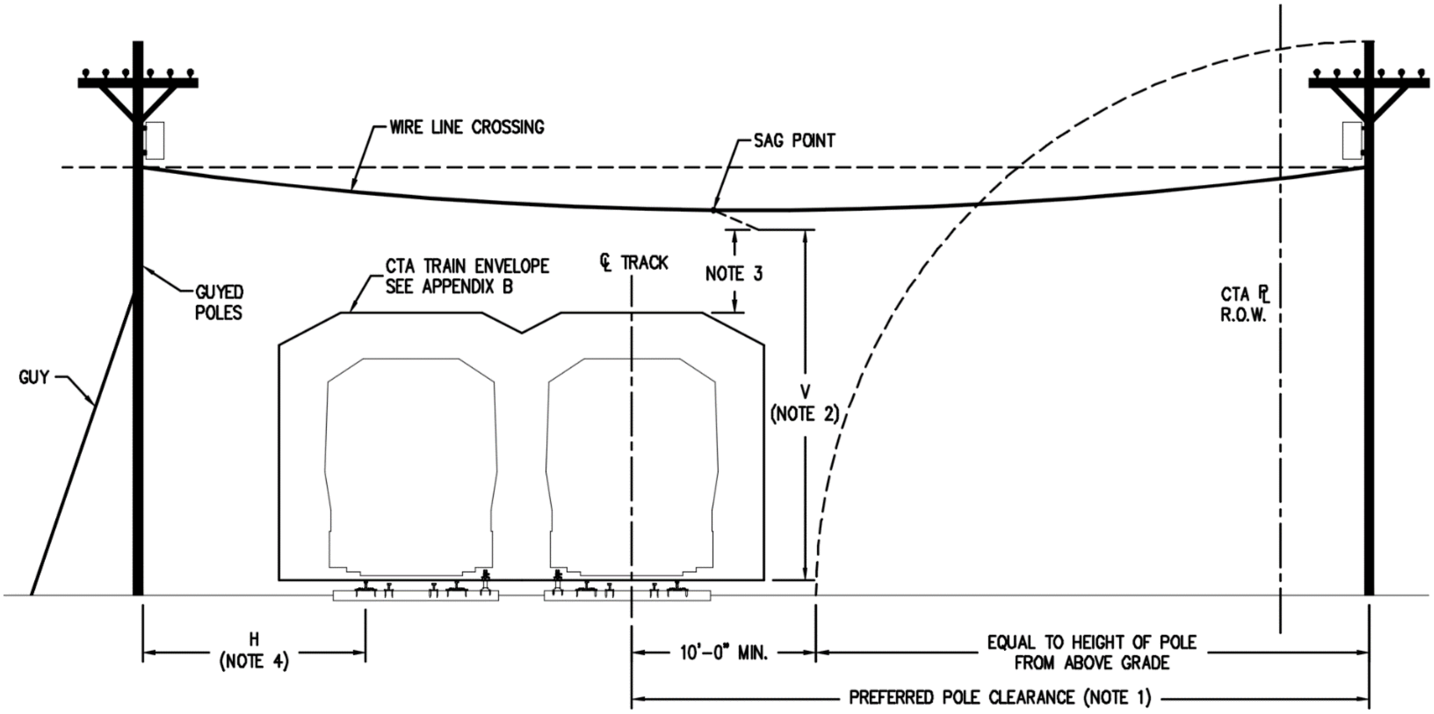

Figure 11 - 3: Overhead Wire Line Crossings Clearance Diagram

1. The CTA preferred pole clearance is shown in **Figure 11 - 3** on the right-hand side and shall always be followed where possible. If not possible, Note 4 denotes the minimum horizontal clearance (H) that must be followed as the minimum clearance for locating poles. Note 2 and 3 denotes the minimum vertical clearance (V and V1) and shall be strictly followed.

2. The minimum vertical clearance (V) shall be as followed:
   - Non-electrified wire lines: 23’-6”
   - Grounded guys, or guys exposed to 0-300V: 23’-6” (note 6)
   - Neutral conductors; terminal bushing; secondary cable; aerial cable: 24’-0”
   - Guys exposed to 300-750V: 24’-6” (note 7)
   - Open supply conductors; spacer cable:
     a. 0-750V: 24’-6”
     b. Or guys exposed to 750V-15kV: 26’-6” (note 7)
     c. Or guys exposed to 15kV-34.5kV: 27’-0” (note 7)
     d. Above 34.5kV: 27’-0” plus 0.4 inches for each 1,000 volts (note 7)

3. The minimum vertical clearance to the top of the envelope of the train (V1) shall be the minimum vertical clearance (V) minus 14’-6”. This dimension is also to be used for any wireline crossings over any CTA structures, such as stations and canopies.

4. Minimum horizontal clearance (H) from the nearest running rail shall be the minimum vertical clearance (V) minus 15’-0” but shall not be less than 12’-0”.
5. No additional reduction to H or V is permitted.
6. No clearance from ground is required for anchor guys not crossing tracks or rails.
7. The portions of span guys between guy insulators and the portions of anchor guys above guy insulators that are not grounded shall have clearances based on the highest voltage to which they may be exposed due to a slack conductor or guy.
8. Wooden poles supporting the crossing span shall be side-guyed in both directions (parallel and perpendicular to tracks), if practicable, and be head-guyed away from the crossing span. Braces may be used instead of guys and clearances to guys are to apply to braces. **All down guys shall have high visibility guarding**.
9. Crossing poles and towers shall be located as far as possible from combustible structures. The space around the poles and towers shall be kept free from underbrush, grass, and other combustible material.
10. Where necessary for unobstructed view of wayside signals, signs, etc., CTA may require greater clearances than specified in the diagram. Coordination with Rail Operations will be required.
11. The poles or towers shall be plainly marked with the name, initials, or trademark and the pole numbers, if used, of the Crossing Company. When required by CTA, the Crossing Company shall place, on all crossing structures located on CTA property.
12. In general, lines shall be arranged in the order of their operating voltages, conductors of the greatest voltage occupying the highest position. Where lines of lower voltage are permitted to cross over circuits of higher voltage, their mechanical strength shall conform to that required for the higher voltage lines.
13. Splices shall not be made in the crossing span, and preferably not in the adjacent spans, which are depended upon for withstanding the longitudinal tension of the crossing conductors. Taps shall not be made in the crossing span. If a splice or tap is made in any conductor in the span adjacent to the crossing span, it shall, where practicable, be placed at a point nearer to the crossover support than is the nearest conductor crossed over.
14. Cradles, baskets, and overhead bridges are generally not acceptable and shall not be used except under unusual conditions where it is economical to build such a structure of sufficiently substantial nature and when approved by CTA. Drop outs shall not be used.
15. The crossing construction shall be subject at all times to the inspection and approval of CTA.

16. All parts of the supporting structures of the crossing span shall be inspected annually by the owner and all defective parts shall be promptly restored to a safe condition.

17. The details of construction and maintenance of the crossing, unless otherwise specified herein, shall be in accordance with the current specifications of the National Electrical Safety Code, except when modified construction is permitted by CTA.

18. The Crossing Company shall submit plans showing proposed construction for review and approval with its application. The plan shall also include details of future maintenance. All requirements in Section 2 are required prior to commencement of construction.

11.2.5 Bridge Girder Erection Over CTA Tracks

Bridge girder erection activities have the potential to run significantly longer than time durations between trains. Per Section 3.9, CTA prohibits bridge girder erection activities during rush hour periods. These activities are further constrained to overnight hours to avoid impacting rush hour periods and to take advantage of non-revenue hours, or longer headways. Any significant delay will result in enforcement of Section 3.8. Adjacent Construction Owner/Contractor may request a scheduled Line Cut or Single Track through a Variance Request. CTA reserves the right to require a scheduled Line Cut or Single Track for performance of these activities when CTA determines Contractor cannot meet Condition 1 or 2 as described below without incurring significant train delays or risk to Operating System. The Adjacent Construction Owner/Contractor is fully responsible for all costs associated with any scheduled Line Cut or Single Track.

CTA will allow trains to pass underneath a bridge girder only after it is assured the girder is stable per one of the conditions shown below. In the CPP, the Erector's Engineer in Responsible Charge must clearly delineate the requirements for each of the condition. Coordinate with IDOT or other controlling agency for their roadway requirements.

Condition 1:

- Girder is erected and stable on its own without assistance from crane. As determined by Erector's Engineer in Responsible Charge with structural analysis.

Condition 2:

- Girder is held by crane with crane utilization less than or equal to 0.67 of the lift capacity, and;
- Girder is set on two supports. Where the support is a splice, minimum number of erection pins/bolts must be installed in the web to support 150% of the girder dead load, but no less than two (2) erection pins/bolts; and two erection pins/bolts near the extreme bolt holes of the top and bottom flange of each connected member.

In addition to the general submittal requirements per Section 2, all bridges above CTA tracks shall be considered as Class B bridge per NHI Publication No. FHWA-NHI-15-044 Engineering for Structural Stability in Bridge Construction Chapter 8 Section 6. Bridge girder erection CPP shall comply with all requirements as a Class B bridge. For major bridge projects, existing bridge demolition and new bridge construction may be done in different stages, and within the specific stage, removal for multiple spans may be done in different phases. The CPP submitted to CTA shall include all stages/phases as a whole for review.

11.2.6 Miscellaneous Temporary Structure Adjacent to CTA Tracks

Tuckpointing, façade inspections, ComEd line work, or other activities requiring scaffolding, swing stages, crawler cranes, man lifts, etc. next to CTA tracks. These cases do not require an engineering review but will require a safety department review, flaggers, and inspectors on site for these activities. Refer to Section 3.7 for safety requirements.

For swing stages, overnight or longer periods require the platform to be parked in its storage position and secured to the structure to prevent movement or damage due to wind. Trailing ropes and cables should be securely stored, protective devices locked onto ropes, electric cables disconnected from supply and if air operated air-lines, disconnected and pressure released. The control box should be removable, unless an alternative method is used to isolate power to the cradle, for safety and security when the suspended scaffold is not in service.

11.2.7 Tower Crane Over CTA Tracks

Tower crane over CTA tracks typically does not require an engineering review but typically will not be allowed without an electronic limiter. If electronic limiter is used, CTA safety will verify the limits for the picks to ensure it will not encroach the CTA R.O.W. Refer to Appendix A for Tower Crane Checklist.

11.2.8 Small Unmanned Aircraft System

Unmanned Aircraft Systems or Drones are not to be flown at any time on CTA property, as defined per Basic Safety Envelope, without express authorization from CTA. Request shall be submitted using the Variance Request Form attached in ACM Appendix H.

11.3 CONSTRUCTION ADJACENT TO CTA ELEVATED TRACK AND OTHER STRUCTURES

This section includes requirements regarding construction and excavation adjacent to CTA tracks supported by open and closed deck steel and concrete structures, as well as ballasted tracks supported by retaining walls. Construction and excavation adjacent to other CTA facilities and structures are to follow this section, as applicable, unless otherwise allowed by CTA. New constructions adjacent to CTA elevated track and other CTA facility structures must be outside the CTA property line and maintain a minimum 2'-0" clearance if the property line permits a smaller clearance.

11.3.1 Excavation Shoring NOT Required

For construction adjacent to CTA elevated track structures where no excavation is required, Section 3.9 shall apply and any other Sections that are applicable.

11.3.2 Excavation Shoring Required

For construction adjacent to CTA elevated track structures where excavation is required, the Zone of Influence diagram shown in **Figure 11 - 4** shall be used instead of **Figure 3 - 1**. All other requirements of this Manual shall apply, where applicable, except those specifically modified under this Section. Excavation adjacent to other CTA facilities and structures can also use **Figure 11 - 4**. Refer to SECTION 4 through SECTION 9 for ERS design requirements.

▩ **Zone 1:**

- **Excavation is prohibited unless written permission is given from CTA to shore the existing track structure column. Refer to Section 11.4.**

▧ **Zone 2:**

- **Temporary ERS shall be designed with horizontal pressure from the footing surcharge.**
- Bottom heave shall also be evaluated per Section 9.3.2 when soil condition warrants.

▨ **Zone 3:**

- Temporary ERS need not be designed with horizontal pressure from the footing surcharge.
- Excavation beyond the Zone of Influence line within Zone 3 shall not be open cut.

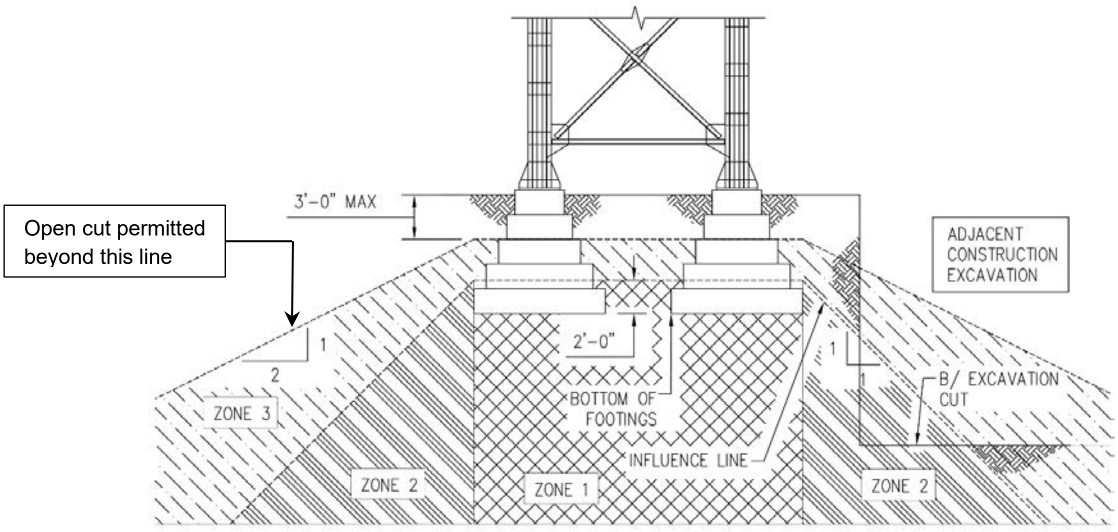

Figure 11 - 4: Elevated Track Structure Footing Zone of Influence

The bearing pressure of the track structure spread footing shall be calculated with (for other CTA facilities, use facility specific loads):

- Dead Loads: track structure, trackwork, track level footwalk, equipment platforms (if any), railings, station structure, and canopy (if any)
- Live Loads: rapid transit cars, railbound crane train (if requested by CTA), 100 psf live load on station platform and all other pedestrian areas (if any), 30 psf live load on canopy (if any), 200 psf live load on track level footwalk and/or equipment platforms (if any)
- Impact Loads and Rocking Effects: shall not be considered for rapid transit cars
- Wind Loads: on structures, rapid transit cars, canopy (if any)
- Snow Loads: on structures, canopy (if any)
- Longitudinal Force
- Centrifugal Force (if any, on curved tracks)

However, at Owner/Contractor's option, the maximum allowable bearing pressure for the spread footings can be conservatively assumed as 4000 psf. This bearing pressure can be used for the shoring wall design to be conservative and eliminate the need to perform a full analysis/load takedown for the elevated track structures. If the excavation is within the Zone of Influence at a tower bent (i.e., diagonal bracing members are present as shown in **Figure 11 - 4**), the bearing pressure used for the shoring wall design shall be the maximum bearing pressure times 1.5.[40]

If the Adjacent Construction work causes excessive settlement (equals to or exceeds 3/8 inch) to the existing CTA elevated track structures, CTA may require the existing CTA track structure foundation be underpinned and jacked; or excavate to expose the settled foundation, disconnect the column base anchors so that shimming can be installed with superstructure raised. The

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[40] See Section 11 Commentary

correction measures shall be designed by the shoring design Engineer in Responsible Charge, reviewed and approved by CTA Engineering on a case-by-case basis.

11.3.3 Deep Foundations

Micropile foundations and caisson/drilled shaft foundations generally are not affected by the adjacent excavation. Shoring designer must provide evaluation of shoring effects on deep foundations. Caution should be exercised during the shoring wall installation and excavation to prevent damaging battered micropiles, or vertical micropiles driven out of tolerances that may become battered. CTA may request excavation under existing pile caps to verify location, angle and based on that the ultimate termination point of Micropiles as part of the design's evaluation of the shoring effects on the CTA structure.

When the proposed adjacent structure deep foundations, such as caissons, are adjacent to CTA micropile foundations, maintain a minimum clearance of 2'-0" from the edge of proposed deep foundations to the outer casing of micropiles.

Open-cut that exposes micropile foundation cap is not permitted without shoring system that resists the lateral forces. Lateral forces can be calculated with the longitudinal and transverse demands as shown in Section 11.3.2. Or at Owner/Contractor's option, shoring system may be designed to resist the full passive resistance acting on the faces of the micropile caps. The soil shall be assumed cohesionless and passive resistance shall be calculated per Rankine's Theory as shown in Section 5.2.4, unless soil can be determined based on Adjacent Construction Project soil borings.

New deep foundations adjacent to existing CTA spread footings will require permanent casings.

11.3.4 Wireline Mounted on Elevated Track Structures

Mounting wirelines on elevated track structures are generally not recommended, unless approved by CTA. The CTA preferred mounting details will be provided if the Variance Request is approved. See Section 11.3.5 for additional recommendations regarding vibration concern on open deck type structures.

11.3.5 Miscellaneous Elements Mounted on Elevated Track Structures

Miscellaneous elements in this Section include lightings, drip pans, etc. elements whose self-weight is neglectable to the track supporting structures. Such work will require engineering, safety review, real estate review, traction power review, as well as needing inspectors and potentially flaggers if the work extends above the ties. Drill fastener holes in the bottom flange of track structures is strictly prohibited. Non-penetrating fasteners shall be provided in locations approved by CTA Engineering. Coordinate with CTA for requirements for right-of-entry. Refer to SECTION 2 for the coordination flowchart.

Based on vibration study[41], the rate of occurrence of the shock and vibration events on open deck type of track structure may be severe and this may impact the wireline and/or miscellaneous elements mounted on the CTA open deck type track structures. Special attention should be paid to minimize the risk of attachments becoming loose. Potential solutions include adding a third mounting bracket to the center of the fixtures, refinement of the bracket design, and reevaluation of the rubber isolator pads, etc.

11.4 ELEVATED TRACK STRUCTURE TEMPORARY SHORING

Temporary shoring structures connecting to CTA elevated track structure columns, cross girders, or stringers to directly carry the Rapid Transit live load is prohibited, unless otherwise permitted by CTA through writing. Coordination Flowchart per Section 2 and Variance Request per Section 2.2 must be followed to obtain the approval. Adjacent Construction Owner, Designer, and/or Contractor shall investigate possible alternatives to avoid shoring the CTA elevated track structure directly.

If no alternate is practical, or as required when excessive settlement occurred to the adjacent CTA track foundation as shown in Section 10.4 , in addition to this Manual, the Adjacent Construction Owner, Designer, and/or Contractor will be provided with a copy of the CTA Infrastructure Design Criteria Manual (IDCM) Chapter 7 – Structural, and CTA's Specifications for track structural shoring and monitoring. These documents must be included as a part of the Contract Document for the Adjacent Construction Project.

The design, construction, and monitoring requirements are provided in the above-mentioned documents in details. In general, the following requirements shall apply:

- Temporary shoring structures to carry Rapid Transit traffic other than Earth Retention System shall be designed as **permanent structures** per AREMA *Manual for Railway Engineering*, latest edition. (i.e., Chapter 15 Part 7 shall not be used.)
- Design methodology for all material used for the temporary shoring structures shall be **Allowable Stress Design (ASD)**.
- Structural analysis of the existing track structures, especially at curved tracks, to determine the temporary shoring structure demands shall consider multiple spans. Typically, from expansion joint to expansion joint which normally consists four (4) to five (5) spans.
- Rapid Transit speed reduction shall not be permitted. All temporary shoring structures must be designed to be able to carry the Rapid Transit live load at full speed (i.e., up to 55 MPH, depending on locations) regardless if the temporary shoring structure is at a station area.

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[41] *"Wabash Vibration Report"* by Color Kinetics Mechanical Engineering Department, 2018/07/23

- For steel members, fatigue analysis need not be performed, provided service life of the temporary shoring structures satisfies Section 1.1. However, fatigue detailing is required. Low fatigue resistant details (Detail Category E', E, and D) shown in Table 15-1-9 in AREMA *Manual for Railway Engineering* shall be avoided.

- The stability of the temporary shoring structures shall be checked. Factor of Safety for stability against over-turning shall be greater than 1.5. Factor of Safety for stability against sliding shall be greater than 2.0.

- No welding to existing track structure is allowed. Connection to existing track structures shall be High Strength structural bolts F3125 Grade A325 type 7/8" diameter installed as Slip Critical Condition using turn-of-the-nut method. Use existing rivet holes to make the connection as practicable as possible. The rivet removal procedures are provided in the Specifications.

- The temporary shoring structure design shall not damage or otherwise reduce the quality or life of any portion of the permanent existing structures.

- Temporary shoring structures shall allow elevation adjustments between short train intervals to adjust system settlement and maintain track profile.

- Temporary shoring structure designer shall include requirements for jacking devices in the drawings. The rated capacity of a jack shall be a minimum of 50% greater than the computed required jacking force. Rapid Transit live loads shall not be supported hydraulically.

- Temporary shoring structure Designer and Contractor shall determine the adequacy of existing structure at time of shoring installation to resist the concentrated force imposed through jacking device. Design shall include details to distribute concentrated force, i.e. full depth stiffeners.

- When temporary shoring structures are located on the roadway and may be subjected to vehicle collision, temporary shoring structures shall be designed to withstand vehicle collision force specified in CTA IDCM Chapter 7, or IDOT standard F shape barriers shall be installed to redirect errant vehicles.

- When shoring structures are exposed to impacts of construction equipment only, IDOT standard F shape barriers or other suitable barrier shall be installed.

- Earth Retention Structure shall be in place before erection/installation of temporary shoring structures.

- If multiple bents are necessary to be shored to facilitate the Adjacent Construction Project, temporary shoring structures will not be permitted to be in service concurrently on adjacent bents.

- Monitoring of temporary shoring structure and the existing track structure shall follow the requirements specified in Section 10 with the modifications in CTA Specification 31 09 13 – Geotechnical and Structural Monitoring Instrumentation Part 3 Execution – Data Collection and Processing.[42]
- After temporary shoring structures are removed, all open holes shall be filled with High Strength structural bolts F3125 Grade A325 type 7/8" diameter installed as Pretensioned Joint using turn-of-the-nut method.

If existing CTA elevated track structure settled more than 3/8" before emergency shoring structure is implemented, CTA may require the settlement be corrected on a case-by-case basis. The correction method may be underpinning the existing foundation, or jack up the settled foundation to the original elevation then shim plates be provided under the column base. The correction method shall be reviewed and approved by CTA Engineering.

11.5 EXISTING CTA FACILITIES

11.5.1 General

Adjacent construction work shall not interfere with any existing CTA structure/facility functions such as station entrances, bus turnarounds, CTA facility/shop entrances, etc. It is recommended that ten (10) feet minimum clearance be provided for all new development next to the adjacent CTA structures to ensure future abilities to inspect and maintain both structures unless additional clearance is required, for example, when impacting station exit, etc.

11.5.2 CTA Subway Vent Shafts Protection or Reconstruction

In no way shall future development incorporate vehicle drive lanes or parking areas over CTA vent shafts.

Where demolition or construction will take place in close proximity to a CTA vent shaft, the vent shaft shall remain open and uncovered during construction at all times. The Contractor shall protect the vent shafts from damage and protect them from construction debris falling into the vent shaft. Typically, this can be achieved by installing a temporary wood structure around the perimeter of the vent shaft, potentially with an access door.

Where the Adjacent Construction proposes to repair/re-profile the sidewalk and CTA vent shafts, CTA typical vent shaft repair guide drawings will be provided after the initial coordination.

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[42] See Section 11 Commentary

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APPENDIX A – SUBMITTAL CHECKLISTS

SHORING DESIGN CHECKLIST

The shoring designer shall complete, sign, seal, and submit the enclosed Shoring Submittal Design Checklist with the shoring design submittal.

SHORING DESIGN REVIEW CHECKLIST

The submitted Shoring Design Checklist shall be utilized by consultants (independent party for QA/QC per Section 2.1) as Submittal Review Checklist to aid the review of shoring design submittals.

CONSTRUCTION PROCESS PLAN (CPP) Checklist

The Construction Process Plan (CPP) Checklist shall be utilized by the Contractor and attached to the CPP to aid the review and can be used as a general CTA Inspector's checklist where indicated on the checklist.

CONCRETE PRE-POUR CHECKLIST

Where it is determined that the concrete placement poses a hazard to CTA operations, the following checklist must be filled and submitted to CTA for record. If during the inspection non-compliance are identified, Contractor must bring items into compliance prior to placing concrete. Checklist must only be submitted when all items are in compliance.

TOWER CRANE CHECKLIST

Where it is determined that the Tower Crane Operation poses a hazard to CTA operations, the following checklist must be filled and submitted to CTA for record. If during the inspection non-compliance are identified, Contractor must bring items into compliance prior to operating the Tower Crane. Checklist must only be submitted when all items are in compliance.

TASK SPECIFIC CHECKLIST

Checklists are provided in this Appendix for the CTA Inspectors to complete during inspections. These blank checklists shall be included and attached digitally to the end of the submitted Construction Process Plan as appropriate based on the work. The checklists for CTA Inspectors are digitized to allow filling the checklists with digital devices. Contractor shall ensure the preserve this function when extracting the checklists from the ACM, and attaching them to the submitted CPP.

Various items are marked with 📷 to indicate that a photo shall be taken by the CTA Inspectors to show the corresponding work has been performed per the CPP. The photos shall be sent to CTA via daily reports with a brief description for each photo that includes information such as: time, location, confirmation that the checklist item has been done according to the CPP, and/or issues encountered, etc.

SHORING DESIGN CHECKLIST

Project Name/Location: ____________________

Submittal Date: ____________________

Shoring Design Firm: ____________________

Contractor: ____________________

Item	Yes/No /NA	Explain if No or NA
Drawings – Checked, Signed & Sealed?		
1. Drawings to-scale?		
2. Plan view is oriented correctly and shows relative position of shoring/excavation and tracks, stationing, bent number, and all pertinent Operating System Facilities (surface and underground)?		
3. Section normal to track(s) shows elevations of track(s), ground surface, excavation subgrade, bracing elements and horizontal clearances?		
4. Dimensions defining the arrangement of all elements of shoring system provided?		
5. Sizes of all shoring elements provided?		
6. All connections detailed?		
7. Specifications for all materials provided?		
8. Specifications and requirements for fabrication and installation provided?		
9. Construction sequence(s) detailing all steps/stages in the shoring installation, excavation, planned installation equipment location and shoring removal provided?		
10. Track monitoring requirements specified?		
11. Impacts to existing drainage addressed?		
Design Calculations – Checked, Signed & Sealed?		
General:		

Item	Yes/No /NA	Explain if No or NA
1. Design calculations provided for all elements of the shoring system?		
2. Calculations for all steps/stages of excavation and support removal?		
3. Shoring designer has verified the accuracy, suitability, and applicability of the information and criteria outlined in the CTA Adjacent Construction Project Manual for the specific application being designed?		
Loading:		
4. Soil loading (active and passive) developed in accordance with Section 5.2?		
5. Groundwater loading developed in accordance with Section 5.3?		
6. Surcharge loading (other than Rapid Transit Live Load Surcharge) developed in accordance with Section 5.4?		
7. Rapid Transit Live Load Surcharge developed in accordance with Section 6?		
8. All required loads considered in shoring analysis?		
Analysis:		
9. Shoring wall analyzed in accordance with Section 7?		
10. Bracing loads determined in accordance with Section 7?		
11. Embedment depth of wall determined in accordance with Section 7?		
12. Bracing system analyzed in accordance with Section 7.6?		
13. Lagging analyzed in accordance with Section 7.7?		
14. Secondary bracing, connections, and stiffeners analyzed and provided in accordance with Section 7.8.2?		

Item	Yes/No /NA	Explain if No or NA
15. Shoring deflection and settlement estimated in accordance with Section 7.9?		
Material Properties and Allowable Stresses:		
16. Material properties and allowable stresses in accordance with Section 8?		
Special Conditions:		
17. Is external dewatering proposed?		
a. If yes, has dewatering been accepted by CTA?		
b. If yes, has a settlement analysis (due to dewatering been provided?		
18. Has the potential for piping been evaluated in accordance with Section 9.3.1?		
19. Has potential for heave been evaluated in accordance with Section 9.3.2?		
20. Has global stability of the shoring system be evaluated in accordance with Section 9.4?		
21. Are tiebacks proposed?		
a. If yes, has CTA accepted their usage?		
b. If yes, are they designed and will they be tested in accordance with Section 9.5?		
22. Are deadmen proposed?		
a. If yes, has CTA accepted their usage?		
b. If yes, has third party approval been granted?		
c. If yes, are they designed in accordance with Section 9.6?		
The following items are to be used for Section 11 only.		
1. Is Adjacent Construction over or adjacent to CTA underground structures and/or underground structures that is within the Zone of Influence in Figure 11-2?		

Item	**Yes/No /NA**	**Explain if No or NA**
• If yes, has Special Monitoring requirements been provided by CTA?		
• If yes, has CTA accepted the Adjacent Construction to be minor construction in accordance with Section 11.1.4?		
• If yes, has a rigid/stiff support of excavation system been designed? Or has CTA accepted the use of any other system?		
• Has tunnel analysis been performed in accordance with Section 11.1.3?		
• Has probing been done to locate the existing CTA underground structures?		
• Is permanent casing included for caissons/drilled shaft?		
2. Is Adjacent Construction directly above CTA tracks and/or facilities?		
a. If yes, is CTA train clearance satisfied in accordance with Section 11.2.1?		
b. If yes, is protective measure provided in accordance with Section 11.2.1?		
c. If yes, is pier/foundation wall protection in accordance with Section 11.2.2?		
d. If yes, are requirements for pier/foundation wall formwork included in the Specifications in accordance with Section 11.2.3?		
3. Is Adjacent Construction adjacent to CTA elevated track structures?		
a. If yes, is excavation required that is within the Zone of Influence shown in Figure 11-4?		
i. If yes, has CTA provided necessary information to calculate the bearing pressure? Or allowable bearing pressure is used for the design?		
ii. Is the excavation adjacent to a tower bent and is the 1.5 factor being included		

Item	Yes/No /NA	Explain if No or NA
if the allowable bearing pressure is used?		
4. Is Adjacent Construction adjacent to CTA vent shafts?		
a. Will CTA vent shaft(s) be repaired?		
i. If yes, are typical vent shaft guide drawings filled and submitted to CTA for review?		

Shoring Designer Signature and IL SE Seal

Print Name

Independent Reviewer's Signature and IL SE SEAL

Print Name

Status:
☐ No Exceptions Taken
☐ Make Corrections Noted
☐ Revise and Resubmit

Attach additional sheets for review comments, as necessary. All additional review comments and their dispositions must be submitted with the checklist to CTA for record.

CONSTRUCTION PROCESS PLAN CHECKLIST

Project Name/Location: ______________________

Submittal Date: ______________________

Shoring Design Firm: ______________________

Contractor: ______________________

Note: shaded cells are intended for CTA Inspectors.

<table>
<tr><th>Item</th><th>ACM Section</th><th>Yes/No/NA</th><th>Explain if No or NA</th></tr>
<tr><td>Contact list included?</td><td>2.7(a)</td><td>Yes</td><td></td></tr>
<tr><td>General Project information included?</td><td>2.7(b)</td><td>Yes</td><td></td></tr>
<tr><td>Table of contents included?</td><td>2.7(c)</td><td>Yes</td><td></td></tr>
<tr><td rowspan="2">Summary of potential changes on site included?</td><td>2.7(d)</td><td>Yes</td><td></td></tr>
<tr><td colspan="3">CTA Inspectors field verify required.</td></tr>
<tr><td colspan="4"><i><u>CTA Inspector Note: ensure the potential change summary is followed on-site. Include in the daily report to CTA noting any potential changes are made on-site based on the CPP and reasons why changes were made.</u></i></td></tr>
<tr><td rowspan="2">Summary of possible conflicts/issues with actions?</td><td>2.7(e)</td><td>Yes</td><td></td></tr>
<tr><td colspan="3">CTA Inspectors field verify required.</td></tr>
<tr><td colspan="4"><i><u>CTA Inspector Note: include in the daily report to CTA noting any conflicts/issues encountered on-site and confirm proper actions are taken.</u></i></td></tr>
<tr><td rowspan="2">Description of proposed temporary changes to CTA Operating System.</td><td>2.7(f)</td><td>Yes</td><td></td></tr>
<tr><td colspan="3">CTA Inspectors field verify required.</td></tr>
<tr><td colspan="4"><i><u>CTA Inspector Note: Coordinate with CTA Operation for safety related procedures/checklists for any changes to CTA Operating System such as Single Track, etc. Include the number of flaggers in the daily report to CTA.</u></i></td></tr>
<tr><td rowspan="2">Material and equipment list with site plan?</td><td>2.7(j)</td><td>Yes</td><td></td></tr>
<tr><td colspan="3">CTA Inspectors field verify required.</td></tr>
<tr><td colspan="4"><i>CTA Inspector Note: Verify and confirm material and equipment match the list in CPP. For example, material would include sheet pile, H pile, timber lagging size and grade, grout, or concrete mix, etc. For equipment, verify the equipment model number, especially for crane or any weightlifting equipment that may foul the CTA tracks.</i></td></tr>
</table>

Detail construction sequences with drawings, and how each activity affects the normal operation.	2.7(g) (i) (k)	Yes	
	CTA Inspectors field verify required.		
CTA Inspector Note: Verify and confirm the construction sequences are followed and if any deviations occur on site other than what is included in the potential changes in the CPP as shown in ACM Section 2.7(d).			
Detail schedule.	2.7(h)	Yes	
	CTA Inspectors field verify required.		
CTA Inspector Note: Verify and confirm the percentage of completion of each activity in the daily report to CTA. Confirm if the Adjacent Construction is on schedule.			
Quality control plan, Construction Verification.	2.7(l) (m) (o) (n) 2.8	Yes	
	CTA Inspectors field verify required.		
*CTA Inspector Note: Verify and confirm the quality control plan is followed such as Welding Procedure Specification is followed, concrete break test, etc. Where Construction Verification is required for the work and shown in the CPP, verify, **witness**, and confirm hold point(s) are provided and the Engineer In Responsible Charge is on-site performing the verifications.*			
Monitoring plan and contingency plan.	2.7(p) (q)	Yes	
	CTA Inspectors field verify required.		
CTA Inspector Note: Verify and confirm monitoring plan included in the CPP is followed. Verbally confirm with the surveyor after each reading is taken. If no settlement or settlement less than 1/16" is confirmed, include the information in the daily report. If settlement greater than 1/16" but less than 3/16" is confirmed, report to CTA Engineering immediately via email with the confirmed settlement reading. If reading equal to or greater than 3/16" is confirmed, the actions shown in the contingency plans shall be followed per the CPP.			
Job Hazard Analysis.	2.7(r)	Yes	
	CTA Inspectors field verify required.		
CTA Inspector Note: Coordinate with CTA Safety and report any safety violation, if any, in daily report, as necessary.			

Task specific checklists	2.7(t) Appendix A	Yes	
	CTA Inspectors field verify required.		
CTA Inspector Note: Coordinate with CTA Safety and report any safety violation, if any, in daily report, as necessary.			
Approved Variance Requests	2.7(s)	Yes	
Methods to identify underground utilities, if required.	2.7(u) 2.8 3.6	Yes	
	CTA Inspectors field verify required.		
CTA Inspector Note: verify and confirm, when required, underground utilities are identified with the approved methods in the CPP.			

Additional Field Notes for CTA Inspector:

CTA INSPECTOR GENERAL INSPECTION CHECKLIST

Project Name/Location: ____________________

Inspection Date: ____________________

CTA Inspector Name: ____________________

Contractor Superintendent Name: ____________________

Note: This CTA Inspector Checklist is required to be attached and completed for all CPP. CTA Inspectors are recommended to complete these inspection checklists with assistance/coordination with the Contractor's superintendent.

ITEM	**ACM Section**	**Yes/No/ NA**	**Explain if No or NA**
Do you have a copy of the approved Construction Process Plan?	2.7 Appendix A	Yes	
Is the GC's Superintendent or quality representative on site?	N/A	Yes	
Did you attend or confirm that the Contractor conducted a briefing/pre-activity meeting on the CPP prior to the start of work.	2.7	Yes	
CTA Inspector Note: CTA Engineering will provide briefing points for Contractor upon review of the CPP. CTA Inspectors shall ensure these briefing points are understood by all parties doing the work.			
Did you verify and confirm that the Contractor has obtained the necessary documents such as Right of Entry Document, Rail Safety Training, etc?	2 3.4	Yes	
📷 If flaggers are required for the work, did you verify the number of flaggers?	3.9	Yes	
If single track/reroute, or line cut is required for the work, did you coordinate with CTA Train Operations and CTA safety?	3.9	Yes	
If CTA track/facility structure monitoring is required, did you verify and confirm with the Contractor that the baseline monitoring had been conducted?	10.3 10.6	Yes	
📷 If identifying underground utilities is required, did you witness and confirm all existing utilities, especially for CTA utilities, have been identified in the field prior to any excavation?	3.6	Yes	
Did you verify and confirm that Contractor personnel have the proper Personal Protection Equipment, including fall protection, when required?	3.7	Yes	

TEMPORARY EARTH RETENTION STRUCTURE INSPECTION CHECKLIST

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
📷 Did you verify the distance from edge of the ERS system/excavation to the center line of adjacent track or edge of CTA track/facility structures matches the approved CPP?	2.7(a)	Yes	
CTA Inspector Note: OUC typically permits to move the utility alignment for up to 2 feet in all directions which may result in ERS system moving 2 feet closer to CTA structures. However, this is not allowed in the ACM per Section 2.1.			
Did you verify the delivered material such as sheet piles, and H piles, equal to or exceed the minimum required length per the Drawings?	N/A	Yes	
📷 Did you verify if there are markings on the sheet piles or H piles that can indicate embedment depth and excavation limits? If not, did you confirm with the Contractor what is the method used to determine these depths?	N/A	Yes	
📷 If sheeting piles are cold-formed type and ground water is anticipated to be retained, did you witness or verify if Contractor applied interlock sealant on the installed sheet piles?	8.1.2	Yes	
CTA Inspector Note: cold-formed type sheet piles are usually designated as SKL, SKS, or SKZ types. If cold-formed sheet piles are designed to retain groundwater, CTA Engineering will ensure the requirement to apply interlock sealant is clearly shown in the drawings. CTA Inspector needs to review the drawings and ensure this is implemented in the field.			
If soldier piles/H piles require splices, or waler/strut connections contain welded joints, did you verify the welder's certificates, and the welding procedure specification is on-site and followed such as pre-heat? After welding is completed, did you witness any visual inspection done to ensure the weld size and length comply with the Drawings and no other obvious defects that may affect the soundness of the weld.	1.4 AWS D1.1	Yes	
📷 If soldier pile ERS is used, did you verify that timber laggings were installed with the maximum excavation lift as recommended by the Geotechnical Engineer? Did you verify that grout was poured behind the laggings to fill the voids?	3.1 Zone 3 4.2.2	Yes	
CTA Inspector Note: when micropiles are permitted to be used as soldier piles for the ERS, CTA Inspector shall complete the Micropile Checklist.			

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
If secant pile ERS is used, did you verify and confirm with the Contractor on how drilling tolerances of the piles were checked and ensured compliance with the tolerance limits shown on the drawings?	4.2.1	Yes	
CTA Inspector Note: Per ACM Section 4.2.1 piles tolerances are 2 inches offset and 1% vertical out-of-plumb by default, unless otherwise shown on the Drawings or waived entirely and approved by CTA Engineering. Secant pile construction is similar to caisson/drilled shaft. CTA Inspector shall complete the Caisson/Drilled Shaft Checklist.			
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

FLAGGER VERIFICATION/RAIL SERVICE BULLETIN CHECKLIST

Project Name/Location: ____________________

Job Order Number: ____________________

Flagger Confirmation Number: ____________________

Rail Service Bulletin Number: ____________________

Date: ____________________

Note: An approved Flagging Request form/spreadsheet, and Rail Service Bulletin Request if Single Track/Reroute is required, shall be used to complete this checklist. The above-mentioned Job Order Number and Confirmation Number are shown in the Flagging Request form/spreadsheet.

ITEM	ACM Section	Yes/No/ NA	Explain if No or NA
Did you verify a Confirmation Number is provided in the Flagging Request form/spreadsheet for today's work?	N/A	Yes	
Did you verify and confirm the Contact Person shown on the approved Flagging Request is on-site.	N/A	Yes	
📷 Did you verify and confirm the correct number of flaggers is on-site and positioned per the Flagger Manual?	N/A	Yes	
If Single Track/Reroute is required for the work, did you verify and confirm the Rail Service Bulletin has been approved?	N/A	Yes	
If Single Track/Reroute is required for the work, did you verify and confirm the Contractor Person in Charge/Requestor is on-site?	N/A	Yes	
📷 If Single Track/Reroute is required for the work, did you verify and confirm the correct number of additional personnel and equipment are on-site and installed, such as additional signal, traction power isolation, etc?	N/A	Yes	

Additional Field Notes for CTA Inspector:

FIELD WELDING CHECKLIST

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
Did you confirm if Contractor's Superintendent and Quality Representative/Certified Welding Inspector were on site?	2.7(I) 7.8.6	Yes	
Did you verify and confirm if welding performed was according to the approved welding procedure?	7.8.6	Yes	
Did you verify and confirm if welding inspector AWS Certified Welding Inspector (CWI)?	7.8.6	Yes	
Were the conditions acceptable during the welding process?	7.8.6	Yes	
CTA Inspector Note: No welding in water, rain, or snow, high winds, and not under 0ºF without a shelter. Refer to AWS D1.1 Article 5.11 for more information.			
Did you visually verify and confirm if the surface of steel was clean and clear, paint, water, or grease?	7.8.6	Yes	
Did you verify and confirm with the Welding Inspector that he/she ascertain that only materials conforming to the requirements of the CPP were used?	2.8	Yes	
Did you verify and confirm if the welders had a way to prove their amperes and voltage was correct; i.e., calibrated gauges or a calibrated clamp meter?	7.8.6	Yes	
Did you verify and confirm if at the start of welding on the piles, was alignment and fit-up acceptable?	7.8.6	Yes	
Did you verify and confirm if the welding inspector required requalification of any welder, welding operator, or tack welder whose qualifications are not current as per welding code?	7.8.6	Yes	
Did you verify and confirm if the welders were working within his qualification limits? Is the welder certificate current as most field welders are qualified for only one year at a time?	7.8.6	Yes	
CTA Inspector Note: Welder's Performance Qualification Test Report may not be within one year, however, welders are qualified as long as their continuity log shows the welders have been performing the qualified welds.			
During welding, did the CWI check the following: a. Preheat and Interpass Temperature b. Cleaning, Chipping, Grinding, and Gauging c. Structural Discontinuities	7.8.6	Yes	

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
Did you confirm with the CWI if he/she ascertain that the size, length, and location of all welds conform to the requirements of the code and to the detailed drawings and that no unspecified welds have been added without approval?	2.8	Yes	
Did you confirm with the CWI if 100% visual inspection of welded connections were performed and 15% of welds selected at random were measured for length, thickness, and profile?	2.8	Yes	
📷 Was the general weld appearance acceptable? (There should not be an arc strike, or excessive undercut. Is the size O.K.)?	2.8	Yes	
📷 Did you verify if CWI recorded types and locations of all defects found in the work and measures required and performed to correct all these defects?	2.8	Yes	
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

CAISSON/DRILLED SHAFT/SECANT PILE CHECKLIST

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
Did you confirm if Contractor's Superintendent and Quality Representative in Geotechnical Engineering were on site?	2.7(I)	Yes	
Did you confirm if the testing agency Inspector/Engineer is on site performing full time inspection of the whole caisson work?	2.7(I)	Yes	
📷 Did you confirm if the probing operation was done to identify the edge of CTA's adjacent structures prior to the caisson work?	11.1.4	Yes	
📷 If required by CTA, did you attend the pre- and post-inspection was done for the CTA substructures? If required by CTA that continuous monitoring is required for the CTA substructures, is there enough CTA Inspectors to provide inspections for the caisson drilling on the surface level and continuous monitoring in the CTA substructures?	11.1.4	Yes	
CTA Inspector Note: Based on the type, depth, location, and soil layers of the adjacent caisson installation, CTA Engineering may determine a pre- and post-inspection of the CTA substructures/subway tunnels are required. Pre-inspection requires a walkthrough to identify and document all existing cracks and their measurements (width, length, etc). Post-inspection would verify if existing crack measurements increased. If continuous monitoring is required inside the CTA subway tunnels, depending on the subway tunnel layout, multiple CTA Inspectors are needed to provide continuous monitoring when special inspection and monitoring is required per 11.1.4.			
When shown in the CPP that permanent casings are required, did you verify if permanent casing wall thickness and lengths comply with the CPP?	11.1.4	Yes	
When permanent or temporary casings are used, did you coordinate with the Contractor's superintendent to confirm the drill auger did not extend beyond the bottom of the casings in weak soil layer?	11.1.4	Yes	
📷 When there is a line of caissons longitudinally adjacent to the CTA underground structures, did you verify and confirm that no more than one shaft is excavated and open at any time?	11.1.4	Yes	
CTA Inspector Note: This requirement may be waived by CTA Engineering when the two shafts open are not next to each other and permanent casings are used.			
If de-watering is permitted for the caisson construction, did you verify and confirm Contractor provided continuous monitoring on the adjacent CTA structures? Did you make sure the amount of water pumped did not exceed 900 gallons?	9.2	Yes	

Task Specific Item	**ACM Section**	**Yes/No /NA**	**Explain if No or NA**
Did you verify and confirm with the Superintendent understands that the once excavation has started for an adjacent shaft beyond the casing, the work of that caisson shall be carried on 24/7 until caisson has been completed?	11.1.4	Yes	
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

MICROPILE CHECKLIST

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
Did you confirm if Contractor's Superintendent and Quality Representative in Geotechnical Engineering were on site?	2.7(I)	Yes	
Did you confirm if the micropile design Engineer in Responsible Charge is on site performing full time inspection of the whole micropile work?	2.7(I)	Yes	
📷 Did you confirm if the probing operation was done to identify the edge of CTA's adjacent structures prior to the micropile work?	3.6 11.1.4	Yes	
📷 Did you verify and confirm the installation method is Rotary Duplex Drilling method?	11.1.4	Yes	
Did you verify and confirm with Contractor's Superintendent that a CCP briefing was conducted prior to the work so that drill rig operator is familiar with the extent/depth of the <u>weak</u> soil layer, and is aware the drill bit shall not extend beyond the bottom of the casing in weak soil layer?	11.1.4	Yes	
Did you verify and confirm with Contractor's Superintendent that a CCP briefing was conducted prior to the work so that drill rig operator is familiar with the extent/depth of the <u>competent</u> soil layer, and is aware the drill bit shall not extend beyond the bottom of casing exceeding the maximum distance shown in the CPP?	11.1.4	Yes	
📷 Did you verify and confirm with the installer that flushing fluid/air pressure is continuously monitored?	11.1.4	Yes	
Did you verify and confirm with Contractor's Superintendent that a CCP briefing was conducted prior to the work so that installer understands external flushing shall be continuous monitored and if external flushing occurred drilling shall be stopped?	11.1.4	Yes	
📷 Did you verify and confirm temporary shoring material was on-site and ready to be installed when settlement occurs per the Supplement Monitoring in Section 10.4?	10.4	Yes	
Did you familiarize yourself with ACM Section 10.4 for the Supplemental Monitoring when it is required?	10.4	Yes	
<u>CTA Inspector Note: micropile installation, especially when it is in close proximity to CTA elevated track structure shallow foundations, require extensive monitoring to verify if any settlements occurred. A</u>			

Task Specific Item	**ACM Section**	**Yes/No /NA**	**Explain if No or NA**
specific contingency plan is included in ACM Section 10.4 *CTA Inspectors shall ensure the specific actions are taken when required.*			
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

JACK-AND-BORE / HORIZONTAL DIRECTIONAL BORING CHECKLIST

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
Did you confirm if Contractor's Superintendent and Quality Representative in Geotechnical Engineering were on site?	2.7(I)	Yes	
📷 Did you verify and confirm that all CTA underground utility locations have been field verified by potholing when required?	2.8 3.6 4.4	Yes	
Did you verify and confirm that casing pipes are used and consistent with the dimensions shown in the CPP regarding wall thickness, diameter, and length?	4.4	Yes	
If casing pipe requirement is waived, did you verify with CPP and confirm a signed and approved copy of Variance Request is attached to the CPP?	3.2	Yes	
Did you verify and confirm with the Contractor that all mitigation measures have been properly taken as shown on the approved Variance Request?	3.2 Appendix H	Yes	
CTA Inspector Note: When a Variance Request is approved to waive the casing pipe requirement, mitigation measures would include increased carrier pipe thickness, additional corrosion protective coating, or additional capacity for the splice welds, etc. CTA Inspector shall visually verify if mitigation measures are taken properly. For example, CTA Inspector could request the welding inspection report for record.			
Did you verify and confirm that water or slurry under pressure (jetting) or puddling was not used to facilitate boring, pushing, jacking operations, or HDD operations?	4.4	Yes	
Did you confirm with the Contractor's Superintendent that the Jack and Bore operations shall be continuous on a 24-hour per day basis?	4.4	Yes	
📷 For auger boring method, did you verify that the front of the pipe was provided with mechanical arrangements or devices that prevent auger from leading the casing?	4.4	Yes	
📷 For auger boring method, did you verify and confirm that the over-cut by the cutting head/auger did not exceed the outside diameter of the casing pipe by more than one-half inch?	4.4	Yes	

Task Specific Item	**ACM Section**	**Yes/No /NA**	**Explain if No or NA**
📷 For jack-and-bore construction, did you verify if the jacking equipment is properly installed?	3.2 Appendix H	Yes	
CTA Inspector Note: CTA Inspector shall pay extra attention when the jacking pit is within the CTA Zone of Influence, especially the reaction piles are also a part of the ERS retaining soil and track structures. The forces applied to the reaction piles are in the same direction to the soil load/train surcharge. CTA Engineering will verify the reaction piles are designed with the jacking equipment operating pressure and show such information in the CPP. Contractor shall have a gage installed so that the jacking pressure can be continuously monitored. CTA Inspector shall confirm that the jacking pressure is being continuously monitored by the Contractor and the jacking pressure does not exceed the design especially when obstruction is encountered.			
Did you coordinate and confirm with the Contractor Superintendent on the actions required when an obstruction is encountered during the installation and it becomes evident that it is impossible to advance the pipe? Is the equipment on-site to support such actions such as grouting machine, etc?	4.4	Yes	
📷 For horizontal directional drilling, did you coordinate and verify with the Superintendent on the method to verify the advancing of borehole, including angles, depths, exact location of the exit ditch, pilot hole diameter, etc?	4.5 (6) (8)	Yes	
📷 For horizontal directional drilling, did you coordinate and confirm that Contractor was monitoring the actual use of bentonite slurry during boring operation to determine the slurry loss, and how the bentonite slurry return was calculated?	4.5	Yes	
Did you verify and confirm the monitoring requirements specifically for Jack-and-Bore and HDD construction are included in the CPP and followed? Also refer to the Monitoring Checklist.	4.5 (9) 10.3 (i) (j)	Yes	
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

MONITORING CHECKLIST

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
Did you confirm if Contractor's Superintendent and field instrumentation specialist were on site?	10.1	Yes	
Did you verify and confirm that the baseline readings have been done?	10.3 (a)	Yes	
CTA Inspector Note: The 3-day average baseline reading is a recommendation and optional. However, the baseline reading method must be consistent with what is shown in the CPP.			
📷 Did you verify and confirm that all the material/equipment needed to implement the contingency plan is on-site?	10.4	Yes	
Did you verify and confirm verbally with the surveyor after each reading is taken on the amount of movements?	10.3 (b)	Yes	
CTA Inspector Note: Verify and confirm monitoring plan included in the CPP is followed. Verbally confirm with the surveyor after each reading is taken. If no settlement or settlement less than 1/16" is confirmed, include the information in the daily report. If settlement greater than 1/16" but less than 3/16" is confirmed, report to CTA Engineering immediately via email with the confirmed settlement reading. If reading equal to or greater than 3/16" is confirmed, the actions shown in the contingency plans shall be followed per the CPP.			
📷 Did you verify and confirm the monitoring is done **on a daily basis, before and after each shift** before the excavation reaches the design elevation?	10.3 (b)	Yes	
📷 After monitoring frequency is reduced (7) days after excavation reaches final the design elevation, did you verify and confirm the monitoring frequency is back to **daily, before and after each shift when conditions warrant**?	10.3 (e)	Yes	
CTA Inspector Note: Conditions include: modifications are made to shoring structures, weather condition changes such as heavy rain, freezing temperature and thawing temperature, readings that hit the warning limits and others as directed at the sole discretion of CTA. CTA Inspector may coordinate and confirm with CTA Engineering on the conditions on-site.			
📷 If shoring removal is permitted, did you verify and confirm the monitoring frequency is back to **daily, before and after each shift during the shoring removal process**?	10.3 (f)	Yes	
📷 Did you verify and confirm the monitoring continues after excavation has been backfilled **weekly for a minimum of four weeks**?	10.3 (g)	Yes	

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
When monitoring instruments are used, did you verify and confirm these instruments have been calibrated by the Contactor's field instrumentation specialist and have been properly installed?	10.3 (h)	Yes	
Did you verify and confirm the special monitoring requirements are followed for Jack and Bore and Horizontal Directional Drilling constructions?	10.3 (i) (j)	Yes	
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

HANDRAIL/GUARDRAIL AND WALKWAY CHECKLIST

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
Did you confirm with Contractor's Superintendent that the temporary handrail/guardrail and walkway are regularly inspected and maintained? (Write information on inspection/maintenance frequency in the comment box.)	3.11	Yes	
Did you confirm with the Contractor's Superintendent that a brief safety walk is done at the end of the shift before construction site is shut down?	3.11	Yes	
📷 *CTA Inspector Note: It is recommended that CTA Inspectors witness and participate the safety walk at least twice a week and provide summary on the safety walk. CTA inspectors may also independently verify if there are any protruding objects, loose boards, etc. if the temporary walkway is accessible during the site visit.*			
The following checklist items are required when a high wind event is forecasted. High wind event is defined as: defined as: (1) wind speed equal or greater than 40 mph lasting one hour or longer, or (2) wind speed equal or greater than 58 mph for any duration.	3.11	Yes	
Date of the forecasted high wind event: ___________	3.11	Yes	
CTA Inspector Note: The date of completion of the following items shall be before the date of the high wind event.			
Did you confirm with the Contractor's Superintendent that he/she is aware a high wind event is forecasted?	3.11	Yes	
📷 Did you confirm with the Contractor's Superintendent has coordinated with the temporary structures designer of record to evaluate if any additional measures should be taken to secure the temporary structures against the high wind event? If yes, did you confirm or witness the measures have been implemented before the end of the shift.	3.11	Yes	
📷 Did you witness/participate the required safety walk prior to a forecasted high wind event with the Contractor to ensure the temporary structures are fully secured against the high wind?	3.11	Yes	
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

CONSTRUCTION EQUIPMENT CHECKLIST

Task Specific Item	**ACM Section**	**Yes/No /NA**	**Explain if No or NA**
Did you attend the construction equipment demonstration and have knowledge on all the operational constrains?	3.9.1	Yes	
📷 Did you verify the Construction Equipment on-site matches the brand and model number attached in the CPP?	2.7 w. 10) 3.9.1	Yes	
📷 Did you confirm with the Contractor’s Superintendent all construction equipment on-site is properly maintained and inspected?	3.9.1	Yes	
CTA Inspector Note: Take photos on the maintenance log or inspection log, or any tags/plates available on the equipment.			
📷 Did you confirm with the Contractor’s Superintendent or the equipment operator direct supervisor that a copy of the equipment operation manual is on-site and available that matches what is submitted in the CPP.	3.9.1	Yes	
📷 Did you verify the operators’ qualification cards that should be in compliance with OSHA 1926.1427?	3.9.1	Yes	
Did you confirm with the Contractor’s Superintendent that the platform/ground levelness is within 1 percent grade where the equipment operates on.	3.9.1	Yes	
📷 If the equipment operates on cribbing, or any other type of temporary platform, did you observe restraining devices used to secure the platform?	3.9.1	Yes	
Did you verify if the construction equipment operators and their supervisors completed the accident prevention course?	3.9.1	Yes	
📷 Did you confirm a qualified designated person is on-site to determine and control safety of the equipment operation? Did you observe the designated person use hand signal to direct the operators on equipment operations?	3.9.1	Yes	
📷 If there are additional operational constrains and requirements imposed by the SE review, did you make sure the qualified designated person has knowledge of such requirements and they are being followed?	3.9.1	Yes	
When required per CPP, did you confirm the required hold-down device is in place for the construction equipment?	3.9.1	Yes	

Task Specific Item	ACM Section	Yes/No /NA	Explain if No or NA
📷 Did you confirm with construction equipment operators and their supervisors that when a passing train is present, construction equipment is not permitted to operate within and above the CTA Train Envelope?	Appendix B 3.9.1	Yes	
📷 If the equipment is excavator mounted with a mast, did you confirm a mast foot is installed and used to support the mast on sound ground/platform?	3.9.1	Yes	
📷 If the equipment is excavator mounted with a mast, did you observe and confirm the mast is fully retracted before any movements such as swinging, rotating, or traveling.	3.9.1	Yes	
📷 If the equipment is excavator mounted with a mast, did you observe and confirm the mast is always within ground/platform limit as the equipment swings/travels.	3.9.1	Yes	
📷 If the equipment is excavator mounted with a segmented mast assembly, did you confirm the mast is not extended taller than what is required for the work?	3.9.1	Yes	
📷 If the equipment is excavator mounted with a mast, did you confirm with Contractor's Superintendent that no modifications have been made that are different from what is approved in the CPP?	3.9.1	Yes	
CTA Inspector Note: Take photos of components such as counterweights, undercarriage, mast, mast foot, etc.			
Checklist Completed by (Print / Signature):			

Additional Field Notes for CTA Inspector:

CONCRETE PRE-POUR CHECKLIST

User Note:

- Marks indicate compliance with documents submitted and accepted by CTA. N/A indicates not applicable.
- Inspectors 1, 2 and 3: shall be Designer of Record, Site Superintendent, QA Inspector

Date:	**Time:**	**Temperature:**	**Weather:**	**Wind Speed:**

Location Description:		
Owner Project No.		
Owner Project Name:		
CTA Project #:	**CTA LOCID:**	**CTA Line:**
Mix Design #:	**Formwork Design Pressure:**	
Design Pour Rate:		
Formwork Design Pressure		

FORMS	**Inspector 1**	**Inspector 2**	**Inspector 3**
Wind speed is less than Design Wind Speed	☐	☐	☐
Approved shop drawings are at site	☐	☐	☐
Support and Bracing are outside CTA train clearance envelope	☐	☐	☐
Formwork Concrete Design Pressure	☐	☐	☐
Scheduled Pour Rate	☐	☐	☐
Formwork is installed per shop drawings	☐	☐	☐
Temperature is at or above design temperature	☐	☐	☐
Concrete mix being used matches design mix	☐	☐	☐

Inspectors	**Signature**	**Time**	**Date**
Formwork Designer of Record			
Superintendent			
QA Inspector			

TOWER CRANE CHECKLIST

This checklist provides the basic requirements for safe operations of a tower crane. Tower crane users should consult manufacturers, suppliers and owners on operations and safety requirements and address any concerns before using the equipment. This checklist is non-exhaustive, and users are recommended to make the necessary customization to suit your work processes and conditions at workplace.

S/N	Items		Remarks
	A. Tower Crane Approved For Use		
1	Tower Crane is approved by Ministry of Manpower (MOM).	☐Yes / No☐	
2	Tower Crane has a valid Lifting Machine (LM) certificate (issued less than 12 months ago).	☐Yes / No☐	
	B. General Requirements		
3	Tower Crane is provided with markings of the Safe Working Load, serial number and LM number.	☐Yes / No☐	
4	Safe access and egress are provided to the crane operator.	☐Yes / No☐	
5	A load capacity chart is displayed in the operator cabin.	☐Yes / No☐	
6	Operator crane cabin is provided with a locking mechanism so as to prevent unauthorized entry.	☐Yes / No☐	
7	A safety bar is fitted across the operator’s cabin window where there is likelihood of the operator falling through it.	☐Yes / No☐	
8	Fire extinguisher is fit for use and provided in the operator cabin.	☐Yes / No☐	
9	An updated Operation and Maintenance logbook is available in the operator cabin.	☐Yes / No☐	
10	Manufacturer Operating Manual and Maintenance Manual are made available.	☐Yes / No☐	
11	Tower Crane is adequately grounded or protected against lightening.	☐Yes / No☐	
	C. Other Visual Checks		
12	Load charts and other symbols are available and visible.	☐Yes / No☐	
13	Hydraulic fluid level is sufficient.	☐Yes / No☐	
14	Slewing oil level is sufficient.	☐Yes / No☐	
15	All mounting bolts are in good condition.	☐Yes / No☐	
16	Hydraulic system is free of leaks.	☐Yes / No☐	
17	Boom sections are free of cracks or dents.	☐Yes / No☐	
18	Main and auxiliary wire ropes are well lubricated and that there are no visible defects such as broken wires, kinks, excess wear, crushing etc.	☐Yes / No☐	
19	Winches, pulleys, and wire ropes are in good working condition.	☐Yes / No☐	
20	Crane hook is provided with a safety catch to prevent displacement of the sling or load from the hook.	☐Yes / No☐	
	D. Safety and Operational Devices		
21	Load radius indicator with warning alarm is installed.	☐Yes / No☐	
22	Jib angle indicator is provided (For Luffing Jib Tower Crane).	☐Yes / No☐	
23	Emergency stop button, which will terminate the operation of the crane engine, is installed in the operator cabin and correctly identified.	☐Yes / No☐	

24	Effective braking mechanisms for the following is maintained:		
	(a) Hoisting	☐Yes / No☐	
	(b) Derricking	☐Yes / No☐	
	(c) Slewing	☐Yes / No☐	
	(d) Trolley Travelling	☐Yes / No☐	
25	Hoisting Limiter to prevent over-hoisting of the hook block is functional.	☐Yes / No☐	
26	Trolley Travelling limiter to prevent over-travelling of trolley is functional.	☐Yes / No☐	
27	Limit switches to prevent over-derricking and over-lowering of jib (For Luffing Jib Tower Crane) is functional.	☐Yes / No☐	
28	Slewing limiter to restrict slewing of crane is function.	☐Yes / No☐	
29	Overload Limiter to prevent overlading of crane is functional.	☐Yes / No☐	
30	Load Moment Limiter to prevent over-turning moment is functional.	☐Yes / No☐	
31	Anti-collision devices are tested to stop the tower crane's operation such that the crane-to-crane interference must be maintained at not less than 3 meters (approximately 10 feet).	☐Yes / No☐	
32	Wind anemometer is installed and is in good working condition.	☐Yes / No☐	
33	Adequate aircraft warning lights and/or chequered white and red flags are provided.	☐Yes / No☐	
	E. Maintenance		
34	Data logger for recording key operating parameters of the crane is functional.	☐Yes / No☐	
35	Tower Crane has a regular maintenance program that is in accordance with manufacturer's specifications.	☐Yes / No☐	
36	Maintenance work on the Tower Crane is carried out by Competent Persons.	☐Yes / No☐	

IC-SOP-P002 CHECKLIST

PROJECT TITLE: ________________________________

LOCATION/ACTIVITY: ________________________

EXHIBIT A
REV. 0
IC-SOP-P002

IC-SOP-P002 Extended Duration Construction Slow Zones without Flaggers

Check List – check each applicable box

- ☐ Construction activity adjoining, above or beneath the trackway that has the potential for personnel, material or equipment to accidentally intrude upon a train's clearance envelope
- ☐ Excavation under or adjacent to any ballasted track or elevated, subway or earth retention structure
- ☐ Any shoring required of an elevated track structure
- ☐ Profiling and/or lining of ballasted track
- ☐ Partial loosening or removal of any track element in advance of track renewal (e.g., steel or timber guards, restraining rails, spikes, clips, anchors, lag screws, track bolts, shims, plates…)
- ☐ Partial removal or temporary repositioning of any traction power elements (e.g., contact rail chairs, taps, pot heads, cables, rail and/or structure bonds)
- ☐ Partial loosening or temporary relocation of any signal or communication system cables, conduits and equipment
- ☐ Incomplete installation of new materials or fasteners
- ☐ Temporary storage of any materials in the trackway (e.g., on footwalk, platforms, between rails)
- ☐ Construction activities with potential to cause storm water flooding of the trackway
- ☐ Other activity that may pose a risk to safe operations,

  Describe:____

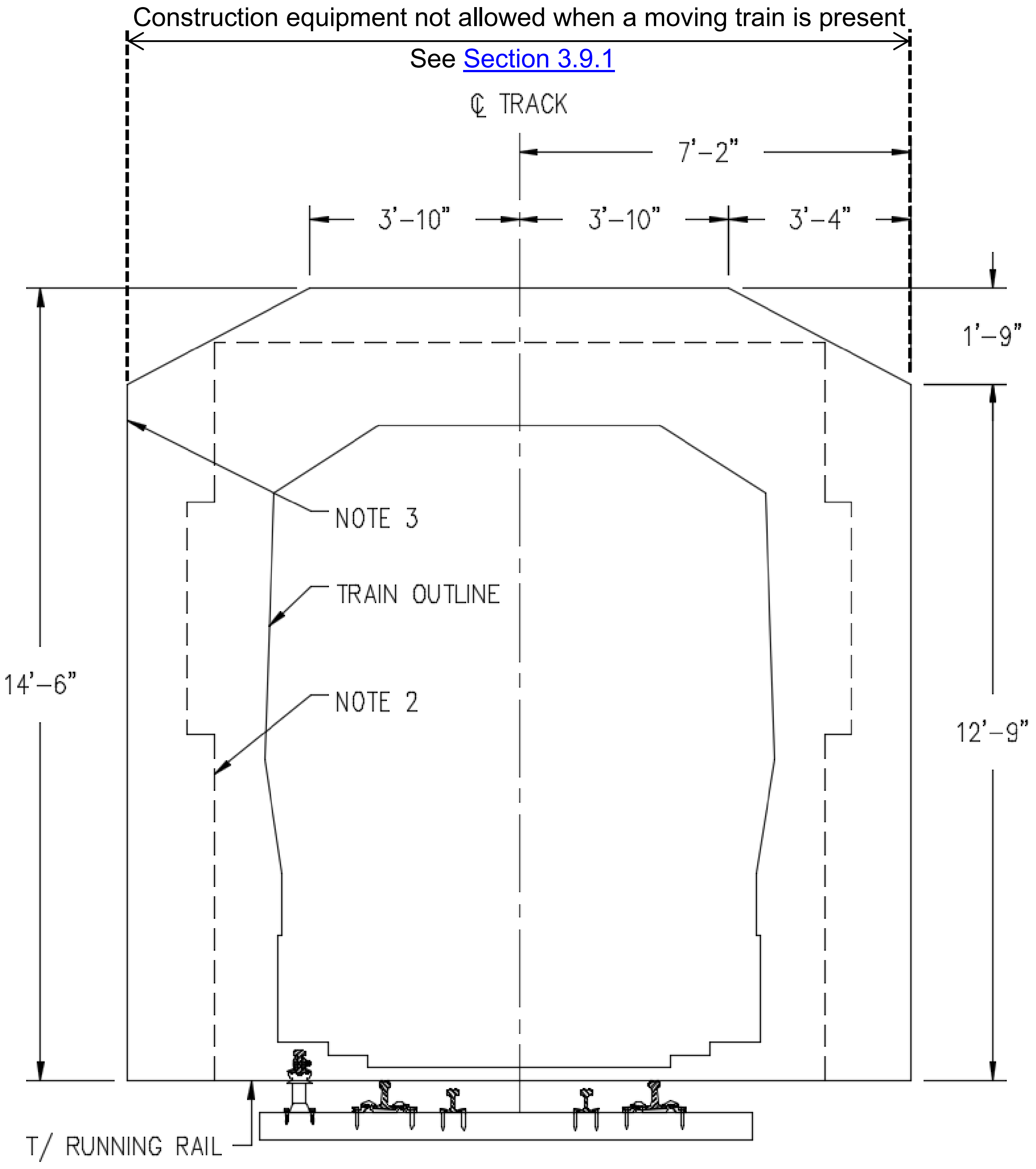
  ____

Submitted by (name, title and employer – please print):

____

Date ____________

APPENDIX B – CTA STANDARD TRAIN ENVELOPE CLEARANCE



NOTES:

1. CONTACT CTA IF WORK WILL BE IN CURVED TRACK AREA OR STATION AREAS.

2. THE MINIMUM TRAIN CLEARANCE ENVELOPE AND SHALL NOT BE USED EXCEPT WHEN PERMITTED BY CTA IN APPENDIX G NOTE 1.

3. WHERE NECESSARY FOR UNOBSTRUCTED VIEW OF WAYSIDE SIGNALS, SIGNS, ETC, CTA MAY REQUIRE GREATER CLEARANCES THAN SPECIFIED IN THE DIAGRAM. COORDINATION WITH RAIL OPERATIONS WILL BE REQUIRED.

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APPENDIX C – SAMPLE CALCULATIONS

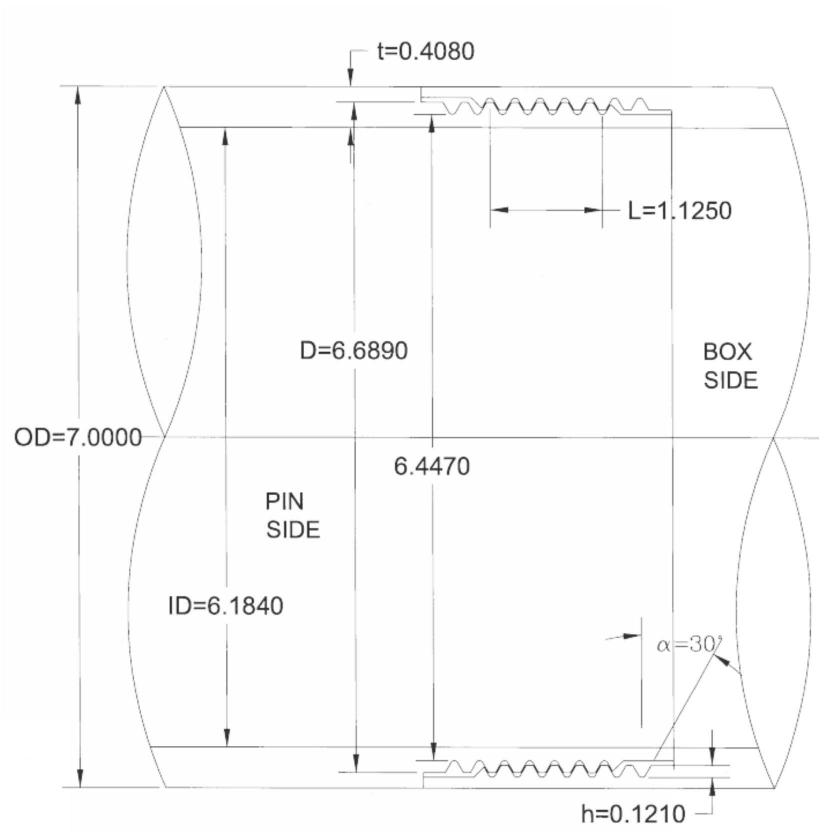
Disclaimer Note:

Sample calculations are intended as guideline for the designer. In no way are these calculations intended to be mistake free and applicable to every project. The project designer is to take full ownership of calculations that they submit and cannot hold CTA liable for any mistakes or non-project application of details contained within these sample calculations.

EXAMPLE 4.1 – BENDING STRENGTH OF THREADED MICROPILE CONNECTIONS

PROBLEM:

DETERMINE THE BENDING CAPACITY FOR THE THREADED MICROPILE CONNECTION SHOWN BELOW FOR THE 7” Φ X 0.408” WALL THICKNESS CASING WITH THE REFERENCE SHOWN IN SECTION 4 COMMENTARY. (“*Bending Strength of Threaded Micropile Connections*” by Steven R. Musselman, J.H. Long, N. Carroll, and S. Farr)



SOLUTION:

DETERMINE MATERIAL PROPERTIES AND JOINT GEOMETRY:

$F_y = 80\ ksi$ $\quad F_u = 100\ ksi$

$ID = 6.184\ in$ $\quad OD = 7\ in$

$l = 1.125\ in$ $\quad h = 0.121\ in$ $\quad D = 6.689\ in$ $\quad \alpha = 30°$

"JUMP OUT" EQUATION PARAMETERS TESTED/PROPOSED BY CLINEDINST PER REFERENCE:

$a = 2.39$ $\quad b = 0.59$ $\quad \psi = 14.35\ deg$ $\quad \Delta_e = 0$

$D_{tension} = D - 2h = 6.447\ in$

CRITICAL AREA OF THE PIN CALCULATED USING EQN. (2) IN REFERENCE:

$$A_p = \frac{\pi\left[(D-h)^2 - ID^2\right]}{4} = 3.846\ in^2$$

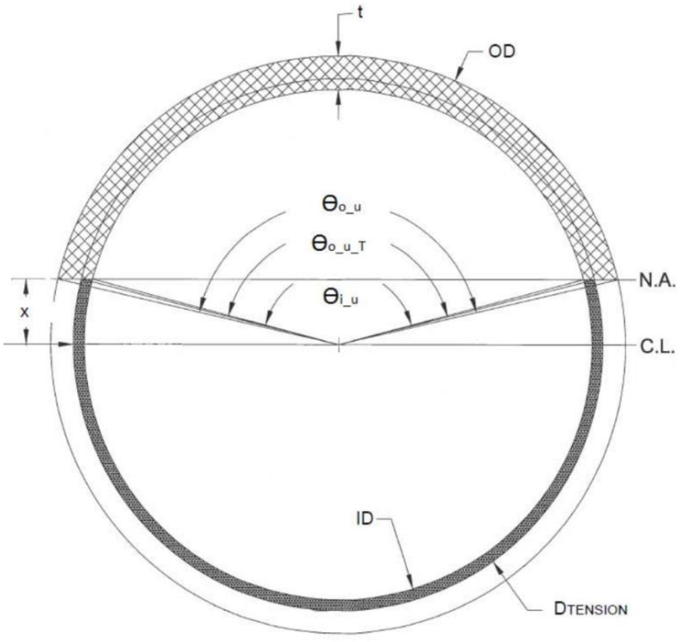
"JUMP OUT" CAPACITY OF API ROUND THREAD CONNECTIONS IN TENSION USING EQN. (1) IN REFERENCE:

$$P_i = \left\{\frac{a\left({}^{2h}/_{D} - \Delta_e\right)^b (F_u)}{{}^{1}/_{2} + {}^{D}/_{2L}[\tan{(a-\psi)}]} + \frac{F_y}{1 + {}^{D}/_{2L}[\tan{(a-\psi)}]}\right\} = \underline{\underline{265.165\ kip}}$$

"FRACTURE" CAPACITY OF THE PIN USING EQN. (3) IN REFERENCE:

$$P_{fracture} = F_u \frac{\pi\left[(D-2h)^2 - ID^2\right]}{4} = \underline{\underline{260.906\ kip}}$$

THE FAILURE MODE IS "FRACTURE" SINCE $P_{fracture} < P_i$.



BASED ON THE RECOMMENDATIONS OF THE REFERENCE PAPER, THE BENDING CAPACITY OF THE CASING WILL BE DETERMINED USING THE PLASTIC TENSION-LINEAR COMPRESSION MODEL. BEFORE THE BENDING CAPACITY CAN BE DETERMINED, THE LOCATION OF THE NEUTRAL AXIS MUST BE FOUND. THE NEUTRAL AXIS CAN BE FOUND BY TRIAL AND ERROR METHOD.

ASSUME AN “x” VALUE:

$$x = 0.79\ in$$

$$\Theta_{o\_u} = 180^\circ - 2\left[\operatorname{asin}\left(\frac{x}{OD/2}\right)\right] = 2.686\ rad$$

$$I_{xo\_u} = \frac{(OD/2)^4}{8}\left\{\Theta_{o\_u} - \sin(\Theta_{o\_u}) + 2[\sin(\Theta_{o\_u})]\left[\sin\left(\Theta_{o\_u}/2\right)\right]^2\right\} = 57.797\ in^4$$

$$A_{o\_u} = \frac{(OD/2)^2}{2}\left[\Theta_{o\_u} - \sin(\Theta_{o\_u})\right] = 13.76\ in^2$$

$$C_{yo\_u} = \frac{4(OD/2)}{3}\left\{\frac{\left[\sin\left(\Theta_{o\_u}/2\right)\right]^3}{\Theta_{o\_u} - \sin(\Theta_{o\_u})}\right\} = 1.921\ in$$

$$I_{xco\_u} = I_{xo\_u} - A_{o\_u}\left(C_{yo\_u}\right)^2 = 7.04\ in^4$$

$$I_{xo\_u}{}' = I_{xco\_u} + A_{o\_u}\left(C_{yo\_u} - x\right)^2 = 24.629\ in^4$$

$$\Theta_{i\_u} = 180^\circ - 2\left[\operatorname{asin}\left(\frac{x}{ID/2}\right)\right] = 2.625\ rad$$

$$I_{xi\_u} = \frac{(ID/2)^4}{8}\left\{\Theta_{i\_u} - \sin(\Theta_{i\_u}) + 2[\sin(\Theta_{i\_u})]\left[\sin\left(\Theta_{i\_u}/2\right)\right]^2\right\} = 34.879\ in^4$$

$$A_{i\_u} = \frac{(ID/2)^2}{2}\left[\Theta_{i\_u} - \sin(\Theta_{i\_u})\right] = 10.186\ in^2$$

$$C_{yi\_u} = \frac{4(ID/2)}{3}\left\{\frac{\left[\sin\left(\Theta_{i\_u}/2\right)\right]^3}{\Theta_{i\_u} - \sin(\Theta_{i\_u})}\right\} = 1.748\ in$$

$$I_{xci\_u} = I_{xi\_u} - A_{i\_u}\left(C_{yi\_u}\right)^2 = 3.759\ in^4$$

$$I_{xi\_u}{}' = I_{xci\_u} + A_{i\_u}\left(C_{yi\_u} - x\right)^2 = 13.116\ in^4$$

$$I_{ABOVE} = I_{xo\_u}{}' - I_{xi\_u}{}' = \underline{\underline{11.514\ in^4}}$$

$$I_{tot\_x}{}' = \frac{\pi}{64}\left(D_{tension}{}^4 - ID^4\right) + \frac{\pi}{4}\left(D_{tension}{}^2 - ID^2\right)(x^2) = 14.642\ \ in^2$$

$$\Theta_{o\_u\_T} = 180° - 2\left[\operatorname{asin}\left(\frac{x}{{D_{tension}}/{2}}\right)\right] = 2.646\,rad$$

$$I_{xo\_u\_T} = \frac{\left({D_{tension}}/{2}\right)^4}{8}\left\{\Theta_{o\_u\_T} - \sin(\Theta_{o\_u\_T}) + 2[\sin(\Theta_{o\_u\_T})]\left[\sin\left({\Theta_{o\_u\_T}}/{2}\right)\right]^2\right\} = 41.36\,in^4$$

$$A_{o\_u\_T} = \frac{\left({D_{tension}}/{2}\right)^2}{2}[\Theta_{o\_u\_T} - \sin(\Theta_{o\_u\_T})] = 11.28\,in^2$$

$$C_{yo\_u\_T} = \frac{4({D_{tension}}/{2})}{3}\left\{\frac{\left[\sin\left({\Theta_{o\_u\_T}}/{2}\right)\right]^3}{\Theta_{o\_u\_T} - \sin(\Theta_{o\_u\_T})}\right\} = 1.804\,in$$

$$I_{xco\_u\_T} = I_{xo\_u\_T} - A_{o\_u\_T}(C_{yo\_u\_T})^2 = 4.653\,in^4$$

$$I_{xo\_u\_T}{}' = I_{xco\_u\_T} + A_{o\_u\_T}(C_{yo\_u\_T} - x)^2 = 16.249\,in^4$$

$$\Theta_{i\_u\_T} = 180° - 2\left[\operatorname{asin}\left(\frac{x}{{ID}/{2}}\right)\right] = 2.625\,rad$$

$$I_{xi\_u\_T} = \frac{({ID}/{2})^4}{8}\left\{\Theta_{i\_u\_T} - \sin(\Theta_{i\_u\_T}) + 2[\sin(\Theta_{i\_u\_T})]\left[\sin\left({\Theta_{i\_u\_T}}/{2}\right)\right]^2\right\} = 34.897\,in^4$$

$$A_{i\_u\_T} = \frac{({ID}/{2})^2}{2}[\Theta_{i\_u\_T} - \sin(\Theta_{i\_u\_T})] = 10.186\,in^2$$

$$C_{yi\_u\_T} = \frac{4({ID}/{2})}{3}\left\{\frac{\left[\sin\left({\Theta_{i\_u\_T}}/{2}\right)\right]^3}{\Theta_{i\_u\_T} - \sin(\Theta_{i\_u\_T})}\right\} = 1.748\,in$$

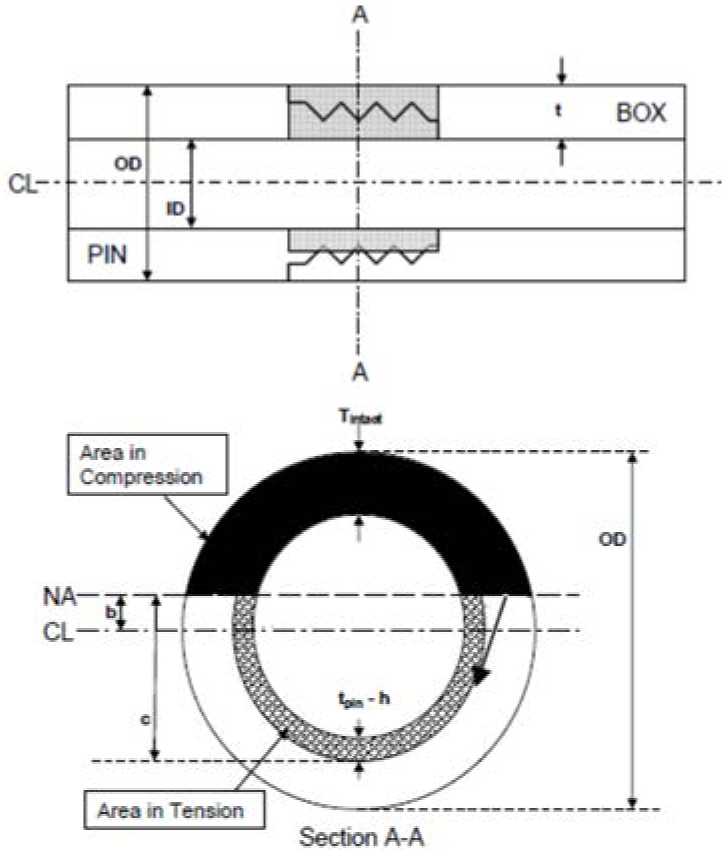
$$I_{xci\_u\_T} = I_{xi\_u\_T} - A_{i\_u\_T}(C_{yi\_u\_T})^2 = 3.759\,in^4$$

$$I_{xi\_u\_T}{}' = I_{xci\_u\_T} + A_{i\_u\_T}(C_{yi\_u\_T} - x)^2 = 13.116\,in^4$$

$$I_{ABOVE\_T} = I_{xo\_u\_T}{}' - I_{xo\_u\_T}{}' = 3.133\,in^4$$

$$I_{BELOW} = I_{tot\_x}{}' - I_{ABOVE\_T} = \underline{\underline{11.508\,in^4}}$$

SINCE $I_{ABOVE} = 11.514\,in^4 \approx I_{BELOW} = 11.508\,in^4$, PROCEED WITH $x = 0.79\,in.$



$$I_{REDUCED} = I_{BELOW} + I_{ABOVE} = 23.022\ in^4$$

$$I_{FULL} = {}^{\pi}/_{64}\,(OD^4 - ID^4) = 46.071\ in^4$$

$$Stiffness\ Ratio = {}^{I_{REDUCED}}/_{I_{FULL}} = 0.5$$

DETERMINE BENDING CAPAICTY BASED ON THE PLASTIC TENSION-LINEAR COMPRESSION MODEL:

$$f_{LIM} = \frac{P_{fracture}}{\pi[(D-2h)^2 - ID^2]/_4} = 100\ ksi$$

$$A_{TENSION} = \frac{\pi}{4}\left(D_{tension}{}^2 - ID^2\right)\left[\frac{360° - \left(\Theta_{o\_u\_T} + \Theta_{i\_u\_T}/_2\right)}{360°}\right] = 1.515\ in^2$$

$$P_T = f_{LIM}(A_{TENSION}) = 151.462\ kip$$

$$M_T = P_T(C_{yo\_u\_T}) = 273.226\ kip \cdot in$$

$$P_T = P_C$$

$$M_C = P_C(C_{yo\_u}) = 290.903\ kip \cdot in$$

BENDING CAPACITY AT THE THREADED JOINT IS CALCULATED AS:

$$M_{TOT} = M_T + M_C = \underline{\underline{564.129\ kip \cdot in}}$$

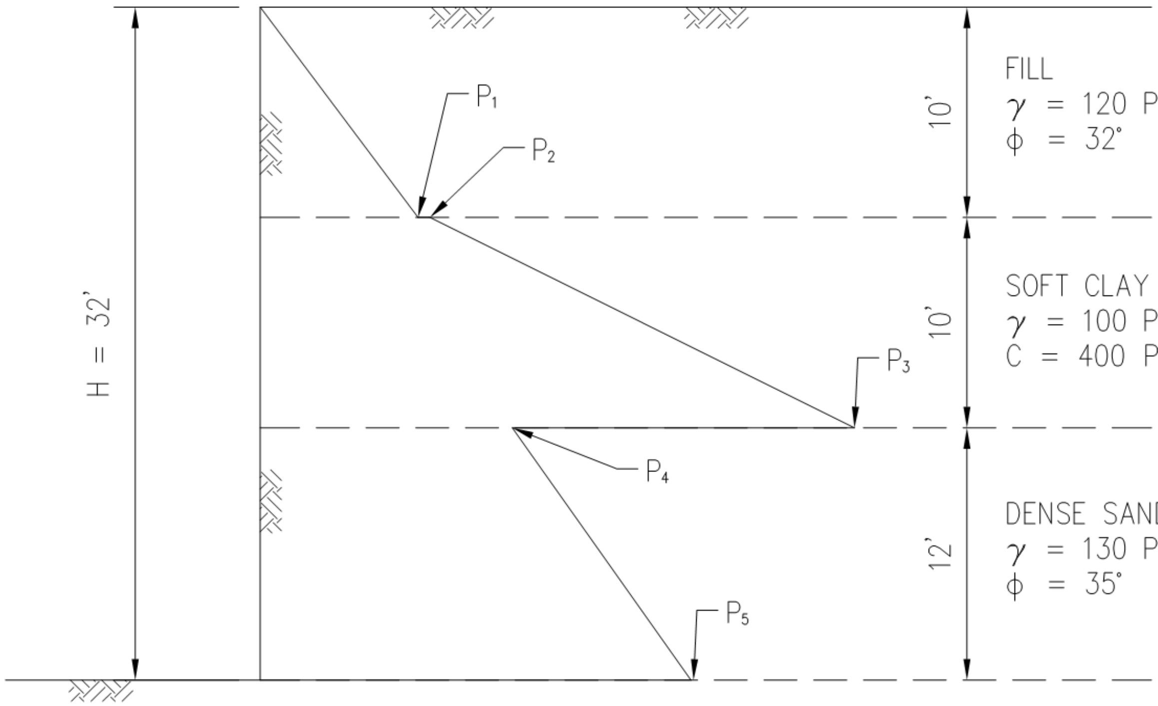
$$M_{FULL} = \frac{F_y(I_{full})}{{}^{OD}/_{2}} = 1{,}053.062\ kip \cdot in$$

$$Bending\ Capacity\ Ratio = \left({}^{M_{TOT}}/_{M_{FULL}}\right)100\% = \underline{\underline{53.6\%}}$$

EXAMPLE 5.1 – DEVELOP AN ACTIVE SOIL PRESSURE DIAGRAM

PROBLEM:

DEVELOP ACTIVE SOIL PRESSURES FOR THE FOLLOWING SOIL PROFILE.



SOLUTION:

USING RANKINE'S THEORY –

$$K_{A,FILL} = tan^2(45° - \phi_{FILL}/2) = tan^2(45° - 32°/2) = \underline{\underline{0.31}}$$

$$K_{A,DENSE\ SAND} = tan^2(45° - \phi_{DENSE\ SAND}/2) = tan^2(45° - 35°/2) = \underline{\underline{0.27}}$$

COMPUTE ACTIVE PRESSURES –

$$P_1 = K_{A,FILL}(\gamma_{FILL})(10') = 0.31(120)(10) = \underline{\underline{372PSF}} > 30(10) = 300PSF$$

$$P_2 = \gamma_{FILL}(10') - 2C = 120(10) - 2(400) = \underline{\underline{400PSF}}$$

$$P_3 = P_2 + \gamma_{SOFT\ CLAY}(10') = 400 + 100(10) = \underline{\underline{1{,}400PSF}} > 30(20) = 600PSF$$

$$P_4 = K_{A,DENSE\ SAND}[(\gamma_{FILL})(10') + (\gamma_{SOFT\ CLAY})(10')] = 0.27[(120)(10) + (100)(10)]$$

$$= 594PSF < 30(20) = \underline{\underline{600PSF}}$$

$$P_5 = P_4 + K_{A,DENSE\ SAND}[(\gamma_{DENSE\ SAND})(12')] = 594 + 0.27(130)(12)$$

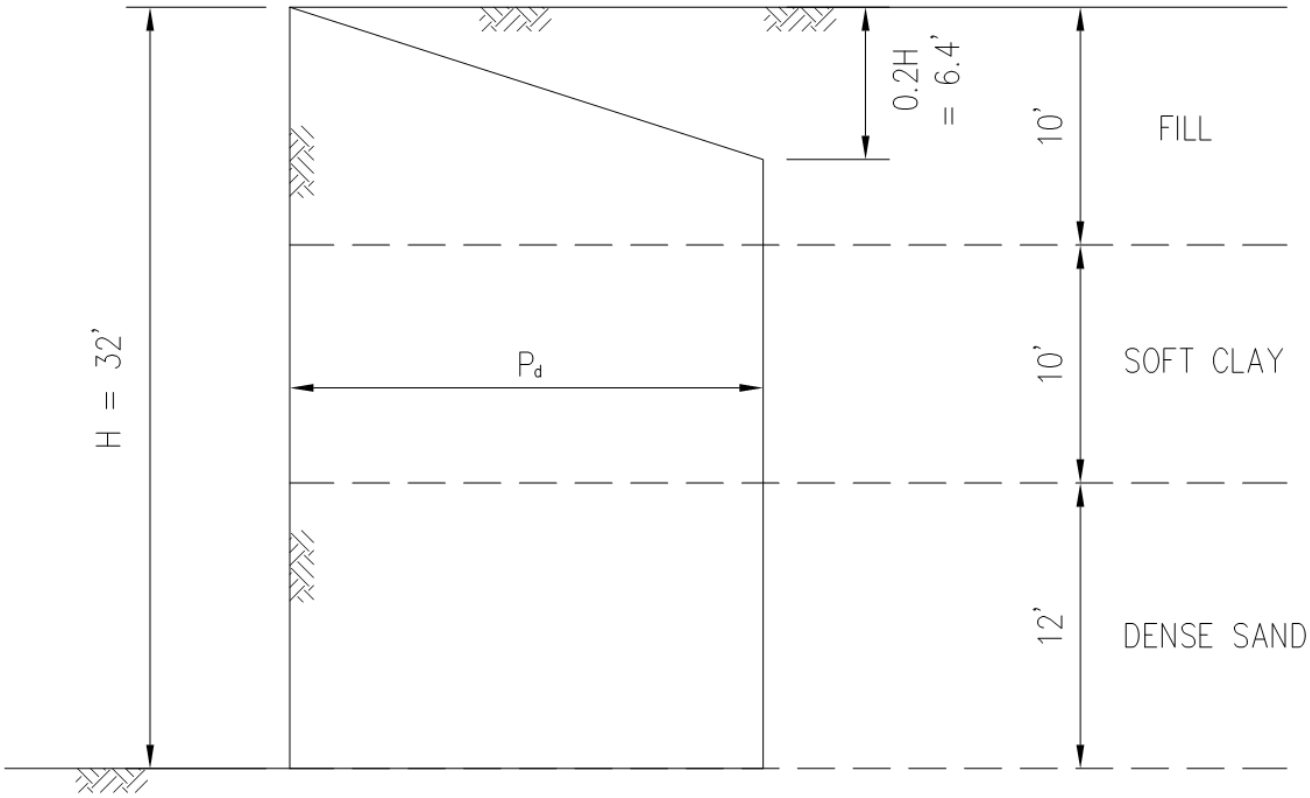
$$= \underline{\underline{1{,}015PSF}} > 30(32) = 960PSF$$

Note: Refer to Section 5.2.2 for the minimum active pressure requirement (the active pressure at any depth shall not be less than 30(Y) psf where Y is a depth below the ground surface in feet) and its commentary[9].

EXAMPLE 5.2 – DEVELOP AN APPARENT SOIL PRESSURE DIAGRAM

PROBLEM:

DEVELOP AN APPARENT PRESSURE DIAGRAM FOR THE SOIL PROFILE GIVEN IN EXPAMPLE 5.1.



SOLUTION:

COMPUTE TOTAL ACTIVE PRESSURE RESULTANT (A_1) –

$$A_1 = (372)(10)/2 + (400 + 1400)(10)/2 + (594 + 1015)(12)/2 = \underline{\underline{20{,}514 LBS/FT}}$$

COMPUTE P_d –

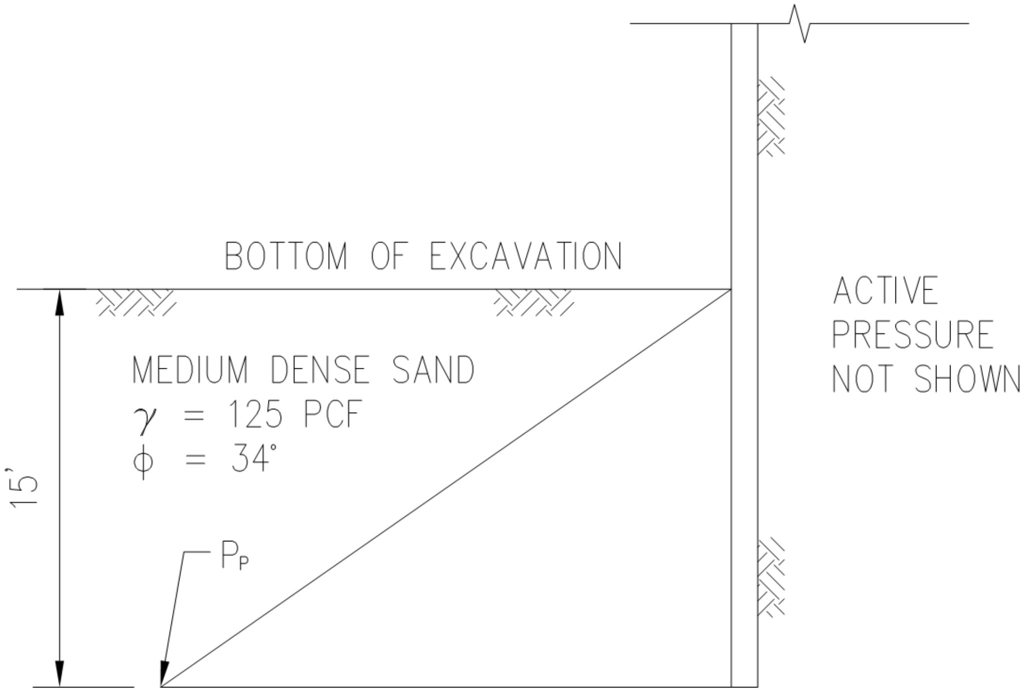
$$P_d = 1.4A_1/0.9H = 1.4(20{,}514)/0.9(32) = \underline{\underline{997 PSF}}$$

EXAMPLE 5.3 – DETERMINE PASSIVE RESISTANCE (COHESIONLESS SOIL)

PROBLEM:

DETERMINE THE PASSIVE RESISTANCE ACTING ON THE BOTTOM OF A STEEL SHEET PILE WALL EMBEDDED IN MEDIUM DENSE CLEAN SAND WITH THE FOLLOWING PROPERTIES WITH:

1. RANKINE'S THEORY
2. LOGARITHMIC SPIRAL THEORY



SOLUTION:

1. USING RANKINE'S THEORY –

$$K_{P.RANKINE} = tan^2(45° + \phi/2) = tan^2(45° + 34°/2) = \underline{\underline{3.54}}$$

$$P_{P,RANKIN=}K_{P.RANKINE}(\gamma)(15') = 3.54(125)(15) = \underline{\underline{6{,}637.5PSF}}$$

2. USING LOGARITHMIC SPIRAL THEORY

Interface Materials	Friction Angle, δ (degrees)	Coefficient of Friction, tan δ (dim.)
Mass concrete on the following foundation materials:		
• Clean sound rock	35	0.70
• Clean gravel, gravel-sand mixtures, coarse sand	29 to 31	0.55 to 0.60
• Clean fine to medium sand, silty medium to coarse sand, silty or clayey gravel	24 to 29	0.45 to 0.55
• Clean fine sand, silty or clayey fine to medium sand	19 to 24	0.34 to 0.45
• Fine sandy silt, nonplastic silt	17 to 19	0.31 to 0.34
• Very stiff and hard residual or preconsolidated clay	22 to 26	0.40 to 0.49
• Medium stiff and stiff clay and silty clay	17 to 19	0.31 to 0.34
Masonry on foundation materials has same friction factors.		
Steel sheet piles against the following soils:		
• Clean gravel, gravel-sand mixtures, well-graded rock fill with spalls	22	0.40
• Clean sand, silty sand-gravel mixture, single-size hard rock fill	17	0.31
• Silty sand, gravel or sand mixed with silt or clay	14	0.25
• Fine sandy silt, nonplastic silt	11	0.19
Formed or precast concrete or concrete sheet piling against the following soils:		
• Clean gravel, gravel-sand mixture, well-graded rock fill with spalls	22 to 26	0.40 to 0.49
• Clean sand, silty sand-gravel mixture, single-size hard rock fill	17 to 22	0.31 to 0.40
• Silty sand, gravel or sand mixed with silt or clay	17	0.31
• Fine sandy silt, nonplastic silt	14	0.25
Various structural materials:		
• Masonry on masonry, igneous and metamorphic rocks:		
○ dressed soft rock on dressed soft rock	35	0.70
○ dressed hard rock on dressed soft rock	33	0.65
○ dressed hard rock on dressed hard rock	29	0.55
• Masonry on wood in direction of cross grain	26	0.49
• Steel on steel at sheet pile interlocks	17	0.31

TABLE 3.11.5.3-1 – FRICTION ANGLE FOR DISSIMILAR MATERIALS
AASHTO LRFD 7TH EDITION, 2014

DETERMINE THE DESIGN WALL INTERFACE FRICTION ANGLE δ_{DESIGN} –

$$\delta_{ULTIMATE} = 17°$$

FOR STEEL SHEET PILES AGAINST CLEAN SAND SHOWN IN TABLE ABOVE

$$\delta_{DESIGN} = \delta_{ULTIMATE}/2 = 8.5° \leq \phi/4 = 34°/4 = 8.5°$$

USE THE DIAGRAM IN THE NEXT PAGE TO COMPUTE K$_P$ –

$K_{P,\delta/\emptyset=-1.0} = 9.5$ (FOR ϕ = 34° & β / ϕ = 0)

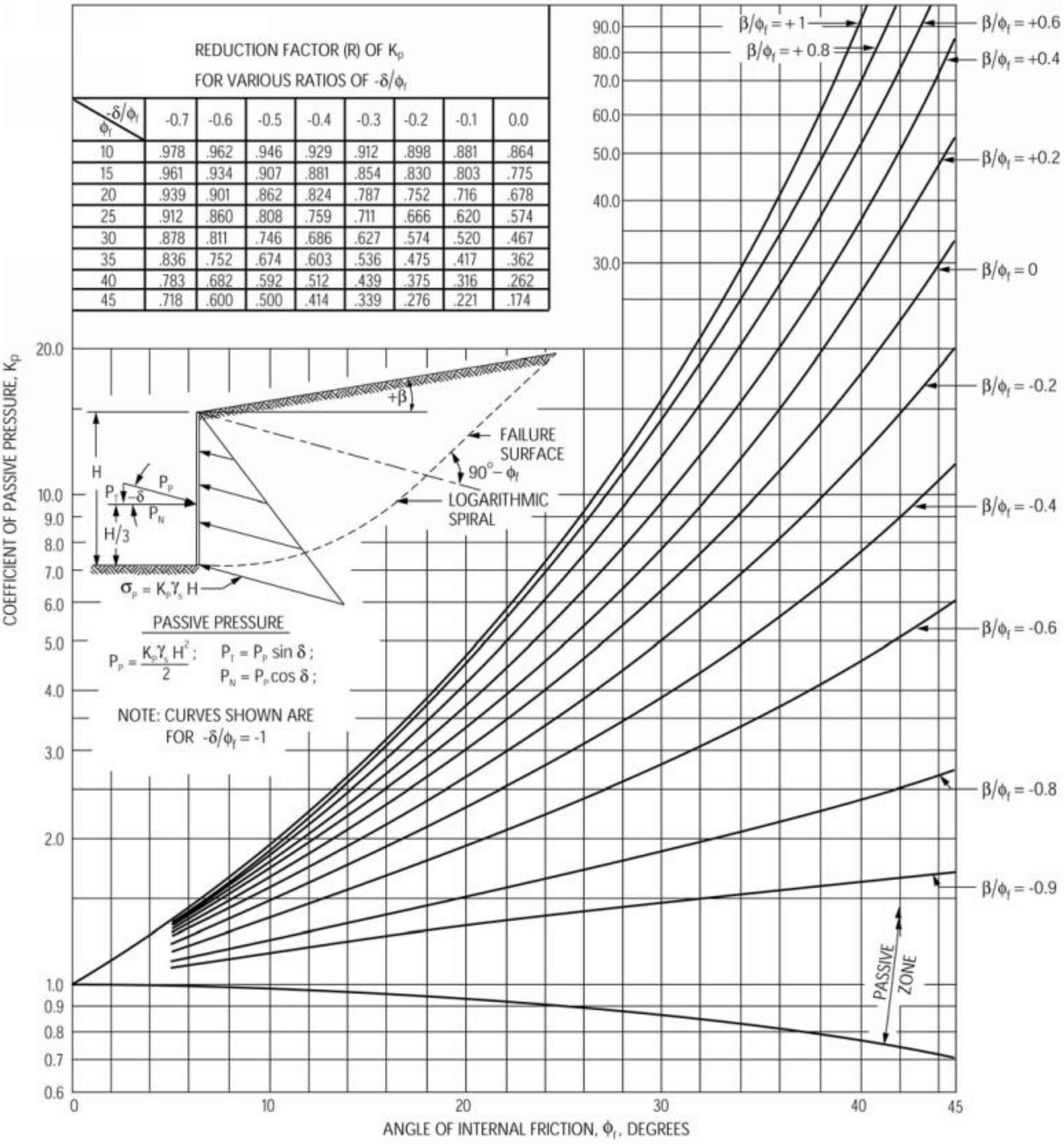
$-\,\delta/\phi = -8.5°/34° = -0.25$

$REDUCTION\ FACTOR\ (R) \approx 0.52$ (LINEAR INTERPOLATION IS ACCEPTED)

$K_P = R\left(K_{P,\delta/\emptyset=-1.0}\right) = 0.52(9.5) = \underline{\underline{4.9}}$

COMPUTE P$_P$ –

$P_P = K_P(\gamma)(15') = 4.9(125)(15) = \underline{\underline{9{,}188PSF}}$



REDUCTION FACTOR (R) OF K_p FOR VARIOUS RATIOS OF $-\delta/\phi_f$

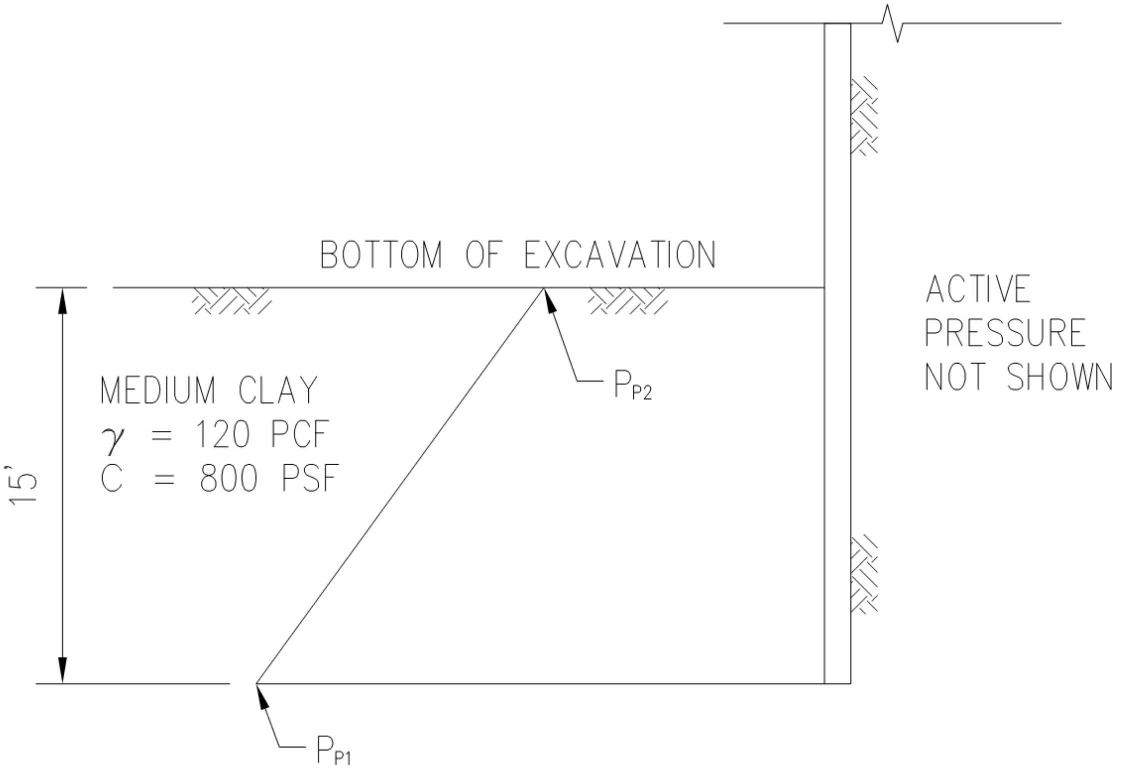
ϕ_f \ $-\delta/\phi_f$	-0.7	-0.6	-0.5	-0.4	-0.3	-0.2	-0.1	0.0
10	.978	.962	.946	.929	.912	.898	.881	.864
15	.961	.934	.907	.881	.854	.830	.803	.775
20	.939	.901	.862	.824	.787	.752	.716	.678
25	.912	.860	.808	.759	.711	.666	.620	.574
30	.878	.811	.746	.686	.627	.574	.520	.467
35	.836	.752	.674	.603	.536	.475	.417	.362
40	.783	.682	.592	.512	.439	.375	.316	.262
45	.718	.600	.500	.414	.339	.276	.221	.174

PASSIVE EARTH PRESSURE COEFFICIENT (Caquot and Kerisel, 1948)

EXAMPLE 5.4 – DETERMINE PASSIVE RESISTANCE (COHESIVE SOIL)

PROBLEM:

DETERMINE THE PASSIVE RESISTANCE ACTING ON THE BOTTOM OF SHORING WALL EMBEDDED IN MEDIUM CLAY WITH THE FOLLOWING PROPERTIES:



SOLUTION:

COMPUTE P_{P1} & P_{P2} –

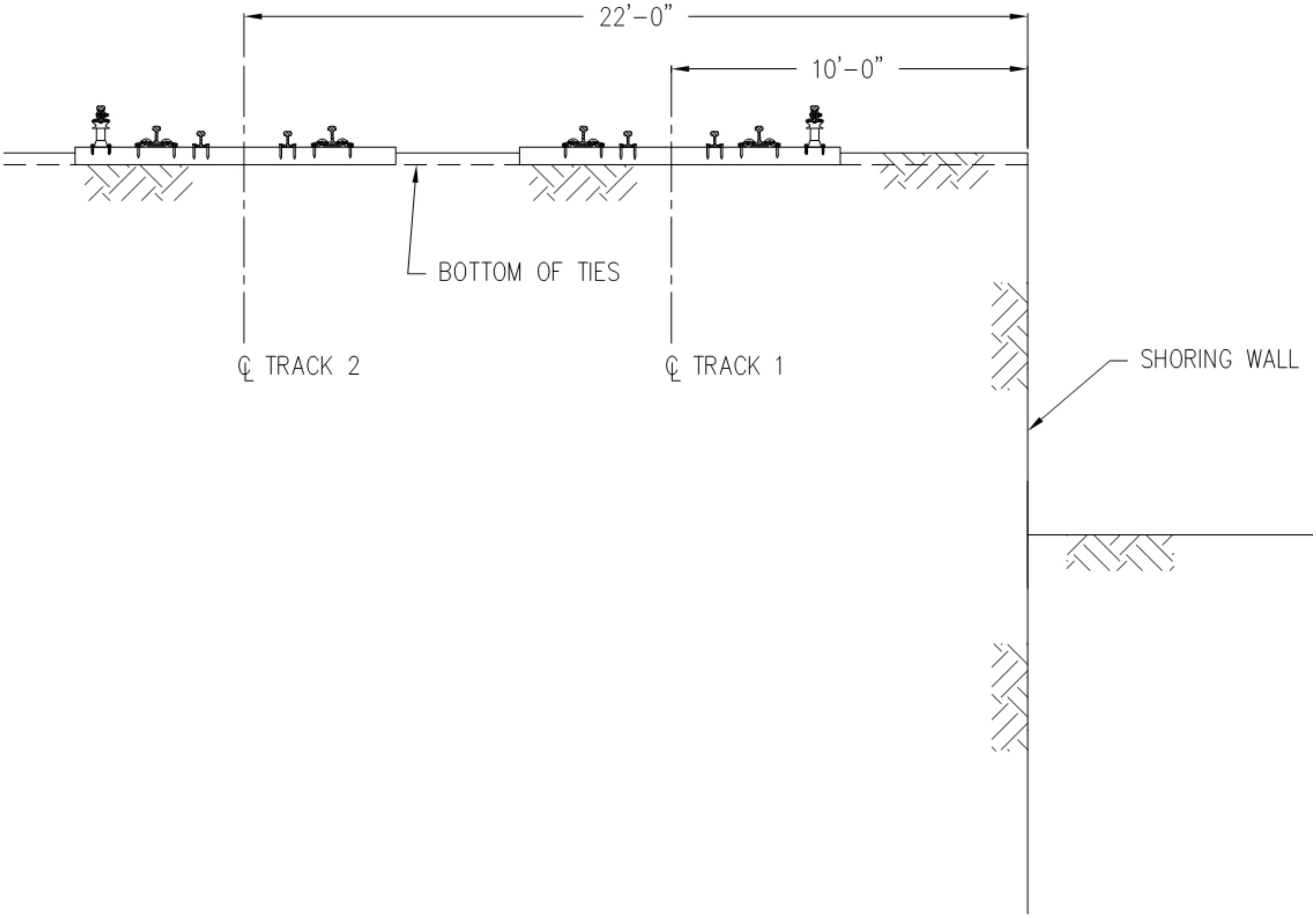
$$P_{P1} = 2C = 2(800) = \underline{\underline{1{,}600PSF}}$$

$$P_{P2} = P_{P1} + \gamma(15') = 1600 + 120(15) = \underline{\underline{3{,}400PSF}}$$

EXAMPLE 6.1 – RAPID TRANSIT LIVE LOAD SURCHARGE FROM TWO TRACKS

PROBLEM:

COMPUTE THE LATERAL SURCHARGE PRESSURES ACTING ON THE SHORING WALL BASED ON THE FOLLOWING TRACK GEOMETRY. CTA RAILBOUND CRANE TRAIN MAY OPERATE ON TRACK 2.



SOLUTION: (SEE NEXT PAGE)

Analysis Parameters

Tie Length:	9 ft					
Distance from face of shoring wall to centerline of track 1:	10 ft	Strip Load:	491 psf	606 psf for crane train
Distance from face of shoring wall to centerline of track 2:	22 ft	Strip Load:	606 psf	491 psf for normal service
Distance from face of shoring wall to centerline of track 3:	0 ft	Strip Load:	0 psf	50% Reduction Included
Distance from face of shoring wall to centerline of track 4:	0 ft	Strip Load:	0 psf	25% Reduction Included

Lateral Pressures Per AREMA Manual for Railway Engineering Chapter 8 Article 20.3.2.2 & Section 5.1

Depth d (ft)	Track 1 $P_{s,1}$ (psf)	Track 2 $P_{s,2}$ (psf)	Track 3 $P_{s,3}$ (psf)	Track 4 $P_{s,4}$ (psf)	Total $P_{s,total}$ (psf)
0	0	0	0	0	**0**
1	69	15	0	0	**84**
2	127	29	0	0	**156**
3	168	43	0	0	**212**
4	192	56	0	0	**248**
5	201	67	0	0	**268**
6	199	77	0	0	**276**
7	189	86	0	0	**275**
8	176	92	0	0	**268**
9	161	97	0	0	**258**
10	145	101	0	0	**246**
11	130	103	0	0	**234**
12	116	104	0	0	**221**
13	103	104	0	0	**208**
14	92	104	0	0	**195**
15	82	102	0	0	**184**
16	73	100	0	0	**172**
17	65	97	0	0	**162**
18	58	94	0	0	**151**
19	52	90	0	0	**142**
20	46	87	0	0	**133**
21	42	83	0	0	**125**
22	37	79	0	0	**117**
23	34	76	0	0	**110**
24	31	72	0	0	**103**
25	28	69	0	0	**96**
26	25	65	0	0	**91**
27	23	62	0	0	**85**
28	21	59	0	0	**80**
29	19	56	0	0	**75**
30	18	53	0	0	**71**
31	16	50	0	0	**66**
32	15	48	0	0	**62**
33	14	45	0	0	**59**
34	13	43	0	0	**55**
35	12	40	0	0	**52**
36	11	38	0	0	**49**
37	10	36	0	0	**47**
38	9	35	0	0	**44**
39	9	33	0	0	**42**
40	8	31	0	0	**39**
41	8	30	0	0	**37**
42	7	28	0	0	**35**
43	7	27	0	0	**33**
44	6	25	0	0	**32**
45	6	24	0	0	**30**
46	6	23	0	0	**29**
47	5	22	0	0	**27**
48	5	21	0	0	**26**
49	5	20	0	0	**25**
50	4	19	0	0	**23**

d = depth below bottom of tie

$P_{s,1}$ = lateral surcharge from track 1

$P_{s,2}$ = lateral surcharge from track 2

$P_{s,3}$ = lateral surcharge from track 3

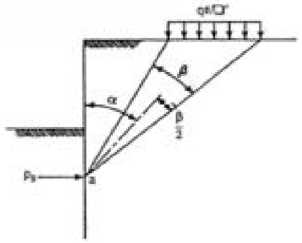
$P_{s,4}$ = lateral surcharge from track 4

$P_{s,total}$ = combined lateral surcharge $\Sigma P_{s,n}$

$P_{s,total,max}$ 276 PSF

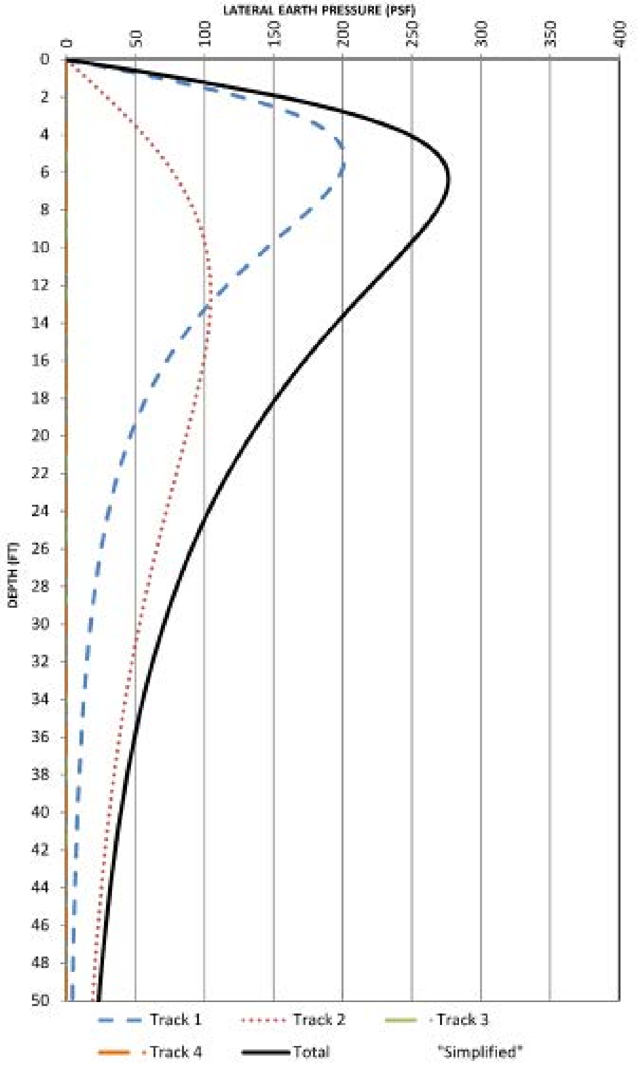
For "Simplified" Surcharge

$P_{s,simple}$ 220.8 PSF



$$P_s = \frac{2q}{\pi}(\beta + \sin\beta\sin^2\alpha - \sin\beta\cos^2\alpha)$$

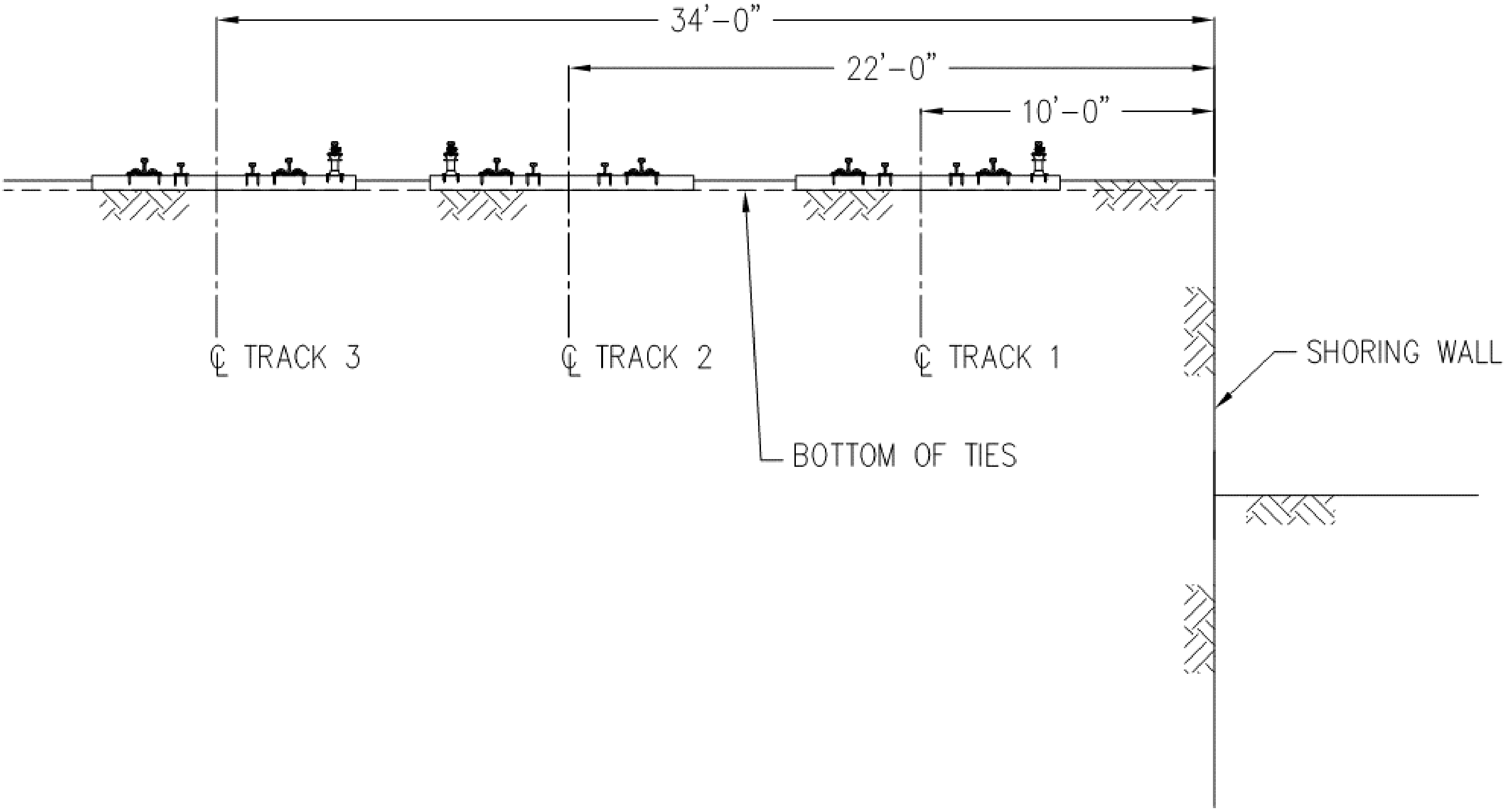
Note: α & β are in radians



EXAMPLE 6.2 – RAPID TRANSIT LIVE LOAD SURCHARGE FROM THREE TRACKS

PROBLEM:

COMPUTE THE LATERAL SURCHARGE PRESSURES ACTING ON THE SHORING WALL BASED ON THE FOLLOWING TRACK GEOMETRY. CTA RAILBOUND CRANE TRAIN MAY OPERATE ON TRACK 3.



SOLUTION: (SEE NEXT PAGE)

Analysis Parameters

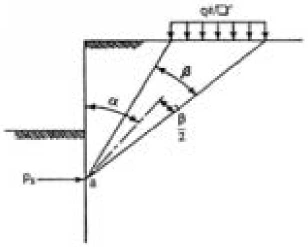
Tie Length:	9	ft				
Distance from face of shoring wall to centerline of track 1:	10	ft	Strip Load:	491	psf	606 psf for crane train
Distance from face of shoring wall to centerline of track 2:	22	ft	Strip Load:	491	psf	491 psf for normal service
Distance from face of shoring wall to centerline of track 3:	34	ft	Strip Load:	606	psf	50% Reduction Included
Distance from face of shoring wall to centerline of track 4:	0	ft	Strip Load:	0	psf	25% Reduction Included

Lateral Pressures Per AREMA Manual for Railway Engineering Chapter 8 Article 20.3.2.2 & Section 5.1

Depth d (ft)	Track 1 $P_{s,1}$ (psf)	Track 2 $P_{s,2}$ (psf)	Track 3 $P_{s,3}$ (psf)	Track 4 $P_{s,4}$ (psf)	Total $P_{s,total}$ (psf)
0	0	0	0	0	**0**
1	69	12	3	0	**84**
2	127	24	6	0	**157**
3	168	35	9	0	**212**
4	192	45	12	0	**249**
5	201	55	15	0	**270**
6	199	63	17	0	**279**
7	189	69	20	0	**278**
8	176	75	22	0	**273**
9	161	79	24	0	**264**
10	145	82	26	0	**253**
11	130	84	27	0	**241**
12	116	85	29	0	**230**
13	103	85	30	0	**218**
14	92	84	31	0	**207**
15	82	83	32	0	**196**
16	73	81	33	0	**186**
17	65	78	33	0	**176**
18	58	76	33	0	**167**
19	52	73	33	0	**158**
20	46	70	33	0	**150**
21	42	67	33	0	**142**
22	37	64	33	0	**135**
23	34	61	33	0	**128**
24	31	59	32	0	**121**
25	28	56	32	0	**115**
26	25	53	31	0	**109**
27	23	50	31	0	**104**
28	21	48	30	0	**99**
29	19	45	29	0	**94**
30	18	43	29	0	**89**
31	16	41	28	0	**85**
32	15	39	27	0	**81**
33	14	37	26	0	**77**
34	13	35	26	0	**73**
35	12	33	25	0	**69**
36	11	31	24	0	**66**
37	10	30	23	0	**63**
38	9	28	23	0	**60**
39	9	27	22	0	**57**
40	8	25	21	0	**55**
41	8	24	21	0	**52**
42	7	23	20	0	**50**
43	7	22	19	0	**48**
44	6	21	19	0	**45**
45	6	20	18	0	**43**
46	6	19	17	0	**42**
47	5	18	17	0	**40**
48	5	17	16	0	**38**
49	5	16	16	0	**36**
50	4	15	15	0	**35**

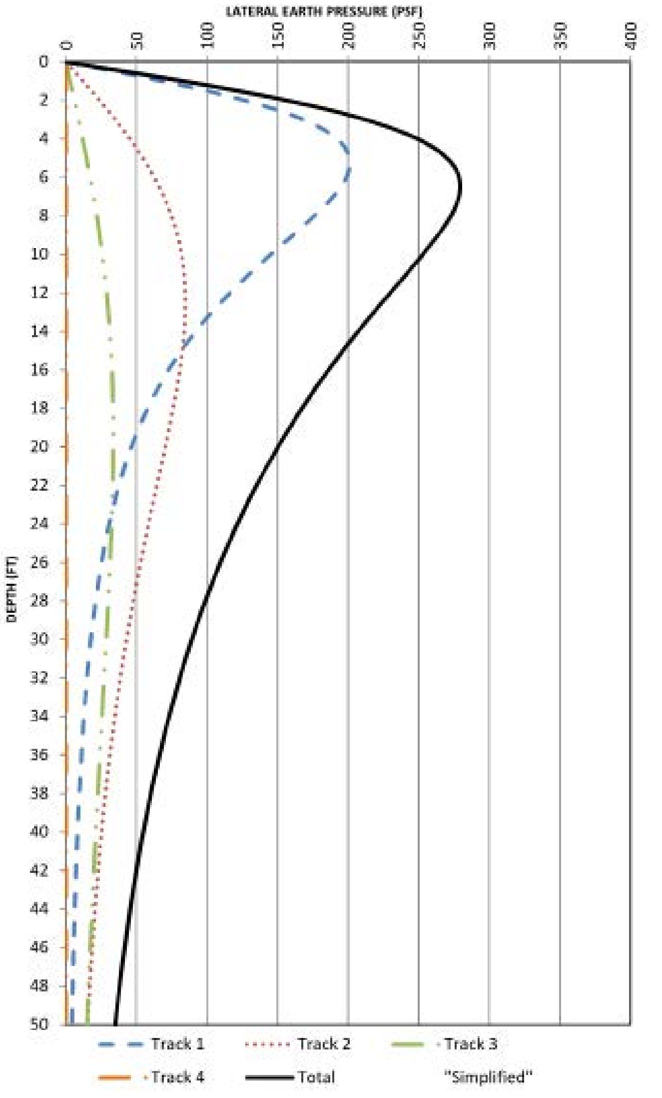
d = depth below bottom of tie
$P_{s,1}$ = lateral surcharge from track 1
$P_{s,2}$ = lateral surcharge from track 2
$P_{s,3}$ = lateral surcharge from track 3
$P_{s,4}$ = lateral surcharge from track 4
$P_{s,total}$ = combined lateral surcharge $\Sigma P_{s,n}$

$P_{s,total,max}$ **279 PSF**
For "Simplified" Surcharge
$P_{s,simple}$ **222.9 PSF**



$$P_s = \frac{2q}{\pi}(\beta + \sin\beta \sin^2\alpha - \sin\beta \cos^2\alpha)$$

Note: α & β are in radians



EXAMPLE 6.3 – "SIMPLIFIED" RAPID TRANSIT LIVE LOAD SURCHARGE

PROBLEM:

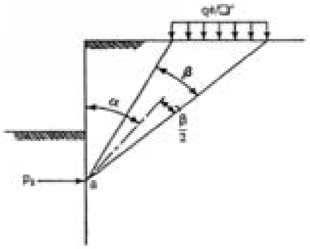
COMPUTE THE "SIMPLIFIED" LATERAL SURCHARGE PRESSURES ACTING ON THE SHORING WALL BASED ON THE TRACK GEOMETRY IN EXAMPLE 6.3 WITH AN ADDITIONAL TRACK 4 AT 46'-0" FROM FACE OF THE SHORING WALL. CTA RAILBOUND CRANE TRAIN MAY OPERATE ON TRACK 4.

SOLUTION: (SEE NEXT PAGE)

Analysis Parameters

Tie Length:	9 ft					
Distance from face of shoring wall to centerline of track 1:	10	ft	Strip Load:	491	psf	606 psf for crane train
Distance from face of shoring wall to centerline of track 2:	22	ft	Strip Load:	491	psf	491 psf for normal service
Distance from face of shoring wall to centerline of track 3:	34	ft	Strip Load:	491	psf	50% Reduction Included
Distance from face of shoring wall to centerline of track 4:	46	ft	Strip Load:	606	psf	25% Reduction Included

Lateral Pressures Per AREMA Manual for Railway Engineering Chapter 8 Article 20.3.2.2 & Section 5.1



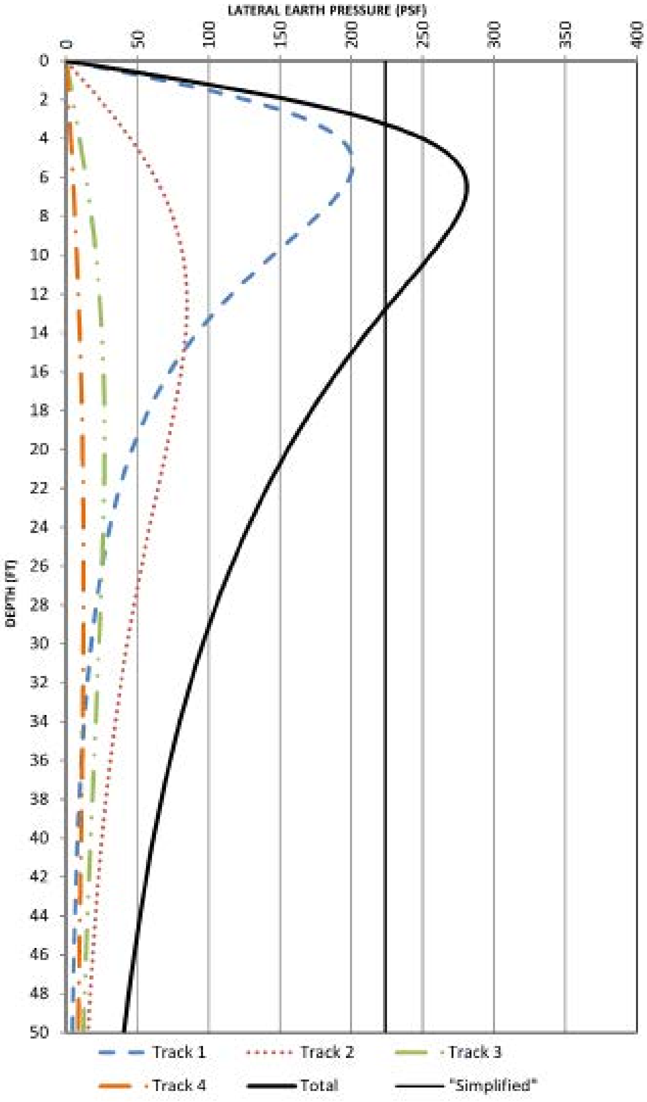
Depth d (ft)	Track 1 $P_{s,1}$ (psf)	Track 2 $P_{s,2}$ (psf)	Track 3 $P_{s,3}$ (psf)	Track 4 $P_{s,4}$ (psf)	**Total $P_{s,total}$ (psf)**
0	0	0	0	0	**0**
1	69	12	2	1	**84**
2	127	24	5	2	**157**
3	168	35	7	2	**213**
4	192	45	10	3	**250**
5	201	55	12	4	**271**
6	199	63	14	5	**280**
7	189	69	16	6	**280**
8	176	75	18	6	**275**
9	161	79	19	7	**266**
10	145	82	21	8	**256**
11	130	84	22	8	**244**
12	116	85	23	9	**233**
13	103	85	24	9	**222**
14	92	84	25	10	**211**
15	82	83	26	10	**200**
16	73	81	26	11	**190**
17	65	78	27	11	**181**
18	58	76	27	11	**172**
19	52	73	27	11	**163**
20	46	70	27	12	**155**
21	42	67	27	12	**148**
22	37	64	27	12	**141**
23	34	61	27	12	**134**
24	31	59	26	12	**128**
25	28	56	26	12	**122**
26	25	53	25	12	**116**
27	23	50	25	12	**110**
28	21	48	24	12	**105**
29	19	45	24	12	**100**
30	18	43	23	12	**96**
31	16	41	23	12	**91**
32	15	39	22	12	**87**
33	14	37	21	12	**83**
34	13	35	21	12	**80**
35	12	33	20	12	**76**
36	11	31	20	11	**73**
37	10	30	19	11	**70**
38	9	28	18	11	**67**
39	9	27	18	11	**64**
40	8	25	17	11	**61**
41	8	24	17	10	**59**
42	7	23	16	10	**56**
43	7	22	16	10	**54**
44	6	21	15	10	**52**
45	6	20	14	10	**50**
46	6	19	14	9	**48**
47	5	18	14	9	**46**
48	5	17	13	9	**44**
49	5	16	13	9	**42**
50	4	15	12	9	**41**

d = depth below bottom of tie
$P_{s,1}$ = lateral surcharge from track 1
$P_{s,2}$ = lateral surcharge from track 2
$P_{s,3}$ = lateral surcharge from track 3
$P_{s,4}$ = lateral surcharge from track 4
$P_{s,total}$ = combined lateral surcharge $\Sigma P_{s,n}$

$P_{s,total,max}$ **280** **PSF**
For "Simplified" Surcharge
$P_{s,simple}$ **224.2** **PSF**

$$P_s = \frac{2q}{\pi}(\beta + \sin\beta \sin^2\alpha - \sin\beta \cos^2\alpha)$$

Note: α & β are in radians



EXAMPLE 6.4 – CONSTRUCT THE ACTUAL RAPID TRANSIT SURCHARGE PRESSURE

PROBLEM:

PER SECTION 5.3, THERE ARE CASES WHERE “SIMPLIFIED” SURCHARGE PRESSURE DISTRIBUTION MAY NOT BE ALLOWED (REFER TO SECTION 6.3). CONSTRUCT THE ACTUAL TRANSIT SURCHARGE PRESSURE FOR A SHORING WALL 10’-0” FROM THE CENTERLINE OF TRACK. CTA RAILBOUND CRANE TRAIN MAY OPERATE ON THIS TRACK.

SOLUTION: (SEE NEXT PAGE)

Note: This example only illustrates how CTA Engineering would distribute the surcharge pressure. The actual Rapid Transit surcharge pressure is NOT required to be distributed as shown in this example. The Engineer in Responsible Charge shall evaluate how surcharge should be distributed for the shoring system design with engineering knowledge, experience, and judgment.

Analysis Parameters

Tie Length: 9 ft

Distance from face of shoring wall to centerline of track 1:	10 ft	Strip Load:	606 psf	606 psf for crane train
Distance from face of shoring wall to centerline of track 2:	0 ft	Strip Load:	0 psf	491 psf for normal service
Distance from face of shoring wall to centerline of track 3:	0 ft	Strip Load:	0 psf	50% Reduction Included
Distance from face of shoring wall to centerline of track 4:	0 ft	Strip Load:	0 psf	25% Reduction Included

Lateral Pressures Per AREMA Manual for Railway Engineering Chapter 8 Article 20.3.2.2 & Section 5.1

Depth d (ft)	Track 1 $P_{s,1}$ (psf)	Track 2 $P_{s,2}$ (psf)	Track 3 $P_{s,3}$ (psf)	Track 4 $P_{s,4}$ (psf)	**Total $P_{s,total}$ (psf)**
0	0	0	0	0	**0**
1	85	0	0	0	**85**
2	157	0	0	0	**157**
3	208	0	0	0	**208**
4	237	0	0	0	**237**
5	248	0	0	0	**248**
6	245	0	0	0	**245**
7	234	0	0	0	**234**
8	217	0	0	0	**217**
9	198	0	0	0	**198**
10	179	0	0	0	**179**
11	161	0	0	0	**161**
12	143	0	0	0	**143**
13	128	0	0	0	**128**
14	113	0	0	0	**113**
15	101	0	0	0	**101**
16	90	0	0	0	**90**
17	80	0	0	0	**80**
18	71	0	0	0	**71**
19	64	0	0	0	**64**
20	57	0	0	0	**57**
21	51	0	0	0	**51**
22	46	0	0	0	**46**
23	42	0	0	0	**42**
24	38	0	0	0	**38**
25	34	0	0	0	**34**
26	31	0	0	0	**31**
27	28	0	0	0	**28**
28	26	0	0	0	**26**
29	24	0	0	0	**24**
30	22	0	0	0	**22**
31	20	0	0	0	**20**
32	18	0	0	0	**18**
33	17	0	0	0	**17**
34	16	0	0	0	**16**
35	15	0	0	0	**15**
36	13	0	0	0	**13**
37	13	0	0	0	**13**
38	12	0	0	0	**12**
39	11	0	0	0	**11**
40	10	0	0	0	**10**
41	9	0	0	0	**9**
42	9	0	0	0	**9**
43	8	0	0	0	**8**
44	8	0	0	0	**8**
45	7	0	0	0	**7**
46	7	0	0	0	**7**
47	6	0	0	0	**6**
48	6	0	0	0	**6**
49	6	0	0	0	**6**
50	5	0	0	0	**5**

d = depth below bottom of tie

$P_{s,1}$ = lateral surcharge from track 1

$P_{s,2}$ = lateral surcharge from track 2

$P_{s,3}$ = lateral surcharge from track 3

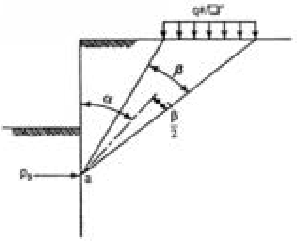
$P_{s,4}$ = lateral surcharge from track 4

$P_{s,total}$ = combined lateral surcharge $\Sigma P_{s,n}$

$P_{s,total,max}$ **248 PSF**

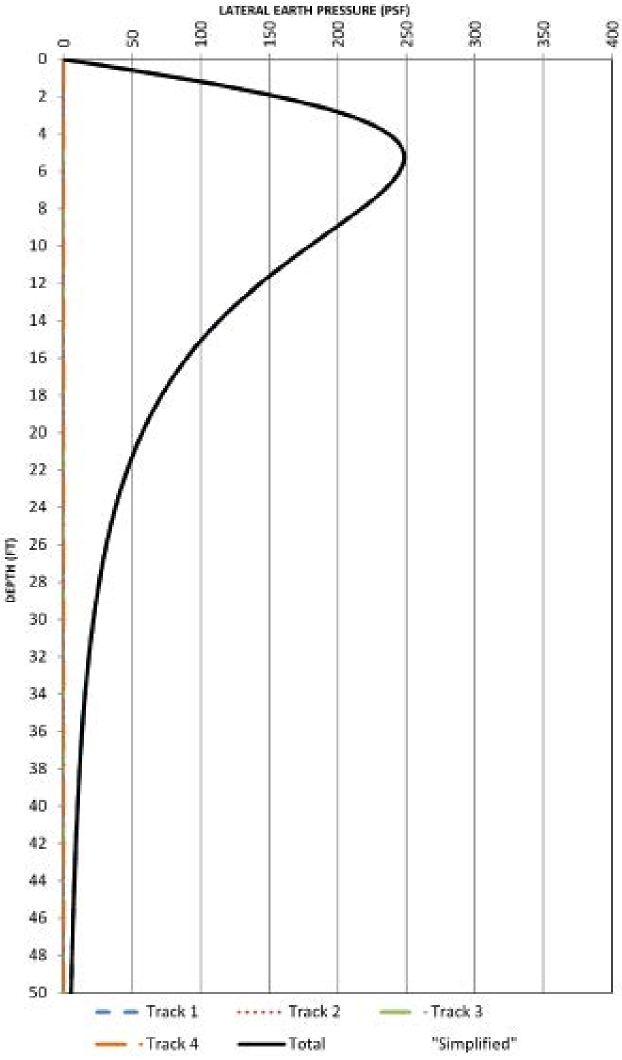
For "Simplified" Surcharge

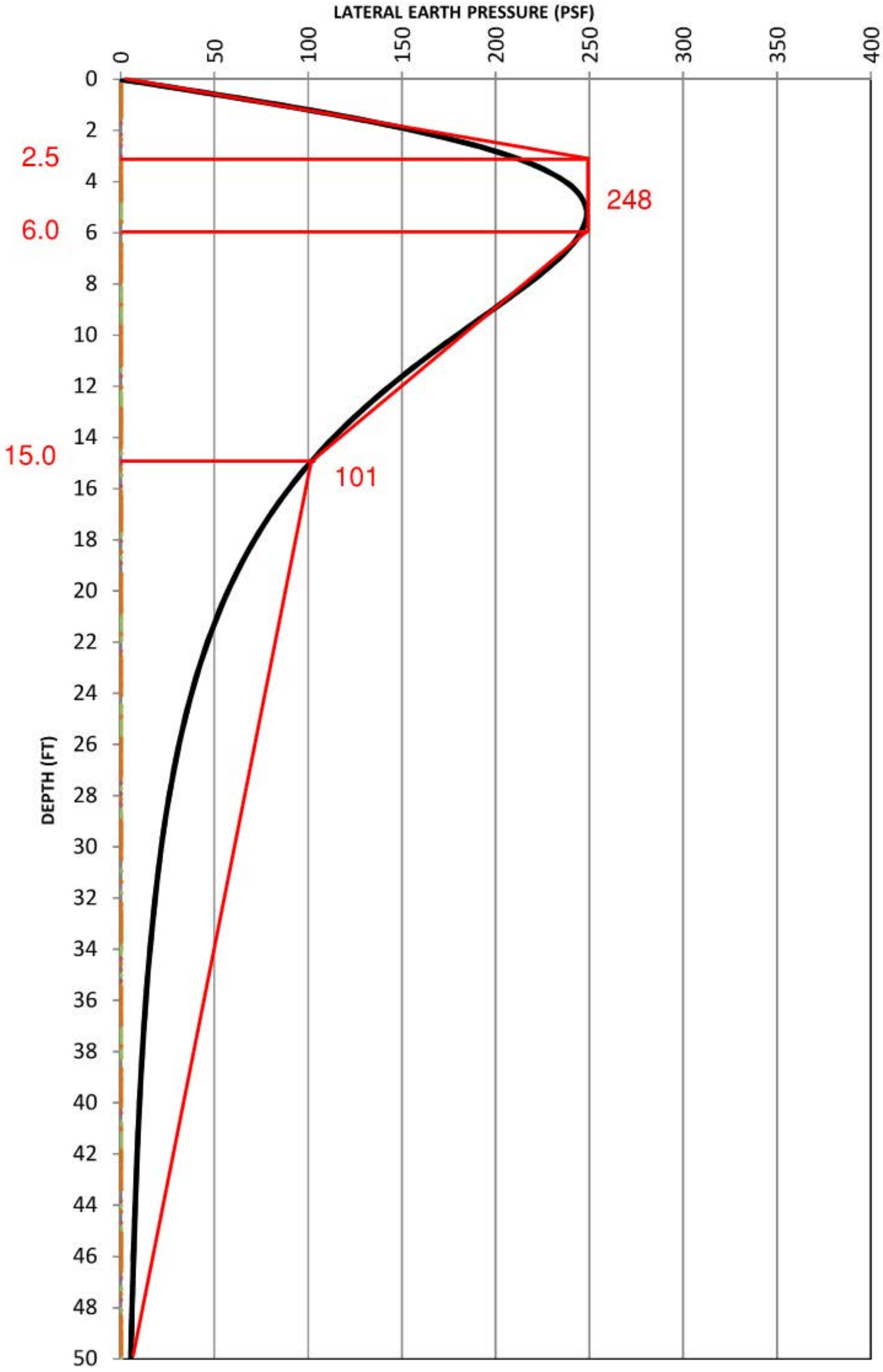
$P_{s,simple}$ **198.4 PSF**



$$p_s = \frac{2q}{\pi}(\beta + \sin\beta \sin^2\alpha - \sin\beta \cos^2\alpha)$$

Note: α & β are in radians

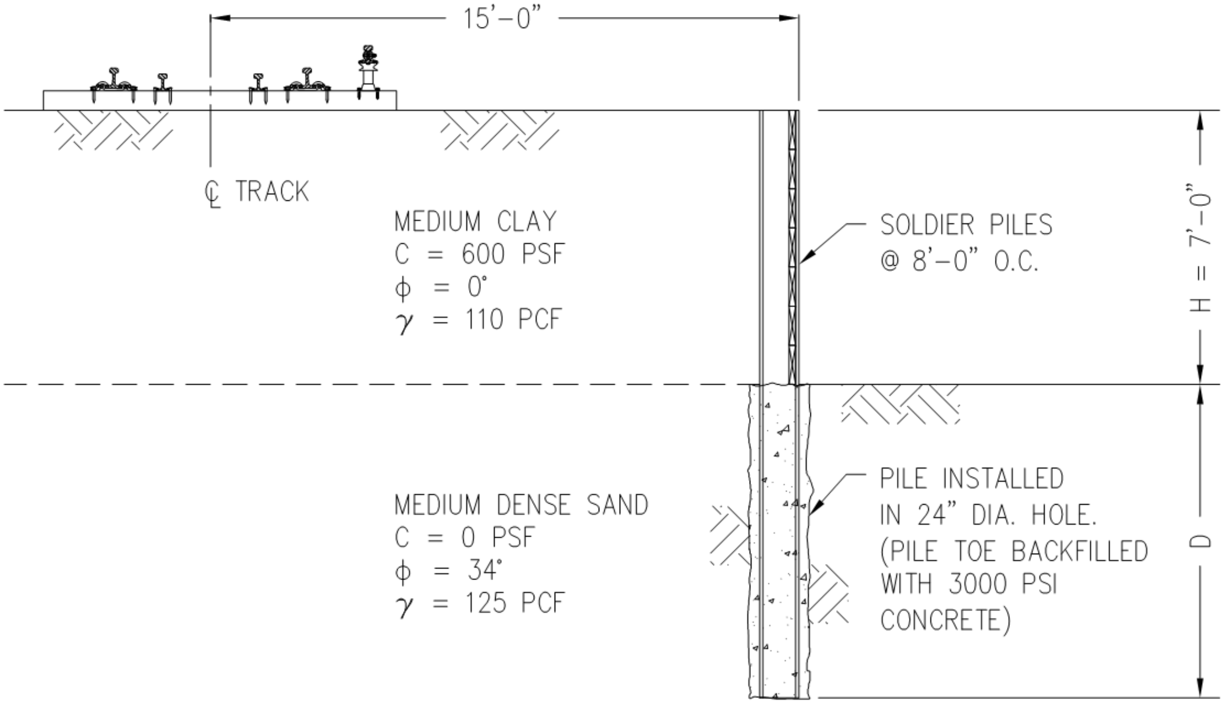



LATERAL EARTH PRESSURE (PSF)
0
50
100
150
200
250
300
350
400
DEPTH (FT)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
50
2.5
6.0
15.0
248
101

EXAMPLE 7.1 – CANTILEVER SOILDIER PILE AND LAGGING SHORING WALL

PROBLEM:

DETERMINE THE REQUIRED DEPTH OF PENETRATION AND THE DESIGN SHEAR AND MOMENT FOR A CANTILEVER SOLDIER PILE AND LAGGING WALL FOR THE SOIL CONDITIONS AND PILE SPACING INDICATED BELOW. RAILBOUND CRANE TRAIN WILL NOT OPERATE ON THIS TRACK, AND THE TRACKWORK WEIGHT CAN BE IGNORED FOR THIS PROBLEM. NO SPECIAL TREATMENT IS CONSIDERED FOR THE BOTTOM OF THE CUT SUCH AS MUD SLAB, GROUND STABILIZATION, ETC.



SOLUTION:

COMUPTE ACTIVE SOIL PRESSURES –

MEDIUM CLAY:

NO THEORETICAL NET ACTIVE PRESSURE BECAUSE

$\gamma_{CLAY}H - 2C = 110(7) - 2(600) = -430\ PSF < 0$

THEREFORE, USE <u>30 PSF/FT</u> EPF MINIMUM ACTIVE PRESSURE.

MEDIUM DENSE SAND:

$K_A = tan^2(45° - \phi/2) = tan^2(45° - 34°/2) = \underline{\underline{0.28}}$

ACTIVE GRADIENT = $K_A \gamma_{SAND} = 0.28(125) = \underline{\underline{35\ PSF/FT}}$

COMPUTE PASSIVE SOIL PRESSURE USING LOG-SPIRAL THEORY –

REFER TO EXAMPLE 4.3: $K_P = \underline{\underline{4.9}}$

PASSIVE GRADIENT = $K_P \gamma_{SAND} = 4.9(125) = \underline{\underline{613\ PSF/FT}}$

RAILROAD SURCHARGE –

SINCE THE SHORING WALL IS ZONE 3, “SIMPLIFIED” RAPID TRANSIT SURCHARGE IS ALLOWED FOR CANTILEVERED SYSTEM:

REFER TO NEXT PAGE: $P_S = \underline{\underline{101.6\ PSF/FT}}$

EFFECTIVE WIDTH OF EMBEDDED PORTION OF SOILDIER PILE –

PER SECTION 6.2 FOR COHESIVE SOIL

EFFECTIVE WIDTH $(w_{EFF}) = 2d$

WHERE d = DIAMETER OF CONCRETE FILLED DRILLED HOLE

$w_{EFF} = 2(2) = 4\ FT$

SINCE NO SPECIAL TREATMENT IS CONSIDERED AT THE BOTTOM OF THE CUT, FOR SOLDIER PILE SHORING WALLS, PER SECTION 6.2, A DEPTH OF 1.5 TIMES THE WIDTH OF THE SOLDIER PILE IN SOIL SHALL NOT BE CONSIDERED IN PROVIDING PASSIVE LATERAL SUPPORT.

$1.5d = 1.5(2) = 3\ FT$

USE “SIMPLIFIED” METHOD OF CANTILEVER PILE ANALYSIS.

Analysis Parameters

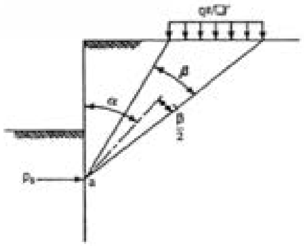
Tie Length:	9	ft				
Distance from face of shoring wall to centerline of track 1:	15	ft	Strip Load:	491	psf	606 psf for crane train
Distance from face of shoring wall to centerline of track 2:	0	ft	Strip Load:	0	psf	491 psf for normal service
Distance from face of shoring wall to centerline of track 3:	0	ft	Strip Load:	0	psf	50% Reduction Included
Distance from face of shoring wall to centerline of track 4:	0	ft	Strip Load:	0	psf	25% Reduction Included

Lateral Pressures Per AREMA Manual for Railway Engineering Chapter 8 Article 20.3.2.2 & Section 5.1

Depth d (ft)	Track 1 $P_{s,1}$ (psf)	Track 2 $P_{s,2}$ (psf)	Track 3 $P_{s,3}$ (psf)	Track 4 $P_{s,4}$ (psf)	**Total $P_{s,total}$ (psf)**
0	0	0	0	0	**0**
1	27	0	0	0	**27**
2	53	0	0	0	**53**
3	75	0	0	0	**75**
4	94	0	0	0	**94**
5	109	0	0	0	**109**
6	119	0	0	0	**119**
7	125	0	0	0	**125**
8	127	0	0	0	**127**
9	127	0	0	0	**127**
10	124	0	0	0	**124**
11	120	0	0	0	**120**
12	114	0	0	0	**114**
13	108	0	0	0	**108**
14	102	0	0	0	**102**
15	95	0	0	0	**95**
16	89	0	0	0	**89**
17	82	0	0	0	**82**
18	76	0	0	0	**76**
19	71	0	0	0	**71**
20	65	0	0	0	**65**
21	61	0	0	0	**61**
22	56	0	0	0	**56**
23	52	0	0	0	**52**
24	48	0	0	0	**48**
25	44	0	0	0	**44**
26	41	0	0	0	**41**
27	38	0	0	0	**38**
28	35	0	0	0	**35**
29	33	0	0	0	**33**
30	30	0	0	0	**30**
31	28	0	0	0	**28**
32	26	0	0	0	**26**
33	25	0	0	0	**25**
34	23	0	0	0	**23**
35	21	0	0	0	**21**
36	20	0	0	0	**20**
37	19	0	0	0	**19**
38	18	0	0	0	**18**
39	16	0	0	0	**16**
40	15	0	0	0	**15**
41	15	0	0	0	**15**
42	14	0	0	0	**14**
43	13	0	0	0	**13**
44	12	0	0	0	**12**
45	11	0	0	0	**11**
46	11	0	0	0	**11**
47	10	0	0	0	**10**
48	10	0	0	0	**10**
49	9	0	0	0	**9**
50	9	0	0	0	**9**

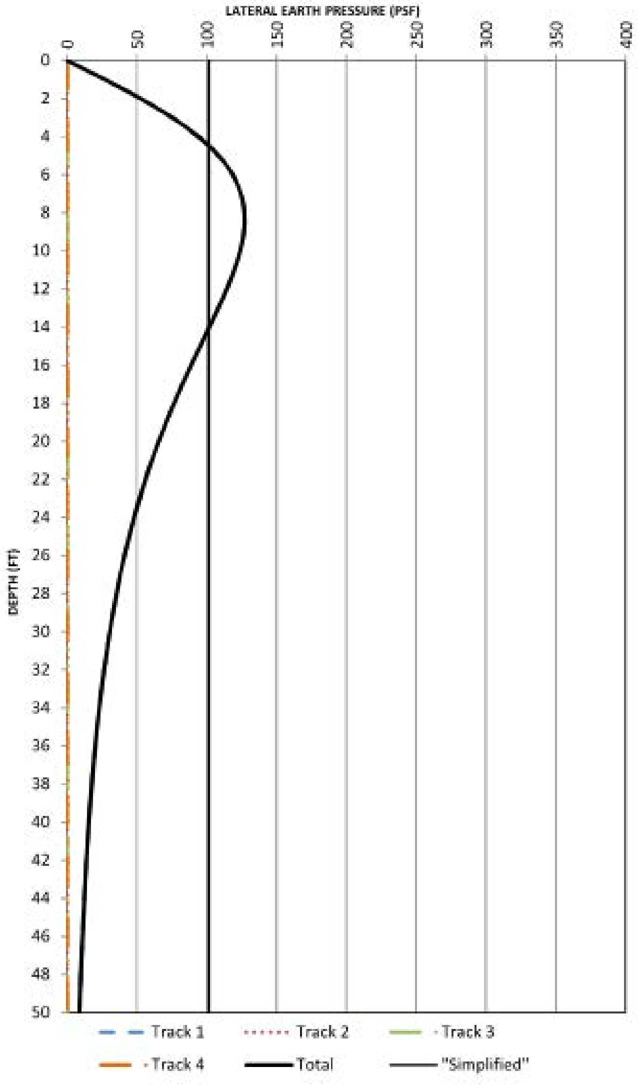
d = depth below bottom of tie
$P_{s,1}$ = lateral surcharge from track 1
$P_{s,2}$ = lateral surcharge from track 2
$P_{s,3}$ = lateral surcharge from track 3
$P_{s,4}$ = lateral surcharge from track 4
$P_{s,total}$ = combined lateral surcharge $\Sigma P_{s,n}$

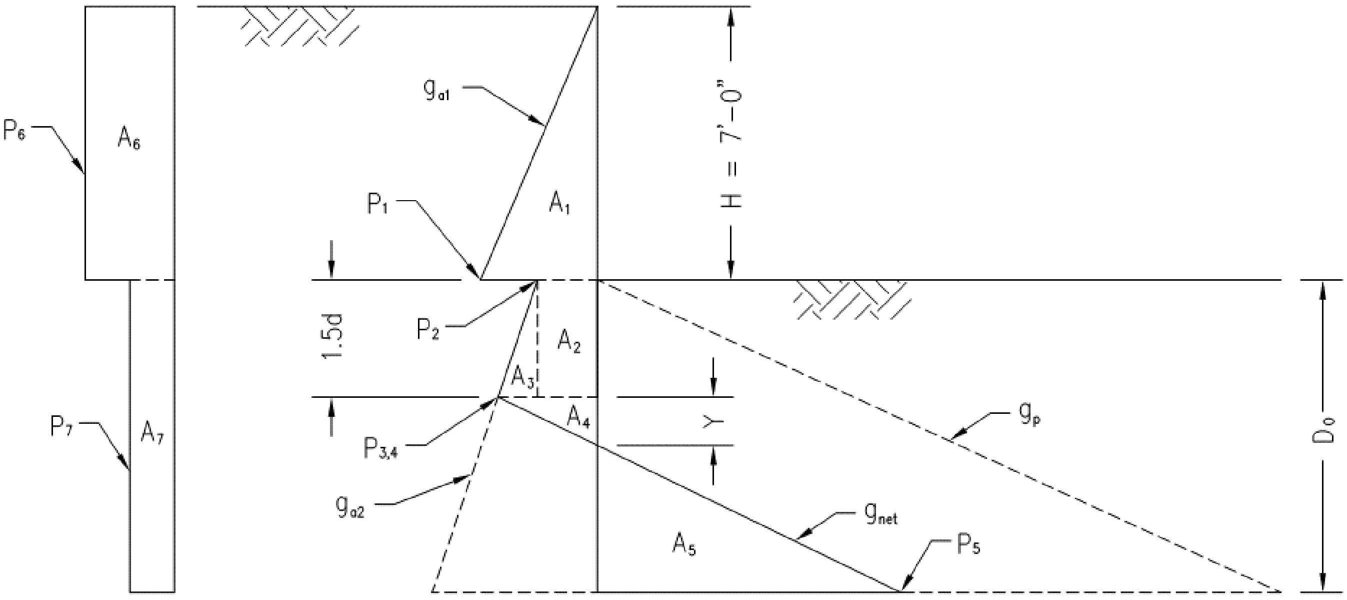
$P_{s,total,max}$ 127 **PSF**
For "Simplified" Surcharge
$P_{s,simple}$ 101.6 **PSF**



$$P_s = \frac{2q}{\pi}(\beta + \sin\beta\sin^2\alpha - \sin\beta\cos^2\alpha)$$

Note: α & β are in radians





RT SURCHARGE SOIL LOADING

$g_{a1} = 30(PILE\ SPACING) = 30(8) = \underline{\underline{240\ PSF}}$

$g_{a2} = 35w_{EFF} = 35(4) = \underline{\underline{140\ PSF}}$

$g_P = 613w_{EFF} = 613(4) = \underline{\underline{2{,}452\ PSF}}$

$g_{net} = g_P - g_{a2} = 2{,}452 - 140 = \underline{\underline{2{,}312\ PSF}}$

$P_1 = g_{a1}H = 240(7) = \underline{\underline{1{,}680\ LBS/FT}}$

$P_2 = K_A\gamma_{CLAY}Hw_{EFF} = 0.28(110)(7)(4) = \underline{\underline{862.4\ LBS/FT}}$

$P_{3,4} = P_2 + 1.5d(g_{a2}) = 862.4 + 1.5(2)(140) = \underline{\underline{1{,}282.4\ LBS/FT}}$

$P_5 = g_{net}(D_O - 1.5d) - P_{3,4} = 2{,}312[D_O - 1.5(2)] - 1{,}282.4 = \underline{\underline{2{,}312D_O - 8{,}218.4\ LBS/FT}}$

$P_6 = P_S(PILE\ SPACING) = 101.6(8) = \underline{\underline{812.8\ LBS/FT}}$

$P_7 = P_S(w_{EFF}) = 101.6(4) = \underline{\underline{406.4\ LBS/FT}}$

$Y = P_{3,4}/g_{net} = 1{,}282.4/2{,}312 = \underline{\underline{0.55\ FT}}$

$A_1 = P_1(H/2) = 1{,}680(7/2) = \underline{\underline{5{,}880\ LBS}}$

$$A_2 = P_2(1.5d) = 862.4(1.5)(2) = \underline{\underline{2{,}587.2\ LBS}}$$

$$A_3 = (P_{3,4} - P_2)(1.5d)/2 = (1{,}282.4 - 862.4)(1.5)(2)/2 = \underline{\underline{630\ LBS}}$$

$$A_4 = P_{3,4}(Y/2) = 1{,}282.4(0.55/2) = \underline{\underline{352.66\ LBS}}$$

$$A_5 = P_5(D_O - 1.5d - Y)/2 = (2{,}312D_O - 8{,}218.4)(\,D_O - 3 - 0.55)/2$$

$$= \underline{\underline{4{,}624{D_O}^2 - 32{,}852D_O + 58{,}350.6\ LBS}}$$

$$A_6 = P_6H = 812.8(7) = \underline{\underline{5{,}689.6\ LBS}}$$

$$A_7 = P_7D_O = \underline{\underline{406.4D_O\ LBS}}$$

COMPUTE REQUIRED EMBEDMENT DEPTH –

SUM MOMENTS ABOUT BOTTOM OF WALL TO DETERMINE D$_O$ –

$$A_1(D_O + H/3) + A_2(D_O - 1.5d/2) + A_3\left(D_O - \tfrac{2}{3}1.5d\right) + A_4(D_O - 1.5d - Y/3)$$

$$-A_5\,(D_O - 1.5d - Y)/3 + A_6(D_O + H/2) + A_7(D_O/2) = 0$$

$$5{,}880(D_O + 7/3) + 2{,}587.2(D_O - 3/2) + 630\left(D_O - \tfrac{2}{3}2\right) + 352.66(D_O - 2 - 0.55/3)$$

$$-(4{,}624{D_O}^2 - 32{,}852D_O + 58{,}350.6)\,(D_O - 2 - 0.55)/3 + 5{,}689.6(D_O + 7/2) +$$

$$406.4D_O(D_O/2) = 0$$

$$1{,}541.33{D_O}^3 - 15{,}084.24{D_O}^2 + 32{,}234.91D_O - 77{,}740.68 = 0$$

SOLVE FOR D$_O$:

$$D_O = \underline{\underline{7.95\ FT}}$$

INCREASEMBEDMENT DEPTH BY 20% TO ACCOUNT FOR “SIMPLIFIED” ANALYSIS AND THEN ADD AN ADDITIONAL 40% FOR SAFETY FACTOR.

$$D = 1.4[1.2(D_O)] = 1.4[1.2(7.95)] = \underline{\underline{13.36\ FT}}\ MINIMUM$$

PROVIDE $\underline{\underline{14\ FT}}$ OF EMBEDMENT.

CHECK SECTION 6.8.1 FOR GENERAL REQUIREMENT FOR CANTILEVERED SHORING WALL:

$14\ FT > H = 7\ FT\ OK$

DETERMINE DESIGN SHEAR FORCE –

MAXIMUM SHEAR FORCE IS AT BOTTOM OF PILE

$V_{MAX} = A_5 - A_1 - A_2 - A_3 - A_4 - A_6 - A_7$

$[(4{,}624D_O{}^2 - 32{,}852D_O + 58{,}350.6) - 5{,}880 - 2{,}587.2 - 630 - 352.66$

$-5{,}689.6 - 406.4D_O]/1000$

$V_{MAX} = \underline{\underline{71.06\ KIPS}}$

DETERMINE DESIGN MOMENT –

FIND POINT OF ZERO SHEAR (depth of X below bottom of excavation)

$A_1 + A_2 + A_3 + A_4 + A_6 + P_7X - P_5\,(X - 1.5d - Y)/2 = 0$

$5{,}880 + 2{,}587.2 + 630 + 352.66 + 5{,}689.6 + 406.4X - (2{,}312X - 8{,}218.4)$

$(X - 3 - 0.55)/2 = 0$

$1{,}156X^2 - 8{,}619.4X + 551.8 = 0$

SOLVE FOR X:

$X = \underline{\underline{7.52\ FT}}$

$M_{MAX} = [A_1(X + H/3) + A_2(X - 1.5d/2) + A_3\left(X - \frac{2}{3}1.5d\right) + A_4(X - 1.5d - Y/3)$

$+A_6(X + H/2) + P_7X^2/2 - P_5(X - 1.5d - Y)^2/6]/1000$

$= \{5{,}880(7.52 + 7/3) + 2{,}587.2(7.52 - 3/2) + 630(7.52 - 6/3) + 352.66(7.52 - 2 -$

$0.55/3) + 5{,}689.6(7.52 + 7/2) + 406.4(7.52)(7.52)^2/2 - [2{,}312(7.52) - 8{,}218.4]$

$(7.52 - 3 - 0.55)^2/6\}/1000$

$M_{MAX} = \underline{\underline{203.90\ KIP \cdot FT}}$

EXAMPLE 7.2 – SHEET PILE SHORING WALL WITH ONE LEVEL OF BRACING (FREE EARTH SUPPORT METHOD)

EXAMPLE 7.3 – SHEET PILE SHORING WALL WITH ONE LEVEL OF BRACING (FIXED EARTH SUPPORT METHOD)

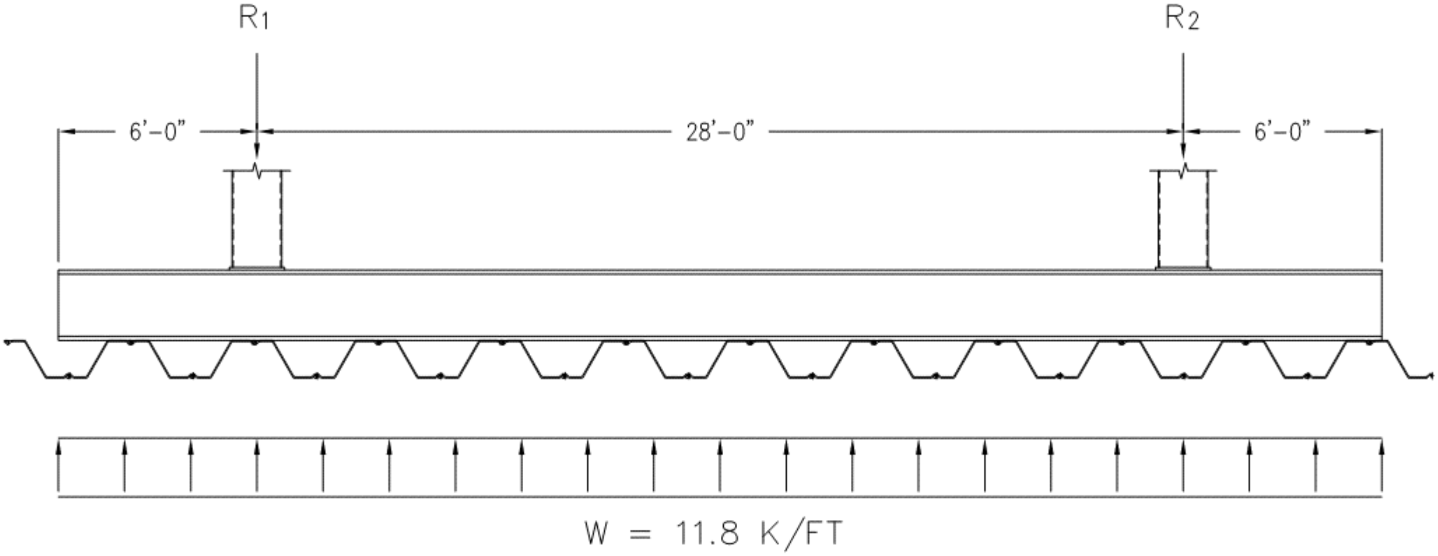
EXAMPLE 7.4 – ANALYSIS OF A DIAPHRAGM SHORING WALL WITH THREE LEVELS OF BRACING

(These examples will be provided in later revisions)

EXAMPLE 8.1 – WIDE FLANGE WALER DESIGN

PROBLEM:

SIZE A WALER FOR THE FOLLOWING BRACING GEOMETRY AND LOADING.



SOLUTION:

ANALYZE WALER TO DETERMINE DESIGN MOMENT AND SHEAR –

$$M_{MAX} = 11.8(28)^2/8 - 11.8(6)^2/2 = \underline{\underline{944\ KIP \cdot FT}}$$

$$V_{MAX} = 11.8(28)/2 = \underline{\underline{165.2\ KIPS}}$$

$$STRUT\ LOADS = R_1 = R_2 = 11.8(40)/2 = \underline{\underline{236\ KIPS}}$$

ASSUMPTIONS –

USE GRADE 36 WIDE FLANGE BEAM FOR WALER

COMPRESSION FLANGE IS CONTINUOUSLY BRACED BY SHEET PILINGS, THEREFORE, LATERAL TORISIONAL BUCKLING FAILURE STATE WILL NOT CONTROL.

$$F_b = 0.55F_y = 0.55(36) = \underline{\underline{19.8\ KSI}}$$

$$F_v = 0.35F_y = 0.35(36) = \underline{\underline{12.6\ KSI}}$$

$$S_{REQD} = M_{MAX}/F_b = 944(12)/19.8 = \underline{\underline{572.12\ IN^3}}$$

$$A_{WEB,REQD} = V_{MAX}/F_v = 165.2/12.6 = \underline{\underline{13.11\ IN^2}}$$

<u>ACCEPTABLE SIZES</u>	S (in^3) (Note 2)	A$_{WEB}$ (in^2)
W24X229	588	24.96
W27X217	627	23.57
W30X191	600	20.11

OTHER ACCEPTABLE SIZES ARE AVAILABLE.

NOTES:

1. STIFFENERS AT POINTS OF BEARING ARE NOT SHOWN AND THE DESIGN IS NOT INCLUDED IN THIS DESIGN EXAMPLE.
2. AISC SPECIFICATION ALLOWS THE USE OF PLASTIC SECTION MODULUS WHEN CALCULATING BENDING CAPACITY. HOWEVER, ONLY ELASTIC SECTION MODULUS WILL BE PERMITTED IN THIS MANUAL.

EXAMPLE 8.2 – PIPE STRUT DESIGN

PROBLEM:

DESIGN A PIPE STRUT FOR THE STRUT LOAD (236 KIPS) COMPUTED IN EXAMPLE 8.1. ASSUME STRUT LENGTH (UNBRACED) IS 38 FEET.

SOLUTION:

DETERMIEN MINIMUM CROSS-SECTIONAL AREA REQUIRED BASED ON THE 12 KSI MAXIMUM AXIAL STRESS CRITERION IN SECTION 7.1.1 –

$$A_{REQD} = STRUT\ LOAD/12 = 236/12 = \underline{\underline{19.67\ IN^2}}$$

TRY 18” DIA. X 3/8” WALL THICKNESS PIPE, ASTM A252, GRADE 2 (F_Y = 35 KSI) –

PIPE PROPERTIES

$$A = 19.4\ IN^2$$

$$I = 754\ IN^4$$

$$r = 6.24\ IN$$

$$S = 83.8\ IN^3$$

CHECK WIDTH-TO-THICKNESS RATIO FOR COMPRESSION ELEMENTS MEMBERS SUBJECT TO FLEXURE PER AISC SINCE AREMA DOES NOT HAVE PIPE SHAPE. DESIGN WALL THICKNESS SHALL BE TAKEN EQUAL TO 0.93 TIMES THE NOMINAL WALL THICKNESS PER AISC SPECIFICATION B4.2.

$$D/t = 18/[0.93(3/8)] = 51.6 < 0.07\, {}^{E}\!/_{F_y} = 0.07\, {}^{29{,}000}\!/_{35} = 58$$

SECTION IS COMPACT. LOCAL BUCKLING IS NOT A CONCERN.

$$WEIGHT\ (W) = 71\ LBS/FT$$

$$M_{SELF\ WEIGHT} = WL^2/8 = 71(38)^2/8 = 12{,}816\ LB \cdot FT = \underline{\underline{12.82\ KIP \cdot FT}}$$

CHECK SLENDERNESS RATIO PER AREMA –

$k = 7/8$ FOR MEMBERS WITH PIN-END CONNECTIONS

$$kl/r = 7/8\,(38)(12)/6.24 = 63.94 < 100\ \ O.K.$$

COMPUTE STRESSES –

$$f_a = STRUT\ LOAD/A = 236/19.4 = \underline{\underline{12.16\ KSI}} > 12KSI\ CONSIDER\ O.K.$$

$$f_b = M_{SELF\ WEIGHT}/S = 12.82(12)/83.8 = \underline{\underline{1.84\ KSI}}$$

COMPUTE ALLOWABLE STRESSES –

AXIAL COMPRESSION –

$$0.62/\sqrt{F_y/E} = 0.62/\sqrt{35/29{,}000} = 17.85$$

$$5.034/\sqrt{F_y/E} = 5.034/\sqrt{35/29{,}000} = 144.90$$

$$0.62/\sqrt{F_y/E} = 17.85 < kl/r = 63.94 < 5.034/\sqrt{F_y/E} = 144.90$$

$$F_a = 0.60F_y - \left(17{,}500\frac{F_y}{E}\right)^{3/2}(kl/r)$$

$$= 0.60(35) - \left(17{,}500\frac{35}{29000}\right)^{3/2}(63.94)/1{,}000 = \underline{\underline{14.79\ KSI}}$$

BENDING –

AREMA DOES NOT HAVE ALLOWABLE STRESSES FOR PIPE SHAPE. ALLOWABLE BENDING STRESS FOR ROLLED BEAMS IS PERMITTED TO USE.

$$F_b = 0.55F_y - \frac{0.55\left(F_y\right)^2}{6.3\pi^2 E}(l/r)^2 = 0.55(35) - \frac{0.55(35)^2}{6.3\pi^2(29{,}000)}\left[\frac{38(12)}{6.24}\right]^2 = \underline{\underline{17.25\ KSI}}$$

COMPUTE COMBINED STRESSES –

$$f_a/F_a = 12.16/14.79 = 0.82 > 0.15$$

$$\frac{f_a}{F_a} + \frac{f_b}{F_b\left[1 - \frac{f_a}{0.514\pi^2 E}\left(\frac{kl}{r}\right)^2\right]} = 0.82 + \frac{1.84}{14.79\left[1 - \frac{12.16}{0.514\pi^2(29{,}000)}(63.94)^2\right]}$$

$$= 0.82 + 0.19 = \underline{\underline{1.01}}\ 1\%\ OVERSTRESSED.SAY\ O.K.$$

<u>18" DIA. X 3/8" WALL THICKNESS (ASTM A252, GRADE 2) PIPE IS ACCEPTABLE.</u>

EXAMPLE 8.3 – SHORING WALL DESIGN

PROBLEM:

THE DESIGN BENDING MOMENT FOR A SHORING WALL IS 84 KIP-FT PER LINEAL FOOT. SIZE THE FOLLOWING SHORING WALL MEMBERS FOR THIS DESIGN MOMENT*:

(A) STEEL SHEET PILES
(B) SOIL-MIX WALL PILES INSTALLED @ 4'-0" ON CENTER

*NOTE: OTHER FACTORS NOT CONSIDERED IN THIS EXAMPLE (e.g., SHORING WALL STIFFNESS REQUIRED TO LIMIT WALL DEFLECTION, AXIAL LOAD IN SHORING WALL PILES, ETC.) MAY AFFECT THE DESIGN OF SHORING WALL MEMBERS.

SOLUTION:

(A) STEEL SHEET PILES

HOT-ROLLED SHEET PILES CONFORM TO ASTM A328 GRADE 50

COLD-ROLLED SHEET PILES CONFORM TO ASTM A572 GRADE 50

$F_y = 50\ KSI$

$F_b = 65\% F_y = 65\%(50) = 32.5\ KSI$

$S_{REQD} = M_{DESIGN}(12)/F_b = 84(12)/32.5 = 31.02\ IN^3/FT$

<u>ACCEPTABLE SHEET PILE SECTIONS</u>	S (in^3/ft)
AZ 23-800 (HOT ROLLED)	43.3
PZ 35 (HOT ROLLED)	48.5
SKZ 31 (COLD ROLLED)	0.9(51.56) = 46.40

OTHER ACCEPTABLE SHEET PILE TYPES ARE AVAILABLE.

(B) SOIL-MIX WALL PILES INSTALLED AT 4'-0" ON-CENTER

ASSUME PILE STEEL CONFORMS TO ASTM A572, GRADE 50

$F_y = 50\ KSI$

$F_b = 0.55 F_y = 0.55(50) = 27.5\ KSI$

$$S_{REQD} = M_{DESIGN}(PILE\ SPACING)(12)/F_b = 84(4)(12)/27.5 = 146.418\ IN^3/PILE$$

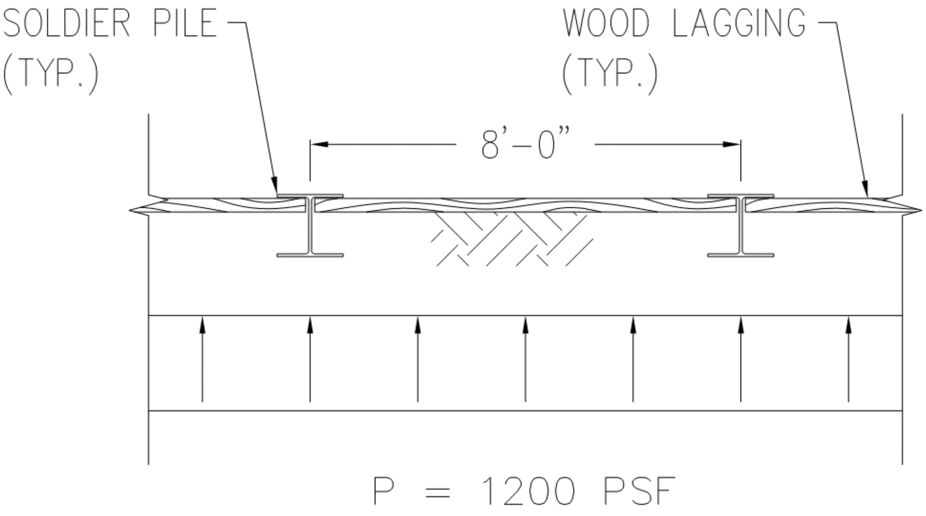
ACCEPTABLE PILE SIZES	S (in^3/pile)
W18X86	166
W21X73	151
W24X68	154

OTHER ACCEPTABLE PILE SIZES ARE AVAILABLE.

EXAMPLE 8.4 – WOOD LAGGING DESIGN

PROBLEM:

DETERMINE THE WOOD LAGGING THICKNESS REQUIRED FOR THE SHORING GEOMETRY ILLUSTRATED BELOW.



SOLUTION:

COMPUTE LAGGING DESIGN LOADING –

$$P_{LAGGING} = \frac{2}{3}P = \frac{2}{3}(1200) = \underline{\underline{800\ PSF}}$$

COMPUTE M_{MAX} AND V_{MAX} –

$$M_{MAX} = P_{LAGGING}(PILE\ SPACING)^2/8 = 800(8)^2/8 = \underline{\underline{6{,}400\ LB \cdot FT/FT}}$$

$$V_{MAX} *= P_{LAGGING}(PILE\ SPACING)/2 = 800(8)/2 = \underline{\underline{3{,}200\ LB/FT}}$$

(*CONSERVATIVE, V_{MAX} CAN BE TAKEN CENTER OF FLANGE BEARING)

TRY 6X, S4S (THICKNESS = 5½"), DOUGLAS FIR NO. 2 MATERIAL –

$$A = 5.5(12) = 66\ IN^2/FT$$

$$S = 12(5.5)^2/6 = 60.5\ IN^3/FT$$

CHECK BENDING AND SHEAR –

$$f_b = M_{MAX}(12)/S = 6{,}400(12)/60.5 = \underline{\underline{1{,}269.42\ PSI < 1{,}500\ PSI}}\ O.K.$$

$$f_v = 3V_{MAX}/2A = 3(3{,}200)/2(66) = \underline{\underline{72.73\ PSI\ < 140\ PSI}}\ O.K.$$

6X, S4S, DOUGLAS FIR NO.2 MATERIAL IS ACCEPTABLE.

APPENDIX D – TABLE OF MINIMUM WALL THIKCNESS FOR STEEL CASING PIPE FOR JACK-AND-BORE CONSTRUCTION

PIPE SIZE (INCHES)	WALL THICKNESS (INCHES) (PROTECTED)
10	0.375
12	0.375
14	0.375
16	0.375
18	0.375
20	0.375
22	0.375
24	0.375
26	0.375
28	0.406
30	0.469
32	0.501
34	0.532
36	0.532
38	0.569
40	0.569
42	0.569
44	0.594
46	0.688
48	0.688
50	0.688
52	0.813
54	0.813
56	0.876
58	0.876
60	0.876
62	0.876
64	0.876
66	0.876
68	0.876
70	0.906

Note: For unprotected pipe 26” and under, add 0.032” to protected wall thickness. For unprotected pipe 28” and over, add 0.063” to protected wall thickness.

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APPENDIX E – MONITORING/SURVEY RESULTS REPORTING FORMS

Reporting Static Top of Running Rail Survey Results

Point No.	Station	Baseline T/Rail Elevation (Date) MM/DD/YYYY			Surveyed Static T/Rail Elevation (Today's Date) MM/DD/YYYY			Static T/Rail Change from Previous (Previous Survey Date) MM/DD/YYYY			Static T/Rail Change from Baseline		
		E_L	E_R	E_{avg}	E_L	E_R	E_{avg}	ΔE_L	ΔE_R	ΔE_{avg}	ΔE_{Li}	ΔE_{Ri}	ΔE_{avgi}
1	100+00												
2	100+10												
3	100+20												
.	.												
.	.												
.	.												
n													

Reporting Dynamic Measurement Results

Point No.	Station	Baseline Dynamic Movements (Date) MM/DD/YYYY				Measured Dynamic Movements (Today's Date) MM/DD/YYYY				Dynamic Change from Previous (Previous Survey Date) MM/DD/YYYY				Dynamic Change from Baseline			
		Total			Cross-Slope	Total			Cross-Slope	Total			Cross-Slope	Total			Cross-Slope
		δ_L	δ_R	δ_{avg}	$\delta_{cs} = \lvert\delta_L - \delta_R\rvert$	δ_L	δ_R	δ_{avg}	$\delta_{cs} = \lvert\delta_L - \delta_R\rvert$	$\Delta\delta_L$	$\Delta\delta_R$	$\Delta\delta_{avg}$	$\Delta\delta_{cs} = \lvert\Delta\delta_L - \Delta\delta_R\rvert$	$\Delta\delta_{Li}$	$\Delta\delta_{Ri}$	$\Delta\delta_{avgi}$	$\Delta\delta_{csi} = \lvert\Delta\delta_{Li} - \Delta\delta_{Ri}\rvert$
1	100+00																
2	100+10																
3	100+20																
.	.																
.	.																
.	.																
n																	

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APPENDIX F – COMMENTARY

The commentary is not a part of the Adjacent Construction Manual, but is included for informational purposes only unless otherwise noted in the Manual.

The Commentary furnishes background information and references for the benefit of the design professional seeking further understandings of the basis, derivations, and limits of the Manual.

SECTION 1 INTRODUCTION COMMENTARY

C1.1 PURPOSE[1]

AREMA *Manual for Railway Engineering* Chapter 8 – Concrete Structures and Foundations Part 28 – Temporary Structures for Construction Article 28.1.1 (c) recommends “all temporary structures anticipated to be in service for more than an 18-month period are not within the scope of these specifications”. The 18-month period required by AREMA *Manual for Railway Engineering* applies mostly to heavier passenger/freight trains, which usually has a lower average daily train traffic. CTA system, on the other hand, has a significantly higher average daily train traffic. Therefore, the period length is decided to be reduced to one year. For long-term permanent earth-retention structures, the cohesive soil cohesion may be omitted and treated as cohesionless soil.

C1.5 DEFINITIONS[2]

The strut to soldier pile or waler connection utilizing a single gusset/knife plate can be problematic. Such gusset/knife plate must satisfy the non-compact limit of $b/t > 95/F_y^{0.5}$ which may often be ignored for a temporary construction, otherwise a significant reduction in allowable stress can occur when the plate is considered slender. Secondly, field installation modifications to these gusset/knife plates such as gaps between gusset/knife plate and soldier pile or waler flange and angle of strut intersection with the said members may often be susceptible to significant stress increase. In order to avoid this concern, construction tolerances must be specified and taken into account during the design phase, which is often neglected for a temporary construction. Finally, it is impossible to predict the movement of the shoring wall and the gusset/knife plate connecting waler, which with such movement, some rotation will be introduced into the gusset/knife plate and result in additional bending stress that cannot be accounted for in design phase. For these reasons, CTA Engineering has decided not to allow gusset/knife plate connections.

SECTION 2 SUBMITTAL REQUIREMENTS COMMENTARY

(This page reserved for future commentary for Section 2)

SECTION 3 BASIC CONSTRUCTION AND EXCAVATION REQUIREMENTS COMMENTARY

C3.1 ZONE OF INFLUENCE[3,4, 5, 6]

For utility works with depth less than 12 feet, the Contractor is generally permitted to move the utility alignment for up to 2 feet in all directions without the need to go through OUC review. With this permission from OUC, it brought up concerns that a previous reviewed and approved excavation that showed outside the CTA Zone of Influence or outside a specific Zone would change. The primary concern is for example, a previously design ERS soldier pile with lagging system approved in Zone 3, based on field condition needs to be moved towards the CTA tracks and enters Zone 2. The new requirement by assuming proposed utility alignments are 2 feet closer to CTA structures in the worst-case scenario can address this concern. However, this requirement may be waived by a Variance Request if the proposed utility is in Zone 4 and more than 2 feet away from Zone 3.

Per AREMA *Manual for Railway Engineering* Chapter 8 Article 28.5.1.1 – Restrictions of Use for cantilever sheet pile walls, where it states, “if used for shoring adjacent to an operating track the wall should be at least ten (10) feet away from the centerline of track, and its maximum height shall not exceed ten (10) feet.” Figure C2-1 shows the lateral pressure based on criteria from AREMA *Manual for Railway Engineering* shown above and cooper E80 loading condition. Figure C2-2 shows the lateral pressure based on criteria for Zone 2 in this Manual with CTA train loading condition.

Cantilever walls undergo large lateral deflections and the member stresses increase rapidly with height. Therefore, it is important to restrict the maximum height of the wall and ensure existence of good quality soil below the excavation line that can provide adequate passive resistance. The maximum lateral pressure occurs at a higher elevation with Zone 2 requirements in this Manual comparing to the AREMA *Manual for Railway Engineering* criteria. Previous experience shows for the normal size sheet piling, when cantilever height exceeds six (6) feet the maximum deflection at the top of the sheet piling wall exceeds 1/4 inch. Therefore, for Zone 2 the maximum cantilever height for sheet piling is restricted to four (4) feet. This cantilever height limitation also avoids the cantilevered sheet pile from being stressed with the maximum lateral pressure that can occur.

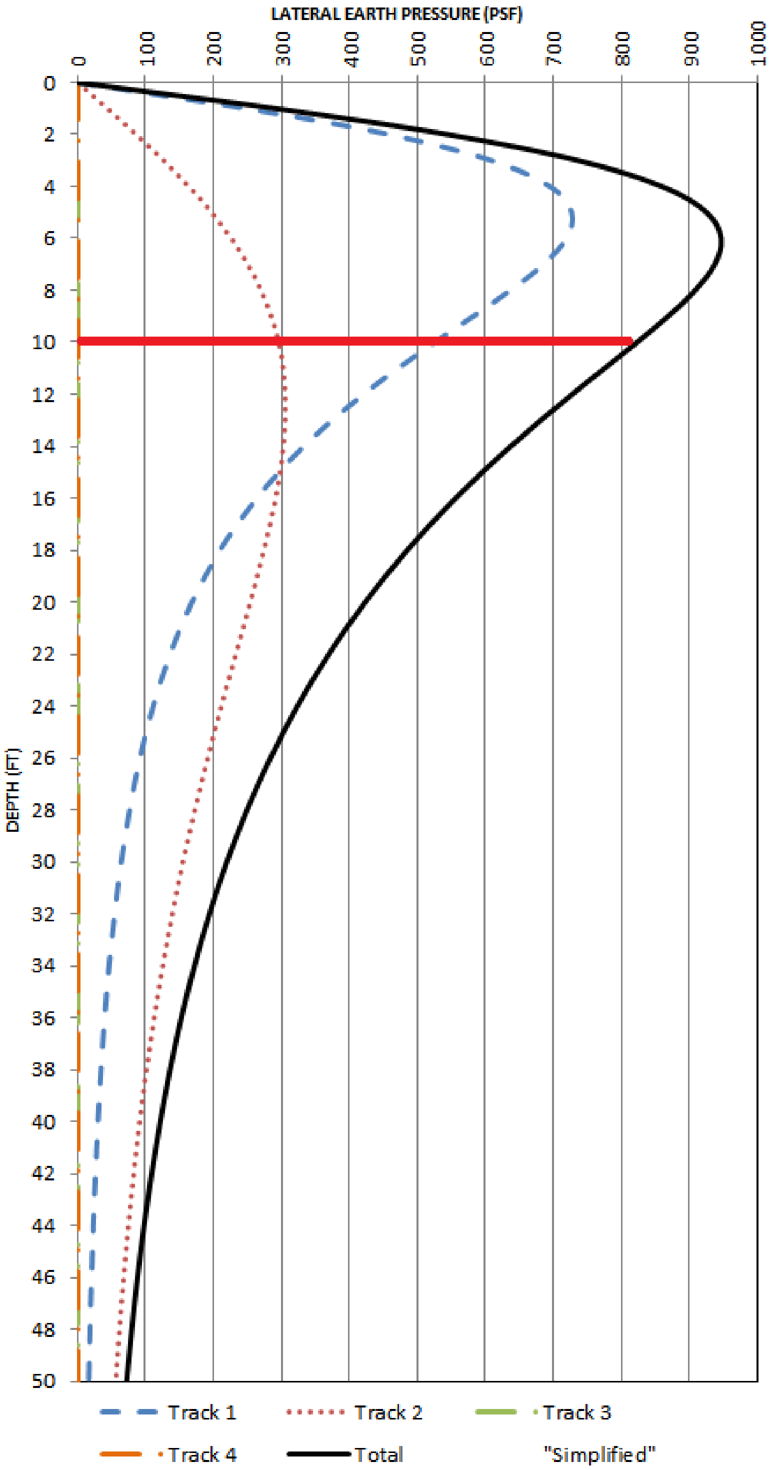


Figure C2-1: Lateral Pressure AREMA Cooper E80 Loading 10' from CL Adjacent Track (2 Tracks considered)

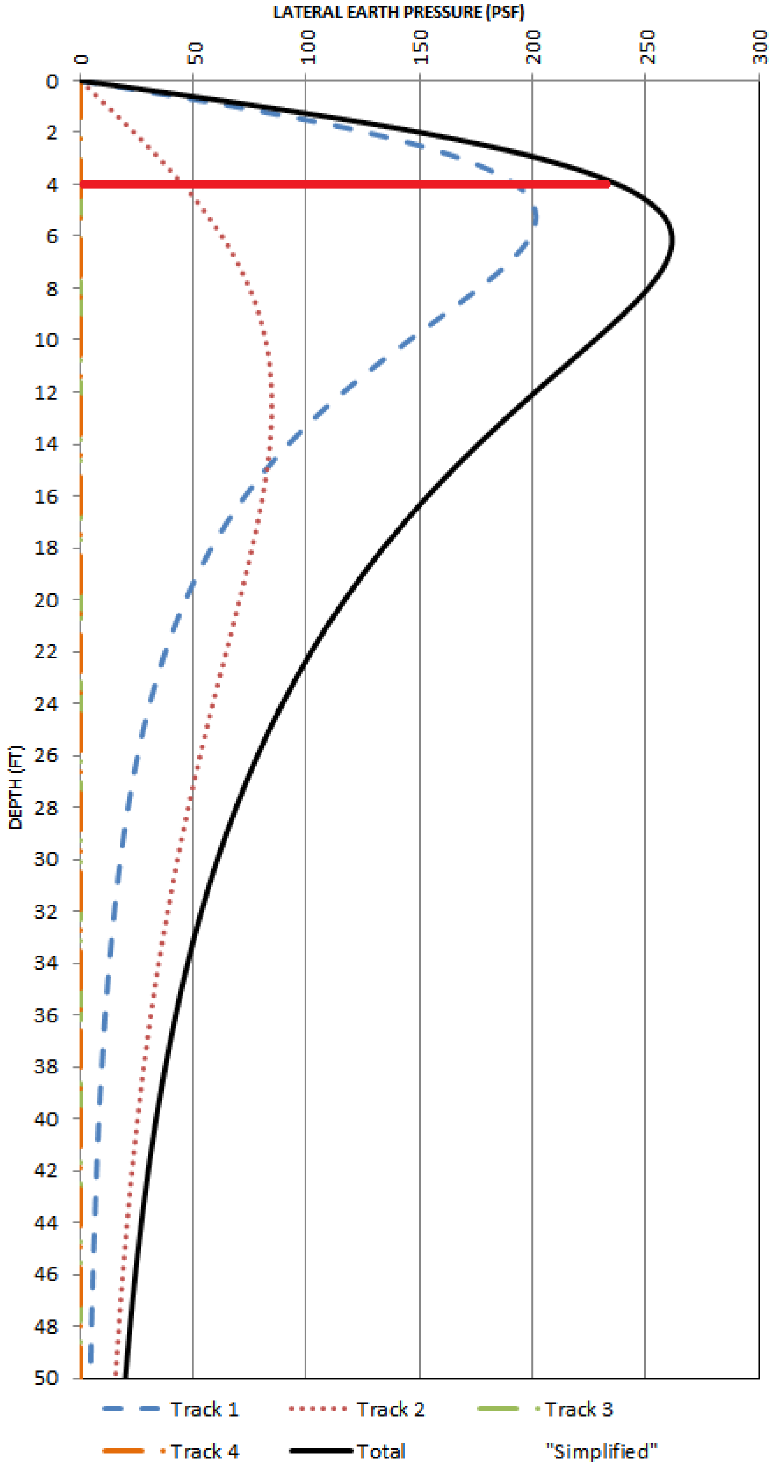


Figure C2-2: Lateral Pressure CTA Train Loading 5’-7” from CL Adjacent Track (2 Tracks considered)

Per AREMA *Manual for Railway Engineering* Chapter 8 Article 28.5.3.1 – Restrictions of Use for cantilever soldier beam with lagging walls, where it states, “if used for shoring adjacent to an operating track the wall should be at least 13 feet away from the centerline of track, and its maximum height shall not exceed eight feet”. Figure C2-3 shows the lateral pressure based on criteria from AREMA *Manual for Railway Engineering* shown above and cooper E80 loading condition. Figure C2-4 shows the lateral pressure based on criteria for Zone 3 in this Manual with CTA train loading condition.

A cantilever soldier pile wall behaves similarly to a cantilever sheet pile wall. Due to the rapid increase in deflections and moments with the wall height, maximum height restrictions needed to be imposed. With the maximum lateral pressure elevation generally lower due to the increased distance from the shoring wall to the centerline of track, it is reasonable and practicable to avoid loading the cantilevered shoring wall with the maximum lateral pressure. Therefore, for Zone 3 the maximum cantilever height for flexible shoring walls is restricted to six (6) feet.

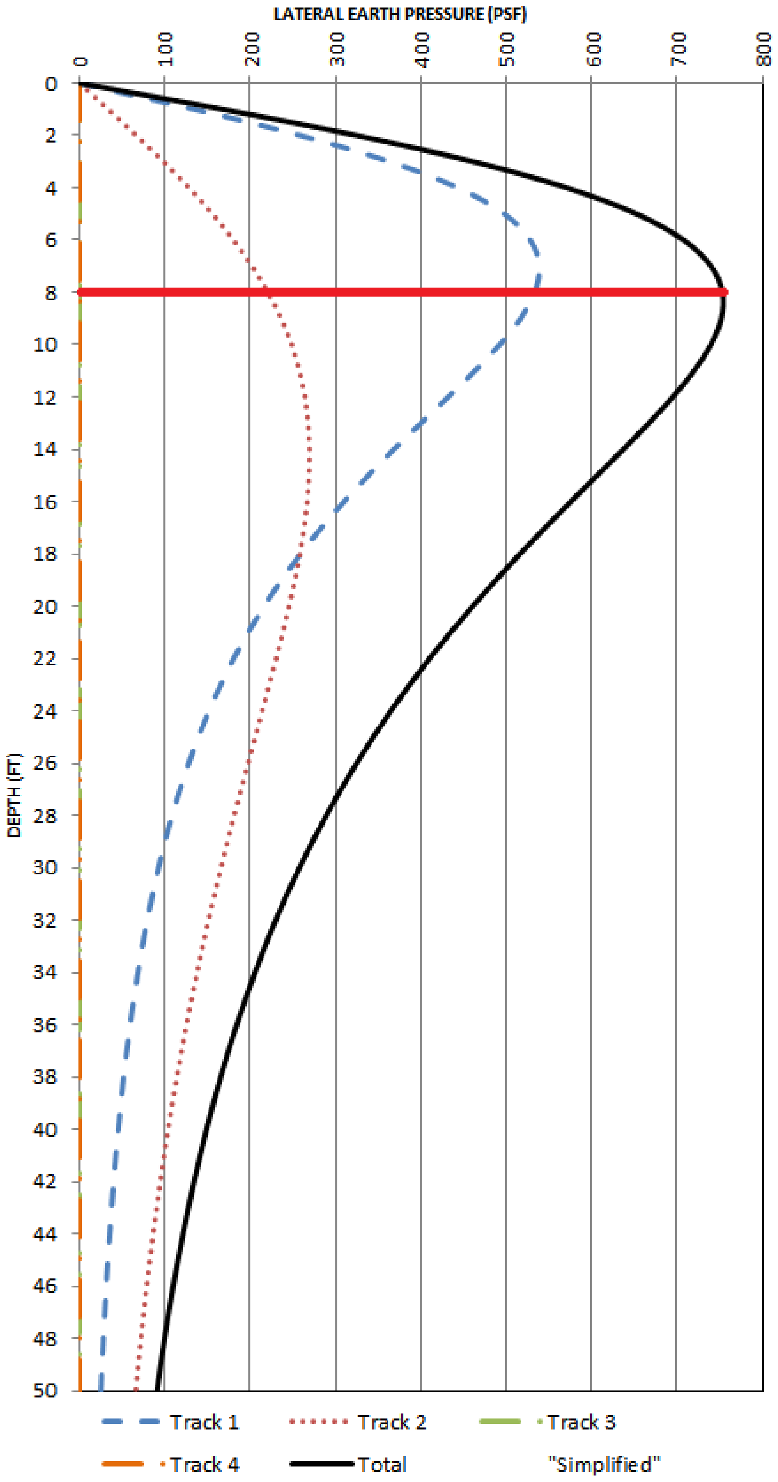


Figure C2-3: Lateral Pressure AREMA Cooper E80 Loading 13' from CL Adjacent Track (2 Tracks considered)

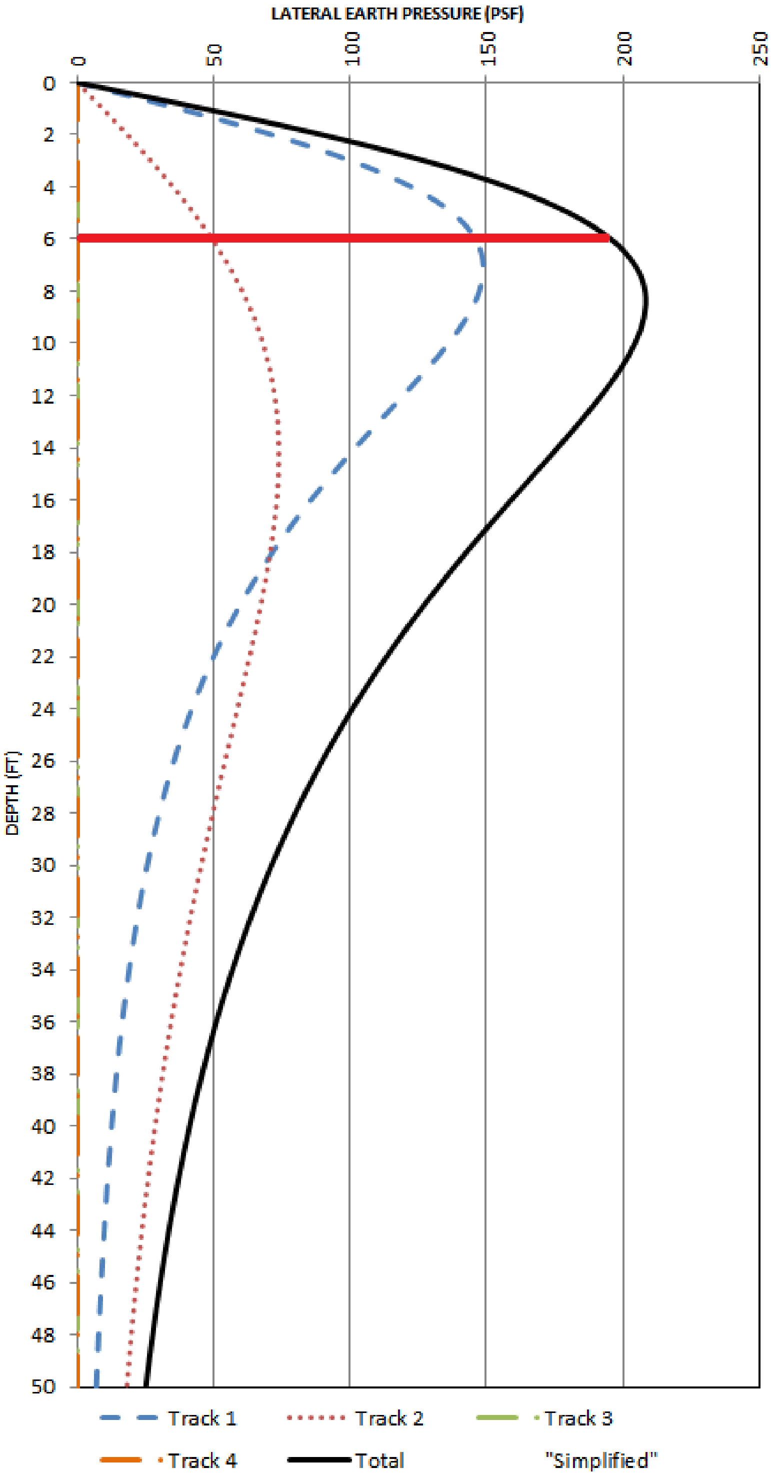


Figure C2-4: Lateral Pressure CTA Train Loading 8'-6" from CL Adjacent Track (2 Tracks considered)

The condition of the ballast section and the amount of ballast at the ends of the ties is considered very important to the lateral stability of the track, especially at curved tracks. The 12-inch minimum dimension for tangent tracks is considered sufficient for wind force on train or nosing force and is recommended by AREMA *Manual for Railway Engineering.* For Continuously Welded Rail at curved track locations, the ballast shoulder width is important and should be evaluated if disturbed and shall be restored immediately. For reference purposes, the following commentary is provided to determine the ballast shoulder width.

The equation determining Ballast Side Slope run (BSS) which is also called Ballast Shoulder Width is recommended to be calculated by the provision in AREMA *Manual for Railway Engineering* Chapter 16 – Economics of Railway Engineering and Operations Part 10 – Construction and Maintenance Operations Article 10.3.2.2 – Width of Ballast Shoulder at Ends of Ties, where it states “the forces necessary to move a tie buried to a depth of 4 inches in ballast, having a 6-inch ballast shoulder and carrying no vertical load is approximately 300 lb.” Linear interpolation is permitted by AREMA *Manual for Railway Engineering.* Vertical train live loads provide significant hold-down force, however, because track buckling often occurs immediately ahead of a moving train due to the rail uplift “wave” described by Talbot equation, train live load should be ignored.

SECTION 4 TEMPORARY SHORING SYSTEM COMMENTARY

C4.3 PROHIBITED SHORING TYPES[7]

Earth Retention Systems with elements installed and left in place in Zone 1 are not preferred due to future possible excavation such as track/ballast replacement etc. Therefore, systems included in this section are not allowed.

Soil nailing and helical screw anchors are strictly prohibited for the following reasons:

- Performances highly depend on the soil condition, where cohesive soils that have good stand-up time are required. For track drainage purposes, the fill within the Zone of Influence is usually granular engineered fill.
- Systems are not pre-loaded and require relatively large movement to mobilize the passive pressure. Therefore, deflections for this type of system are higher than other systems.

Tieback wall system is not permitted for the same reason shown above except that tiebacks are left in place in Zone 1. However, tieback wall system may be accepted by CTA if any other alternate is not practical since tiebacks are pre-loaded/tested, and the system works in most soil conditions.

Micropiles with laggings system is not permitted since micropiles are slender elements and should not be statically loaded in bending. In addition, the typical threaded joint used in the oil industry can only achieve 50% of the bending capacity of the intact casing. Structural welding may also be a concern since the typical N80 oil pipe has lower carbon composition than the structural steel type. The soundness of the welds is difficult to control. However, the use of micropiles with laggings system may be accepted by CTA if warranted by the low headroom clearance. 100% bending capacity of the intact casing can be achieved at the threaded joint by providing an inner casing extending a certain distance each side of the joint to reinforce the threaded joint. If the Designer in Responsible Charge elects to use only the threaded joint, the bending strength at the threaded joint must be calculated. Threading length can be increased to achieve 100% bending capacity of the intact casing. Designer in Responsible Charge can refer to the research paper "*Bending Strength of Threaded Micropile Connections*" by Steven R. Musselman, J.H. Long, N. Carroll, and S. Farr for methods to predict joint strength and stiffness.

See Example 4.1 – Bending Strength of Threaded Micropile Connections.

One of the most significant disadvantages of slurry wall construction is the extensive field setup required. The excavation and mixing/fill equipment need to be located at each ends of the excavated trench, with this setup equipment may foul the tracks when the slurry wall is in Zone 2. Therefore, the use of slurry wall is prohibited in Zone 2. Another disadvantage is that during the excavation before concrete can be placed, only bentonite slurry is used to support the adjacent soil to prevent the collapse of the trench. It may not support the lateral pressure from the Rapid Transit surcharge. Therefore, when slurry walls are used, the walls should be installed without trains. Considering the ballasted on-grade track North Main Line operates 24 hours every day, the use of slurry wall is considered not feasible unless a weekend shutdown is allowed.

SECTION 5 LOADING ON TEMPORARY SHORING SYSTEM COMMENTARY

C5.2 SOIL LOADS

C5.2.1 Soil Types and the Determination of Soil Properties[8]

Per ASTM D2573-08 Standard Test Method for Field Vane Shear Test in Saturated Fine-Grained Soils, Section 11 does not provide test data precision due to the nature of the test method. Section 5.3 also requires the peak undrained shear resistance of the vane test is commonly corrected to determine the undrained shear strength for geotechnical analysis. The agency requesting the testing must interpret these data to determine applicability for strength analysis. The undrained shear strength is commonly adjusted with liquid limit.

C5.2.2 Loading from Retained Soil on Flexible System[9, 10, 11]

The value of 30 psf/ft is based on AREMA *Manual for Railway Engineering* Chapter 8 – Concrete Structures and Foundations Part 28 Temporary Structures for Construction Figure 8-28-2. The apparent earth pressure diagram shows the representative value of F is 28 - 36 psf/ft for soft clay. The lower bound value of 30 psf/ft is selected to represent the minimum soil pressure. This is also consistent with the AASHTO minimum soil pressure with a minimum 0.25 active pressure coefficient. Assuming a soil unit weight of 120 pcf – 0.25(120) = 30 psf/ft.

AREMA *Manual for Railway Engineering* Table 8-5-1 specifies Type 3 backfill to be “fine silty sand; granular materials with conspicuous clay content; or residual soil with stones.” Even though this is not the typical soil profile in Chicago area (Chicago area is usually Type 4 soft or very soft clay, organic silt; or soft silty clay with little cohesion). Per AREMA *Manual for Railway Engineering* Table 8-5-2, Type 3 backfill material is specified to have unit weight of 125 lb. per cu. ft. and 28 degree of internal friction which yields 0.36 active pressure coefficient. This is considered conservative for retained soil.

C5.2.3 Loading from Retained Soil on Flexible System[12]

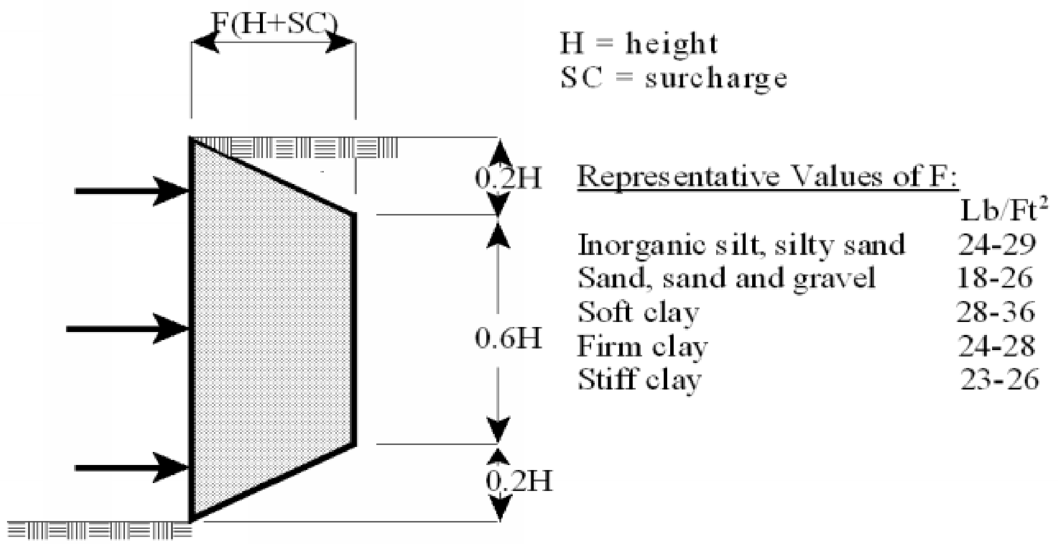
Per AREMA *Manual for Railway Engineering* Chapter 8 – Concrete Structures and Foundations Part 28 Temporary Structures for Construction Article 28.5.4.3 a (2), for masses which do not have a history of sliding, the magnitude of lateral pressures on multi-tiered anchored walls shall be computed following the guidelines on Figure 8-28-2.

C5.2.4 Passive Pressure[14]

Rankine’s Theory does not account for wall friction and can be overly conservative when wall interface friction angle (δ) becomes greater. Especially when the ratio of wall interface friction angle (δ) over soil friction angle (Φ) exceeds 2/3. However, Rankine’s Theory simplifies calculations and is generally used in the industry when calculating passive pressure.

Log-spiral theory accounts for the angle of wall friction and assumes either a curved or composite rupture line. Log-spiral theory provides a more realistic failure surface and yields a higher passive resistance coefficient. However, this is recommended only when there are underground constrains.

Coulomb’s theory “determines the passive earth pressure force accounts for the angle of wall friction, the theory assumes a linear failure surface. The result is an error in Coulomb’s calculated force due to the fact that the actual sliding surface is curved rather than planar. Coulomb’s theory gives increasingly erroneous values of passive earth pressure as the wall friction increases. Therefore, Coulomb’s theory could lead to unsafe shoring system designs because the calculated value of passive earth pressure would become higher than the soil could generate.”[43]



H = height
SC = surcharge

Representative Values of F:

	Lb/Ft²
Inorganic silt, silty sand	24-29
Sand, sand and gravel	18-26
Soft clay	28-36
Firm clay	24-28
Stiff clay	23-26

Figure 8-28-2. Apparent Earth Pressure Diagram

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[43] From Section 4.7 on Pages 4-50 and 4-51 in “*Trenching and Shoring Manual*” by State of California, Department of Transportation, Issued by Offices of Structure Construction, Copyright © 2011 California Department of Transportation. All rights reserved.

SECTION 6 RAPID TRANSIT LIVE LOAD SURCHARGE COMMENTARY

C6.1 GENERAL[15, 16, 17]

It is CTA's policy that the latest CTA Rapid Transit Live Load Diagrams are Sensitive Security Information that are controlled under 49 CFR PARTS 15 AND 1520. These diagrams or no part of these diagrams may be disclosed to persons without a "need to know" basis, as defined in CFR PARTS 15 AND 1520, except with the written permission of the administrator of the Transportation Security Administration or the Secretary of Transportation. Therefore, for CTA Rapid Transit Live Load the calculated strip loads are presented in the Manual. These strip loads were obtained with the following equation conservatively:

$$q = \frac{\max\,(Axle\ Load)}{\min(Axle\ Spacing)\cdot(Tie\ Length)}$$

However, users of this Manual can refer to AREMA *Manual for Railway Engineering* Volume 3 Chapter 12 – Rail Transit Part 4 – Facilities and Structural Considerations for general information, in which Figure 12-4-4 Live Loads Questionnaire, Attachment 3 contains information on the old version of CTA Design Axle Loads and Spacing.

For existing retaining walls supporting CTA tracks built prior to 1970, the design code used was either unclear to CTA Engineering, or may be the outdated AREA code where an older version of the Boussinesq lateral surcharge equation. If the Adjacent Construction Contractor and/or ERS Engineer in Responsible Charge submit the Variance Request with calculations showing factors of safety cannot be achieved, the following surcharge load reductions may be permitted, provided CTA Engineering can verify the period when the retaining walls in question was designed or constructed.

Reduced Strip load q for CTA Rapid Transit Axle Loads – Stability on Existing Retaining Walls:

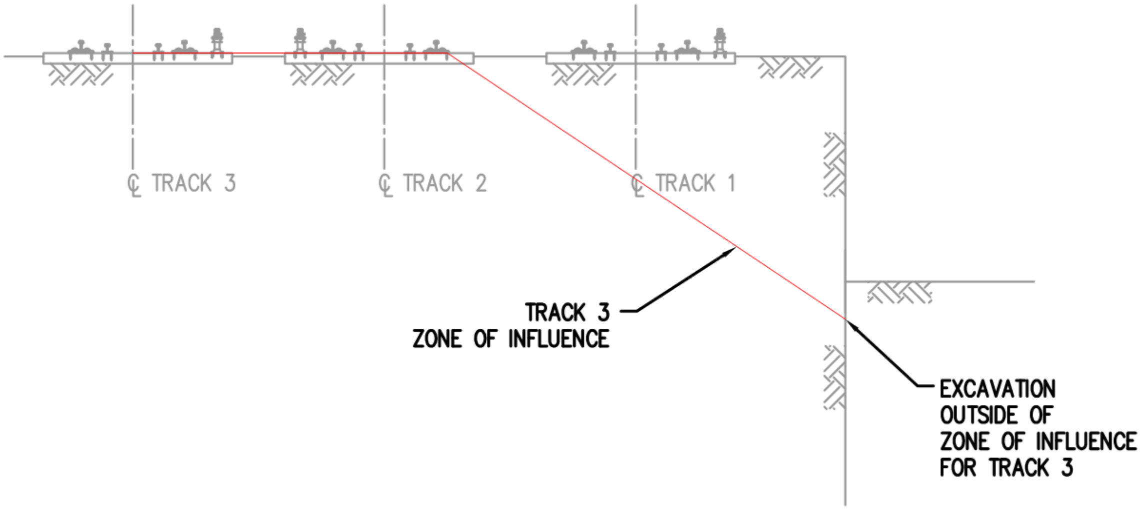
$$q_{stability} = 397psf$$

If with the reduced transit surcharge live load the factor of safety still cannot achieve the requirements in SECTION 7, it is permitted that the modification factor be reduced to 1.5 in the Boussinesq equation as shown in **Figure 6 - 1** and as shown below:

$$p_{s\_modified} = \frac{1.5q}{\pi}(\beta + sin\beta sin^2\alpha - sin\beta cos^2\alpha)$$

C6.2 SURCHARGE FROM MULTIPLE TRACKS[18]

For example, track 3 surcharge needs not be included for the shoring wall design when the excavation is outside the Zone of Influence Line as defined per **Figure 3 - 1**.


℄ TRACK 3
℄ TRACK 2
℄ TRACK 1
TRACK 3
ZONE OF INFLUENCE
EXCAVATION
OUTSIDE OF
ZONE OF INFLUENCE
FOR TRACK 3

SECTION 7 SHORING ANALYSIS METHODOLOGIES COMMENTARY

C7.2 SOLDIER PILE SHORING WALLS[19]

In non-railroad application, it is industrial standard to only apply the effective width to passive pressure while active pressure can be treated acting only on the flange width or the diameter of concrete-filled hole. This may be considered to be acceptable in Zone 4 in the Zone of Influence **Figure 3 - 1**.

C7.3 ANALYSIS OF CANTILEVER WALLS[20, 21, 22]

The 20 percent increase is not a factor of safety since it accounts for the unconservativeness with the “simplified” method for ignoring rotation of the length of vertical wall element.

The overall stability factor of safety shall be 2 for cantilever walls and this is achieved by dividing the passive resistance by 2 for stability check. Some guidelines such as NAVFAC_DM_02 Figure 23 shows “increase D by 20% - 40% to result in approximate factory of safety of 1.5 to 2”. Therefore, increase the theoretical embedment depth by 40% will be accepted for simple calculations.

AREMA *Manual for Railway Engineering* Chapter 8 Article 28.5.1.2 (b) acknowledges this concern and requires “depth of embedment increased to not less than the height of the wall” for “conditions such as unrealistically short penetration requirements into relatively strong layers”. This requirement has been adopted in this Manual.

C7.5 ANALYSIS OF WALLS WITH MULTIPLE LEVELS OF BRACING

C7.5.2 Analysis of Shoring Walls[23]

Some agencies allow moment to be reduced to 80% of their computed values for design to account for wall continuity over the bracing locations. CTA Engineering agrees with this observation, however, since the shoring wall will be analyzed in a way that all bracing locations to be hinges except the uppermost, positive moments between the bracing locations generally govern the shoring wall design. Therefore, this Manual does not mention the 80% reduction to the calculated moment.

C7.8 GENERAL SHORING REQUIREMENTS

C7.8.1 Minimum Embedment Depth[24]

South California Regional Rail Authority (SCRRA) Metrolink Excavation Support Guidelines, July 2009 requires minimum embedment depth for braced wall and these requirements have been adopted in this Manual.

C7.8.2 Secondary Bracing[25]

AREMA *Manual for Railway Engineering* Chapter 15 Article 1.11.6 requires “bracing members used only as ties or struts, to reduce the unsupported length of a member to which they connect, need not be designed for more than 2.5% of the force in that member”.

C7.9 SHORING DEFLECTION AND SETTLEMENT[26, 27]

CTA Engineering understands if including all deflections for each individual element of the shoring wall system, it is very difficult to satisfy the shoring wall deflection and vertical movement of the track limitations specified in Section 10.2. However, this is a practical concern that many times is ignored when estimating the shoring wall deflection and settlement. It is the intent of CTA Engineering to ensure the Adjacent Construction Engineer in Responsible Charge and Contractor know the risks associated with construction and excavation adjacent to an active rapid transit track especially when the shoring walls are in Zone 2 and Zone 3. However, an economical design can still be achieved if track settlement is monitored and controlled in between the shoring wall installation stages. More detailed monitoring requirements are outlined in Section 10.

Deflection limits in Zone 4 as shown in this Section is based on Metra Temporary Shoring Guidelines 10/1/2010 REV 0.

SECTION 8 MATERIAL PROPERTIES AND ALLOWABLE STRESSES COMMENTARY

C8.1 STEEL

C8.1.1 Structural Steel[28]

The 12 ksi axial stress limit is a rule-of-thumb base value based on previous experience, it also provides some factor of safety for the use of HSS shapes as compression member such as strut since AREMA *Manual for Railway Engineering* does not have allowable stress equation for HSS shapes. Users of this Manual can refer to Design Example 8.2 – Pipe Strut Design for more information.

C8.1.2 Steel Sheet Piling[29, 30]

AREMA *Manual for Railway Engineering* Chapter 8 Article 28.5.1.4, a, (1) requires sheet pile section allowable stress to be 2/3 tensile yield strength for new steel. This is not adopted in this Manual because USS Steel Sheet Piling Design Manual recommends 65% of minimum yield point and some increase for temporary overstresses are generally permissible. In this Manual, the overstress allowance is not adopted either.

Because of the nature of cold-bending, the small bend radius at the interlocking joints is small and the thickness is reduced resulting very flexible interlocks. Therefore, a 10% section property reduction is required. In addition, cold-rolled sheet piling cannot prevent water infiltration without interlock sealant.

C8.1.4 Wire Rope Cable and Chain[31]

Based on previous experience, wire rope cable and chain are not allowed to use as main load path structural components or secondary load bracing for track structure shoring structures due to the concern tautness being difficult to maintain.

C8.1.6 Micropile Casing Pipe[32]

All grades of ASTM A500 structural steel pipe are considered exceeding ASTM A252 Grade 2.

The wall thickness reduction for ASTM A252 and ASTM A500 casing pipes are based on AISC Specification 360-10 Article B4.2, where for electric-resistance-welded (ERW) HSS design wall thickness shall be taken equal to 0.93 times the nominal wall thickness, and equal to the nominal thickness for submerged-arc-welded (SAW) HSS. Considering the material quality for temporary shoring wall may be difficult to control, the reduced wall thickness requirement will apply regardless the welding process used to manufacture the HSS.

C8.2 CONCRETE[33]

The Load Factor Design in AREMA *Manual for Railway Engineering* was developed based on ACI 318, 1999 version, in which the load factors are higher than the modern ACI 318 Strength Design Method. Reinforced and plain (unreinforced) concrete may also be designed using the

Strength Design Method in accordance with the newer ACI 318 provided load combinations and load factors are in accordance with Table 8-2-5 AREMA *Manual for Railway Engineering* for Load Factor Design.

SECTION 9 SPECIAL CONDITIONS COMMENTARY

C9.3 BOTTOM STABILITY

C9.3.1 Piping[34]

User of this Manual may refer to “*Trenching and Shoring Manual*” by State of California, Department of Transportation (Caltrans)[44] for additional information in regard to calculating the hydraulic forces in the condition of piping.

C9.4 GLOBAL STABILITY[35]

When the excavation is outside the Zone of Influence or even the Basic Safety Envelope certain conditions exist where the global stability of tracks or structures can still be affected. As an example, this can occur when Adjacent Construction proposes to remove, even temporarily, a large structure that serves to provide stability to embankment structure/tracks. In this example, this may occur where the soil profile contains weak clay with sand, or other similar poor soil conditions. Global stability of the tracks will be affected and stability analysis needs to be performed to ensure existing tracks will not be affected. It is not practical or safe to expect CTA Engineering reviewers to provide directions on when a global stability analysis is warranted since CTA Engineering reviewers would not be familiar with the Adjacent Construction site, geotechnical soil profile and the scope of the work. Therefore, the Engineer in Responsible Charge must determine if global stability analysis is warranted.

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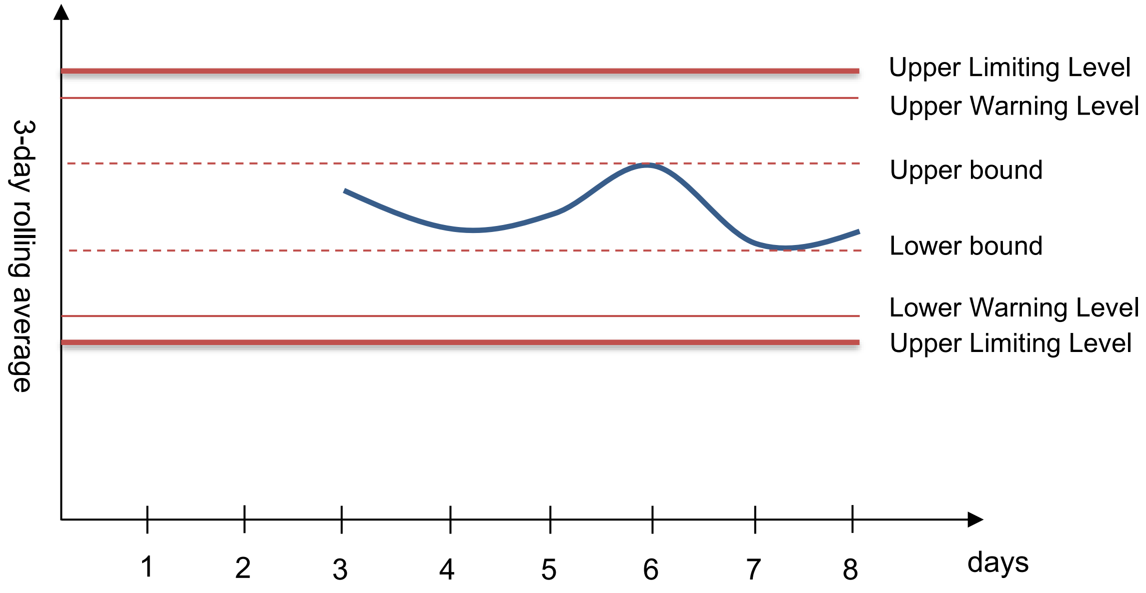
[44] “*Trenching and Shoring Manual*” by State of California, Department of Transportation, Issued by Offices of Structure Construction, Copyright © 2011 California Department of Transportation. All rights reserved.

SECTION 10 TRACK MONITORING COMMENTARY

C10.3 MINIMUM MONITORING RQUIREMENTS[36, 37]

Based on various previous experience, more reliable survey data can be obtained by mounting the survey points (equipment) on the crossties, while handheld survey equipment set up on top of running rail in between trains may generate unreliable survey data.

Structural thermal expansion and contraction can affect the monitoring baseline readings. Therefore, it is recommended the baseline readings be averaged with all readings taken over a three-day period. If baseline readings are taken with more than three days, it may be more beneficial to the Contractor as 3-day rolling average readings can be permitted to be used with the highest value as the upper bound, and lowest value as the lower bound, as shown in below figure, especially for the Adjacent Construction Projects that require extensive construction time. A minimum of seven sets of baseline readings are required to construct a minimum of five rolling average readings.



SECTION 11 OTHER TYPES OF ADJACENT CONSTRUCTION COMMENTARY

C11.1 CONSTRUCTION ADJACENT TO CTA UNDERGROUND STRUCTURES

C11.1.3 Tunnel Analysis Criteria[38]

The assumption that all CTA underground structures are cut-and-cover is not true based on history references found. These references indicate that the subway tunnels in the loop were either bored, or constructed with compressed air temporarily supporting the tunnel construction, and this type of construction should be considered as bored. Adjacent Construction that requires excavation and exposing large portion of CTA subway structures is rare, and even less likely being inside the loop. If new construction is adjacent to or over existing CTA bored tunnels, as directed by CTA, provide an analysis of the tunnel support system (liner) for the changed loading condition due to the adjacent construction. The analysis shall follow requirements outlined in Section 11.1.3 and include uplift of tunnel when excavation is over CTA bored underground structures.

C11.1.4 Augered, Driven and Vibrated Penetration Construction Protocol[39]

CTA Red Line State Street underground structures have been recently surveyed with relatively more accurate survey data, therefore probing may not be required.

C11.3 CONSTRUCTION ADJACENT TO CTA ELEVATED TRACK STRUCTURES

C11.3.2 Excavation Shoring Required[40]

Per AREMA *Manual for Railway Engineering* Chapter 8 Part 3 Article 3.4.2, for the allowable bearing pressure, the safety factor for primary loads shall not be less than 3. For primary and secondary loads, the safety factor shall not be less than 2. A primary function for a tower bent is to resist lateral and longitudinal forces and the footing bearing pressure may be greater than the typical spans. Therefore, it is required to have the allowable bearing pressure time 3/2 = 1.5 for the shoring wall design to account for all the secondary loads.

C11.4 ELEVATED TRACK STRUCTURE TEMPORARY SHORING[42]

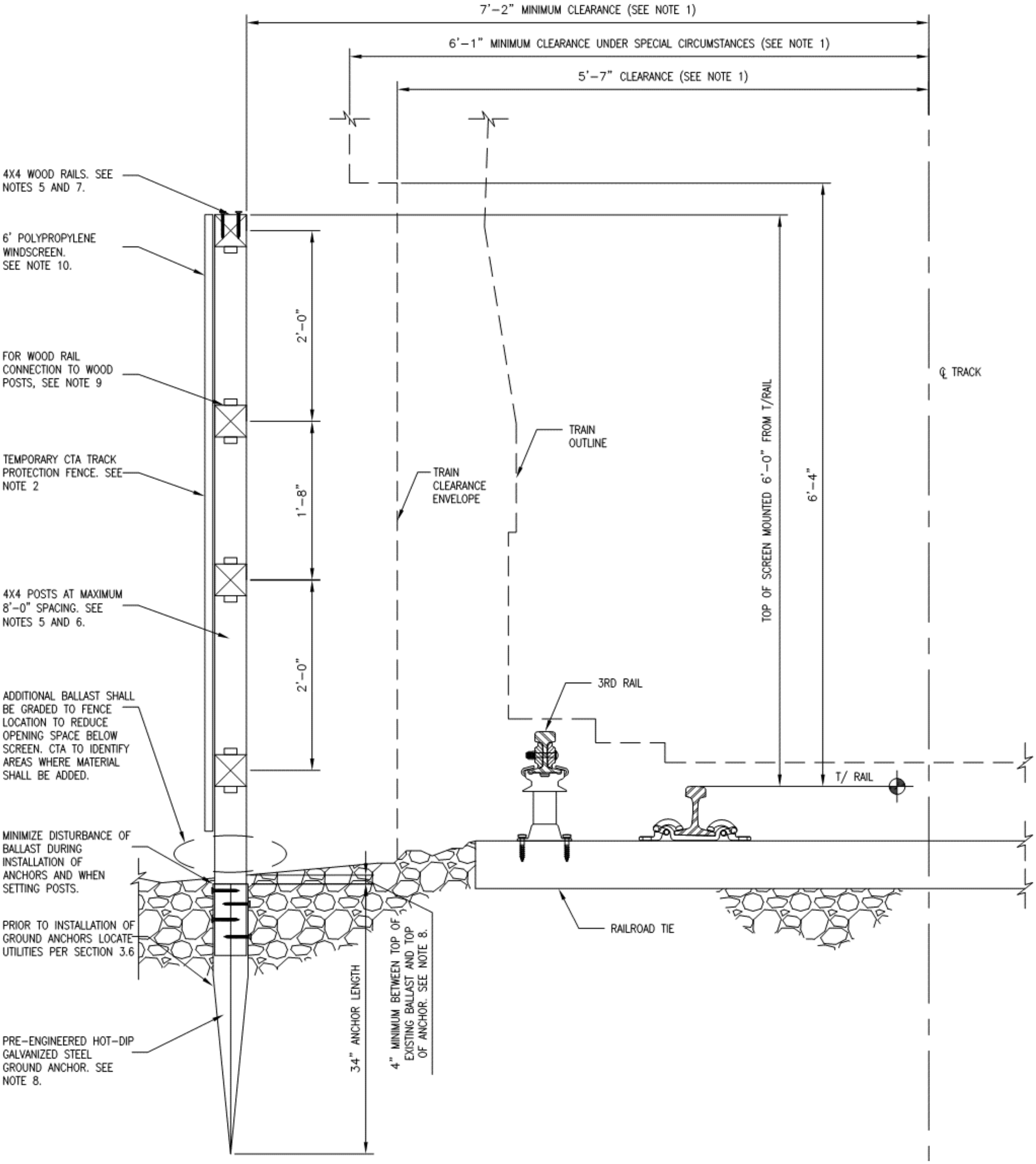
As discussed in the Manual, directly shoring of the elevated track structures is prohibited for Adjacent Construction Projects, unless otherwise permitted by the CTA in writing when no alternate is practical. All requirements associated with this type of work are covered in the CTA Infrastructure Design Criteria Manual (IDCM) Chapter 7 – Structural, and CTA's Specifications for track structural shoring and monitoring. The CTA Specifications that govern the work are:

- 31 15 00 – Structural Shoring

- 31 50 00 – Geotechnical Structural Monitoring Instrumentation, and,
- All related sections included

In an effort not to duplicate information, the Manual refers to the above-mentioned references for the design, construction, and monitoring for direct shoring of elevated track structures. With the same reason, the monitoring requirements for Earth Retention Structures are in the Manual and all CTA Specifications refer to the Manual.

APPENDIX G – PRE-APPROVED WORK AREA-TRACK SEPARATION FENCE



Notes:

1. Horizontal clearances less than 7'-2" can be allowed under special permission from the CTA. Section 4-5.3 in CTA's Safety Manual contains additional information and may be provided by Safety Department after reviewing the CPP. See Appendix B for train clearance envelope.
2. Temporary CTA track protection fence is designed to resist a horizontal wind pressure of not less than 30 pounds per square foot or a simultaneous vertical and horizontal thrust of 50 pounds per linear foot applied to each rail or a simultaneous vertical and horizontal concentrated load of 200 pounds in any direction applied to each rail, whichever loading produced the greatest stress.
3. Temporary CTA track protection fence layout and installation process plan shall be submitted for cta review and approval prior to start of installation. All procedures for installation must meet the requirements of the CTA flagging and coordination special provision and associated CTA procedures.
4. Submit shop drawings including, but not limited to, product and material certificates for all products and materials used prior to start of installation.
5. Wood shall be pressure treated and per Section 8.3.
6. Wood post size shall be 4" x 4" spaced a maximum of 8 feet on center, length of post may vary to maintain top of fence at minimum height above top of rail.
7. Wood rail size shall be minimum 4" x 4" spaced a maximum 24" center to center.
8. To minimize disturbance of the ballast and subgrade along the tracks, support 4" x 4" posts with pre-engineered hot-dip galvanized steel ground anchors, model t4-850, 34" long, as manufactured by Oz-post, Richardson, Texas or approved equal.
    a. Submit certifications and independent load tests from manufacturer that post anchors, used with posts specified in note 5, are capable of resisting a minimum 120 miles per hour wind load for a minimum of 5 minutes.
    b. Install wood posts to galvanized steel post anchors and install post anchors in ground in accordance with manufacturer's instructions. Using equipment and connectors as recommended by manufacturer of post anchor, unless otherwise specified.
    c. The top of the steel ground anchors shall be set a minimum of 4" below existing ballast grade and backfilled to match existing adjacent area. The bury depth shall be evaluated and adjusted based on load tests performed by the contractor and certified by an independent testing firm licensed in the state of Illinois. Submit load test procedure and results sealed and signed by the testing firm's Illinois registered professional engineer. Load tests will not be paid for separately.

   d. A mock-up post installation shall be built and load test conducted to evaluate the adequacy of the bury depth shown on this drawing. The mock-up shall be installed in an area where the post and steel ground anchor can be load tested. A load of 1300 pounds shall be applied to the post at the ground level. The deflection at the top of the post shall be measured.

   e. If the ground anchor shifts out of position or the post deflects greater than 1 inch at the top, a mock-up installation and load test shall be repeated with the distance between the existing ballast grade to the top of the ground anchor increased incrementally until the load test results in a successful test that meets the required deflection criteria. The steel ground anchors for all fence posts shall be installed at the bury depth that meets the required deflection criteria.

9. Wood rail to wood post connections shall be made with hot-dip galvanized or stainless steel nails or hot-dip galvanized or stainless steel framing angles manufactured by Simpson strong-tie company, Columbus, Ohio or approved equal, for use with pressure treated wood. Galvanizing shall conform to ASTM A653, G185 coating protection or greater. Wood rail to post connections shall be horizontally. Use four (4) 30d sinker nails to toenail wood rails to wood posts, two (2) top and two (2) bottom of rails or two (2) a34 framing angles one (1) top and one (1) bottom of rails as manufactured by Simpson strong-tie company, or approved equal.

10. Windscreen as manufactured by Carron net co. Inc., Two Rivers, Wisconsin or approved equal shall be 6 feet high, with sections a minimum of 8 feet long, open mesh, 75% opening, vinyl coated dark green polypropylene (weight - 1 lb per 21 sq ft of material) with edges reinforced with 1" herculite vinyl material and heavy duty solid brass grommets located at 18 inches on center on all 4 sides and at 18 inches on center horizontally at each rail for attachment to intermediate fence rails spaced to match rail spacing. Attach windscreen to wood posts and rails with heavy duty plastic zip ties placed through the grommets and around the posts and rails. The heavy-duty plastic zip ties shall be rated for a minimum tensile strength of 175 pounds. Length of the ties shall be as required to securely fasten the windscreen taught around the wood posts and rails. Submit manufacturer's certification for the zip ties and windscreen. Install wind screen per manufacturer's recommendations.

11. Any proposed Contractor changes shall be submitted for review to engineer and CTA, with calculations and drawings sealed and signed by an Illinois licensed Structural Engineer employed by the Contractor. Review and comment by engineer and CTA shall not relieve the Contractor of his responsibility for the design of any modifications proposed by the Contractor.

12. All maintenance of the fence prior to removal is the responsibility of the Contractor, the fence shall remain in the same horizontal and vertical position, with the windscreen remaining secure to the rails and posts. The Engineer will alert the Contractor to any issues that require immediate attention.

13. After the need for the temporary CTA track protection fence is complete, all components of the fence installation shall be completely removed, including the ground anchors. Contractor shall submit removal plan to the engineer and CTA for approval prior to the execution of the removal work. All items shall be disposed of properly, or retained by the Contractor. The ground along the fence installation shall be restored to pre-existing conditions and to the satisfaction of the engineer and the CTA.

APPENDIX H – VARIANCE REQUEST FORM

At a minimum, the information in the following form must be submitted for CTA's review of variance requests. Part 1 and 2 must be filled in by the requestor.

Part 1 - Adjacent Construction Manual Variance Request	
Project Name	
Location Description	[include OUC when available] – [adjacent CTA infrastructure] – [project address]
Date	
Originator of Request	*Name:*
	Title:
	Company: [include contact information]
	Signature:
Part 2 - Variance Request Background Data	
Impacts	Does this Variance impact Safety and Operations? ☐ Yes ☐ No Does this Variance conflict with any IDOT/CDOT regulations and requirements? ☐ Yes ☐ No
Variance Information	*Does this variance affect the following?* This Manual ☐ Yes ☐ No Safety ☐ Yes ☐ No
	Description of Variance: [include specific section/citations of adjacent construction manual]
	Mitigation Measures:

Reason for Request	*Design Variance must address the following:* • Manual criteria versus proposed • Reason the appropriate design criteria cannot be met • Justification for the proposed Criteria • Any background information which documents, support, or justification for the request • Any mitigation that will be provided to further support or justify the request • Safety implication of the request • The comparative cost of the full standard versus the lower design being proposed. Show what it would cost to meet the standard for which the Variance is requested. • Long term effect of the reduced design as compared to the full standard
Attachments	[The completed CTA Variance Request Form and all supporting documentation (drawings, reports, and calculations) shall be submitted with all requests for Variances. This form and all documentation attached with the request must be stamped and sealed by a Licensed Structural Engineer Registered in the State of Illinois.]

Part 3 - CTA Disposition

Approved? ☐ Yes ☐ No

Chief Engineer, Infrastructure Date

APPENDIX E

CHICAGO DOT
DEO ELECTRICAL SPECIFICATIONS

ELECTRICAL SPECIFICATION 1407
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED APRIL 2, 2009

POLE MOUNTED CAST ALUMINUM JUNCTION BOX FOR TRAFFIC SIGNALS

SCOPE

1. This specification states the requirements for pole mounted, cast aluminum junction boxes, with terminal strips, to be used for traffic signal multiple cable terminations.

GENERAL

2. (a) Specifications. The junction boxes shall conform in detail to the requirements herein stated, and to the specifications and methods of test of the American Society for Testing and Materials cited by ASTM Designation Number, of which the most recently published revisions will govern. The terminal strip shall meet the applicable sections of NEMA ICS 4-2005, as well as the requirements herein stated.

(b) Drawing. The drawing mentioned herein is a drawing of the Department of Transportation, and will be interpreted as part of these specifications.

(c) Acceptance. Junction boxes not conforming to this specification will not be accepted.

(d) Sample. One complete junction box with terminal strip of the manufacture intended to be furnished shall be submitted within fifteen (15) business days after receipt of a request from the Chief Procurement Officer. The box must be delivered to the Division of Electrical Operations at 2451 South Ashland.

(e) Workmanship. All junction boxes shall be free of casting flaws and must have neat, smooth exterior surfaces. All holes must be accurately located and drilled to ensure interchangeability of all components.

DESIGN

3. (a) Drawing. The junction box must conform in detail to the dimensions and requirements shown on Drawing Number 954.

(b) Material. The body door and plate must be castings of non-heat treated aluminum silicon alloy conforming to ANSI alloy 443.0 of ASTM B26.

DETAIL REQUIREMENTS

4. (a) Assembly. Each junction box shall consist of the body, door with its gasket, two cast elbows with gaskets at either end of the box, terminal block mounting bracket, and terminal strip on channel mounted to bracket. All must be completely assembled, painted and ready for installation. A flat plate with gasket shall also be provided so that the City can use the junction box with only one elbow if desired.

(b) Body. The body shall be cast as shown in Drawing Number 954. The top and bottom sides of the box where flat plates, or other fittings, will be attached, must be identically cast, machined flat, and drilled and tapped in accordance with dimensions shown. All fittings which fit on the top side must fit on the bottom side.

(c) Door. The door shall be cast as shown in Drawing Number 954. The door must be hinged at the left with stainless steel hinge pins and must open not less than 180º to permit complete access to the interior of the junction box. Two stainless steel Allen head machine screws, undercut and held captive, shall hold the door closed and maintain positive pressure against a sponge neoprene gasket cemented in place completely around the door jamb. The door shall be finished and painted prior to cementing the gasket into its groove in the door.

(d) Elbow sweep. Two elbows must be provided for cable entry and exit into the box. The elbows shall be cast of the same alloy as the box. The dimensions will be as indicated on Standard Drawing 954.

(e) End Plate. A flat end plate shall be furnished with each body casting. The plate must be drilled to align with tapped holes in the body casting and have a flush match with the periphery of the top and bottom body casting pads. The plate must have a properly fitted gasket.

(f) Gaskets. The gasketing between the body and the door shall be of sponge neoprene and must be cemented in place after painting of the door. A cork gasket, 1/8 inch thick, shall be used between the elbow or end plate and the body of the junction box on the top end and bottom end and held in place by four (4) stainless steel screws.

(g) Mounting Bracket. A terminal block mounting bracket, as shown on Drawing Number 954, shall be furnished and installed in each junction box. The bracket must be cast from ANSI alloy 443.0 per ASTM B26.

(h) Terminal Strip. The terminal strip will consist of modular blocks. Each block will consist of two terminals to handle one circuit. The strip will consist of twenty blocks to handle twenty circuits. The terminal strip will be mounted to an aluminum channel. The channel will have pre-punched holes for mounting to the junction box. The channel will be mounted to the box with two #10 screws.

Each block housing shall be constructed of nylon, polypropylene, or another approved material of equal properties. The bottom of the block housing will be dovetailed to fit into the aluminum channel. Overall dimensions of each block will be approximately 1.2 inches wide by 1.5 inches high. Center-to-center spacing between contacts (blocks) must be at least .375 inches.

The terminals shall accommodate AWG wire sizes 8 to 22. The contact type will be tubular clamp, with electroplated tubular copper contact. The screw type will be a steel electroplated number 10-32, slotted pan head. The terminals will be rated at 30 amps and 600 volts.

Maximum service temperature for the terminal strip will be 150° Celsius. The flammability rating must meet UL 94V-0.

(i) Hardware. The hinge pins and all screws required for assembly of this junction box must be of stainless steel.

(j) Painting. The exterior surfaces of the junction box shall be properly cleaned and given one (1) coat of zinc chromate primer containing ten percent (10%) iron oxide and one (1) coat of enamel. The color of the enamel must be gloss black or as ordered. A color sample must be submitted and approved before manufacturing commences. The primer and enamel shall be of an approved grade and quality.

(k) Packing. After the paint is completely dry, and the junction boxes have been assembled, they shall be suitably packed to prevent damage to painted surfaces during shipping and handling. All shipments must be fastened to, and shipped on, 48" x 48" hardwood, 4 way, non-returnable pallets. Total height must not exceed 64" and total weight must not exceed 2,000 pounds.

ELECTRICAL SPECIFICATION 1428
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
SEPTEMBER 11, 1989

THERMAL MAGNETIC CIRCUIT BREAKER

SUBJECT

1. This specification covers the requirements for thermal-magnetic circuit breakers capable of providing complete over-current protection for street lighting branch-load and service circuits.

GENERAL REQUIREMENTS

2. (a) Sample. One complete circuit breaker of each type and size, and of the manufacture intended to be furnished must be submitted upon request of the Chief Procurement Officer within fifteen (15) business days after receipt of such request. The sample(s) shall be delivered to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608.

(b) U.L. Approval. Circuit breakers furnished under this specification shall be listed and approved by Underwriter's Laboratories, Inc.

(c) Applicable Specifications. Where reference is made to applicable requirements of Underwriter's Laboratories, Inc., Bulletin #489, entitled "Standard for Branch Circuit and Service Circuit Breakers," hereinafter cited as the U.L. Standards, the most recently published revision will govern.

(d) Assembly. Each circuit breaker must have the thermal-magnetic trip installed, calibrated and sealed within its insulated housing.

(e) Instructions. Complete installation instructions, details on wiring, and information on operation shall be furnished with each circuit breaker, except as otherwise indicated.

(f) Packing. Each circuit breaker shall be packed in a suitable manner so that it will not be damaged in shipping or handling.

TYPES AND SIZES

3. (a) EHD Frame Circuit Breakers. For use on A-C Systems with a 100-ampere frame; minimum interrupting rating of 18,000 R.M.S. symmetrical amperes at 240 volts A.C.

   1. Single pole, 240 or 480 volts A.C., ampere rating from 15 to 100.

   2. Double pole, 240 or 480 volts A.C., ampere rating from 15 to 100.

   (b) FDB Frame Circuit Breakers. For use on A-C Systems with a 150 ampere frame; minimum interrupting capacity of 18,000 R.M.S. symmetrical amperes at 240 volts A-C.

   1. Double pole, 240, 480 or 600 volts A-C, ampere rating from 15 to 150.

   2. Triple pole, 240, 480 or 600 volts A-C, ampere rating from 15 to 150.

   (c) JDB Frame Circuit Breakers. For use on A-C Systems with a 250 ampere frame; minimum interrupting current of 65,000 R.M.S. symmetrical amperes at 240 volts A-C.

   1. Double pole, 240, 480 or 600 volts A-C, ampere ratings from 70 to 250.

   2. Triple pole, 240, 480 or 600 volts A-C, ampere ratings from 70 to 250.

DESIGN AND CONSTRUCTION

4. Circuit breakers furnished under this specification must include the following design and construction features: (1) molded insulated housing, (2) thermal-magnetic trip mechanism, (3) silver alloy contacts, (4) corrosion-resistant internal parts, (5) trip-free, indicating handle, and (6) pressure-type terminals.

DETAIL REQUIREMENTS

5. (a) Thermal-Magnetic Trip Mechanism. The breaker must be activated on current overload by means of a thermal-magnetic trip mechanism. This mechanism must be non-adjustable, non-interchangeable, and factory calibrated and sealed. Instantaneous tripping as controlled by the magnetic trip setting, and time delay tripping accomplished by thermal action must be in accordance with the manufacturer's published characteristic curves for these breakers or with calibration requirements of the U. L. Standards, as applicable.

(b) Contact Mechanism. The contacts must be spring loaded and provide a quick-make, quick-break non-teasing action. The contact mechanism must be such that the breaker will trip open even if the handle is held or locked in the ON position.

(c) Calibration. Rating and performance of these breakers must be based on calibration at an ambient temperature of 40^{o} C. (104^{o}F.).

(d) Rated Current. Each breaker must be capable of carrying 100% rated current continuously in its calibrated ambient temperature without tripping and without exceeding the temperature limits specified in the U. L. Standards.

(e) Contacts. The contacts must be made of a non-welding silver alloy or equivalent, subject to approval.

(f) Internal Parts. All internal parts of these circuit breakers shall be corrosion resistant material.

(g) Terminals. Solderless, pressure type terminals of copper construction must be provided for both line and load connections.

(h) Handle Indication. The handle must indicate clearly whether the circuit breaker is on the ON, OFF, or TRIPPED position.

(i) Mounting. Breakers furnished under this specification must have drilled and counterbored holes for front mounting which must conform to spacings shown on Department of Transportation Drawings numbered 883, 884, 886, and 887.

(j) Test Requirements. These breakers must be capable of meeting the following sequence of test requirements as specified in the U. L. Standards.

1. Endurance test.
2. Calibration test at 200% and 125% of rated current.
3. Short circuit tests
4. Calibration test at 500% rated current.
5. Dielectric strength test.

WARRANTY

6. Circuit breakers furnished under this specification shall be warranted by the manufacturer against defects in materials or workmanship for a period of one year after installation. During this period, should a failure occur, repair or replacement must be made without cost to the City.

ELECTRICAL SPECIFICATION 1458
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED MARCH 4, 2014

ELECTRICAL MANHOLE FRAMES AND COVERS 24 INCH AND 30 INCH DIAMETER

SCOPE

1. This specification describes the requirements for both 24 inch and 30 inch round frames and covers. These frames and covers will be used for electrical manholes and handholes and will provide access to the interior of the manholes and handholes. The 24 inch frames and covers will be used in parkway and sidewalk areas. The 30 inch frames and covers will be used in streets and in driveways and will provide sufficient strength to withstand normal traffic conditions.

GENERAL REQUIREMENTS

2. (a) Conformance. The manhole frames and covers shall conform with every detail of the requirements herein stated and to the specifications and methods of test of the American Society for Testing and Materials cited by ASTM Designation Number in which the most recently published revision will govern.

(b) Acceptance. Frames and covers not conforming to this specification will not be accepted. The Commissioner of Transportation will have the final say as to whether or not the frames and covers meet specifications.

(c) Drawings. The drawings mentioned herein are drawings of the Department of Transportation, Division of Engineering, and must be interpreted as part of these specifications.

(d) Sample. Upon request, one complete manhole frame and cover of the manufacture intended to be furnished must be submitted within fifteen (15) business days after receipt of such a request from the Chief Procurement Officer. The samples must be delivered to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois.

(e) Warranty. The manufacturer shall warrant that the frames and covers meet the specifications and warrant the frames and covers for a period of one (1) year from the date of delivery against defects which may occur during that period from normal and customary use. Any frame or cover which fails during this period must be replaced by the manufacturer at no cost to the City.

DESIGN

3. (a) The frames and covers shall each conform in detail to the designs shown on Drawings 872, 874 and 10927.

(b) Each frame and cover shall weigh approximately as shown on the drawings.

(c) Machining. The bearing surfaces of both the cover and the frame shall be machine finished as indicated on the drawings.

(d) Workmanship. The frames and covers must be mutually interchangeable size for size, so that each lid will fit every frame neatly without jamming and with only such clearance as the drawings indicate. In addition, 24" & 30" covers must fit existing 24" & 30" frames, as shown on drawings 872, 874 and 10927. The castings shall be neat, true to pattern and free from cracks and casting flaws. No welding of defective castings will be permitted nor must the castings be painted.

(e) Material. The frames and covers must be made of Class 30 Cast Iron described in the specifications for Gray Iron Castings of ASTM A48. No plugging of defective castings will be permitted.

TESTS

4. (a) Test bars of the metal used for the castings shall be made and tested for tensile and transverse strength in accordance with ASTM A48. The metal must be tested at the works of the manufacturer. The manufacturer must furnish a certified copy of all test data sheets to the City prior to delivery of the castings. Frames and covers shall each be considered a separate casting for determining the requirement of testing.

ELECTRICAL SPECIFICATION 1462
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED NOVEMBER 21, 2014

RIGID STEEL CONDUIT
(HOT DIPPED GALVANIZED)

SCOPE

1. This specification describes rigid steel conduit, zinc coated. This specification also describes rigid steel conduit that is both zinc and PVC coated. The conduit will be used underground or on structure as a raceway for electrical cables.

GENERAL REQUIREMENTS

2. (a) Rigid steel conduit must be zinc coated by the hot-dip process. Conduit must be furnished in 10 foot lengths, threaded on each end and with one coupling attached to one end and a protective cap at the other end.

(b) The conduit shall be manufactured according to Underwriters Laboratories Standard U.L. - 6 and must meet ANSI Standard C 80.1 and the requirements of NEC Article 344. In addition, conduit must be recognized as an equipment grounding conductor as per NEC Article 250. There will be no exceptions to meeting these standards.

(c) Acceptance. Conduit not conforming to this specification will be rejected. The Commissioner will be the final judge in determining if the conduit meets the specification.

(d) Sample. If requested by the Chief Procurement Officer, a sample of conduit must be submitted to the Engineer of Electricity within fifteen (15) business days of receipt of such a request.

(e) Warranty. The manufacturer shall warrant the construction and performance of the conduit to meet the requirements of this specification and shall warrant all parts and components against defects due to design, workmanship, or material developing within a period of one (1) year after the conduit has been delivered.

STEEL

3. Conduit shall be formed from steel suitable for use as an electrical raceway. It shall be structurally sound so that it will hang straight and true when supported by hangers in accordance with Chicago electrical code requirements and shall be capable of being field bent without deformation of the walls.

Conduit shall have a circular cross section sufficiently accurate to permit the cutting of threads in accordance with Table 2 and shall provide a uniform wall thickness throughout. All surfaces shall be smooth and free of injurious defects. The dimensions and weights of rigid steel conduit must be in accordance with Table 1.

THREADING AND CHAMFERING

4. Each length of conduit, and each nipple, elbow and bend must be threaded on both ends, and each end must be chamfered to remove burrs and sharp edges.

The number of threads per inch, and the length of the threaded portion at each end of each length of conduit, nipple and elbow must be as indicated in Table 2. The perfect thread must be tapered for its entire length, and the taper must be 3/4 inch per foot.

ZINC COATING

5. After all cutting, threading, and chamfering all conduit surfaces shall be thoroughly cleaned before application of zinc. The cleaning process shall leave the interior and exterior surfaces of the conduit in such a condition that the zinc will be firmly adherent and smooth.

The conduit must be hot dipped galvanized both inside and out to provide approximately two (2) ounces of zinc per square foot. This is equivalent to 3.4 mils of zinc coating. An additional interior coating to aid in the installation of wires is required.

COUPLINGS

6. (a) The outside surface of couplings shall be protected by means of a zinc coating. The zinc content of the coating on the outside surface must be equivalent to a minimum thickness of 3.4 mils.

(b) Couplings shall be so made that all threads will be covered when the coupling is pulled tight on standard conduit threads.

(c) Both ends of the coupling must be chamfered to prevent damage to the starting threads.

(d) The outside diameter, length and weight of coupling must be as indicated in Table 3.

(e) Couplings must be straight tapped, except that the 2 1/2 inch and larger sizes may be taper-tapped.

PVC COATED (WHEN SPECIFIED)

7. (a) Only hot dipped galvanized conduit, couplings, and fittings may be polyvinylchloride (PVC) coated.

(b) All conduit, couplings, and fittings must be cleaned before being coated.

(c) All conduit, couplings, and fittings must have a PVC coating applied to the exterior by dipping in liquid plastisol. The coating thickness must be a nominal 40 mils.

(d) All coated conduit, couplings, and fittings must conform to the requirements of NEMA Standard RN1- Section 3 , “External Coatings”. The latest revision will apply.

PACKING AND IDENTIFICATION

8. The pipe shall be delivered in bundles. Each length of conduit must be marked with the manufacturer's name or trademark. Securely attached to each bundle at two (2) locations on the bundle must be a weather resistant tag containing the following information:

a. conduit size
b. footage of bundle
c. gross weight of bundle
d. manufacturer’s name

Precaution will be taken by the contractor in handling during shipment or delivery of conduit, and any conduit found to be damaged will not be accepted.

TEST AND INSPECTION

9. Galvanized rigid conduit must be capable of being bent cold into a quarter of a circle around a mandrel, the radius of which is four times the nominal size of the conduit, without developing cracks at any portion and without opening the weld.

The protective coatings used on the outside and inside surfaces of rigid steel conduit must be sufficiently elastic to prevent their cracking or flaking off when a finished sample of ⍰ inch conduit is tested within one year after the time of manufacture, by bending it into a half of a circle around a mandrel, the radius of which is 3 1/2 inches.

Tests on sizes other than 1/2 inch may be conducted within one year after the time of manufacture. If such tests are conducted, the conduit must be bent into a quarter of a circle around a mandrel, the radius of which is six times the nominal size of the conduit.

One of the following three test methods shall be employed for measuring the thickness or extent of the external zinc coating on conduit:

(a) Magnetic test.
(b) Dropping test.
(c) Preece test (Material which will withstand four 1-minute immersions will be considered as meeting requirements as follows; the zinc content of the coating on the outside surface must be equivalent to a minimum thickness of 3.4 mils).

All tests and inspections must be made at the place of manufacture prior to shipment unless otherwise specified, and shall be so conducted as not to interfere with normal manufacturing processes.

Each length of conduit shall be examined visually both on the outside and inside to determine if the product is free from slivers, burrs, scale or other similar injurious defects (or a combination thereof), and if coverage of the coating is complete.

If any samples of rigid steel conduit tested as prescribed in this specification should fail, two additional samples must be tested, both of which must comply with the requirements of the specification.

All pipe which may develop any defect under tests, or which may before testing or on delivery be found defective, or not in accordance with these specifications, must be removed by the Contractor at his own expense; and such pipe so removed by the Contractor must be replaced by him within ten (10) days of such rejection with other pipe which will conform to these specifications.

TABLE 1

Design Dimension and Weights of Rigid Steel Conduit

Nominal or Trade Size of Conduit	Inside Diameter	Outside Diameter	Wall Thickness	Length Without Coupling	Minimum Weight of Ten Unit Length w/couplings
(Inches)	(Inches)	(Inches)	(Inches)	(Feet/Inches)	(Pounds)
1/2	0.622	0.840	0.109	9-11 1/4	79.00
3/4	0.824	1.050	0.113	9-11 1/4	105.0
1	1.049	1.315	0.133	9-11	153.0
1 1/4	1.380	1.660	0.140	9-11	201.0
1 1/2	1.610	1.900	0.145	9-11	249.0
2	2.067	2.375	0.154	9-11	334.0
2 1/2	2.469	2.875	0.203	9-10 1/2	527.0
3	3.068	3.500	0.216	9-10 1/2	690.0
3 1/2	3.548	4.000	0.226	9-10 1/4	831.0
4	4.026	4.500	0.237	9-10 1/4	982.0

NOTE: The applicable tolerances are:

Length: + 1/4 inch (without coupling)

Outside diameter: + 1/64 inch or -1/32 inch for the 1 1/2 inch and smaller sizes,

± 1 % for the 2 inch and larger sizes.

Wall thickness: - 12 1/2 %

TABLE 2

Dimensions of Threads

Nominal or Trade Size of Conduit (Inches)	Threads per Inch	Pitch Diameter at end of Thread (Inches) Tapered 3/4 Inch per foot	Length of Thread (Inches) Effective L2	Length of Thread (Inches) Overall L4
1/2	14	0.7584	0.53	0.78
3/4	14	0.9677	0.55	0.79
1	11 1/2	1.2136	0.68	0.98
1 1/4	11 1/2	1.5571	0.71	1.01
1 1/2	11 1/2	1.7961	0.72	1.03
2	11 1/2	2.2690	0.76	1.06
2 1/2	8	2.7195	1.14	1.57
3	8	3.3406	1.20	1.63
3 1/2	8	3.8375	1.25	1.68
4	8	4.3344	1.30	1.73

NOTE: The applicable tolerances are:

Threaded Length (L4 Col 5): Plus or minus one thread

Pitch Diameter (Col 3): Plus or minus one turn is the maximum variation permitted from the gaging face of the working thread gages. This is equivalent to plus or minus one and one half turns from basic dimensions, since a variation of plus or minus one half turn from basic dimensions is permitted in working gages.

TABLE 3

Designed Dimensions and Weights of Couplings

Nominal or Trade Size of Conduit (INCHES)	Outside Diameter (INCHES)	Minimum Length (INCHES)	Minimum Weight (POUNDS)
1/2	1.010	1-9/16	0.115
3/4	1.250	1-5/8	0.170
1	1.525	2	0.300
1 1/4	1.869	2-1/16	0.370
1 1/2	2.155	2-1/16	0.515
2	2.650	2 1/8	0.671
2 1/2	3.250	3-1/8	1.675
3	3.870	3-1/4	2.085
3 1/2	4.500	3-3/8	2.400
4	4.875	3-1/2	2.839

ELECTRICAL SPECIFICATION 1465
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED JULY 12, 2006

GROUND RODS

SUBJECT

1. This specification states requirements for ground rods and clamps to be used for ground electrodes in street lighting, traffic signal, and miscellaneous electrical circuits.

GENERAL

2. (a) Ground rods must be copper clad, steel rods suitable for driving into the ground without deformation of the rod or scoring, separation or other deterioration of the copper cladding.

(b) Sample. If requested by the Chief Procurement Officer, the contractor must furnish one sample of the ground rod proposed to be furnished within fifteen (15) business days from receipt of such request. The sample ground rod must be delivered to the Division of Electrical Operations, 2451 S. Ashland Avenue, Chicago, Illinois 60608.

(c) Warranty. The manufacturer shall warrant every ground rod against defects due to design, workmanship, or material developing within a period of one (1) year after the ground rod has been accepted. Any ground rod which fails during this period must be replaced by the contractor without expense to the City. The Commissioner of Transportation or his duly authorized representative will be the sole judge in determining which replacements are to be made.

(d) The Commissioner will be the sole judge in determining whether the submitted ground rods meet the requirements of this specification. Ground rods not accepted must be removed at the sole expense of the contractor.

DESIGN

3. (a) The ground rods and couplings must meet the latest requirements of (National Electrical Manufacturer’s Association) NEMA Standard GR-1, for copper bonded ground rod electrodes and couplings. The ground rods must also meet the requirements of (Underwriter’s Laboratories) UL 467.

(b) Ground rods shall be made of steel core suitable for driving into the earth without deformation.

(c) A uniform covering of electrolytic copper, 10 mils in thickness, shall be metallically bonded to the steel core to provide a corrosion resistant, inseparable bond between the steel core and the copper overlay.

(d) The finished rod must be of uniform cross-section; straight, and free of nicks, cuts or protuberances.

(e) The rod must be pointed at one end and chamfered at the other.

(f) All ground rods must be three-quarter inches (3/4") in diameter. The length shall be as specified in the order or in the plans. The length and diameter of the rod and the manufacturer must be clearly and permanently marked near the top of the rod (chamfered end).

(g) All ground rods must have a ground clamp capable of accommodating a No. 6 AWG Copper Wire.

PACKING

4. (a) Ground rods must be packed in bundles with reinforced tape or plastic banding that will not damage the rods. Small bundles may then be bound in larger bundles held together with steel banding.

(b) Ground clamps must be packed in a suitable carton. The carton must be labeled to indicate the contents.

SPECIFICATION 1467
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED JUNE 28, 2012

ROD: ANCHOR, STEEL, WITH HARDWARE

SUBJECT

1. This specification states the requirements for steel anchor rods with hardware for street light pole foundations.

GENERAL

2. (a) Specifications. The anchor rods shall conform in detail to the requirements herein stated, and to the specifications of the American Society for Testing and Materials cited by ASTM Designation Number, of which the most recently published revision will govern.

(b) Drawing. The drawings mentioned herein are issued by the Department of Transportation, Division of Engineering, and are an integral part of this specification.

ANCHOR ROD

3. (a) Fabrication. Each anchor rod must be fabricated in conformity with City of Chicago drawings numbered 806, 811, 830 and 844.

(b) Material. The rods must be fabricated from cold rolled carbon steel bar meeting the requirements of ASTM Specification A-36, except that the Specification must be modified to provide a minimum yield point of 55,000 psi (379 MPa).

(c) Thread. The straight end of each rod must be threaded as shown on City of Chicago drawing for that size rod, and must be American Standard, National Coarse.

HARDWARE

4. Hardware furnished with the anchor rod shall be as shown on the applicable drawing. It must include two (2) hexagonal nuts, American Standard Regular, two (2) flat washers, type B, series W, and one (1) lock washer, steel, helical spring. The nuts must have a Class 2 or 3 fit.

FINISH

5. Galvanizing. The threaded end of each rod must be hot dipped galvanized for the distance shown on the applicable drawing. The thickness of the galvanized coating must not be less than 0.0021 inches. Each hexagonal nut and washer must be galvanized to the minimum thickness required by ASTM A-153, Class C, or ASTM B-454, Class 50. After galvanization, each anchor rod and nut must have a mating fit equivalent to the American Standard Class 2 or 3 fit for nuts and bolts.

TESTS

6. At the discretion of the Commissioner, anchor rods and hardware furnished under this specification will be subject to testing to determine compliance with the materials physical requirements.

INSPECTION

7. Final inspection must be made at point of delivery. Any anchor rods and hardware rejected must be removed by the Contractor at his sole expense.

ELECTRICAL SPECIFICATION 1475
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED SEPTEMBER 26, 2006

CORD: TRAFFIC SIGNAL, EIGHT CONDUCTOR NO. 16 AWG, 600 VOLT

SUBJECT

1. This specification states the requirements for an eight (8) conductor number 16 AWG, electrical cable, to be installed in poles and conduit and used to electrically energize traffic signal faces at street intersections within the City of Chicago. The cable shall be flame retardant, have low acid gas content, good resistance to oil, moisture and mechanical abuse, and exhibit excellent heat aging and electrical characteristics.

GENERAL

2. (a) Specifications. The cable shall conform in detail to the requirements herein stated, and to the specifications and methods of test of the American Society for Testing and Materials cited by ASTM Designation Number, the Underwriters Laboratories, Inc. Standard or Style number and any other recognized standardization group's specifications referred to by the appropriate designation, of which the most recently published revision will govern.

(b) Acceptance. Cable not conforming to this specification will not be accepted.

(c) Warranty. The manufacturer shall warrant the cable to be first class material throughout. In addition to any other claims against them, if the cable is installed within six months of date of shipment, the manufacturer must replace any cable failing during normal and proper use within two years of date of installation. All replacements under this warranty must be made free of charge F.O.B. delivery point of the original contract.

(d) Sample. If requested by the Chief Procurement Officer, a three (3) foot sample of the cable intended to be provided under this specification must be submitted to the attention of the Engineer of Electricity within fifteen (15) business days after receipt of such request.

CABLE

3. (a) Construction. This cable shall consist of stranded, coated, conductors each concentrically encased with a "free stripping," ethylene propylene rubber insulation. Suitable fillers shall be used to produce an essentially round cross-section. The insulated conductors and the fillers must be cabled with a suitable left-hand lay as close together as is consistent with forming a core of minimum diameter. A Mylar tape must be wrapped over the conductor assembly, and a jacket applied overall.

(b) Outer Diameter. The maximum allowable outer diameter must be one-half (0.50) inch.

(c) Sealing. Both ends of each length of cable must be thoroughly sealed to prevent the entrance of moisture or other foreign matter.

MARKING

4. (a) Conductors. Identification must be provided by colors in accordance with I.M.S.A. Standards.

(b) Jacket. The outer jacket must be marked as follows: "8/C 16 AWG 600V 90ºC LSZH, name of manufacturer and date of manufacture. The height of letters must not be less than 1/8 inch in height and the message must repeat at approximately two (2) foot intervals. A sequential footage marking must be located on the opposite side of the jacket. All marking must be perfectly legible with permanent white ink.

CONDUCTOR

5. (a) Material. Round, Soft or annealed, stranded copper wire in accordance with ASTM B-3 and B-8, and coated in accordance with ASTM B33 (tin coated) , must be furnished.

(b) Size. The stranded conductor must consist of stranded wires twisted with an appropriate lay to form a No. 16 AWG conductor with an approximate diameter of 0.048 inches.

INSULATION

6. (a) Type. The insulation must be an easily strippable low smoke zero halogen (LSZH) thermosetting polyolefin compound or ethylene propylene rubber (EPR), or equal meeting or exceeding the requirements of ICEA S-95-658 and the additional requirements of this specification.

(b) Rating. The insulation must be rated for continuous duty at 90°C in accordance with U.L. AWM Style 3400.

(c) Thickness. The insulated conductor must be circular in cross-section, concentric to the conductor, with a nominal insulation thickness of 0.031 inches (2/64") and a minimum spot thickness of 90% of the nominal thickness.

(d) Initial Physical Requirements:

1. Tensile strength, min., PSI	1,600
2. Elongation at rupture, min. %	250

(e) Air Oven Exposure Test. After conditioning in an air oven at 158 ± 1°C for 168 hours using methods of test described in ASTM-D 573:

Tensile strength, minimum percent of unaged value 85

Elongation at rupture, minimum percent of unaged value . . . .. .65

(f) Mechanicl Water Absorption:

1. Gravimetric Method. After 168 hours in water at 70± 1°C:

   Water absorption, maximum, milligrams per square inch . . .5.0

(g) Cold Bend Test Requirements. The completed cable must pass the "Cold-Bend," Long-Time Voltage Test on Short Specimens of ASTM D-470 except that the test temperature must be minus (-) 25°C.

(h) Electrical Requirements:

1. Voltage Test. The completed cable must meet an A.C. and D.C. voltage test in accordance with ASTM D-470 and D-2655.

2. Insulation Resistance. The completed cable must have an insulation resistance constant of not less than 20,000 when tested in accordance with methods shown in ASTM D-470.

(i) Flexibility Tests. A sample length of insulated conductor must be formed in a loose coil, placed in a circulating air oven, and aged for 168 hours at 158° C ± 1°C. The sample must then be allowed to cool to room temperature for one (1) hour and tightly wrapped around a 3X metal mandrel. The sample must show no cracks and must pass the same voltage test specified for the "Cold-Bend Test."

JACKET

7. (a) Type. The jacket must be a thermosetting low smoke zero halogen (LSZH) polyolefin compound or chlorinated polyethylene (CPE), or equal meeting the physical and electrical requirements specified herein.

(b) Rating. The jacket must be rated for continuous duty at 90° C.

(c) Thickness. The jacket must be circular in cross-section, concentric with the insulation, must have an average thickness not less than 45 mils and a spot thickness not less than ninety percent (90%) of the average thickness.

(d) Initial Physical Requirements:

1.	Tensile strength minimum PSI	1800
2.	Elongation at rupture, minimum percent	300

(e) Air Oven Exposure Test. After conditioning in an air oven at 121 ± 1°C for 168 hours for LSZH or 136 ± 1°C for CPE:

1.	Tensile strength, minimum percent of unused value	75
2.	Elongation at rupture, minimum percent of unaged valued	55

(f) Mechanical Water Absorption**.** After 168 hours at 70 ± 1° C:

1.	Milligrams per square inch, maximum	20

TESTING

8. (a) General. Tests shall be performed on insulation, jacket and completed cables in accordance with applicable standards as listed in this specification. Where standards are at variance with each other or with other portions of this specification, the most stringent requirements, as determined by the Engineer of Electricity will apply.

All tests must be conducted on cable produced for this order. Where cable insulation and/or jacket thickness preclude obtaining samples of sufficient size for testing, special arrangements must be made with the engineer to obtain samples of unprocessed materials directly from the extrusion feed bins which will be separately processed and prepared for tests.

(b) Number of Tests. Insulation and jacket tests must be conducted on samples taken every 25,000 feet or fraction thereof of each conductor size. In no case must samples be taken closer than 15,000 feet apart.

(c) Test Reports. No cable shall be shipped until certified copies of all factory tests have been reviewed and approved by the engineer.

(d) Acceptance. Samples shall be taken from each reel and must successfully conform to all tests specified herein. Reels from which samples fail to conform, will be rejected.

PACKAGING

9. (a) Reels. The completed cord shall be delivered on sound, substantial reels. The ends of the cable must be securely fastened so that they will not become loose during shipment and handling.

(b) Footage. The number of feet per reel must be five hundred (500) feet plus or minus ten percent (±10%).

(c) Marking. A metal tag, or an approved indelible marking material such as alkyd enamel paint, must be used to mark the reel. The marking information must include, but not be limited to, the following: reel number, contract number, a description of the cord, and the footage of that particular reel.

ELECTRICAL SPECIFICATION 1493
DIVISION OF ELECTRICAL OPERATIONS
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED FEBRUARY 6, 2014

TRAFFIC SIGNAL: VEHICULAR, TWELVE-INCH SINGLE FACE, SINGLE OR MULTIPLE-SECTION, POLYCARBONATE, LED OR INCANDESCENT

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1. GENERAL REQUIREMENTS

1.1 This specification states the requirements for twelve-inch, single face, single and multiple-section, traffic signals with polycarbonate housings, using LED or incandescent light source, for use in the traffic control system of the City of Chicago. Units include red ball, yellow ball, green ball, red arrow, yellow arrow, green arrow, red bicycle, yellow bicycle, green bicycle, white vertical bar, and white horizontal bar.

1.2 Sample and Certified Test Reports. One complete signal, fully assembled and wired, of the manufacture proposed to be furnished, must be submitted along with the required certified test reports, within 15 business days upon request of the Chief Procurement Officer. The sample must be delivered to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608.

1.3 Standards. Equipment furnished under this specification shall meet the appropriate requirements of the following standards, as required within the body of this specification:

American Association of State Highway and Transportation Officials (AASHTO)
American Iron and Steel Institute (AISI)
American Society for Testing and Materials (ASTM)
Institute of Transportation Engineers (ITE)
National Electrical Manufacturers Association (NEMA)
Underwriters Laboratories (UL)

1.4 Approval. Approval will mean approval in writing by the Commissioner or his duly authorized representative.

1.5 Warranty. The manufacturer shall warrant the signals to meet the requirements of this specification, and shall warrant all equipment, components, parts and appurtenances against defective design, material and workmanship for a period of 3 years from date of delivery [date of acceptance for contract construction]. In addition, LED optical modules must carry a 7 year warranty against failure or loss of color (chromaticity) and signal brightness (luminance) below minimum acceptable ITE standard levels from date of delivery [date of acceptance for contract construction]. In the event defects or failures occur in the units during the warranty period, the manufacturer must replace all defective units, at no expense to the City. This warranty shall be evidenced by a letter or certificate of warranty submitted to the City at the time delivery is made. The warranty must cover all units delivered in an order or installed by contract, and must include unit serial numbers. The warranty must be signed and dated by an official of the manufacturer who is empowered by the manufacturer to enter into such a warranty.

2. MATERIALS AND EQUIPMENT REQUIREMENTS

2.1 The traffic signal heads shall conform to ITE Standard "Vehicle Traffic Control Signal Heads" (VTCSH), in which the most recently published revision will govern.

2.2 Housing. The housing of each section must be one piece, ultraviolet stabilized polycarbonate resin of the specified color, injection molded complete with integral top, bottom, and sides, having a minimum thickness of 0.1 inch.

(a) The polycarbonate shall meet or exceed the following tests:

TEST	REQUIRED	METHOD
Specific gravity	1.17 minimum	ASTM D 792
Vicat Softening temp	310-320º F	ASTM D 1525
Brittleness temp.	-200º F	ASTM D 746
Flammability	Self-extinguishing	ASTM D 635
Tensile strength, yield	8,500 PSI	ASTM D 638
Elongation at yield	5.5-8.5%	ASTM D 638
Shear strength, yield	5,500 PSI min.	ASTM D 732
Izod impact strength (notched, .125" thick)	12-16 ft-lbs/in.	ASTM D 256
Fatigue strength (at 2.5 mm cycles)	950 PSI min.	ASTM D 671

(b) Assembly. A traffic signal section shall be comprised of, but not limited to, the housing, hinged door, visor, optical unit and all necessary gaskets and hardware. The multi-section, single face, traffic signal shall be comprised of single face single sections assembled together, containing an internally mounted terminal block. Arrow indications must be shipped as single sections. The traffic signals shall be designed and constructed to permit sections to be assembled together, one above the other, forming a weatherproof and dust-tight unit.

(c) Individual sections shall be fastened together with a coupling washer assembly composed of 2 washers, 3 zinc plated bolts, nuts, and lock washers which lock the individual sections together. As an alternative, individual sections may be fastened together with 4 cadmium plated bolts, lock washers, and nuts.

(d) Height. The overall height of an assembled traffic signal must be 14 inches ±1 inch for a single-section signal, 42 inches ±3 inches for a three-section signal, and 70 inches ±5 inches for a five-section signal.

(e) Mounting. The traffic signal shall be designed for mounting with standard traffic signal brackets using 1.5 inch pipe size fittings.

(f) Positioning Device. The top and bottom opening of each housing must have integral serrated bosses that will provide positive positioning of the signal head in 5° increments. A total of 72 teeth must be provided in the serrated bosses to allow the signal face to be rotated 360° about its axis. The teeth shall be clean and well defined to provide positive positioning.

(g) Hinges. The signal housing shall be sectional; one section for each optical unit. Each housing must have 4 integral hinge lugs, with stainless steel hinge pins (AISI 304 or equivalent), located on the left side for mounting the door. The hinge pins shall be straight and not protrude past the outside of the housing lugs. The housing must have 2 integral latching bolt lugs on the right side each with a stainless steel hinge pin to which a latching bolt (AISI 304 or equivalent), washer, and wing nut will be attached. The wing nuts must be captive. Each housing must be equipped with holes to be used for mounting backplates.

(h) Door. The door shall be a one piece ultraviolet stabilized polycarbonate resin of the specified color, injection molded complete with a minimum thickness of 0.1 inch. Two hinge lugs on the left side and 2 sets of latch screw jaws centered on the right side, as viewed from the front of the signal, must be integrally cast with the housing door. The door must be hinged to the housing with 2 stainless steel hinge pins, drive fitted. Two stainless steel latch screws and wing nut and washer assemblies on the latch side of the housing body shall provide for opening and closing the door without the use of tools. The door must have holes with threaded metal inserts for stainless steel machine screws to secure the visor and the lens. The inside of the door must be grooved to accommodate a one piece, air-cored ethylene propylene diene monomer (EPDM) gasket to provide a weatherproof and dust proof seal when the door is closed. The inside of the door must have 4 equally spaced threaded metal inserts for the lens attachment. The outside of the door must have an integral rim completely encircling the lens opening to prevent leakage between the door and the lens. The rim must have 4 equally spaced tabs around the circumference with threaded metal inserts for the visor.

(i) Visor. Each traffic signal shall have a visor for each signal indication (section).

The visor shall be the tunnel type, 9.25 inches long, fabricated of ultraviolet stabilized polycarbonate resin of the specified color, injection molded. The visor shall fit tightly against the door and not permit any light leakage between the door and visor. All hardware necessary for, but not limited to, attachment of the visor must be of stainless steel. The visor must have 4 mounting lugs for attaching the visor to the door. Screws must go through the visor lugs into the metal inserts in the door to secure the visor.

2.3 The traffic signal heads shall be provided with incandescent or LED optical modules as specified in the line item [or Contract Plans].

2.3.1 INCANDESCENT OPTICAL UNITS

(a) Incandescent Optical Unit. The incandescent optical unit consists of the lens, reflector and lamp holder. The optical unit and visor shall be designed as a whole so as to eliminate the return of outside rays entering the unit from above the horizontal (known as sun phantom). The optical unit shall be designed and assembled so that no light can escape from one indication to another.

(b) Lenses. The red, green, and yellow polycarbonate lenses must be round with a nominal 12 inch diameter and shall conform to all requirements set forth under the heading "Traffic Signal Lenses" in the ITE standard. The red, green, and yellow arrow lenses must be round with a nominal 12 inch diameter and the outside surface must be covered, except for the arrow, with a dull or dark grey opaque material of a thickness sufficient to totally hide the light from a 2000-lumen lamp placed behind it operating at rated voltage. The opaque material shall be hard and durable and shall be bonded such that it will not peel or flake when subject to the heat of a signal lamp or when the lens is washed. The shape and size of the arrow shall meet ITE standards. The arrow shall appear uniformly illuminated when viewed from angles usually encountered in service, whatever may be the angular position of the lens in the signal section. The lens must be enclosed by an air-cored EPDM gasket providing a weather proof and dust proof seal between the lens, door, and reflector assembly. The gasketed lens must be secured to the housing door by 4 stainless steel screws (AISI 304 or equivalent) and clamps equally spaced around the lens opening. The door must have threaded metal inserts to receive the screws.

(c) Reflector. The reflector shall be fabricated of high-purity, clad-type aluminum sheet formed to a parabolic shape and cut to fit in a circular polycarbonate, hinged frame for rigid mounting within the housing. The circular rim of the reflector shall be mounted in such a way as to seal the internal optical system by being compressed against the lens gasket when the signal door is closed. The reflecting surface must be an "ALZAK" class SI specular finish having a minimum reflectivity of 82% and a protective oxide coating. The reflector must have an opening in the back to accommodate the lamp holder.

(d) Lamp Holder. The lamp holder must have a heat, moisture, and weatherproof molded phenolic housing designed to accommodate a standard 133 watt, 3 inch light center length, incandescent lamp. The lamp holder shall be so designed that it can be readily rotated and positively positioned to provide proper lamp filament orientation and focus. The inner brass shell, or ferrule, of the lamp holder must have a grip to prevent the lamp from working loose due to vibration. A gasket must be furnished at the junction of the lamp holder and the reflector.

2.3.2 LIGHT EMITTING DIODE (LED) OPTICAL MODULES

(a) Light emitting diode (LED) optical modules shall consist of an integral unit containing the following components: power leads, housing, matrix of light emitting diodes (LEDs) emitting monochromatic light of desired signal color, and electronic and electrical components necessary to permit operation at nominal 120 volt, 60 hertz power.

(b) The LED module shall be of such dimensions as to permit mounting in any standard traffic signal housing, be interchangeable with incandescent optical units, and must include appropriate gasket for this purpose. Gasketing provided must provide a watertight seal meeting existing ITE standard for signal heads, and exclude the infiltration of moisture into either the signal housing or into the LED optical unit case.

(c) The LED module shall meet the applicable requirements of the ITE standards for Vehicle Traffic Control Signal Heads (VTCSH) Part 2: LED Vehicle Signal Modules, for color (chromaticity), signal brightness (luminance), and beam spread (luminance at various vertical and horizontal angles).

(d) Minimum brightness of LED signal units shall be in accordance with the luminous requirements in a standard testing procedure as defined by Section 4 of the VTCSH Part 2: LED Vehicle Signal Modules. During the required operating life of LED signal units, the luminance output of the units must not be less than 60% of the values specified in the standard.

(e) The module indicator surface shall be constructed of ultraviolet (UV) stabilized, impact resistant polycarbonate, acrylic, or other approved material. The surface must be anti-glare, smooth texture, and clear.

(f) Modules shall consist of LEDs uniformly distributed to present a homogeneous appearance on the indicator face from a wide viewing angle.

(g) LEDs shall be wired so that the loss of a single LED or a string of LEDs will not reduce the luminescence below the minimum requirement.

(h) For purposes of this specification, failure of a single unit is defined as an occurrence where the luminescence of the signal measured in candela in standard test procedures is less than the required initial luminance or luminance at time points and conditions specified; or where minimum required brightness is achieved, but 2 or more series strings of LEDs or in excess of 20% of LEDs are not operable.

(i) Module power supply shall be constant current regulated and filtered to provide instant on indications, and to prevent momentary signal outages or flicker. Units must be fully operable over a range of 90 volts to 130 volts at 60 hertz ± 3 hertz.

(j) Surge protection: Each module must be provided with integral surge protection to withstand transient of 600 volt, 100 microsecond rise and 1 millisecond pulse width. The surge protector shall provide full electrical and physical protection to all unit components.

(k) Maximum permissible power consumption at ambient conditions (nominal 120 volts, 60 hertz, 70˚F.) must be 30 watts at a minimum 90% power factor. Power consumed must not vary by more than 10% from nominal power consumption over a voltage range of 105 volts to 125 volts, and over permissible environmental ranges.

(l) Modules must be fully operable at temperature ranges of -40˚F. (-40˚C.) to +165˚ F. (+74˚C.) at up to 100% relative humidity.

(m) Modules shall be clearly marked on the back surface of the unit in a permanent manner showing information required for warranty and long term performance. Information to be shown must include manufacturer name, date of manufacture, electric power requirements, signal model type including color and indication type, and signal serial number.

(n) The LED module shall be compatible with the traffic signal controller equipment currently in use by the City of Chicago, and meeting the City's latest specifications for traffic signal control equipment. In particular the LED unit shall be compatible with the NEMA TS-1 and later traffic signal load switches and conflict monitors.

(o) Modules shall meet applicable sections of Title 47, Sub-Part B, Section 15 of the Federal Communications Commission (FCC) rules as applies to electronic noise limitation and electromagnetic interference.

(p) Total harmonic distortion (THD) induced into the voltage and current AC power line sine waves must not exceed 20%.

(q) LED modules must meet the requirements of VTCSH Part 2: LED Vehicle Signal Modules Section 6.3.1 for signal burn-in.

2.4 Wiring. Each lamp holder must be furnished with two (2) leads color coded as follows:

First Lead Wire:

White	Common

Second Lead Wire:

Red	Red Section
Yellow	Yellow Section
Green	Green Section
Green with Black Tracer	Green Arrow Section
Yellow with Black Tracer	Yellow Arrow Section
Red with Black Tracer	Red Arrow Section
Green with White Tracer	Green Bicycle Section
Yellow with White Tracer	Yellow Bicycle Section
Red with White Tracer	Red Bicycle Section
Any Other Colors	Bus Sections

The leads must be No. 18 AWG stranded copper wire rated at 600 volt, 105° C., with thermo-plastic insulation. The leads must connect to the terminal strip without being spliced. The ends of the leads must be stripped of 0.5 inches of insulation and tinned.

2.5 Terminal Strip. A dual-point, barrier type terminal strip with a solid base and pressure plate type connectors shall be securely attached at both ends to the housing body inside the "Green" section of the signal head, or other approved section within a multiple section head.

2.6 Cable. One 11 foot length of flexible electric cord, medium duty, type SO, No. 16 AWG stranded copper conductor, color coded, rubber insulated, neoprene jacketed, must be furnished with each signal head. The number of conductors must include a neutral and one leg for each section. Both ends of each cable length must be carefully stripped of 6 inches of jacket and 1 inch of insulation, and each conductor properly tinned.

2.7 Gaskets. Wherever necessary to make a completely dustproof, moistureproof and weatherproof assembly of the housing and optical system, approved type gaskets of neoprene or silicone rubber shall be provided.

3. TESTING AND DOCUMENTATION REQUIREMENTS

3.1 Documentation. The contractor shall provide certified manufacturing and testing documentation to demonstrate that the traffic signals being supplied meet or exceed the specification requirements. All LED modules shall be tested by a nationally recognized testing laboratory (NRTL), such as Intertek (ETL division), to demonstrate compliance with the latest ITE VTCSH specification. All LED units shall have the testing laboratory's label attached.

3.2 Inspection. The signals shall be subject to inspection at the request of the Commissioner. Final inspection shall be made at point of delivery. Any signal rejected shall be removed, disposed of, and replaced by the contractor at his sole cost.

4. PACKAGING

4.1 Packing. Each traffic signal assembly shall be packed in a suitable carton so secured that the signal will not be damaged during shipment, handling or storage.

4.2 Marking. Each carton containing a traffic signal shall be clearly marked on the outside in letters not less than 3/8 inch tall with the legend: "TRAFFIC SIGNAL, TWELVE-INCH, POLYCARBONATE" or "TRAFFIC SIGNAL, TWELVE INCH, POLYCARBONATE, LED OPTICS" and the number of Sections as required, the color and indication types, the name of the manufacturer, the date of manufacture, the pertinent Contract Number and the appropriate City Commodity Code Number.

ELECTRICAL SPECIFICATION 1494
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED FEBRUARY 6, 2014

PEDESTRIAN TRAFFIC SIGNAL, 16 INCH LED WITH SYMBOLIC WALK/DON'T WALK, POLYCARBONATE HOUSING

SCOPE

1. This specification states the requirements for a single section pedestrian signal with light emitting diode (LED) symbolic messages on a nominal sixteen inch by eighteen inch message surface and enclosed in a polycarbonate housing.

GENERAL REQUIREMENTS

2. (a) Sample and Certified Test Reports. One complete pedestrian signal, fully assembled and wired, of the manufacture proposed to be furnished, must be submitted along with the required certified test reports, within 15 business days upon request of the Chief Procurement Officer. The sample must be delivered to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608.

(b) Standards. Equipment furnished under this specification shall meet the appropriate requirements of the following standards, as required within the body of this specification:

American Association of State Highway and Transportation Officials (AASHTO)
American Iron and Steel Institute (AISI)
American Society for Testing and Materials (ASTM)
Institute of Transportation Engineers (ITE)
National Electrical Manufacturers Association (NEMA)
Underwriters Laboratories (UL)

(c) Approval. Approval will mean approval in writing by the Commissioner or his duly authorized representative.

(d) Warranty. The manufacturer shall warrant the signals to meet the requirements of this specification, and shall warrant all equipment, components, parts and appurtenances against defective design, material and workmanship for a period of 3 years from date of delivery [date of acceptance for contract construction]. In addition, LED modules must carry an additional warranty against failure or loss of color (chromaticity) and signal brightness (luminance) below minimum acceptable ITE standard levels for a period of 7 years from date of delivery [date of acceptance for contract construction]. In the event defects or failures in the LED units occur during the warranty period, the manufacturer must replace all defective units at no expense to the City. This warranty shall be evidenced by a letter or certificate of warranty submitted to the City at the time final delivery is made. The warranty must cover all units delivered in an order or installed by contract, and must include module serial numbers for all LED modules. The warranty must be signed by an official of the manufacturer who is empowered by the manufacturer to enter into such an agreement.

MATERIAL

3. (a) The pedestrian signal heads shall conform to ITE Standard "Pedestrian Traffic Control Signal Indications" (PTCSI), in which the most recently published revisions will govern.

(b) Housing Design. The housing must be one piece, ultra violet stabilized polycarbonate resin of the specified color, injection molded complete with integral top, bottom, and sides, having a minimum thickness of 0.1 inches.

(c) The polycarbonate formulation used must provide these physical properties in the housing (Tests may be performed on separately molded specimens).

TEST	**REQUIRED**	**METHOD**
Specific gravity	1.17 minimum	ASTM D 792
Vicat Softening temp	310-320° F	ASTM D 1525
Brittleness temp.	-200° F	ASTM D 746
Flammability	Self-extinguishing	ASTM D 635
Tensile strength, yield	8,500 PSI	ASTM D 638
Elongation at yield	5.5-8.5%	ASTM D 638
Shear strength, yield	5,500 PSI min.	ASTM D 732
Izod impact strength (notched, .125" thick)	12-16 ft-lbs/in.	ASTM D 256
Fatigue strength (at 2.5 mm cycles)	950 PSI min.	ASTM D 671

EQUIPMENT REQUIREMENTS

4. (a) Positioning Device. The top and bottom opening of each housing must have integral serrated bosses that will provide positive positioning of the signal head in 5˚ increments to eliminate undesirable rotation or misalignment of

the signal head between sections. A total of 72 teeth must be provided in the serrated bosses to allow the signal face to be rotated 360° about its axis. The teeth shall be clean and sharp to provide positive positioning with the grooves of the mating section or framework. Each opening shall accommodate standard 1.5 inch pipe fittings and brackets.

(b) Hinges. The housing must have four integral hinge lugs, with stainless steel hinge pins (AISI 304 or equivalent), located on the left side for mounting the door. The hinge pins must be straight and not protrude past the outside of the housing lugs. The housing must have two integral latching bolt lugs on the right side each with a stainless steel hinge pin to which a latching bolt (AISI 304 or equivalent), washer, and wing nut will be attached. The wing nuts must be captive.

(c) Door. The door must be a one piece ultraviolet stabilized polycarbonate resin of the specified color, injection molded complete with a minimum thickness of 0.1 inch. Two hinge lugs on the left side and 2 sets of latch screw jaws centered on the right side, as viewed from the front of the signal, must be integrally cast with the housing door. The door must be hinged to the housing with 2 stainless steel hinge pins, drive fitted. Two stainless steel latch screws and wing nuts and washer assemblies on the latch side of the housing body shall provide for opening and closing the door without the use of tools.

The inside of the door must be grooved to accommodate a one piece, air-cored ethylene propylene diene monomer (EPDM) gasket to provide a weatherproof and dust proof seal when the door is closed. The outside of the door must have an integral rim completely encircling the opening to prevent leakage between the door and the LED module. The rim must have equally spaced tabs around the circumference with threaded metal inserts for the visor attachment.

LED OPTICAL MODULE

5. (a) LED Optical Module. Light emitting diode (LED) optical modules shall consist of an integral unit containing the following components: power leads, housing, matrix of light emitting diodes (LEDs) emitting monochromatic light of desired colors, and electronic and electrical components necessary to permit operation at nominal 120 volt, 60 hertz power. All units must form a neat compact unit within the housing body with no light leakage between the door and the housing body, and the signal indication and the visor.

(b) The LED module shall meet the applicable requirements of ITE’s LED Pedestrian Traffic Signal Modules. During the required operating life of LED signal units, the luminance output of the units must not be less than 60% of the values specified in the standard.

(c) Module power supply must be constant current regulated and filtered to provide instant on indications, and to prevent momentary signal outages or flicker.

(d) Modules must consist of LEDs uniformly distributed to present a homogeneous appearance on the face of the lens from a wide viewing angle.

(e) LEDs shall be wired so that the loss of a single LED or a string of LEDs will not reduce the luminescence below the minimum requirement.

(f) For purposes of this specification, failure of a single module is defined as an occurrence where the luminescence of the signal measured in candela in standard test procedures is less than the required initial luminance or luminance at time points and conditions specified; or where minimum required brightness is achieved, but 2 or more series strings of LEDs or in excess of 20% of LEDs are not operable.

(g) Modules must be fully operable over a range of 90 volts to 130 volts at 60 hertz ± 3 hertz.

(h) <u>Surge protection</u>. Each module must be provided with integral surge protection to withstand transient of 600 volt, 100 microsecond rise and 1 millisecond pulse width. The surge protector shall provide full electrical and physical protection to all module components.

(i) Maximum permissible power consumption at ambient conditions (nominal 120 volts, 60 hertz, 70º F.) must be 18 watts at a minimum 90% power factor. Power consumed must not vary by more than 10% from nominal power consumption over voltage range of 105 volts to 125 volts, and over permissible environmental ranges.

(j) Modules must be fully operable at temperature ranges of -40º F. (-40º C) to +165º F. (+74º C) at up to 100% relative humidity

(k) Modules shall be clearly marked on the back surface of the unit in a permanent manner showing information required for warranty and long term performance. Information to be shown must include manufacturer name, date of manufacture, electric power requirements, signal model type, and signal serial number.

(l) The LED module shall be compatible with the traffic signal controller equipment currently in use by the City of Chicago, and meeting the City�s latest specifications for traffic signal control equipment. In particular the LED module must be compatible with the NEMA TS-1 and later traffic signal load switches and conflict monitors.

(m) Modules must meet applicable sections of Title 47, Sub-Part B, Section 15 of the Federal Communications Commission (FCC) rules as applies to electronic noise limitation and electromagnetic interference.

(n) Total harmonic distortion (THD) induced into the voltage and current AC power line sine waves must not exceed 20%.

(o) Burn-in. LED Optical units must be energized for a minimum 24 hour burn-in at 100% on-time duty cycle.

SYMBOLIC MESSAGE

6. (a) Symbols for "Walk" (Man) and "Don't Walk" (Hand) shall conform in style and color to those of the "Institute of Transportation Engineers" (I.T.E.). The messages shall be approximately 16 inches square and display the "Don't Walk" and "Walk" symbols. The symbols shall be applied in such a manner as to provide an opaque polycarbonate background and illuminated legends. The symbols must be not less 9.5 inches tall with proportional width. The "Don't Walk" symbol must be Portland orange, and the "Walk" symbol must be lunar white, conforming to the specifications of the PTCSI.

(b) The module message surface shall be constructed of ultraviolet (UV) stabilized, impact resistant polycarbonate, acrylic, or other approved material. The surface must be anti-glare, smooth texture, and clear.

WIRING

7. (a) Each lamp holder must have 3 wire leads color coded as follows:

White - Common
Red - "Don't Walk" Indication
Green - "Walk" Indication

The leads must be No. 18 AWG stranded copper wire rated at 600 volt, 105° C., with thermo-plastic insulation. The ends of the lamp leads must be stripped of 0.5 inches of insulation and tinned. The leads must be splice-free and connected to one side of the terminal strip.

(b) Terminal Strip. A four terminal, eight point, barrier type terminal strip with solid base and pressure plate type connectors shall be securely attached at each end to the housing body inside the walk section.

(c) Cable. One 11foot length of flexible electric cord, medium duty, type SO, 3-conductor No. 16 AWG stranded copper, color coded, rubber insulated, neoprene jacketed, must be furnished with each signal housing. Both ends of each cable length must be carefully stripped of 6 inches of jacket and 1 inch of insulation, and each conductor properly tinned.

TESTING AND DOCUMENTATION REQUIREMENTS

8. (a) Documentation. The contractor shall provide certified manufacturing and testing documentation to demonstrate that the pedestrian signals being supplied meet or exceed the specification requirements. All LED modules shall be tested by a nationally recognized testing laboratory (NRTL), such as Intertek (ETL division), to demonstrate compliance with the latest ITE VTCSH specification. All LED modules shall have the testing laboratory's label attached.

(b) Inspection. The signals shall be subject to inspection at the request of the Commissioner. Final inspection shall be made at point of delivery. Any signal rejected must be removed, disposed of, and replaced by the contractor at his sole cost.

PACKAGING

9. (a) Each pedestrian signal assembly shall be packed in a suitable carton so secured that the signal will not be damaged during shipment, handling, or storage.

(b) Marking. Each carton containing a pedestrian signal shall be clearly marked on the outside in letters not less than 3/8 inch tall with the legend: "PEDESTRIAN SIGNAL, SIXTEEN-INCH, SYMBOLIC LED WALK-DON'T WALK," the appropriate City Commodity Code Number, the name of the manufacturer, the date of manufacture, and the pertinent contract number.

ELECTRICAL SPECIFICATION 1495
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED FEBRUARY 7, 2014

TRAFFIC SIGNAL MOUNTING BRACKET
POLYCARBONATE, SIDE OF POLE

SCOPE

1. This specification states the requirements for polycarbonate brackets designed for mounting traffic and pedestrian signal heads from the side of poles.

GENERAL REQUIREMENTS

2. (a) Sample and Certified Test Reports. One complete signal bracket of the manufacture proposed to be furnished, must be submitted along with the required certified test reports, within 15 business days upon request of the Chief Procurement Officer. The sample must be delivered to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608.

(b) Standards. Equipment furnished under this specification must meet the appropriate requirements of the following standards, as required within the body of this specification:

American Association of State Highway and Transportation Officials (AASHTO)
American Society for Testing and Materials (ASTM)
Institute of Transportation Engineers (ITE)
National Electrical Manufacturers Association (NEMA)

(c) Approval. Approval will mean approval in writing by the Commissioner or his/her duly authorized representative.

(d) Warranty. The manufacturer shall warrant the signal bracket to meet the requirements of this specification, and shall warrant all equipment, components, parts and appurtenances against defective design, material and workmanship for a period of 3 years from date of delivery [date of acceptance for contract construction]. In the event defects and failures become apparent during this period, the manufacturer must replace the defective brackets at no expense to the City. This warranty must be evidenced by a letter or certificate of warranty submitted to the City at the time final delivery is made.

MATERIAL

3. (a) The bracket must be one piece, ultra violet stabilized polycarbonate resin of the specified color, injection molded complete with integral top, bottom, and sides.

(b) The polycarbonate formulation used must provide these physical properties (Tests may be performed on separately molded specimens).

TEST	REQUIRED	METHOD
Specific gravity	1.17 minimum	ASTM D 792
Vicat Softening temp	310-320° F	ASTM D 1525
Brittleness temp.	-200° F	ASTM D 746
Flammability	Self-extinguishing	ASTM D 635
Tensile strength, yield	8,500 PSI	ASTM D 638
Elongation at yield	5.5-8.5%	ASTM D 638
Shear strength, yield	5,500 PSI min.	ASTM D 732
Izod impact strength (notched, 1/8" thick)	12-16 ft-lb/in.	ASTM D 256
Fatigue strength (at 2.5 mm cycles)	950 PSI min.	ASTM D 671

(c) Glass. The polycarbonate may be glass impregnated to increase strength.

POSITIONING DEVICE

4. The top and bottom opening of the bracket must have integral serrated bosses that will provide positive positioning of the signal head in 5° increments to eliminate undesirable rotation or misalignment of the signal head between sections. A total of 72 teeth must be provided in the serrated bosses to allow the signal head to be rotated 360° about its axis. The teeth must be clean and sharp to provide positive positioning with the grooves of the signal head.

HARDWARE

5. The mounting brackets must be provided complete with 1 polycarbonate shim(.25 inches thick), one 1.5 inch chase nipple with rubber gasket, and 1 pinnacle cap with rubber gasket.

DIMENSIONS

6. The bracket must have nominal dimensions of 12 inches long, by 6 inches high, by 3 inches wide.

WIRING SPACE

7. The bracket must have an integral molded wireway with a minimum 1.5 inch diameter opening.

DESIGN STRENGTH

8. The bracket must be designed to support a 12 inch, single face, five-section, polycarbonate signal head.

TESTING AND DOCUMENTATION REQUIREMENTS

9. (a) Documentation. The contractor must provide certified manufacturing and testing documentation to demonstrate that the brackets being supplied meet or exceed the specification requirements.

(b) Inspection. The brackets will be subject to inspection at the request of the Commissioner. Final inspection must be made at point of delivery. Any bracket rejected must be removed, disposed of, and replaced by the contractor at his sole cost.

PACKAGING

10. (a) Each bracket must be packed in a suitable carton so secured that the bracket will not be damaged during shipment, handling, or storage.

(b) Marking. Each carton containing brackets must be clearly marked on the outside in letters not less than 3/8 inch tall with the legend: "POLYCARBONATE SIGNAL BRACKET, SIDE OF POLE" the appropriate City Commodity Code Number, the name of the manufacturer, the date of manufacture, and the pertinent contract number.

ELECTRICAL SPECIFICATION 1528
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED JUNE 6, 2014

PRECAST CONCRETE STRUCTURES

SUBJECT

1. This specification covers the requirements for precast concrete structures to be used for City of Chicago electrical facilities. The structures will include manholes, handholes, and street light pole foundations.

GENERAL

2. (a) Specifications. The precast structures must conform in detail to the requirements herein stated and to the specifications and methods of test of the American Society for Testing and Materials cited by ASTM Designation Number of which the most recently published revision will govern.

(b) Acceptance. Precast structures not conforming to this specification will not be accepted. The Commissioner of Transportation or his representative will be the sole judge in determining if the precast structures meet this specification. The Commissioner's decision will be final.

(c) Drawings. The drawings mentioned herein are drawings of the Department of Transportation. They are integral parts of this specification cooperating to state necessary requirements.

(d) Bidders Drawings. The apparent low bidder must submit detailed scale drawings of the precast structures showing actual dimensions and details, if so requested. Shop drawings must be original engineering drawings created by the manufacturer. The drawings must give every dimension necessary and show how the structure is assembled.

(e) Sample. One complete precast structure of each item must be submitted within fifteen (15) business days upon request of the Chief Procurement Officer.

(f) Warranty. The manufacturer must warrant the performance and construction of the precast structures to meet the requirements of this specification and must warrant all parts, components, and appurtenances against defects due to design, workmanship, or material developing within a period of one (1) year after the precast structures have been delivered. This will be interpreted particularly to mean structural failure of any element. The warranty must be furnished in writing guaranteeing material replacement including shipment, free of charge to the City. The Commissioner will be the sole judge in determining which replacements are to be made. The Commissioner's decision will be final.

DESIGN

3. (a) Material. Concrete must be Portland cement concrete, Class SI or PC, meeting current IDOT specifications. Pulling irons in manholes must meet or exceed the requirements of ASTM A36 steel. Pulling irons must be hot dipped galvanized. Steel reinforcing bars must meet or exceed the requirements of ASTM A615, Grade 60. Cable supports in manholes, including stanchions and racks, must be manufactured for that specific purpose. Stanchions must be non-metallic and must be capable of accommodating several different sizes of cable hooks at various elevations. A minimum of eight cable hooks, 4 inches in length, must be provided with each manhole, and should include any hardware necessary to affix the hooks to the racks. Cable hooks for handholes must be manufactured for that specific purpose. Cable hooks for handholes must be a minimum of 3 inches in length and 3 inches in depth. Anchor rods in foundations must meet the latest Electrical Material Specification 1467. Conduit elbows in foundations must meet the latest Electrical Material Specification 1462.

(b) Foundations must include conduit elbows, anchor rods, washers, and nuts. The 7 foot foundation must include a 6 foot re-bar cage. Handholes must include cable hooks. Manholes must include cable racks, pulling irons, and cable hooks. Each manhole and each handhole must have lifting anchors cast in the concrete to facilitate shipment and installation. If the manhole or handhole is in more than one piece, instructions for assembly must be provided. Also, a sufficient amount of bonding agent must be provided. The bonding agent must be approved material. Frames and covers, sump grates, clay tile, and ground rods are not included under this specification.

(c) Dimensions of Manholes and Handholes. Each manhole or handhole must be dimensioned as shown on the appropriate standard drawing. The 30 inch diameter handhole is Standard Drawing 867. The 36 inch diameter handhole for 24 inch frame and cover is Standard Drawing 866. The 36 inch diameter for 30 inch for frame and cover is Standard Drawing 871. The 3 foot by 4 foot by 4 foot manhole for a 24 inch diameter frame and cover is Standard Drawing 730. The 3 foot by 4 foot by 4 foot manhole for 30 inch frame and cover is Standard Drawing 729. The 4 foot by 6 foot by 6 foot manhole for 24 inch frame and cover is Standard Drawing 732. The four foot by 6 foot by 6 foot manhole for 30 inch frame and cover is Standard Drawing 733. The 5 foot 4 inch by 7 foot 4 inch manhole roof is Standard Drawing 733.

(c) Dimensions of Grade Rings. Grade rings shall be in four different dimensions. The 39 inch outside diameter ring shall have a 24 inch diameter opening and shall come in both 2 inch and 4 inch thicknesses. The 45 inch outside diameter ring shall have a 30 inch diameter opening and shall also come in both 2 inch and 4 inch thicknesses.

(d) Dimensions of foundations. The residential street light foundation shall be dimensioned as shown on standard drawing 565. The 7 foot arterial street light foundation shall be as shown on standard drawing 818.

DELIVERY

4. All manholes, handholes, and foundations will be delivered to the Division of Electrical Operations storage yard at 1539 South Ashland Avenue in Chicago, or to another location within the City as indicated on the order. Any manhole, handhole, or foundation deemed to be defective by the Commissioner or his representative must be removed and replaced at no cost to the City. The Commissioner�s decision will be final.

ELECTRICAL SPECIFICATION 1533
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED NOVEMBER 21, 2014

NON-METALLIC CONDUIT

SCOPE

1. This specification states the requirements for both rigid and coilable non-metallic conduit. The conduit will be used for low voltage (600 volt rated cables) electrical street lighting and traffic control systems. It may also be used for fiber-optic communications cables. This conduit will be installed underground. Rigid non-metallic conduit may be installed on structure.

GENERAL

2. (a) Standards. The following standards are referenced herein.

ASTM – American Society for Testing and Materials
NEC – National Electrical Code
NEMA – National Electrical Manufacturer's Association
UL – Underwriter's Laboratories

(b) Warranty. The manufacturer must warrant the conduit against defective workmanship and material for a period of one year from date of installation or date of delivery. Any conduit that is found to be defective must be replaced without cost to the City.

(c) Sample. If requested by the Chief Procurement Officer, a sample of the conduit intended to be furnished under this specification, must be submitted to the Engineer of Electricity within fifteen (15) business days upon receipt of such request.

MATERIAL

2. (a) Rigid non-metallic conduit will be made of polyvinyl chloride (PVC). All conduit and fittings must comply with ASTM D 1784 and with the applicable sections of NEMA TC2, UL standard 651, and NEC Article 352. Fittings must meet the standards of NEMA TC3 and TC6, as well as UL 514.

(b) Coilable non-metallic conduit will be made of high density polyethylene (HDPE). All conduit must comply with ASTM D3485 ,ASTM D 1248, and NEMA TC7.

(c) A tape must be installed in the HDPE conduit at the factory. The tape is for pulling cable through the conduit. The tape must be specifically manufactured for this purpose. The tape must have a tensile strength of at least 1000 pounds.

SIZES

3. (a) PVC and HDPE will come in two wall thicknesses; schedule 40 and schedule 80.

(b) PVC will come in ten foot sections. HDPE will come on reels.

(c) Nominal inside diameters (in inches) for non-metallic conduits will include the following: ½ , ¾ , 1, 1 ¼, 1 ½ , 2, 2 ½ , 3, 3 ½, 4.

PACKING

4. Rigid conduit must be shipped in bundles. Coilable conduit must come on wooden reels. Both bundles and reels must be tagged to indicate the size and diameter of the conduit, the quantity in feet, the weight, and the manufacturer's name. The conduit itself must be marked to indicate the type and size, as well as the manufacturer.

ELECTRICAL SPECIFICATION 1534
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED AUGUST 5, 2013

CABLE: SINGLE-CONDUCTOR, COPPER 600 VOLT

SUBJECT

1. This specification states the requirements for single conductor cables intended to be used in 240 VAC street lighting circuits. The cable will also be used as service cable for both street light controllers and traffic signal controllers. The cables will be installed in underground conduit and rated as 600 volt.

GENERAL

2. (a) Specifications. The cable must conform in detail to the requirements herein stated, and to the applicable portions of the latest revisions of the specifications and methods of test of the following agencies:

(1) ASTM – American Society for Testing and Materials
(2) ICEA – Insulated Cable Engineers Association
(3) IEEE – Institute of Electrical and Electronics Engineers
(4) UL – Underwriters Laboratories

(b) Acceptance. Cable not in accordance with this specification will not be accepted.

(c) Sample. If requested by the Chief Procurement Officer, a three (3) foot sample of the cable intended to be provided under this specification must be sent to the attention of the Engineer of Electricity within fifteen (15) days of receipt of such request.

(d) Warranty. The manufacturer must warrant the cable to be first class material throughout. In lieu of other claims against them, if the cables are installed within twelve (12) months of date of shipment, the manufacturer must replace any cable failing during normal and proper use within two years of date of installation. All replacements under this warranty must be made free of charge F.O.B. delivery point of the original contract.

CABLES

3. (a) Construction. The cable must consist of an uncoated multiple strand copper conductor with a tight fitting thermoset, free stripping, concentric layer of ethylene propylene (EPR) insulation.

(b) The number of strands and the outer diameter of the cable shall be as noted in TABLE A.

(c) Cable shall be UL approved for sunlight resistance and for direct burial applications.

(d) Cable must meet IEEE 383 and UL 1581 70,000 BTUs per hour flame test requirements.

COLOR CODE

4. (a) Triplexed cable shall consist of a black cable, a red cable, and a green ground cable. Triplexed cable will have a 16” to 18” lay.

(b) Individual cables will be black, red, or white, depending upon the order.

CONDUCTOR

5. (a) Material. The conductors must be soft round copper strands.

(b) Specifications. The conductor must meet the requirements of ASTM B3 and ASTM B8.

(c) Sizes. The conductor sizes must be in accordance with all requirements in Table A of this specification.

(d) Stranding. The number of strands must be as indicted in Table A. Stranding must meet the requirements of ASTM B8, Class B.

INSULATION

6. (a) Type. The insulation must be ethylene propylene rubber compound (EPR) meeting the requirements of ICEA S-95-658 and UL 44 for RHW-2 cable and UL 854 for USE-2 cable.

(b) Thickness. The insulation must be circular in cross-section, concentric to the conductor, and must have an average thickness not less than that set forth in Table A of this specification, and a spot thickness not less than ninety percent (90%) of the average thickness.

(c) Cable Marking. The cable must be identified by a permanently inscribed legend in white lettering as follows:

1/C No. (conductor size) AWG-600V-90°C-EPR-RHW-2

The legend must be repeated at approximately eighteen (18) inch intervals on the outside surface of the cable parallel to the longitudinal axis of the conductor. A sequential footage marking must be located on the opposite side from the legend.

TESTING

7. (a) Initial Physical Requirements.

1. Tensile strength, minimum, p.s.i.	1200
2. Elongation at rupture, minimum %	250

(b) Oven Exposure Test. After conditioning in an air oven at 121±1ºC for 168 hours using methods of test described in ASTM D 573:

1. Tensile strength, minimum % of initial value	75
2. Elongation at rupture, minimum percent of initial value	75

(c) Water Absorption Test. Gravimetric method: After 168 hours in water at 70±1ºC water absorption, at a maximum – 5 milligrams per square inch

(d) Cold Bend Test. The completed cable must pass the test requirements of ASTM D 470, except that the test temperature must be -25ºC.

(e) Electrical Tests.

1. Voltage. The completed cable must meet an A.C. and D.C. voltage test in accordance with ASTM D 470 and D 2655.
2. Insulation Resistance. The completed cable must have an insulation resistance constant of not less than 20,000 ohms when tested in accordance with ASTM D 470.

(f) Flame Tests. Cable must pass a 70,000 BTU flame test in accordance with IEEE 383.

(g) All of the above tests must be on cable produced for the order. Tests must be taken on samples taken every 25,000 feet, or fraction therof, of each conductor size.

(h) Test Reports. No cable shall be shipped until certified copies of all factory tests have been reviewed and approved by the City. Cable that does not pass any one of the above tests will be rejected.

PACKAGING

8. (a) Reels. The completed cable must be delivered on sound substantial, non-returnable reels. Both ends of each length of cable must be properly sealed against the entrance of moisture and other foreign matter by the use of clamp-on cable caps. The ends must be securely fastened so as not to become loose in transit. Before shipment, complete 2 X 4 lagging must be applied to all reels.

(b) Footage. Each reel must contain the length of cable as set forth in Table A of this specification. Alternate lengths may be considered.

(c) Reel Marking. A metal tag must be securely attached to each reel indicating the reel number, contract number, date of shipment, gross and tare weights, the appropriate City commodity code if applicable, and a description of the cable. Also, each reel must have permanent marking on it indicating the total footage, and the beginning and ending sequential footage numbers. Directions for unrolling the cable must be placed on the reel with an approved permanent marking material such as oil-based paint or a securely attached metal tag.

TABLE A

CONDUCTOR		INSULATION THICKNESS	A-C TEST	REEL LENGTH	OVERALL DIAMETER
AWG	**STRANDS**	**MILS**	**VOLTS**	**FEET**	**INCH**
14	7	45	5500	2000	.133
12	7	45	5500	2000	.152
10	7	45	5500	2000	.176
8	7	60	5500	2000	.236
6	7	60	5500	2000	.274
4	7	60	5500	2000	.322
2	7	60	5500	1000	.382
1/0	19	80	7000	1000	.470
2/0	19	80	7000	1000	.514
3/0	19	80	7000	1000	.564
4/0	19	80	7000	1000	.620
250 MCM	37	95	8000	1000	.705

ELECTRICAL SPECIFICATION 1537
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED AUGUST 5, 2013

CABLE: TRAFFIC SIGNAL, MULTIPLE CONDUCTOR, COPPER WIRE, 600 VOLT

SUBJECT

1. This specification states the requirements for a multiple conductor cable to be installed in underground conduits and used to distribute electrical energy to operate automatic traffic control signals for both vehicular and pedestrian traffic at street intersections within the City of Chicago. The cable will be used between the traffic controller cabinet and the junction boxes on the traffic signal poles. The cable will be rated as 600 volt.

GENERAL

2. (a) Specification. The cable must conform in detail to the requirements herein stated, and to the specifications and methods of test of the following:

ASTM - American Society for Testing and Materials
ICEA - Insulated Cable Engineers Association
IEEE - Institute of Electrical and Electronic Engineers
UL - Underwriters Laboratories

(b) Acceptance. Cable not conforming to this specification will not be accepted.

(c) Sample. If requested by the Chief Procurement Officer, a three (3) foot sample of the cable intended to be furnished under this specification must be submitted to the attention of the Engineer of Electricity within fifteen (15) business days of receipt of such request.

(d) Warranty. The manufacturer must warrant the cable to be first class material throughout. In lieu of other claims against them, if the cable is installed within twelve (12) months of date of shipment, the manufacturer must replace any cable failing during normal and proper use within two years of date of installation. All replacements under this warranty must be made free of charge F.O.B. delivery point of the original contract.

CABLES

3. (a) Construction. The cable must consist of coated conductors each concentrically encased with a free- stripping, thermoset cross-linked polyethylene insulation. Suitable fillers must be used to produce an essentially round cross-section. A Mylar tape must be wrapped over the conductor assembly, and a thermoset low smoke zero halogen polyolefin (LSZH) jacket applied overall.

(b) Outer Diameter. The maximum allowable outer diameter for round cables must be as follows:

No. Of Conductors	Outer Diameter (inches)
Ten	0.69
Nineteen	0.90

(c) Cable shall be UL approved for sunlight resistance and for direct burial applications.

(d) Cable must meet IEEE 383 and UL 1581 and UL1202 70,000 BTUs per hour flame test requirements.

COLOR CODE

4. Conductor identification must be provided by color synthetic-resin coverings, or an approved equal. Table A sets forth the color code for the various conductor arrangements.

CONDUCTOR

5. (a) Material. Solid, soft or annealed, tinned copper wire, meeting the requirements of ASTM B-33 and B-258.

(b) Size. Cables must be made up of conductor sizes as set forth in this specification. The Number 14 AWG will be solid.

INSULATION

6. (a) Type. The insulation must be a thermoset cross-linked polyethylene compound meeting the requirements of ICEA S-73-532 and UL 44 for XHHW-2 cable.

(b) Thickness. The insulation must be circular in cross-section and have the following minimum thicknesses.

Conductor Size. AWG	stranding (No. Of Wires)	No. of Conductors	Insulation Thickness (mils)
#14	1	10	30
#14	1	19	30

CABLE TAPE

7. The assembled and cabled conductor core must be wrapped with a one mil (0.001 inch) thick Mylar tape allowing a minimum of ten percent (10%) overlap.

JACKET

8. (a) Material. The jacket must be a thermoset low smoke zero halogen (LSZH) polyolefin.

(b) Workmanship. The jacket must have a smooth exterior surface free from holes, cracks and splits, and must be tough, elastic, homogeneous in composition, and properly vulcanized.

(c) Thickness. Thickness of the jacket must be 4/64 inches. Minimum thickness must be not less than ninety percent (90%) of the average thickness.

(d) Cable Marking. Outer Jacket must be embossed or printed with the manufacturer’s name, year of manufacture, insulation and jacket materials, conductor number, conductor size, at approximately 18" intervals. On the side opposite, the cable must be sequentially marked in one (1) foot increments. The jacket must be black.

TESTING

9. (a) Initial Physical Properties of Insulation.

1. Tensile Strength, minimum	1200psi
2. Elongation at Rupture, minimum	250%

(b) Physical Properties of Insulation After Aging. After 168 hours in air oven at 121° C.

1. Tensile Strength	75% of initial value

2. Elongation	75% of initial value

(c) Initial Physical Properties of Jacket.

1. Tensile Strength, minimum	1800psi
2. Elongation at Rupture, minimum	300%

(d) Physical Properties of Jacket After Aging. After 168 hours in air oven at 121º C.

1. Tensile Strength	75% of initial value
2. Elongation	65% of initial value

(e) Water Absorption. Tests must be made in accordance with ASTM D 470. After 168 hours in distilled water at 70º C., water absorption of the insulation material must not exceed 5 milligrams of water per square inch. For the jacket material the water absorption must not exceed 1 milligram per square inch under the same conditions.

(f) Cold-Bend Test. The completed cable must pass cold bend test of ASTM D 470, except that the test temperature must be minus(-)25ºC.

(g) Electrical Requirements.

1. Voltage. The completed cable must meet an A.C. and D.C. voltage test in accordance with ASTM D 470 and D 2655.
2. Insulation Resistance. The completed cable must have an insulation resistance of not less than 20,000 ohms when tested in accordance with methods in ASTM D 470.

(h) Flame Tests. Cable must pass a 70,000 BTU flame test in accordance with IEEE 383.

(i) Tests. The above tests must be performed on the insulation, the jacket, and the completed cable as required above. Tests must be performed on samples taken every 25,000 feet or fraction thereof of each cable size.

(j) Reports. No cable will be accepted until certified copies of the test reports have been reviewed and approved by the City. Cable that does not pass any of the above tests will be rejected.

PACKAGING

10. (a) Reels. The completed cable must be delivered on sound substantial, non-returnable reels. Both ends of each length of cable must be properly sealed

against the entrance of moisture and other foreign matter by the use of clamp-on cable caps. The ends must be securely fastened so as not to become loose in transit. Before shipment, complete 2 x 4 lagging must be applied to all reels.

(b) Footage. Each reel must contain the length of cable as set forth below.

(1) Ten-Conductor	2000 feet
(2) Nineteen-Conductor	1000 feet

(c) Marking. A metal tag must be securely attached to each reel indicating the reel number, contract number, date of shipment, gross and tare weights, the appropriate City commodity Code Number if applicable, and a description of the cable. Also, each reel must have permanent marking on it indicating directions for unrolling the cable and the footage of cable contained in the reel. Indelible ink or other such material susceptible to washing off or fading will not be permitted; and approved permanent marking material such as paint or a securely attached metal tag is required.

TABLE A COLOR CODE CONDUCTOR IDENTIFICATION

Base Color	First Tracer	Second Tracer	10	19
White	Black	Red	--	14
White	Red	Green	--	14
Black	--	--	14	14
White	--	--	14	14
Red	--	--	14	14
Green	--	--	14	14
Orange	--	--	14	14
Blue	--	--	14	14
White	Black	--	--	--
Red	Black	--	14	14
Green	Black	--	14	14
Orange	Black	--	14	14
Blue	Black	--	14	--
Black	White	--	--	--
Red	White	--	--	14
Green	White	--	--	14
Blue	White	--	--	14
Orange	White	--	--	14
White	Red	--	--	--
Blue	Orange	--	--	14
Red	Blue	--	--	14
Green	Blue	--	--	14
Orange	Blue	--	--	14

ELECTRICAL SPECIFICATION 1545
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED FEBTRUARY 7, 2014

PEDESTRIAN COUNTDOWN TRAFFIC SIGNAL LED, 16 INCH WITH SYMBOLIC WALK/DON’T WALK, POLYCARBONATE HOUSING

SUBJECT

1. This specification states the requirements for a single section pedestrian countdown signal with light emitting diode (LED) symbolic messages on a nominal sixteen inch by eighteen inch message surface and enclosed in a polycarbonate housing.

GENERAL REQUIREMENTS

2. (a) Sample and Certified Test Reports. One complete pedestrian countdown signal, fully assembled and wired, of the manufacture proposed to be furnished, must be submitted along with the required certified test reports, within 15 business days upon request of the Chief Procurement Officer. The sample must be delivered to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608.

(b) Standards. Equipment furnished under this specification shall meet the appropriate requirements of the following standards, as required within the body of this specification:

American Association of State Highway and Transportation Officials (AASHTO)
American Iron and Steel Institute (AISI)
American Society for Testing and Materials (ASTM)
Institute of Transportation Engineers (ITE)
National Electrical Manufacturers Association (NEMA)
Underwriters Laboratories (UL)

(c) Approval. Approval will mean approval in writing by the Commissioner or his duly authorized representative.

MATERIAL AND EQUIPMENT REQUIREMENTS

3. (a) The pedestrian signal heads must conform to ITE Standard "Pedestrian Traffic Control Signal Indications" (PTCSI), in which the most recently published revision will govern.

(b) Housing Design. The housing must be one piece, ultra violet stabilized polycarbonate resin of the specified color, injection molded complete with integral top, bottom, and sides, having a minimum thickness of 0.1 inches.

The polycarbonate formulation used must provide these physical properties in the housing (Tests may be performed on separately molded specimens).

TEST	**REQUIRED**	**METHOD**
Specific gravity	1.17 minimum	ASTM D 792
Vicat Softening temp	310-320º F	ASTM D 1525
Brittleness temp.	-200º F	ASTM D 746
Flammability	Self-extinguishing	ASTM D 635
Tensile strength, yield	8,500 PSI	ASTM D 638
Elongation at yield	5.5-8.5%	ASTM D 638
Shear strength, yield	5,500 PSI min.	ASTM D 732
Izod impact strength (notched, .125" thick)	12-16 ft. lbs./in.	ASTM D 256
Fatigue strength (at 2.5 mm cycles)	950 PSI min.	ASTM D 671

(c) Positioning Device. The top and bottom opening of each housing must have integral serrated bosses that will provide positive positioning of the signal head in 5˚ increments to eliminate undesirable rotation or misalignment of the signal head between sections. A total of 72 teeth must be provided in the serrated bosses to allow the signal face to be rotated 360˚ about its axis. The teeth shall be clean and sharp to provide positive positioning with the grooves of the mating section or framework. Each opening must accommodate standard 1.5 inch pipe fittings and brackets.

(d) Hinges. The housing must have 4 integral hinge lugs, with stainless steel hinge pins (AISI 304 or equivalent), located on the left side for mounting the door. The hinge pins must be straight and not protrude past the outside of the housing lugs. The housing must have 2 integral latching bolt lugs on the right side each with a stainless steel hinge pin to which a latching bolt (AISI 304 or equivalent), washer, and wing nut will be attached. The wing nuts must be captive.

(e) Door. The door must be a one piece ultraviolet stabilized polycarbonate resin of the specified color, injection molded complete with a minimum thickness of 0.1 inch. Two hinge lugs on the left side and 2 sets of latch screw jaws centered on the right side, as viewed from the front of the signal, must be integrally cast with the housing door. The door must be hinged to the housing with 2 stainless steel hinge pins, drive fitted. Two stainless steel latch screws and wing nuts and washer assemblies on the latch side of the housing body must provide for opening and closing the door without the use of tools.

The inside of the door must be grooved to accommodate a one piece, air-cored ethylene propylene diene monomer(EPDM) gasket to provide a weatherproof and dust proof seal when the door is closed. The outside of the door must have an integral rim completely encircling the opening to prevent leakage between the door and the LED module. The rim must have equally spaced tabs around the circumference with threaded metal inserts for the visor attachment.

(f) Gaskets. Wherever necessary to make a completely dust-proof, moisture-proof and weatherproof assembly of the housing and optical system, approved type gaskets of neoprene or silicone rubber shall be provided.

LED OPTICAL MODULES

4. (a) Light emitting diode (LED) optical modules must consist of an integral unit containing the following components: power leads, housing, integral lens, matrix of light emitting diodes (LEDs) emitting monochromatic light of desired colors, and electronic and electrical components necessary to permit operation at nominal 120 volt, 60 hertz power. All units shall form a neat compact unit within the housing body with no light leakage between the door and the housing body.

(b) The LED unit shall meet the applicable requirements of ITE's LED Pedestrian Traffic Control Modules. During the required operating life of LED signal units, the luminance output of the units must not be less than 60% of the values specified in the standard.

(c) LED module power supply must be constant current regulated and filtered to provide instant on indications, and to prevent momentary signal outages or flicker.

(d) Modules shall consist of LEDs uniformly distributed to present a homogeneous appearance on the face of the lens from a wide viewing angle.

(e) LEDs shall be wired so that the loss of a single LED or a string of LEDs will not reduce the luminescence below the minimum requirement.

(f) For purposes of this specification, failure of a single unit is defined as an occurrence where the luminescence of the signal measured in candela in standard test procedures is less than the required initial luminance or luminance at time points and conditions specified; or where minimum required brightness is achieved, but 2 or more series strings of LEDs or in excess of 20% of LEDs are not operable.

(g) LED modules must be fully operable over a range of 90 volts to 130 volts at 60 hertz ± 3 hertz.

(h) Surge protection. Each unit must be provided with integral surge protection to withstand a transient of 600 volt, 100 microsecond rise and 1 millisecond pulse width. The surge protector shall provide full electrical and physical protection to all unit components.

(i) Maximum permissible power consumption at ambient conditions (nominal 120 volts, 60 hertz, 70˚F.) must be 18 watts at a minimum 90% power factor. Power consumed must not vary by more than 10% from nominal power consumption over a voltage range of 105 volts to 125 volts, and over permissible environmental ranges.

(j) Modules must be fully operable at temperature ranges of -40˚F. (-40˚C.) to +165˚F. (+74˚C.) at up to 100% relative humidity.

(k) Modules shall be clearly marked on the back surface of the unit in a permanent manner showing information required for warranty and long term performance. Information to be shown must include manufacturer name, date of manufacture, electric power requirements, signal model type, and signal serial number.

(l) The LED module shall be compatible with all traffic signal controller equipment currently in use by the City of Chicago, and meeting the City�s latest specifications for traffic signal control equipment. In particular the LED unit shall be compatible with the NEMA TS-1 and later traffic signal load switches and conflict monitors.

(m) Modules shall meet applicable sections of Title 47, Sub-Part B, Section 15 of the Federal Communications Commission (FCC) rules as applies to electronic noise limitation and electromagnetic interference.

(n) Total harmonic distortion (THD) induced into the voltage and current AC power line sine waves must not exceed 20%.

(o) Burn-in. LED Optical modules must be energized for a minimum 24 hour burn-in at 100% on-time duty cycle.

DISPLAY

5. (a) The message area shall be approximately 16 inches square and display the double overlay "Don't Walk" and "Walk" symbols immediately adjacent to the countdown digits. The symbols shall be applied in such a manner as to provide an opaque polycarbonate background and illuminated legends.

(b) Symbolic Messages. Symbols for "Walk" (Man) and "Don't Walk" (Hand) must conform in style and color to those of ITE. The symbols must not be less than 9.5 inches high with proportional width. The "Don't Walk" symbol must be Portland orange, and the "Walk" symbol must be of lunar white, conforming to the specifications of the ITE/PTCSI.

(c) Countdown Digits. Countdown digits must be Portland orange and not less than 9 inches high with proportional width and shall be compliant with latest ITE standards.

(d) The module message surface shall be constructed of ultraviolet (UV) stabilized, impact resistant polycarbonate, acrylic or other approved material. The surface must be anti-glare, smooth texture, and clear.

WIRING

6. (a) Wire Leads. Each module connector must be furnished with 3 wire leads color coded as follows:

White - Common
Red - "Don't Walk" Indication
Green - "Walk" Indication

The leads must be No.18 AWG, stranded copper wire rated at 600 volt and 105°C., with thermoplastic insulation. The ends of the leads must be stripped of 0.5 inches of insulation and tinned. The leads must be splice-free and connected to one side of the terminal strip.

(b) Terminal Strip. A four terminal, eight point, barrier type terminal strip with solid base and pressure plate type connectors must be securely attached at each end to the housing body inside the walk section.

(c) Cable. One 11 foot length of flexible electric cord, medium duty, type SO, 3-conductor No. 16 AWG stranded copper, with color coded insulation, and an overall jacket, must be furnished with each pedestrian signal. Both ends of each cable length must be carefully stripped of 6 inches of jacket and 1inch of insulation, and each conductor properly tinned.

COUNTDOWN FUNCTIONALITY

7. (a) The countdown unit shall be compatible with all traffic signal controller

equipment currently in use by the City of Chicago, and meeting the City's latest specifications for traffic signal control equipment.

(b) The countdown timer must have a micro-processor capable of recording its own time when connected to a traffic controller.

(c) The countdown timer unit must continuously monitor the traffic controller for any changes to the pedestrian phase time and re-program itself automatically as needed.

(d) The countdown unit must register the time for the walk and clearance intervals individually and must begin counting down at the beginning of the pedestrian change interval (flashing hand).

(e) At the end of the pedestrian change interval, the unit must display “0" and the blank out. The display must remain dark until the beginning of the next countdown.

(f) In the event of a preemption sequence, the countdown unit must skip the pre-empted clearance time and reach “0” at the end of the pedestrian change interval.

(g) The countdown must remain synchronized with signal indications and always reach “0" at the end of the pedestrian change interval.

(h) The countdown must not display an erroneous or conflicting time when subjected to defective load switches.

TESTING AND DOCUMENTATION REQUIREMENTS

8. (a) Documentation. The contractor shall provide certified manufacturing and testing documentation to demonstrate that the traffic signals being supplied meet or exceed the specification requirements. All LED Optical modules shall be tested by a nationally recognized testing laboratory (NRTL), such as Intertek (ETL division), to demonstrate compliance with the latest ITE VTCSH specification. All LED modules shall have the testing laboratory’s label attached.

(b) Inspection. The signals will be subject to inspection at the discretion of the Commissioner. Final inspection shall be made at point of delivery. Any signal rejected must be removed, disposed of, and replaced by the contractor at his sole cost.

(c) Warranty. The manufacturer shall warrant the signals to meet the requirements of this specification, and must warrant all equipment, components, parts and appurtenances against defective design, material and workmanship for a period of 3 years from date of delivery [date of acceptance for contract construction]. In addition, LED optical modules must carry a 7 year warranty against failure or loss of color (chromaticity) and signal brightness (luminance) below minimum acceptable PTCSI standard levels from date of delivery [date of acceptance for contract construction]. In the event defects and failures occur in the LED units during the warranty period, the manufacturer must replace such units at no expense to the City. This warranty shall be evidenced by a letter or certificate of warranty submitted to the City at the time delivery is made. The LED warranty must cover all units delivered in an order or installed by contract, and must include unit serial numbers. The warranty must be signed and dated by an official of the manufacturer who is empowered by the manufacturer to enter into such a warranty.

PACKAGING

9. (a) Packing. Each pedestrian signal assembly shall be packed in a suitable carton so secured that the signal will not be damaged during shipment, handling or storage.

(b) Marking. Each carton containing a pedestrian signal shall be clearly marked on the outside in letters not less than 3/8 inch tall with the legend: "PEDESTRIAN SIGNAL, COUNTDOWN, SIXTEEN-INCH, SYMBOLIC LED WALK-DON’T WALK", the name of the manufacturer, the date of manufacture, the pertinent Contract Number and the appropriate City Commodity Code Number.

ELECTRICAL SPECIFICATION 1560
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED DECEMBER 4, 2014

ADVANCED TRANSPORTATION CONTROLLER AND CABINET WITH UNINTERRUPTIBLE POWER SUPPLY

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1. GENERAL REQUIREMENTS

1.1 This specification details the requirements for traffic signal control equipment for use in the City of Chicago. This equipment will control traffic signal timing and sequencing at an intersection. The equipment must include a battery back-up system which will maintain power to the signals during a power failure.

1.2 (For contract construction only) If requested by the City, the contractor must provide a sample to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608. The sample must consist of the controller, cabinet, load switches, conflict monitor and all appurtenant wiring and equipment completely assembled as a working unit. This sample will be regarded as a finished production sample and conformance or non-conformance to these specifications will be based on the sample submitted.

(For City commodity contract only) If requested by the Chief Procurement Officer, within forty-five (45) days from the receipt of such request, the bidder must provide a sample to the Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608. The sample must consist of the controller, cabinet, load switches, conflict monitor and all appurtenant wiring and equipment completely assembled as a working unit. If the sample is acceptable and the bidder is awarded a contract, the sample will become the property of the City of Chicago with a suitable credit issued to the contract.

1.3 All tests as outlined herein must be regarded as minimum requirements. The contractor must submit his testing procedure for approval prior to performing any testing functions. Upon successful completion of all testing, certified test reports must be submitted for each unit. Units not successfully passing these tests or lacking proper documentation will be rejected. The manufacturer, or manufacturer's representative, must be available for shop testing at the City's facilities.

1.4 <u>Standards.</u> Equipment furnished under this specification must meet the appropriate requirements of the following standards, as required within the body of this specification:

American Association of State Highway and Transportation Officials (AASTHO)
American Society for Testing and Materials (ASTM)
Institute of Transportation Engineers (ITE)
Manual on Uniform Traffic Control Devices (MUTCD)
National Electrical Manufacturers Association (NEMA)
Occupational Safety and Health Administration (OSHA)
Underwriters Laboratories (UL)

1.5 Standard Drawings. The Electrical Standard Drawing 962 “Load Switch and Conflict Assignment”, Electrical Standard Drawing 964 “Traffic Controller Cabinet Back Panel and Power Supply, 1 of 2”, Electrical Standard Drawing 965 “Traffic Controller Cabinet Back Panel and Power Supply, 2 of 2”, and Electrical Standard Drawing 909 “Fiber Optic Patch Panel” are integral parts of this specification.

1.6 Warranty. The manufacturer(s) must warranty the performance and construction of the traffic signal controller and other major components to meet the requirements of this specification, and must warranty all parts, components, and appurtenances against defects in design, material, and workmanship for a period of one (1) year after acceptance by the City. In the event of defects or failures during this period, the manufacturer(s) must repair and/or replace all defective or failed parts or appurtenances at no expense to the City.

1.7 Manufacturer. The manufacturer of the controller and the manufacturer of the battery back-up system must demonstrate a knowledge of past production, or have been actively engaged in the sale and/or service of the equipment herein described, as demonstrated by a submitted list of comparable projects. The manufacturer must be a recognizable company that manufactures ATC controllers, such as Econolite, McCain, Siemens, U.S. Traffic, or equal.

2. CONTROLLER REQUIREMENTS

2.1 ATC. The controller must be an Advanced Transportation Controller (ATC) meeting the requirements of the specification “Advanced Transportation Controller (ATC) Standard Version 5.2b” dated June 26, 2006 and the requirements of NEMA TS2-2003. The referenced specification is a joint effort of AASTHO, NEMA, and ITE. Since each user agency has different controller needs, for the City of Chicago, the controller must meet the programming modifications and options listed in the ATC Matrix as indicated in Table A. All software necessary to make the controller operational must be included.

2.2 Power. The controller must operate on 120 volt, 60 cycle (± 3 Hertz), single phase, alternating current. The controller must function in the range from 89 to 135 Volts a.c. The power consumed must be under 50VA.

2.3 Packing. (For City commodity contracts only) Each controller, with all its component parts, must be suitably packed in a single container in such a manner as to prevent damage to the contents in shipment and handling.

2.4 Instructions. One (1) complete set of up to date instructions providing complete information on installation, adjustment, operation and maintenance, including both up to date "Logic Schematics" and "Electronic Circuit" diagrams, of these controllers, must be furnished to the Division of Electrical Operations for approval prior to the first shipment of controllers. All information, including photos and schematics, must reference to the controller being furnished on this contract and must be a high quality, completely legible reproduction. Upon approval, one complete set of data must be furnished with each controller.

2.5 Training. (For City commodity contracts only) The contractor must provide training at the City's facilities. The training must be on the actual equipment provided under the contract, and must include, but not be limited to, programming all features, connecting and wiring, and troubleshooting. Training manuals are required (training manuals should include the instructions in a teaching-type format). Training material must be provided for up to thirty (30) personnel. Training must be divided into three (3) one week sessions. The timing of these sessions will be determined after contract award and must take place within the contract period. Each week may contain more than one training class (i.e. 2-3 day classes). Each training class may have up to ten (10) personnel. Classes must be structured for both field personnel and shop personnel. The manufacturer must provide all material and equipment necessary for the classes.

2.6 Chassis. The chassis shall be aluminum with a powder coat finish. No plastic chassis or composite chassis will be allowed. The controller must physically fit into existing 'M', 'P', and 'SUPER P' cabinets configured for City of Chicago applications, so that retrofitting will not be a problem. The controller must not exceed the following dimensions: 10.5 inches high, 10.5 inches deep, and 15 inches wide.

2.7 Processor / Memory. At a minimum, the processor will be:

Clock speed - 300MHz
Non-volatile Memory - 32MB Flash

DRAM - 64MB
SRAM - 1MB
(All memory and firmware must be stored in flash memory. No EPROMS will be allowed.)

2.8 Display. The display shall be a 16 x 40 backlit LCD using a 6 x 8 character font. Display and keypad must be permanently attached to chassis. Detachable keypads will not be allowed.

2.9 Environmental. The controller must operate in the temperature range of -34° Celsius to +74° Celsius. The controller must operate within the relative humidity of 5% to 95%.

2.10 All printed circuit boards must be mounted vertically.

2.11 Encapsulation of 2 or more discrete components into circuit modules is prohibited except for transient suppression circuits, resistor networks, diode arrays, solid-state switches, optical isolators and transistor arrays. All encapsulated components must be second sourced and must be of such design, fabrication, nomenclature or other identification as to be purchased from a wholesale distributor or from the component's manufacturer as a standard product. Custom encapsulated components are not allowed.

2.12 Obsolete components, components no longer supported by the manufacturer, components not recommended for new designs, components which have been discontinued or which the contractor should have reasonably been expected to know were discontinued, or components which the vendor/manufacturer has announced plans to discontinue at the time of the bid/contract must not be used in the design of any subassemblies provided under this contract.

2.13 The controller must meet the functional and environmental requirements of NEMA TS2 2003. The use of 2070s, 170s, BIUs, SIUs, or similar devices is not allowed.

2.14 As allowed by ATC v5.2b, Section 8.1.1, the controller will utilize NEMA 'A', 'B', and 'C' I/O connectors, except for the HMC-1000 and LMD40 I/O variants. Pin assignments for NEMA 'A','B', and 'C' connectors must follow the NEMA TS2 2003 standards for I/O. Port 2 must be the ATC v5.2b pin-limited version of NEMA TS2 Port 2. Port 4 (C50S) must be a 9-pin connector with only limited signals being required.

Special function connector for the TS2-2 must follow the CPC style "D" pin outs as follows:

CPC MSD Pin	**Function**
1	Flash
2	Offset 1
3	Interconnect Common
4	User defined input 6
5	Offset 2
6	Offset 3
7	Time Plan A
8	User defined input 7
9	User defined input 8
10	Call to Free
11	Call to week 10
12	Time Plan B
13	Time Plan C
14	Time Plan D
15	Alt Seq A
16	Alt Seq B
17	Alt Seq C
18	Dimming
19	Monitor status bit C
20	System Input
21	Alt Seq D
22	Monitor status bit A
23	Monitor status bit B
24	Veh Det 13
25	Veh Det 9
26	Veh Det 10
27	Veh Det 11
28	Polarizing Pin
29	Veh Det 12
30	Veh Det 14
31	Veh Det 15
32	Veh Det 16
33	SGO/Conditional Service
34	Preempt input 5
35	Preempt output 1
36	Preempt output 2
37	Interconnect inhibit
38	Time Clock sync
39	Sync inhibit
40	Preempt input 1
41	Preempt input 2
42	Preempt input 3

43	Preempt output 3
44	Polarizing Pin
45	Preempt output 4
46	Preempt output 5
47	System Out
48	Preempt output 6
49	Preempt input 4
50	Clock Ckt 9 (Aux 1)
51	Clock Ckt 10 (Aux 2)
52	Clock Ckt 11 (Aux 3)
53	Clock Ckt 12 (Aux 4)
54	Clock Ckt 13 (System)
55	Clock Ckt 8 (Flash)
56	Clock Ckt 3 (Offset 1)
57	Clock Ckt 4 (Offset 2)
58	Clock Ckt 5 (Offset 3)
59	Clock Ckt 1 (T/P A)
60	Clock Ckt 2 (T/P B)
61	Clock Ckt 6 (T/P C)
62	Clock Ckt 7 (T/P D)
63	Preempt input 6

2.15 Downward compatibility with existing City of Chicago cabinets.

(1) The controller must be of a modular design allowing for the ability to exchange I/O modules to allow for use in existing City of Chicago HMC-1000, LMD40, and standard NEMA TS2-2 cabinets. This I/O module must be “plug and play”. The controller’s firmware must detect the type of I/O installed (HMC-1000, LMD40 or NEMA TS2) and provide the proper user interface. Adapter harnesses for the HMC-1000, LMD40 and Setcon clock will not be allowed.

(2) The HMC-1000 I/O module must be pinned as follows:

63 Pin Connector	Function
1	Output 20
2	Output 11
3	Manual Advance
4	Stop Time
5	Output 24
6	Offset 1

7	Offset 3
8	Output 15
9	Preempt 2
10	Advance
11	Output 23
12	Restart
13	Output 32
14	Offset 2
15	Output 16
16	Preempt 1
17	Output 25
18	Output 28
19	Spare 1
20	Spare 2
21	Output 7
22	Output 18
23	Output 21
24	Output 22
25	Dial 3
26	Dial 2
27	Output 1
28	Output 14
29	Output 4
30	Output 29
31	Output 27
32	Output 17
33	Output 9
34	Output 19
35	Dial 4
36	On-Line
37	Flashing Bus
38	Manual
39	Output 30
40	Output 31
41	Output 12
42	Output 10
43	Output 2
44	Output 3
45	Output 13
46	Output 8
47	Output 26
48	Logic Ground
49	Not Used

50	Not Used
51	Output 5
52	Output 6
53	Logic Ground
54	Logic Ground
55	Not Used
56	Not Used
57	Not Used
58	Not Used
59	24 V.D.C
60	Not Used
61	115 Volts AC
62	AC Neutral
63	Chassis Ground

(3) The LMD40 I/O module contains 4 I/O connectors, MSA, MSB, MSD, and communications connectors which must be pinned as follows:

LMD40 MSA	**Pin**	**Voltage Level**
Actuation 3	A	DC
24 V.D.C	B	DC
Voltage Monitor	C	DC
Actuation 1	D	DC
Actuation 2	E	DC
Preemption 2	F	DC
Preemption 1	G	DC
Interval Advance	H	DC
Stop Time	J	DC
MCE (Manual Control)	K	DC
External C/S/O	L	DC
Signal Plan 2	M	DC
Signal Plan 3	N	DC
System Cont/AZ Reset	P	DC
External Start	R	DC
Remote Flash (AC)	S	120 VAC
Interconnect Common	T	120 VAC
AC – (Common)	U	AC
Chassis Ground	V	Earth Ground
Logic Ground	W	DC Reference
Output 1	X	DC
Output 2	Y	DC
Output 3	Z	DC
Output 4	a	DC

Output 5	b	DC
Output 6	c	DC
Output 7	d	DC
Output 8	e	DC
Output 9	f	DC
Output 10	g	DC
Output 11	h	DC
Output 12	i	DC
Output 13	j	DC
Output 14	k	DC
Output 15	m	DC
Output 16	n	DC
AC+ input	p	120 VAC
Output 17	q	DC
Output 18	r	DC
Output 19	s	DC
Output 20	t	DC
Output 21	u	DC
Spare Output	v	DC
Spare Output	w	DC
Spare Output	x	DC
Cycle 2 (User Defined)	y	120 VAC
Cycle 3 (User Defined)	z	120 VAC
Split 2	AA	120 VAC
Split 3	BB	120 VAC
Output 22	CC	120 VAC
Output 23	DD	120 VAC
Offset 1	EE	120 VAC
Offset 2	FF	120 VAC
Offset 3 (user def 1)	GG	120 VAC
Output 24	HH	DC

LMD40 MSB	**Pin**	**Voltage**
Output 25	A	DC
Output 26	B	DC
Output 27	C	DC
Output 28	D	DC
Output 29	E	DC
Output 30	F	DC
Output 31	G	DC
Output 32	H	DC
Output 33	J	DC

Output 34	K	DC
Output 35	L	DC
Output 36	M	DC
Output 37	N	DC
Output 38	P	DC
Output 39	R	DC
Output 40	S	DC
Actuation 4	T	DC
Hold	U	DC
Force Off	V	DC

LMD40 MSD	**Pin**	**Voltage**
Flash Monitor 1	1	120 VAC
Cycle 5	2	120 VAC
PE Clear 1	3	DC
PE Clear 3	4	DC
Flash Monitor 2	5	120 VAC
Spare Input 4	6	120 VAC
System Input	7	120 VAC
AZ Reset (Absolute Zero)	8	DC
PE Clear 2	9	DC
UD 6 Input	10	DC
Call to week 10	11	DC
Signal Plan 6	12	DC
Signal Plan 7	13	DC
Signal Plan 8	14	DC
Actuation 5	15	DC
Actuation 6	16	DC
Actuation 7	17	DC
Spare input 1	18	DC
UD 7 Input	19	DC
Actuation 8	20	DC
Actuation 9	21	DC
Actuation 10	22	DC
Spare input 2	23	DC
UD 8 input	24	DC
Sys Command (Ckt 13)	25	DC
Flash Attained	26	DC
PE Active	27	DC
Polarization	28	DC
System Out	29	DC
Preempt input 3	30	DC

Preempt input 4	31	DC
Preempt input 5	32	DC
Signal Plan 5 in	33	DC
Call to FREE op	34	DC
Output 41	35	DC
Output 42	36	DC
Interconnect Inhibit	37	DC
Spare input 3	38	DC
Sync Inhibit	39	DC
Dimming	40	DC
Added Time inhibit	41	DC
Time Clock Sync	42	DC
Output 43	43	DC
Polarization	44	DC
Output 44	45	DC
Output 45	46	DC
Output 46	47	DC
Output 47	48	DC
Signal Plan 4	49	DC
Aux 1 (Ckt 9)	50	DC
Aux 2 (Ckt 10)	51	DC
Aux 3 (Ckt 11)	52	DC
Aux 4 (Ckt 12)	53	DC
Output 48 (FF Enable)	54	DC
Flash Out (Ckt 8)	55	DC
Offset 1 (Ckt 3)	56	DC
Offset 2 (Ckt 4)	57	DC
Offset 3 (Ckt 5)	58	DC
Cycle 2 (Ckt 1)	59	DC
Cycle 3 (Ckt 2)	60	DC
Split 2 (Ckt 6)	61	DC
Split 3 (Ckt 7)	62	DC
Fast Flash Image	63	DC

LMD40 Communication Connector (15 pin sub-D	**PIN**	**Voltage**
System Detector 11	1	DC
System Detector 12	2	DC
System Detector 13	3	DC
System Detector 14	4	DC
System Detector 15	5	DC
System Detector 16	6	DC

System Detector 17	7	DC
System Detector 18	8	DC
Monitor Status bit B	9	DC
Monitor Status bit A	10	DC
Monitor Status bit C	11	DC
DC User Defined in #1	12	DC
Logic Ground	13	DC
DC User Defined in #2	14	DC
DC User Defined in #3	15	DC

(4) The Setcon I/O connector will be resident on the HMC1000 version of the ASTC I/O.

Setcon Clock Connector	**PIN**	**Voltage**
Output 1	1	DC
Output 2 (Dial 2)	2	DC
Output 3 (Dial 3)	3	DC
Output 4 (Dial 4)	4	DC
Output 5 (Offset 1)	5	DC
Output 6 (Offset 2)	6	DC
Output 7 (Offset 3)	7	DC
Output 8 (Flash)	8	DC
Sync Output	9	DC
Sync Input	10	DC
Not used	11	N/A
Logic Ground	12	DC
Not Used	13	N/A
Not Used	14	N/A
Not Used	15	N/A
Not Used	16	N/A

2.16 Communication.

(1) NTCIP (National Transportation Communications for ITS Protocol).

a. The controller must be compliant with NTCIP Standards as outlined in NEMA TS2 – 2003 and must be tested and documented for compliance.

b. Global objects must be compliant to NTCIP 1201 v2.26 or later.

c. Actuated Signal Controller objects must be compliant to NTCIP 1202 v2.19f or later.

(2) Serial ports, one of which must be set as either RS-232 or RS-485.

(3) Ability to add an internal GPS module.

(4) Ethernet. The controller must be equipped with a minimum of two front panel mounted 10/100Mb Ethernet ports.

(5) A single port USB interface must be provided to facilitate database transfers, re-flashing of operation software and log transfer.

(6) The unit must be fully compatible with, and fully functional within, the City's existing MIST system (Management Information System for Transportation). MIST is a product of Telvent-Farradyne. All available functions and capabilities that exist within existing MIST controllers must be available within this unit, as well as compatible with the ATC LMD40 unit and the ATC NEMA unit. Any additional software or hardware necessary to fully integrate the controller into the MIST

system must be provided by the bidder/contractor and will be considered as part of the requirements of this specification.

(7) A Windows based laptop utility software must be provided for data transfers and monitoring of controller operation.

(8) A fiber-optic modem must be provided, if required. The modem must be compatible with existing City fiber interconnect systems. The modem may be internal or external to the controller.

2.17 Software operation.

(1) The controller must have the ability to re-synch a minimum of 8 cycle lengths to an "absolute zero" reference point. It must be possible to set absolute zero by either global command or individual cycle length.

(2) In addition to hardwire input, it must be possible to set Absolute Zero via keyboard command or fiber optic communication.

(3) The controller must have the ability to operate in two modes of operation, selectable by time of day:

a. Actuated control per NEMA TS2 – 2003.

b. Pre-timed Interval based control per NEMA TS2 – 2003.

(4) The controller must have the ability to transfer between actuated control and interval based control by time of day schedule.

(5) The controller will have 32 Pre-timed plans

a. Each plan will allow for up to 32 timing intervals

b. Each plan will allow for 64 circuit outputs. Each output must be individually programmable per interval.

(6) The controller must have 100 coordination plans.

(7) The controller must provide 6 preempts per NEMA TS2-2003.

(8) The controller must offer security as follows:

a. Two 4 digit security codes can be programmed (one for timing data, one for signal plan data), which when activated, allow data changes. These codes must automatically de-activate 10 minutes after the last user keystroke. It will be possible to re-program the security codes if the previous security code is known or has been defeated.

b. It must not be possible to read the security code from the controller's display.

c. It must be possible to access the controller in the case of a lost security code through a "back door" which is provided only by the controller manufacturer. This "back door" security code must change based upon the controller's internal calendar.

3. CONFLICT MONITOR

3.1 General. Each controller must be furnished with a NEMA conflict monitor unit for checking for conflicts in the signal output circuits. The conflict monitor must be capable of monitoring a minimum of twelve (12) distinct channels. It must be a self-contained unit with its own power supply and not be located within the timer housing.

3.2 Programming Board. A removable programming board must be supplied with the monitor for programming signal compatibility. The circuits for programming must be composed of soldered jumper wires. Diode or dip switch type programming will not be acceptable. The programming board must contain no circuitry or components other than the wire jumpers and the wire jumper soldering devices.

3.3 Flashing Circuit Energizing. The conflict monitor must be programmed to put the controller in a flashing sequence upon detection of a failure or conflicting signal display. The controller must also be programmed to energize the flash circuit if the conflict monitor is removed or loses its supply voltage. The conflict monitor must have a manual reset button to return the controller to normal operation after conflict circuit operation is no longer necessary.

3.4 Stop Time Circuit. A stop-time control circuit must be supplied from the conflict monitor to force the timer unit to stop timing upon detection of a conflict.

3.5 Indicator. The front panel of the conflict monitor housing must have an indicator which will be activated when a conflict or failure occurs as per Section 6 of NEMA Spec. TS1-1983.

3.6 Latch Circuit. The conflict monitor must have a latch circuit, insuring that if a voltage monitor failure occurs, the intersection remains in conflict until reset.

3.7 Memory. The conflict monitor must have the ability to store, in memory, a minimum of ninety-nine (99) conflict events, including date of conflict and channels conflicting.

3.8 Conflict Monitor Assignments

(1) Conflict monitor channels must be assigned as follows:

Channel 1	Load Switch 1	Phase 1 Vehicle
Channel 2	Load Switch 2	Phase 2 Vehicle
Channel 3	Load Switch 3	Phase 3 Vehicle
Channel 4	Load Switch 4	Phase 4 Vehicle
Channel 5	Load Switch 5	Phase 5 Vehicle
Channel 6	Load Switch 6	Phase 6 Vehicle
Channel 7	Load Switch 7	Phase 7 Vehicle
Channel 8	Load Switch 8	Phase 8 Vehicle
Channel 2W	Load Switch 9	Phase 2 Ped
Channel 4W	Load Switch 10	Phase 4 Ped
Channel 6W	Load Switch 11	Phase 6 Ped
Channel 8W	Load Switch 12	Phase 8 Ped
Channel 9	Load Switch 13	Overlap A
Channel 10	Load Switch 14	Overlap B
Channel 11	Load Switch 15	Overlap C
Channel 12	Load Switch 16	Overlap D

(2) It must be possible for the user to change conflict assignments without unsoldering any connections.

(3) All unused channels - vehicle or pedestrian - must be neatly tied or terminal mounted in such a manner that they are readily available in front of the panel. If tied, the harness wires must be labeled. If terminal mounted, the terminations must be labeled.

(4) A terminal must be provided for the red enable feature.

(5) A terminal must be provided for the hook up of any unused red channels to AC.

(6) Controller monitoring must consist of; voltage monitor, 24VDC- I, 24VDC-II.

(7) The output relay must operate a sixty (60) ampere, normally open, “A” type mercury contactor without the use of an external or “cabinet interface” relay.

4. SUPER P CABINET

4.1 Housing. Each controller must be furnished completely housed in a Type 5052-H32 aluminum housing of 0.125 inch thickness. The exterior dimensions of the cabinet must be 57 inches high, 57.625 inches wide, and 26.241 inches deep. The top of the cabinet must be 57.925 inches wide and 28.7 inches deep. The top of the cabinet must have a front to rear slope that will direct rain away from the front cabinet door. Door openings must be double-flanged. The interior of the cabinet will be divided into two compartments. The interior of the main cabinet must be equipped with four (4) “C” mounting channels on both side walls and two (2) “C” mounting channels on the rear wall. The UPS portion of the cabinet must be equipped with two (2) “C” mounting channels on each of the two side walls. All shelves, panels and individual equipment items must be mounted to these channels using 1.0" channel nuts with 1/4-20 bolts. All items mounted on panels must be securely fastened by bolting into drilled and tapped holes. No pop rivet or similar fastening methods will be accepted. The cabinet manufacturer will be Erpel, Hubbell, Southern Manufacturing Company, or approved equals.

4.2 Doors. The cabinet must have a main door hinged with one-quarter inch (1/4") minimum, continuous, removable stainless steel pins. The hinges themselves will be aluminum secured to the cabinet with stainless steel bolts. The battery compartment door on the side of the cabinet must be similarly hinged. The main cabinet door will be hinged on the right side. The battery compartment door will be hinged on the left side. The doors must be closely fitted to a neoprene gasket making the doors dust, water and weather resistant. The doors must be interchangeable with any other doors from any other controller in this order.

Opening of the main door must provide complete access to the cabinet interior. The door must be embossed, subject to approval, with the legend "CITY OF CHICAGO-TRAFFIC CONTROL" in letters at least one (1) inch high. The main door and the battery compartment door must have stops at 90, 150 and 180 degrees, from the closed position. The door latches must have three (3) point locking with rollers at the ends of the latch rods. The latch handle must be capable of being padlocked. The key lock for the latch mechanism must be a Corbin cylinder lock with keys to match existing City of Chicago controller cabinets. Two (2) keys must be furnished with each cabinet. Both the main door and the battery compartment door will have stainless steel handles with an 8” shank. The handles must be able to be padlocked. The padlocking arrangement must clear the lock and key.

Police Panel Door. The police panel door on the main door must be furnished with a lock for a modified Chicago police key per sample to be furnished to the supplier. This key must have a shaft of at least one and three quarter inches (1-3/4") in length. Two keys must be furnished with each cabinet. The door will have a stainless steel piano hinge and be sealed with a neoprene gasket.

<u>Generator Door</u>. This door will be on the rear of the cabinet. This door will

have a stainless steel piano hinge and be sealed with a neoprene gasket. Two keys will be furnished for this door.

4.3 Cabinet Ventilation. The main cabinet compartment must be provided with a mounting assembly to hold the forced air fan system. A fan, having a minimum air movement capacity of 100 CFM, must be mounted in the air baffle in the top of the cabinet with an air outlet built into the roof overhang. The main door must be louvered and equipped with a removable, standard, commercially available aluminum dust filter. The battery compartment must have a similar fan system. The battery compartment door must also have a louvered section with a removable dust filter. The ventilation openings must be equipped with removable covers for summer operation. No external fan housings or air outlets will be allowed. Any other method must be approved.

4.4 Shelves. The cabinet must contain a vertically adjustable shelf large enough to accept the solid state controller and all other shelf mounted devices. The battery compartment must have a minimum of three shelves.

4.5 Bolt Pattern The bolt pattern must be a four (4) point rectangular pattern matching the corresponding foundation. The dimensions will be 40.75” center-to-center and 18.5” center-to-center.

4.6 Finish. The exterior surfaces of the cabinet must be smooth. All drilled, tapped, or punched holes on the outer surface must be filled with liquid metal and ground smooth, and slotted screw heads must be ground smooth flush with surface. Bolts extending through cabinet wall must be round head, carriage, square shoulder type and fastened on the inside of the cabinet with an Esna nut and necessary gaskets to insure the weatherproofing integrity of the cabinet. The finished cabinet must be thoroughly degreased in a wash process and dried in a heated chamber. A thermosetting, ultra violet resistant, polyester powder coat must be electrostatically applied to all cleaned and treated surfaces and cured to a hard, mar resistant finish in a heated chamber at a temperature recommended by the powder coat paint manufacturer. Exterior color must conform to Federal Standard 595, and either be City of Chicago green color No. 14110 or gloss black color. Exterior color must be as defined in the contract, and color samples must be submitted for approval prior to acceptance of cabinet. Cabinet interior must be glossy white and may be either baked enamel or thermosetting, polyester powder coat. For either process, the interior must be prepared as described above. If the baked enamel finish is used, it must be preceded by one (1) coat of primer.

5. POWER SUPPLY

5.1 A sixty (60) ampere main breaker must be inserted in series with the line.

5.2 An un-fused terminal bus must be provided for ground side of the power supply and signal conductor commons.

5.3 Individual circuit breakers must be supplied for: (a) AC+ lights, 50 amperes; (b) AC+ control, 10 amperes; (c) duplex outlet supply, 15 amperes.

5.4 The incoming line must contain lightning protection devices consisting of, but not limited to, a metal oxide varistor and gas type arrestor. The gas type arrestor must be on the line side of the radio interference filter.

5.5 Contactor**.** A sixty (60) ampere, normally open, "A" type mercury contactor must be supplied for opening and closing the AC supply to the signal bus. The contactor must be mounted in such a manner on the power supply panel that accidental contact does not produce a safety hazard.

5.6 R.I.S. Filter. A radio interference suppression filter rated at sixty (60) amperes minimum must be installed in line with the main power supply, after the sixty (60) ampere circuit breaker.

5.7 Ground. The grounded side of the power supply must be continuous throughout the controller and must be grounded to the controller cabinet in an approved manner meeting OSHA requirements.

5.8 Polarity. The phase conductors of the signal circuits must have the same polarity as the phase side of the power supply, and the common conductor(s) must be of the same polarity as the grounded side of the power supply.

6. UNINTERRUPTIBLE POWER SUPPLY

6.1 General. The uninterruptible power supply (UPS) will consist of batteries which will recharge through the 120 volt electric service line. In the event of a power disruption, the unit will automatically activate. The transfer from utility power to battery power will not interfere with the normal operations of the traffic controller, conflict monitor, or any other part of the traffic system. A generator port will be provided to accept input from an external generator that can operate the traffic signals. The UPS must be the product of an established manufacturer, and suitable for the service required. The UPS must be manufactured by an established manufacturer who has been in the business for a minimum of five (5) years.

6.2 General Operation

(1) The line power provided by ComEd is nominally 120 volt, single phase, 60 Hertz. The UPS system must take the line power, regulate it, and provide continuous 120 volt, single phase, 60 hertz power to the

traffic system. The UPS must regulate the input line voltage within the limits specified herein. The input line voltage must also be transformed and rectified to charge the batteries. Under battery operation, the output from the batteries will go through an invertor to provide the proper A.C. current to provide continuous 120 volt, single cycle, 60 Hertz power to the traffic system. In the event of a power loss, the system must automatically switch to battery operation, without adversely affecting the traffic system. When power is restored, the system must automatically switch back without adversely affecting the traffic system. In the event the UPS system fails, an automatic switch must bypass the UPS and connect unconditioned power from ComEd directly to the traffic system. A manual bypass switch must also be provided. The system must be capable of running off a generator. The UPS will allow the generator to be put in or out of the system without adversely affecting the traffic system.

(2) The system will be capable of providing power for normal full timing mode, flash mode, or a combination of both. The operation will be field programmable to activate at various times, to change operation due to changing battery capacities, and to track alarm conditions, using the touch pad or remotely using the RS-232 interface. Programmability must be in ASCII formats and must not require any external or proprietary software. The DB-9 connector for the RS-232 interface must be located on the front panel of the UPS. The UPS must provide a minimum of 4 hours of full normal timing for a full LED controlled intersection.

(3) In the event ComEd line voltage falls outside the high and low limits (95VAC and 130VAC should be the default values) the UPS must transfer the load to battery power. The high and low limits must be programmable.

(4) The UPS must return to line mode when the ComEd power is restored within the proper limits for a specified period of time. The limits must be programmable. The default values should be 105VAC and 125VAC. This time must be programmable and should range from 3 to 30 seconds.

(5) The transfer time allowed, from disruption of normal utility line voltage to batteries or from batteries back to line voltage, must be such that the traffic signal system is not disrupted. The maximum transfer time allowed will be 60 milliseconds.

6.3 Specifications

(1) The UPS capacity will be a minimum of 2000VoltAmps/ 1500 watts.

(2) The inverter must have a minimum efficiency of 80%.

(3) The UPS will have an operating range of between -37°C. to +74°C.

(4) The manual bypass switch must be rated at 240 volts, 40 amps.

(5) The UPS must have a temperature compensated battery charging system. The charging system must compensate over a range of 2.5mV to 4 mV per degree centigrade per cell. Batteries must not be charged when temperatures exceed 50°C. The temperature sensor must be located in the cabinet near the batteries.

(6) The charger must be rated at 10 amps at 48 VDC.

(7) When under battery operation the UPS output voltage must be between 110 VAC and 125VAC, with a sine wave with THD less than 3% at 60 Hertz (±3 Hz).

(8) The UPS must be equipped to prevent a malfunction feedback to the utility service or to the cabinet per UL 1778, Section 48 "Back-Feed Protection Test". The upstream back-feed voltage from the UPS must be less than 1 volt AC.

(9) The UPS must have a lightning surge protection in compliance with IEEE/ ANSI C.62.41 for 2000 volts AC.

(10) The UPS must not weigh more than 50 pounds.

(11) The UPS must have a minimum efficiency of 95%.

(12) The generator bypass switch must be supplied with a 30 amp, weather-proof locking receptacle and cover plate.

6.4 Computer Control and Display

(1) The UPS must include an LCD display with programmable keypad, a red LED and a green LED, and an RS-232 interface.

(2) The UPS processor must be capable of indicating, through the LCD display or the RS-232 interface, the current battery charge status, various input/output voltages, power output, battery temperature, date, time, settings of programmable relays, events, and various other functions.

(3) The UPS must provide a temperature control for the cabinet fan.

(4) The UPS must be provided with a resettable inverter event counter and a cumulative inverter timer.

(5) The UPS must be equipped with an event log for a minimum of 100 events. Each event must have a date and time.

(6) The UPS must be capable of performing a self-test.

(7) Password protection must be provided.

(8) The following LED conditions must be used to indicate current status:

RED FLASHING - Alarm
RED STEADY - Fault
GREEN FLASHING - Battery Mode
GREEN STEADY - Line Mode

(9) The manual UPS bypass switch will allow the UPS to be maintained or replaced.

6.5 Battery System

(1) Individual batteries must be 12 volt, and must be commercially available and easily replaced.

(2) Four 79ah batteries must be supplied.

(3) The batteries will be connected in series. The wiring harness must be color coded with quick disconnects.

(4) Batteries must be certified to operate over a temperature range of -25° C. to +74° C.

(5) The batteries must be extreme temperature, deep cycle, sealed prismatic lead-calcium based AGM/VRLA (absorbed glass mat/valve regulated lead acid) .

(6) Maximum recharge time from protective low cut-off to 80% of full capacity must not exceed 20 hours.

(7) Thermostat controlled heater strips or pads must be supplied to keep battery operation efficient.

6.6 Relay Contacts

(1) The UPS must provide 6 sets of panel-mounted, potential free, fully programmable relay contacts rated at 1 amp, 120 volt. The relays must be numbered from C1 to C6.

(2) Each relay must be programmable to activate under any number of the following conditions:

ON BATTERY, relay activates when UPS switches to battery power.
LOW BATTERY, relay activates when batteries have reached a certain level of remaining capacity. This is adjustable from 0 to100%.
TIMER, relay activates after battery power is on for a certain amount of time. This is adjustable from 0 to 8 hours.
ALARM, relay activates after a specific alarm is detected. Alarm conditions include line frequency, low output voltage, no temperature reading, overload, batteries not connected, high temperature, and low temperature.
FAULT, relay activates after a specific fault is detected. Fault conditions include short circuitry, low battery voltage, high battery voltage, high internal temperature, and excessive overload.
OFF, relay is not active.

7. LOAD SWITCH BAY

7.1 General. A panel must be provided for mounting the load switch jacks, flash transfer relay jacks, flasher jack, auxiliary relays, time clock jacks, switches, flash change combination terminals, and terminals for field signal connections under non-interconnected operation. See Electrical Standard Drawings 964 and 965.

7.2 Wiring. Panel wiring must be neatly laced and properly terminated individual conductors. They must be insulated and properly sized for their application.

7.3 Load Circuits. Each load circuit must be capable of carrying fifteen (15) amperes continuously at a temperature of 165° F. (74° C.).

7.4 Bus Feeds. Bus feeds must be capable of carrying fifty (50) amperes continuously at a temperature of 165° F. (74° C.).

7.5 Equipment. In addition to the items listed in 2(a), the wiring panel must include, but not be limited to, the following:

(1) Ten (10) ampere fuses with barrier type fuse holders must be installed between the load switch signal output circuits and field terminals for

signal light conductors. Each terminal must be the barrier type with sufficiently long screws to accept four (4) #12 AWG solid conductors. The terminals must be located at least two inches (2") above the bottom of the cabinet.

(2) Switching Device. The signal load switching device must be a three (3) circuit, solid state, jack mounted load switch which meets the N.E.M.A. Publication TS-1, Part 5 requirements. Each load switch must be rated for a minimum fifteen (15) ampere continuous resistive load and must mate with an S-2412-SB panel socket. A minimum of twelve (12) and a maximum of sixteen (16) load switches to be provided with each cabinet, as defined in the contract.

(3) User Programmable Interface. Two (2) sets of terminal blocks must be provided between the machine logic output and the input side of the load switches. By terminating all machine logic output on one set of terminals and all load switch input to the other set, an interface is thus created by which the machine logic can be readily connected to any of the load switches by means of a jumper wire. The two (2) sets of terminal blocks must be conveniently located in close proximity to each other and must be arranged such that, initially, each function will be factory wired directly from one set of terminals to the other without the need to criss-cross wires between blocks.

(4) Number of Signal Circuits:

a. Sixteen (16) load bay panel. Each panel must be equipped with sixteen (16) load switch jacks for a minimum of forty-eight (48) signal circuits.

b. All unused signal circuits must be neatly tied or terminated. If tied, the harness wire must be labeled. If terminated, each termination must be identified.

7.6 Identification. All field terminals must be suitably identified, subject to approval.

8. FLASHING FEATURE

8.1 General. The flasher must be a solid state device, with no contact points or moving parts, producing between 50 and 60 flashes per minute with a 40 to 50 percent duty cycle. The flasher mechanism must be mounted on a type P-406-SB plug which will mate with an S-406-SB socket on the controller panel. The flasher must utilize zero-point switching, with turn-on at the zero voltage point (± 5 degrees) of the power line sinusoid.

8.2 Flasher Panel. A panel must be provided with one (1) terminal wired to the flasher and marked "FL". The panel must be equipped with terminals to provide or omit flashing of all red and yellow outputs.

8.3 Flasher Circuits. Flashers must provide two (2) output circuits to permit alternate flashing of signal phases and must be capable of carrying a minimum of twenty (20) amperes per circuit at 120 volts. The flasher must operate continuously so that flashing power will be available at the field terminal marked "FL". The flasher wiring must divide the loads imposed on the two (2) circuit flasher alternately on each phase.

8.4 Manual Flash. A manual flash switch must provide flashing indication for all circuits. The flash change combination terminals must allow the selection of flashing either yellow or red on the main and/or cross streets, or complete omission of the flashing feature if required.

9. POLICE PANEL

9.1 Auto-Off Flash Switch. Each controller must be provided with an auto-off-flash switch. In the "AUTO" position the signals will be on and the controller timing unit will run normally. In the "OFF" position the signals will be OFF and the controller timing unit will continue to run. In the "FLASH" position the signals will flash and the controller timing unit will continue to run. The auto-off flash switch must be located on the side of the police switch panel that faces outward when the police door is open.

9.2 Auto-Hand Switch. Each controller will have an auto-hand switch on the back side of the police switch panel. This switch must be so arranged that the switch can be physically rotated 180 degrees to provide usage after opening the police panel door. It must be so mounted that the act of rotation does not affect the police switch panel. Switch terminals must not be exposed on either position. The auto-hand switch must provide a means of manually timing the signals by use of a separate, momentary contact, hand switch. Operation of the timer by manual control must provide the same color sequence as an automatic operation with no momentary undesirable indications appearing. Manual control must be possible with the door of the cabinet closed. The hand switch required for manual control must only be supplied when specified in the contract. It must be of an approved weatherproof construction with a six (6) foot, retractable, flexible, extension cord to allow connection to the appropriate terminals on the panel of the controller. It must be possible to manually step through a vehicle clearance interval.

9.3 Terminal Block. A two point terminal block must be mounted on the back side of the police switch panel and the hand control circuit terminated on this block. This will be for installation of a hand control cord by others, as required.

9.4 Space Requirement. Adequate room must be provided in the police panel section to store the manual switch and retractable cord.

10. RELAYS

10.1 Transfer Relays. Eight (8) double pole, double throw, flash transfer relays must be furnished with each controller. These relays must be jack mounted into an S-408-SB, or equivalent, socket mounted on the controller panel.

10.2 Contact Arm. Each contact arm must have over travel on the front and back contacts and be independent of any other contact arms. No adjustment of contact pressure or wipe must be necessary. Load capability must be a minimum of fifteen (15) amperes per contact continuously and thirty (30) amperes for one (1) minute. Contacts must be of coin or fine silver or an approved alternate.

10.3 Dust Cover. A suitable dust cover must be furnished for each relay.

10.4 Relay Mounting and Endurance. All relays supplied must meet their approved specified requirements and must have contacts which cannot be opened by unusual vibrations, shock, or momentary voltage excursions of up to 30%. All relays other than the flash and bus relay must be mounted on a molded base with eleven (11) or eight (8) pins for jack mounting to their respective panel or sub-base, and must be electrically interchangeable with those presently used by the City of Chicago.

11. COMMUNICATIONS INTERFACE PANEL

11.1 Where a communications interface has been specified to allow a controller to function as a Master or Secondary controller, then one of the specified options must be provided:

(1) Fiber Optic Communications Interfaces must meet the following requirements:

a. General. The fiber optic communications components must consist of, but not be limited to, an internal fiber optic modem within the controller or an external fiber optic modem, a fiber optic patch panel to interface the modem to field fiber optic cables, and fiber optic jumpers between the modem and patch panel.

b. The modem must either be a multi-directional "star" type or a bi-directional type, as specified in the contract. All modems must be Electronic Industries Association (EIA) compatible for RS-232 data communications via fiber optic link. Modems must be multi-mode, operate at 850nm wavelength, and provide full-duplex, frequency modulated, asynchronous transmission at data rates of up to 38.4 kbps.

c. The fiber optic patch panel must consist of a 14" long by 5-3/4" wide by 3-1/4" high rack constructed in accordance with City of Chicago Electrical Standard Drawing #909. The rack must be designed to mount on the controller cabinet rails. "ST" type terminals, suitably labeled, must be provided for the connection of field fibers and Modem.

d. The fiber optic jumpers (i.e., optical patch cords) must consist of a single multi-mode fiber in 900 micron orange jacket, with "ST" type connectors factory installed on each end. The jumpers must be 3' long in Secondary (i.e., local) controller cabinets and 6' long in Master controller cabinets. The jumpers must be connected to the patch panel and supported in such a manner that the minimum bending radius is ten (10) times the diameter of the cable, and the cables exert no strain on the connectors. Each jumper must have a minimum tensile strength of 50 lbs.

(2) Copper Wire Interconnect Panels (Seven Wire, VAC) must meet the following requirements:

a. General. The interconnect panel must serve to isolate interconnect VAC from the controller. The panel must consist of, but not be limited to, seven (7) relays. Each relay interconnect circuit must include an M.O.V. properly rated for protection against lightning and switching surges injurious to the controller and a barrier type 3AG fuse receptacle and fuse not to exceed five (5) amperes. Each panel must provide a seven (7) wire interface with the T.B.C. functions described below and must provide barrier type terminals suitably labeled for these functions.

b. The secondary interconnect panel must be wired in such a manner that a VAC input activates a relay sending an input from that relay to the controller. It must have a minimum of seven (7) relays for the following functions; Dial 2, Dial 3, Dial 4, Offset 1, Offset 2, Offset 3, M.U.T.C.D. flash.

c. The master interconnect panel must provide a means to establish outgoing VAC for a seven (7) wire interconnect system using eight (8) relays. The relays must have 24 VDC coils and be designated as, Dial 2, Dial 3, Dial 4, Sync, Offset 1, Offset 2, Offset 3, M.U.T.C.D. flash. The sync relay must be wired in such a manner that it provides the offset pulse to the contacts of the three (3) Offset relays.

d. Each relay must be a double pole type, with one pole designated as field interconnect output, and the other designated as controller input. Relay coils must be rated for continuous duty. Relay contacts must be rated for a continuous fifteen (15) AMP resistive load.

e. A terminal strip must be mounted on the top of the master interconnect panel for controller interface.

f. The master panel must interface with the T.B.C. terminals as described above.

g. Each output must be fused as outlined above.

12. RAILROAD INTERCONNECT REQUIREMENTS

12.1 General. The railroad preemption will meet the requirements of the ICC (Illinois Commerce Commission) and the requirements of IDOT (Illinois Department of Transportation).

12.2 IDOT. The railroad preemption will meet all the requirements of the Illinois Department of Transportation's Standard Specifications for Road and Bridge Construction, adopted January 1, 2012. It must meet all the requirements of Article 1073.01 (c) (2) and Article 1074.03 (a) (5) e.

12.3 ICC. The railroad preemption will meet all the requirements of the Illinois Commerce Commission, as stated herein.

(1) The railroad preempt relays and the City traffic cabinet in general must be able to be wired as indicated in IDOT's Standard 857006-01 "SUPERVISED RAILROAD INTERCONNECT CIRCUIT". A failure in the interconnection circuit will result in activation of a supervisory failure alarm.

(2) Remote Flash. The Remote Flash input to the controller must be inverted from normal NEMA logic. Instead of grounding the input to Logic Ground (0 volts DC) to activate, the Remote Flash will be normally grounded and will be activated when the input is in the Logic 1 (+24 volts DC) state. This will preclude the installation of a controller without the proper railroad software and a normal controller with standard (non-railroad) software will not be able to run the traffic signals.

(3) Critical Components Series Loop. All critical components to railroad preemption such as relays and harnesses must utilize the 24 VOLT DC monitor voltage to form a series loop. Removal of any component will result in the traffic signals entering a flashing red condition. The 24 VOLT latch in the Management Malfunction Unit will be programmed, requiring manual reset if a failure in the series loop occurs.

(4) Controller Preempt Input Verification. Like the supervisory

interconnection circuit monitors the integrity of the interconnect cable, this feature monitors the integrity of the controller railroad preemption input and associated wiring within the traffic controller cabinet. This will utilize a secondary railroad preemption input that is normally active (on) when no demand for railroad preemption is present. When a demand for railroad preemption is received, the normal railroad preemptor input is applied and the secondary input is dropped. If both inputs are either simultaneously on or simultaneously off for a time period of more than one (1) second, the controller will recognize this as an input failure. When a failure occurs, the traffic controller will be configured to provide a track clearance interval followed by a flashing red condition. This occurrence will set a preempt input alarm and also will require a manual reset of the controller.

(5) Track Clearance Green Re-service. Any demand for railroad preemption received at any point in the normal sequence, the emergency vehicle preemption sequence, a bus preemption sequence, or any other form of low priority preemption, or a previously called for railroad preemption sequence will result in the traffic controller providing a track clearance green indication within a "maximum time to track clearance green " (usually 8 seconds depending upon site specific criteria) and will provide a full track clearance green time interval after the preemption demand was received. The controller software must have the capability to restart the railroad preemption sequence providing a full track clearance green interval from any point within the railroad preemption sequence from the start of track clear green through the entire dwell/hold interval(s) including any exit yellow and red clearance intervals, if the demand for preemption drops and is reapplied. The number of times the controller is able to react to successive demands for railroad preemption must not be limited. This will be a software based routine that does not require any user programming and must be designed into the software.

(6) Preemption Priority. Preemptor number 1 is typically assigned to a supervisory failure in the interconnection circuit and preemptor 2 is typically assigned to a normal railroad preemption demand. Preemptor 1 must have priority over preemptor 2. Preemptor 2 must have priority over all other forms of preemption.

(7) Delay Time. In order to compensate for noisy or intermittent calls, the controller must have a programmable delay timing parameter for railroad preemptors, programmed at 1 second. Any demands for railroad preemption lasting less than this time will be ignored. This will apply to any subsequent demands for railroad preemption

that may occur while the controller is still within the railroad preemption sequence from a prior demand.

(8) Non-Locking Preemption. The controller must have the capability to configure the railroad preemptors as non-locking calls. If a demand for preemption is placed for a duration of less than 1second (as programmed in the delay timer), the call will not lock and the controller will not initiate the preemption sequence. Furthermore, if an initial demand for preemption is dropped prematurely while the preemption sequence is still timing, the non-locking feature will allow the controller to re-service another demand for preemption.

(9) Minimum Green before Preemption. The controller must have a separate minimum green timing parameter, programmed at 1 second, that replaces normal controller phase minimum green times when entering railroad preemption. When a demand for preemption is applied, any active phase(s) must terminate immediately or after they have been active for 1 second if the demand occurs at the start of the phase(s). If any indications that are part of the track clearance green are active when the demand for railroad preemption is placed, those indications will not terminate until after the track clearance green interval is completed.

(10) Railroad Hold/Dwell Interval. The controller must have the capability to display a programmable phase(s) and rest in that phase(s) until the demand for railroad preemption is released. The controller must also have the option to cycle between a set of programmable phases that don't conflict with the railroad crossing, or rest in an all-red steady state until the demand is released. The necessity for cycling during the hold interval or the use of an all-red steady state is determined by an assessment of the specific site. The controller must have a timing parameter that will provide a minimum hold/dwell time, even if the demand for preemption is dropped prematurely. The controller must be able to re-service any subsequent demands for preemption during this minimum hold/dwell time.

(11) Railroad Hold/Dwell Extension. The controller must have a timing parameter that will extend the hold/dwell interval for a programmed time after the demand for railroad preemption has been released. The controller must be able to re-service any subsequent demands for preemption during this extension time.

(12) Pre-signal Timing. When pre-signals are present in advance of a

railroad crossing, during normal operation the pre-signal green indications terminate a programmable time (timed overlap) prior to the indications at the intersection. The duration of the timed overlap should not be reduced when leaving normal operation to service other forms of preemption, such as emergency vehicle or bus preemption.

If a demand for railroad preemption occurs during the timed overlap portion of the normal sequence, the overlap timer must terminate and the track clear green interval must begin immediately, after the pre-signal yellow and red vehicle clearance intervals are completed.

(13) Remote Monitoring and Alarms. Capabilities to remotely monitor the traffic controller must be provided, including the capability to monitor the operation of the controller, upload logs/events, and to verify the integrity of the database. In addition, the controller must have the ability to automatically report alarms, such as preempt 1 activation, preemptor input failure, automatic flash, CRC failure, 24 volt failure, and other defined alarms. The controller must have the ability to prevent the remote download of changes to the critical data protected by the railroad preemption security feature.

(14) Blank-out Signs. If these signs are used for railroad preemption, they should activate immediately with the activation of the railroad interconnect circuit. They should deactivate immediately with the deactivation of the interconnect circuit, not after the controller exits the railroad preemption sequence. Whenever the traffic signals are in flashing red operation, cabinet circuitry must be such that the signs will remain operational if the interconnect circuit activates due to railroad warning device activation.

12.4 CRC. A CRC module with all connections, a USB memory device, software, and any other firmware necessary to make the CRC fully functional will be provided if so designated.

(1) Hardware. A 16 bit CRC (cyclical redundancy check) module must be provided. The module will connect to the ATC controller using unused I/O pins. Reassignment of unused inputs on the NEMA ‘A’, ‘B’, and ‘C’ connector I/O pins or connection to a proprietary ‘D’ module’s input pins will be acceptable. The final CRC value for the specific intersection requirements will be set on the module for that intersection. Removing the CRC module during normal operation of the intersection, or mismatching the values in the database and the CRC, will result in a fault condition and put the intersection in flash mode.

(2) Software. The controller software/firmware will provide the logic and control facilities to fully implement CRC error detection. All the data elements (objects) required for the implementation will be contained in a proprietary data block. The software will provide a mechanism to “display” the final CRC value to be set on the CRC

module.

A USB memory device will be utilized to ‘lock’ or ‘unlock’ the database. When the USB device is inserted into the controller, the controller will display a menu that will include a utility to ‘unlock’ the database. The USB device will contain a file structure that will allow access to the protected areas of the database. Once ‘unlocked’, the database can be edited through normal user interfaces. While the database is ‘unlocked’, the controller will drop the voltage/fault monitor signal to the conflict monitor to keep the intersection in flash. The CRC comparison check will be disabled during this period.

After all the changes to the database are completed, the user will use a utility on the USB to ‘lock’ the database. After the database is ‘locked’, another utility will allow the calculated CRC to be displayed. This can be used to configure the CRC module. After the CRC is connected and the USB is removed from the controller, the voltage/fault monitor signal to the conflict monitor will be enabled. A restart will be required to restart the controller.

Once the CRC module has been set (programmed), and the database has been locked, the controller can resume normal operation. The controller firmware will validate the stored CRC against the CRC module’s value at least once per second.

13. WIRING

13.1 General. All electrical conductors must be stranded copper, with a minimum of nineteen (19) strands per conductor, and a concentrically applied 90° C. insulation with a 600 VAC rating. Wiring from the fuse block to the first distribution point, and to the controller bus, must be No. 10 AWG. Signal circuit wire must be No. 14 AWG. The wires must be provided with lugs or other approved terminal fittings for attachment to binding posts. All wiring between various parts of the controller must be neatly cabled. All wiring and terminal blocks must be tested for possible short circuits and resistance to ground by a high voltage dielectric test at 1,200 VAC. A wiring harness of adequate length must be provided to the timing device to allow the timer to be placed on top of the cabinet when required.

13.2 All VAC connections to load switches, flasher, and flash transfer relays must be soldered. All VAC connections on back of terminals must be soldered.

13.3 All VDC connections on back of terminals, and load switches must be soldered or connected with pre-approved terminations. All VDC connections to load switches are to be soldered or connected in a manner pre-approved by the City of Chicago's Division of Electrical Operations.

14. TESTING REQUIREMENTS

14.1 General. The testing on the controllers must be done as described herein. Environmental testing must be done at the manufacturer’s facilities or at an independent laboratory, and must be certified by the manufacturer or the independent laboratory. Functional testing will be done at the City’s facilities. All controllers provided under the contract must be tested as stipulated under “Functional Burn-In Testing” and “Physical Inspection” at the manufacturer’s facilities. If a controller is ordered for a specific location, the manufacturer shall program and test the controller at the factory and certify the test results.

14.2 N.E.M.A. Environmental Test. One controller, unless approved previously, must be tested, at the manufacturer's expense, in accordance with Part 2 of NEMA Standards Publication TS1-1983. All of the tests listed must be performed with all data properly recorded and certified. If the manufacturer changes the design, fabrication or components of a previously tested and approved controller, then a sample of the controller containing the new design, fabrication or components must be retested at the manufacturer's expense. Any N.E.M.A. environmental test references to minimum recall must include but not be limited to: All sixty-four (64) output circuits must be programmed in a sequence to simulate the normal functioning of the entire controller cabinet assembly; the conflict monitor must have a test board with the allowable channel jumpers installed to simulate normal operation; All thirty-two (32) intervals must be programmed with a minimum of two (2) seconds per interval.

14.3 Functional "Burn In" Testing. The manufacturer of the controller must perform, at his manufacturing facilities, a one hundred (100) hour burn-in test on every controller, conflict monitor, and appurtenant devices. This test period must be certified by the manufacturer with supportive documentation and must include the device serial number, dates and times of test periods, and results. Any failed, or nonconforming components, must be replaced at this time. After each of the components has passed the burn-in test, they may be used in the assembly of the complete controller unit. Each completed unit must be subjected to the seventy-two (72) hour function test as described in this specification. The "burn in" requirement must include a test that uses all sixty-four (64) output circuits in "solid" burn as well as 1 pps and 5 pps for each circuit. All thirty-two (32) intervals must be programmed with a minimum of two (2) seconds per interval. The documentation for a test program to simulate the normal functioning of the controller phasing must be supplied. A copy of the test program must be approved by the City of Chicago, Division of Electrical Operations prior to testing. Certification of these tests must be attached to the outside of the shipping container. This certification is in addition to any other documentation and/or testing required by these specifications.

14.4 Testing Requirements. In addition to the NEMA environmental test and the "burn-in" requirements stated above, satisfactory performance of the traffic signal cabinet and its equipment must be demonstrated. The manufacturer must submit five (5) copies of his proposed "Test Procedure Document" for approval with the sample requested above. The test procedure must consist of two (2) sections; physical inspection and functional testing. If the test procedure is judged by the Commissioner or his duly authorized representative to be incomplete, inadequate or otherwise deficient, the contractor must revise and resubmit his "test procedure document" until it is approved. No controller will be accepted until the "test procedure document" has been approved. Functional testing must include, but not be limited to, phasing for multiple legged intersections, bridge and railroad pre-empts, flash operation, actuation, and any combinations of these features. Controllers designed to function without railroad pre-empts must be shown to function without the presence of a railroad interconnect. Options for downward compatibility when replacing either HMC1000 controllers or LMD40 controllers must also be demonstrated. In addition, it should be demonstrated that the controller functions within the MIST system. Any failure must be addressed by the manufacturer within the time frame allotted.

14.5 UPS. Testing of the equipment must verify that the operation meets the requirements of this specification. All equipment must be shown to operate correctly, including the rectifier, charger, inverter, batteries, and control unit. The UPS must be connected to a dummy load at the factory and tested for performance under various conditions of line voltage and frequency, varying loads, temperature range, and humidity range. The automatic switching must be successfully demonstrated; losing line power and restoration of line power must not adversely affect the operation of the traffic signals. Use of the manual bypass switch must be successfully demonstrated. A generator must be connected to the unit and successfully operate the system without interruption. The batteries must be shown to be able to operate the traffic signals for the specified time. The batteries must be shown to be able to be recharged in the specified time between failures. The control unit, including the LCD display and the RS-232 interface, must be shown to function according to this specification. All reports and event monitoring must be successfully demonstrated. Programming functions must also be shown to work properly.

14.6 Physical Inspection. The "physical inspection" portion of the test procedure document must require the manufacturer to perform a physical inspection of workmanship and specification compliance for each traffic signal controller assembly. The inspection must be done using a detailed check list defining items to be inspected and criteria for acceptance. The inspection must include, but not be limited to, the following items:

(1) Hardware installation.
(2) Assembly mounting.
(3) Dimensions.
(4) Presence of specified devices and materials.

(5) Presence of required documents.
(6) Labeling and required serial numbers.
(7) Wiring including routing, covering, gauge, length, and soldering of terminations.
(8) Arrangement of equipment for safety and ease of calibration reprogramming troubleshooting and maintenance.
(9) Condition of cabinet body and finish.
(10) Condition and installation of doors, panels, gaskets and ventilation.
(11) High voltage test of insulation resistance to ground, with wires installed in cabinet and equipment disconnected.

14.7 Functional Testing. The "functional testing" portion of the Test Procedure must require the manufacturer to perform a complete room-temperature functional test of each complete traffic signal controller assembly for a minimum of seventy-two (72) hours. This test must be designed to concurrently check integrated hardware systems e.g., from simulated input to load switch output including conflict monitor and time base coordinator. All interface/controller interconnections must be tested. All load switch and interconnect relay positions must be tested, regardless of the number of load switches and interconnect relays being purchased. The functions tested must include, but not be limited to, the following:

(1) Flash logic and operation (color, phases).
(2) Conflict monitor logic and operation.
(3) Police panel switch operation.
(4) Auxiliary panel switches (including fans).
(5) Interface panel.
(6) Time switch operation.
(7) Load switches (with a continuous ten (10) ampere load on each signal circuit).
(8) Outputs.
(9) Power interruptions of less than 500 ms.
(10) Power interruptions of more than 1.0 sec.
(11) Generator Hook-up.

15. SHIPMENT AND DELIVERY (Only applies to City commodity contracts)

15.1 Packaging. The cabinets must be shipped on individual pallets. Each cabinet must be individually wrapped and protected so that it can be handled without damage to the cabinet or its finish. The UPS and cabinet must be wrapped to give protection from the elements, as well as from shipping. If subassemblies or parts are ordered they must be suitably packaged to prevent damage during shipping and handling. All packages should be clearly labeled indicating the contents.

15.2 Delivery. The assembled cabinets, or subassemblies and parts, must be delivered to the Division of Electrical Operations at 2451 S. Ashland Avenue, unless otherwise directed. Assembled cabinets, or subassemblies and parts, must be available for testing and shipping within six weeks of the placement of an order.

CHICAGO ATC MATRIX - TABLE A

(ATC Standard Version 5-2b June 26, 2000)

Since the ATC standard specifies a “family” of controllers, the following options have been selected from the ATC standard to meet the City’s needs.

Functional Requirement	ATC Clause #	Status	Details
Shelf Mounted	2.2.1 4.3.2.1	Required	(Shelf mount only)
Use of ATC Engine Board	2.2.2 4.3.2.2 5.1.1 5.1.2 5.3.2 5.3.4 5.3.5 5.3.5.1 5.4.2 5.4.3 5.4.4 5.4.5	Required	
Use of ATC Engine Board	5.2.1	Required	• Allowed component height below Engine Board PCB provided that the overall envelope remains unchanged, the clearance between the Host Board and Engine Board remains as specified, and the

			Engine Board still fits into a compliant Host Board
Use of ATC Engine Board	5.2.2 5.4.5	Required	In order to show the Ethernet communications to the Engine Board, the following “Reserved” pins can assume the following legacy functions: • P1-34: ENET2 Speed • P1-35: ENET2 Link/Activity • P1-36: ENET1 Speed • P1-37: ENET1 Link/Activity
Use of ATC Engine Board	5.3.1	Required	Minimum CPU capability of 500 MIPS
Use of ATC Engine Board	5.3.3	Required	Additionally, must provide a minimum of 16 MB of Flash total to accommodate future applications.
Use of ATC Engine Board	5.4.1	Required	• Engine Board shall not draw more than 4W of power from VPRIMARY (due to battery backup in Chicago) • Engine **may** supplement VSTANDBY_5 with on-board storage for its standby power.
Use of ATC Engine Board	5.4.3	Required	• All optional baud rates shall be supported
Parallel I/O	2.2.4	Required	• No support required for TS2 Type 1 or ITS cabinets • Must provide parallel I/O for TS2 Type 2 cabinets and legacy parallel I/O interfaces via interchangeable modules
Linux O/S and ATC BSP	2.2.5 4.3.1 4.3.3	Required	
Linux O/S and ATC BSP	2.2.5 4.3.1 4.3.3	Required	
Linux Kernel	Annex A	Required	
Parallel I/O	3.4	Required	Not required to support ITS Cabinet standard (NEMA cabinets are used)

Manage Clock/Calendar functions and synchronize with external source	3.5.1.3	Required	Must also support synchronization with absolute zero.
Manage Clock / Calendar functions and synchronize with External Source	4.1.3	Required	• BSP RTC driver shall automatically update the RTC with the OST time once per second with an accuracy of 0.1 seconds • Successive interruptions (e.g. on for 5 minutes, off for 3 minutes over a period of 8 hours) shall not introduce cumulative error
Configure and Verify Parameters	3.5.1.4 4.1.4	Required	
Upload/Download blocks of data	3.5.1.5 4.1.5	Required	
Monitor & Verify Application Status	3.5.1.6 4.1.6	Required	
Operator Control of Application Execution	3.5.1.7	Required	Only a local operator is allowed to manage the starting, stopping and scheduling of one or more applications on the ATC.
Operator Control of Application Execution	4.1.7	Required	
Long Term Storage of Log Data, etc	3.5.1.8 4.1.8	Required	
Support Diagnostics	3.5.3.3 4.3.4	Required	
Modes of Operation	3.7	Required	(Must support Standalone, Direct, and Distributed modes of operation)
Manage/Control a Variety of External Devices	4.2.1	Required	• Fixed Ports on the front panel shall be specified by the City • Only SP1 and SP2 are required to be supported on the modem slot • The dedicated synchronous serial port (SP5) is to be used exclusively for supporting a

			parallel I/O module (NEMA TS2 or legacy interface)
Monitor the Status of External Devices	4.2.2	Required	• Fixed Ports on the front panel shall be specified by the City • Only SP1 and SP2 and required to be supported on the modem slot • The dedicated synchronous serial port (SP5) is to be used exclusively for supporting a parallel I/O module (NEMA TS2 or legacy interface)
Support future Hardware Upgrades	4.3.2	Required	
Environmental Requirements	5.2.3	Required	
Front Panel Serial Ports	6.2.3.1 6.1.3 6.3.2.1	Required	One serial port on the front panel shall satisfy this section as an EIA-574 (25-pin) and be labeled “Port 2”.
Front Panel Serial Ports	6.2.3.1 6.3.2.1	Required	One serial port shall satisfy this section as an EIA-574 (9-pin) with a reduced pin-out (TXD, RXD, and DC Reference at a minimum) and be labeled “Port 4”. C50_ENABLE shall not be supported. A second serial port shall fully satisfy this section as an EIA-574 (25-pin) and be labeled “Port 5.”
Front Panel Serial Ports	6.2.3.2 6.1.3 6.3.2.2	Required	One serial port shall satisfy this section as an EIA-485 (15-pin) with the TS2 Type 1 Port 1 pin-out and be labeled “Port 1”.
Front Panel Ethernet Ports	6.2.3.9 6.3.2.9 7.1.4.4	Required	There shall be a minimum of two Ethernet ports on the Front Panel (one for ENET1, one for ENET2)
User Interface	7.1 7.1.1.2 7.1.4.4 7.1.4.5 7.1.4.7	Required	
User Interface	7.1.1	Required	Must meet City’s Minimum requirements
User Interface	7.1.1.1 7.1.2.1	Required	• Data key is not required • Front Panel Interface is to be

	7.1.3 7.1.4.1 7.1.5		integral to the controller (i.e. not removable, no SP6 connector) • "Option 1" to be selected but AUX switch is optional • Keypad shall have a minimum of 24 keys • LCD Display shall be graphical with a minimum resolution of 128 rows x 240 columns (up to 16 lines x 40 characters). • LCD pixel size shall be a minimum of 0.32mm x 0.32mm with a minimum pitch of 0.325mm with character size defined as 6 pixels wide x 8 pixels high • Refresh rate is a minimum of 10 times per second (due to larger display requirements) • LCD heater is mandatory to ensure sub-second LCD display response over full temperature range. Heater shall only be active when needed and User is interacting with the controller locally (due to battery backup requirements). • Heater Power shall be up to 15V at 1A current maximum
Power Supply	7.2 7.2.2 7.2.3 7.2.4 7.2.5 7.2.5.1 7.2.5.2 7.2.6.1 7.2.6.2 7.2.6.3 7.2.6.4 7.2.6.6	Required	12 V not required As applicable for NEMA cabinets only
Mechanical/Chassis	7.3.1.3	Required	• Only Shelf mounted units are

	7.3.1.4		acceptable - Only components / connectors specified by the City shall be located on either the Front or Rear panels. No C1 Type Connectors allowed.
I/O Interfaces	8.1.1 8.2.2 8.2.2.1 8.2.2.2 8.2.2.3	Required	- Support for TS2 Type 2 and TS1 Interfaces
I/O Interfaces	8.1.2 8.2.2.5	Required	- Support is only required for NEMA TS2 Type 2, TS1, and other similar legacy interfaces - NEMA TS2 Port 1 shall also be provided (for detectors only)
I/O Interfaces	8.2.3	Required	Port 1 Connector shall be provided as specified within this section (only used for detectors)
I/O Interfaces	8.2.1.13	Required	Legacy I/O interfaces shall respond as required.
I/O Interfaces not required	8.2.1	Required	- No support for Model 332 Cabinets or ITS Cabinets & devices is to be provided
Environmental & Test Procedures	9	Required	All subsections are required
Performance & Material Requirements	10	Required	All subsections are required
Performance & Material Requirements	10.1.15	Required	All PCBs and similar construction mechanisms shall be mounted vertically (i.e. no horizontal PCBs are allowed).
Quality Control	11	Required	All subsections are required

ELECTRICAL SPECIFICATION 1604
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
DECEMBER 5, 2016

LUMINAIRE: LED, VIADUCT/ELEVATED STRUCTURE RETROFIT

SUBJECT

1. This specification states the requirements for an LED (light emitting diode) luminaire. The luminaire will be for a one-to-one replacement of existing luminaires currently in use under viaducts and mounted under CTA elevated structures. The luminaires will have adjustable trunnion brackets for mounting. The luminaires will be capable of being integrated into a centralized lighting management system.

GENERAL

2. (a) References:

American National Standards Institute (ANSI)

- ANSI C78.377-2015, “American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting (SSL) Products”
- ANSI C82.77-10-2014, “American National Standard for Lighting Equipment—Harmonic Emission Limits—Related Power Quality Requirements”
- ANSI C136.2-2015, “American National Standard for Roadway and Area Lighting Equipment—Dielectric Withstand and Electrical Transient Immunity Requirements”
- ANSI C136.15-2015, “American National Standard for Roadway and Area Lighting Equipment—Luminaire Field Identification”
- ANSI C136.22-2004 (R2009, R2014), “American National Standard for Roadway and Area Lighting Equipment—Internal Labeling of Luminaires”
- ANSI C136.25-2013, “American National Standard for Roadway and Area Lighting Equipment—Ingress Protection (Resistance to Dust, Solid Objects and Moisture) for Luminaire Enclosures”
- ANSI C136.31-2015, “American National Standard for Roadway and Area Lighting Equipment – Luminaire Vibration”
- ANSI C136.37-2011, “American National Standard for Solid State

Light Sources Used in Roadway and Area Lighting”

American Society for Testing and Materials (ASTM)

- ASTM B85/B85M-14, “Standard Specification for Aluminum-Alloy Die Castings”
- ASTM B209-14, “Standard Specification for Aluminum and Aluminum Alloy Sheet and Plate”
- ASTM B117-16, “Standard Practice for Operating Salt Spray (Fog) Apparatus”
- ASTM D523-14, “Standard Test Method for Specular Gloss”
- ASTM D1654-08, “Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments”
- ASTM G154-12a, “Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials”

Illuminating Engineering Society of North America (IES)

- ANSI/IES LM-63-02, “Standard File Format for Electronic Transfer of Photometric Data”
- IES LM-79-08, “Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products”
- ANSI/IES LM-80-15, “IES Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules”
- ANSI/IES RP-8-14, “Roadway Lighting”
- ANSI/IES RP-22-11, "Tunnel Lighting"
- IES TM-21-11 (with Addendum B), “Projecting Long Term Lumen Maintenance of LED Light Sources”

Institute of Electrical and Electronics Engineers (IEEE)

- IEEE Standard 1789-2015, “IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers”

International Electrotechnical Commission (IEC)

- IEC 60529-2004, “Degrees of Protection Provided by Enclosures (IP Code)”

Underwriters Laboratories (UL)

- ANSI/UL 1598 (3rd Edition), "Luminaires”

(b) Submittal Requirements:

The bidder, if so requested, must submit the following information pertaining to the specified luminaire within fifteen (15) days of such request:

1. Completed Table A – Submittal Form

2. Product Data Sheets.

   Luminaire data sheets – including summary product description, dimensioned outline drawings, and nominal characteristics including but not limited to: initial luminous flux (lumens), input power (watts), input voltage range (volts), LED drive current (milliamps), correlated color temperature (kelvins), color rendering index, and weight (pounds).

   LED Driver data sheet – including information described in LED Driver Requirements Section 4(c).

   LED light source data sheet

   Surge protection device data sheet - if applicable

3. Photometric Performance Data

   The manufacturer must provide photometric calculations, as part of each luminaire’s submittal package, that demonstrate the luminaire’s photometric performance will meet or exceed the photometric requirements listed in this specification. The submitted lighting calculations must include point-by-point illuminance, luminance and veiling luminance data, as well as listings of all indicated averages and ratios. Photometric reports must include the following information and be in accordance with the standards listed below:

   IES LM-79-08 photometric report that includes measured values for initial luminous flux, input power, correlated color temperature, and color rendering index.

ANSI/IES LM-63-02 electronic format photometric file that corresponds to the LM-79 report.

LM-63 photometric calculations that demonstrate compliance with the illumination requirements specified herein using the LM-63 file. Calculation grids and observer locations not specified herein must be in accordance with ANSI/IES RP-8-14.

IES TM-21-11 calculations that derive the lumen maintenance (lamp lumen depreciation or LLD) factor applied to photometric calculations specified herein.

ANSI/IES LM-80-15 and in-situ temperature measurement testing (ISTMT) reports containing data used in TM-21 calculations must also be submitted. TM-21 calculations must apply to the maximum LED case temperature from ISTMT, shall not extrapolate beyond six times the duration of available LM-80 test data, and must be submitted in the spreadsheet format of the ENERGY STAR TM-21 calculator (https://www.energystar.gov/products/spec/luminaires_specification_version_2_0_pd).

LM-79, ISTMT, and LM-80 reports must correspond directly to submitted luminaires, and must be produced by test laboratories that satisfy the Testing Laboratory Requirements of the DesignLights Consortium (www.designlights.org/content/QPL/ProductSubmit/LabTesting).

ISTMT must be conducted in accordance with the DesignLights Consortium Manufacturer's Guide (https://www.designlights.org/content/qpl/productsubmit).

ISTMT shall be conducted in an ambient temperature of 25 ± 5 °C. Ambient temperature variations above or below 25 °C shall be respectively subtracted from or added to temperatures recorded at points on the luminaire.

4. Safety Certification - file number indicating compliance with UL 1598. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

5. Vibration Testing - the luminaire must be tested in accordance with ANSI C136.31 at a vibration level of 5G.
6. Product Samples - at least two samples of each luminaire that the contractor proposes to use must be submitted to the City. All samples must be representative production units and be supplied at no cost to the City.

(c) Assembly.
Each luminaire must be delivered completely assembled, wired, and ready for installation.

(d) Warranty.
The luminaire manufacturer must warrant the performance and construction of luminaires to meet the requirements of this specification, and must warrant all parts, components and appurtenances against defects due to design, workmanship or material developing within a period of ten (10) years from the date of acceptance by the City.

- Failure of 10% or more of the LED light sources (packages or arrays/modules) in a luminaire will constitute a luminaire failure.
- The warranty must apply for application on all of the City's existing electrical systems, both grounded and ungrounded.
- During the warranty period the City may, from time to time, test a random sampling of 7-10 luminaires for verification of light output per IES LM-79 and to test dimming functionality for a given luminaire population. The percentage of luminaires not performing as required in the random sampling will be applied to the total population quantity to determine the number of new luminaire replacements that must be delivered to the City by the manufacturer, without expense to the City.

(e) Manufacturing Experience and Capacity
The manufacturer must demonstrate at least a five year history of manufacturing LED roadway and outside area luminaires by providing a list of prior projects with project description, date, location, quantities and reference contact information. The manufacturer must also demonstrate the capacity to supply the quantities required for the contract in a timely man

CONSTRUCTION

3. (a) Weight. The net weight of this luminaire must not be more than 30 pounds.

(b) Housing. The housing must be precision die-formed, seam welded aluminum. The aluminum must be marine-grade (3003 alloy or equivalent). Alternate materials will be considered. The housing must have integral heat sink characteristics, such that all enclosed components will operate within their designed operating temperatures under expected service conditions. All heat shields and heat sinks will be integral to the luminaire.

The housing will be designed to encourage water shedding. The housing must be designed to minimize dirt and bug accumulation. The housing will have the general appearance of Electrical Standard Drawing 981.

A wiring compartment capable of accepting a .75 inch threaded conduit fitting to accommodate an electrical whip must be included..

(c) Mounting brackets. Each housing must have two trunnion type brackets. One bracket must be mounted to each end panel of the housing with appropriate screws or bolts. The brackets will allow the luminaire to be positioned up to 90° in either direction from the horizontal. The brackets must be marked on the outside indicating the degrees of angle. The brackets will provide for positive locking in the desired position.

(d) Door and Lens. A replaceable high impact UV resistant polycarbonate drop lens will cover the LED array. This lens will be attached to a door. The door must be of the same aluminum as the housing. The door will be hinged on one side such that when opened the door will fall open toward the roadway. The other side of the door will be attached to the housing with latches, allowing tool-less entry. The door will allow easy access to the driver and terminal strip (unless the terminal strip is in a separate accessible wiring compartment).

In order to make a dustproof assembly, a gasket of silicone rubber or other specifically approved material must be provided.

(e) Hardware. All fasteners necessary to make a firm assembly must be furnished in place. All hardware must be of stainless steel, copper silicon alloy or other non-corrosive metal, and where necessary must be suitably plated to prevent electrolytic action by contact with aluminum.

(f) Finish. The luminaire must have a polyester powder coat with a minimum 2.0 mil thickness. Surface texture and paint quality will be subject to approval. Color must be as specified in the purchase order. A paint chip must be submitted as a sample upon request. The finish must exceed a rating of six per ASTM D1654 after 1000 hours of testing per ASTM B117. The coating must exhibit no greater than 30% reduction of gloss per ASTM D523 after 500 hours of QUV testing at ASTM G154 Cycle 6.

(g) Ingress Protection. The luminaire housing must have an ingress protection rating of IP54 or better as described in ANSI C136.25-2013. The optical system must have a rating of IP66 or better.

(h) The luminaire must be listed for wet locations by a U.S. Occupational Safety Health Administration (OSHA) Nationally Recognized Laboratory (NRTL) and have a safety certification and file number indicating compliance with UL 1598.

(i) The luminaire must be rated to operate between -40° to +50° Celsius.

(j) The luminaire must meet the requirements of ANSI C136.22 for internal labeling.

(k) The luminaire must be labeled for field identification according to ANSI C136.15.

ELECTRICAL COMPONENTS

4. (a) LED Optical Array. The LED arrays must be optimized for the required roadway photometrics. The arrays must be properly secured at the factory and must not require field adjustment for optimum photometric performance.

(b) Terminal Board. A terminal block of high grade molded plastic of the barrier or safety type must be mounted within the housing in a readily accessible location. It must provide all terminals needed to completely prewire all luminaire components.

The terminal board must have plated copper or plated brass, clamp-type pressure terminals of an approved type for "line" connections, to accommodate wire sizes from #12 to #8 A.W.G. The terminals for connection of internal components must be either the screw-clamp or quick disconnect type.

(c) Driver Requirements:

1. Voltage. The electronic driver must operate at a nominal input voltage range of between 120 and 277 volts, 60 Hertz. It must automatically sense the input voltage and adjust the output accordingly. The City uses nominal input voltages of 120, 208, and 240. When operated at any supply voltage between 80% and 110 % of its rated supply voltage, a driver must supply proper current

and/or voltage regulation that equals or exceeds the values specified by the manufacturer.

2. Electrical Safety. Luminaires must operate at or below the Low-Risk Level, as defined in Figure 18 of IEEE 1789-2015.

3. Power Factor. The power factor of the driver over the design range of input voltages specified above must be in accordance to ANSI C82.77-2014. Power factor must be equal to or greater than .9.

4. Total Harmonic Distortion. The driver input current must have Total Harmonic Distortion (THD) specified in accordance to ANSI C82.77-2014. Total harmonic distortion must be less than 32%.

5. Thermal Protection. The driver must be thermally protected to shut off when operating temperatures reach unacceptable levels.

6. Electromagnetic Interference. Luminaire must comply with the FCC radiation emission limits for Class B digital devices given at 47 CFR 15.109.

(d) Electrical Transient Immunity.

1. Dielectric Withstand Testing. Luminaire must meet the performance requirements specified in ANSI C136.2-2015 for dielectric withstand, using the DC test level and configuration.

2. Electrical Transient Immunity. Luminaire must meet the performance requirements specified in ANSI C136.2-2015 for electrical transient immunity, using the Enhanced (10kV/5kA) combination wave test level.

3. Transient Immunity Testing Requirements.

   During electrical transient immunity testing, the device under test (DUT) must be connected to the power source through a series coupler/decoupler network(CDN), using a two-wire (hot or hot/neutral) connection between both the power supply and the CDN input and the CDN output and the DUT.

   If the AC main is used to power the DUT, the input waveform must be characterized and documented both before and after electrical transient immunity testing, with the DUT operating at rated full output.

For pre-test DUT characterization, the diagnostic measurements must, at a minimum, include real power, input current(RMS), power factor, and current distortion factor (THD) when operating at full output.

4. Manufacturer must indicate whether failure of the electrical transient immunity system can possibly result in disconnect of power to the luminaire.

(e) Wiring. All components must be completely factory wired with non-fading, color coded leads. All wires within a single circuit path must be of the same size. No wire nuts will be allowed. No unnecessary splices will be allowed. The use of wiring smaller than #16 AWG will require the written approval of the Commissioner. Quick disconnects must be provided for all components. All wires must be properly terminated.

(f) Component Mounting. All electrical components must be securely mounted in such manner that individual components can be easily maintained or replaced. Permanent straps or tie-wraps will not be permitted. The entire assembly should be easily disconnected and removed for replacement.

PHOTOMETRIC REQUIREMENTS

5. (a) Color Temperature. The correlated color temperature must be a nominal 3000 kelvin.

(b) Lumen Maintenance. LED arrays must deliver a minimum of 90% of the initial lumen output at 36,000 hours of operation.

(c) Light Loss Factor. The light loss factor must be calculated as per IES RP-8-14 using the following three factors.

1. LED Lumen Depreciation (LLD). Calculated at 60,000 hours as per Section 2(b)3. Luminaires with less than 10,000 hours of available LM-80 test data may be submitted for consideration, but must be indicated as such.
2. Luminaire Dirt Depreciation.(LDD). Should be .86.
3. Luminaire Ambient Temperature Factor (LATF). Should be .96.

(d) Roadway Luminance:

Average Luminance	2.5 cd/m2
Uniformity Ratio avg/min	3:1

Uniformity Ratio max/min	5:1
Max veiling Luminance	0.5

(e) Roadway Conditions. The luminaires must meet the requirements for the following physical conditions:

Right-of-way	66’
Curb-to-curb	46’
Sidewalk	10’ each side
Mounting height	13’
Tilt	45°
Setback	10’
Arm length	0’
Spacing	30’
Pavement	R3

PACKAGING

7. (a) Packing. Each luminaire assembly must be securely packed in a suitable carton so as not to be damaged in shipment and handling.

(b) Marking. Each carton containing a luminaire must be clearly marked on the outside in letters not less than three-eighths (3/8) inch tall with the legend: "LUMINAIRE, LED, VIADUCT". The appropriate City Commodity Code Number, the name of the manufacturer, the date of manufacture, and the contract number under which the luminaire is furnished shall also be listed.

TABLE A
PRODUCT SUBMITTAL FORM

PRODUCT INFORMATION	DATA	UNITS/REFERENCE
Luminaire Manufacturer		
Luminaire Model Number		complete ordering information
Initial luminous flux		lumens
Initial input power		watts
Maintained input power		watts
Input voltage range		volts
Initial LED drive current		milliamps
Maintained LED drive current		milliamps
Correlated Color Temperature(CCT)		kelvin
Color rendering Index (CRI)		
Luminaire Weight		pounds
Rated Driver Life		years
Electrical Transient Immunity		kV/kA ANSI C136.2
Vibration Test		5G ANSI C136.31
Warranty period		years
IES LM-80 test duration		hours IES LM-80 Report
LED lumen maintenance at 36,000 hours		% TM-21 Calculator
Max LED Case Temperature		°C ISTMT Report

SPECIFICATION 1606
DIVISION OF ELECTRICAL OPERATIONS
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
OCTOBER 10, 2017

ARTERIAL STREET LIGHTING CONTROLLER

SUBJECT

1. This specification states the requirements for an arterial street lighting controller and aluminum cabinet for use in controlling arterial street lighting circuits. The cabinet shall be mounted on top of a ballast base housing, which will be affixed to a concrete foundation.

GENERAL

2. (a) Specifications. The controller shall conform in detail to the requirements herein stated, to the Federal Standard cited by number, and to the specifications and methods of test of the American Society for Testing and Materials, cited by ASTM Designation Number, in which the most recently published revision will govern. Cabinets must meet or exceed the requirements of a NEMA rating 3R and must be U.L. listed.

(b) Acceptance. Controllers and cabinets not conforming to this specification will not be accepted.

(c) Drawings. The drawings mentioned herein are drawings of the Department of Transportation, Division of Electrical Operations, and must be interpreted as part of these specifications cooperating to state necessary requirements.

(d) Sample. One complete controller in cabinet of the manufacture intended to be furnished must be submitted upon request of the Chief Procurement Officer within fifteen (15) business days after receipt of such a request. The sample must be delivered to the attention of the Engineer of Electricity, Division of Electrical Operations, 2451 South Ashland Avenue, Chicago, Illinois 60608.

(e) Warranty. The manufacturer shall warranty the controller and cabinet against flaws in material or workmanship for a period of two (2) years from the date of delivery. Any controller or cabinet developing flaws within this period must be replaced by the manufacturer, including shipment, at no cost to the City.

DESIGN

3. (a) Drawings. The control cabinet must conform in detail to requirements shown on Drawing 876 for a 100 Amp application and to Drawing 880 for a 200 Amp application.

(b) Material. The cabinet and the door assembly must be constructed of 5052-H32 sheet aluminum alloy, with a minimum thickness of .125 inches. The base plate must be sheet aluminum of .250 inch thickness. All electrical components and wiring must be as shown on the appropriate drawings.

(c) Dimensions. The overall outside dimensions of the 100 amp control cabinet must be 36 inches in height by 20 inches in width by 15 inches in depth. The overall outside dimensions of the 200 amp control cabinet must be 41 inches in height by 25 inches in width by 16 inches in depth. Cabinets must have sloped tops to shed water.

CABINET REQUIREMENTS

4. (a) Cabinet. The cabinet must be sized as shown on either Drawing 876 or Drawing 880, depending on the controller amp rating. The cabinet door opening must be double flanged on all four (4) sides. A door restraint must be provided to prevent the door from moving in windy conditions.

(b) Door. The door size must be a minimum of 80% of the front surface area. The door must be hinged on the right side when facing the cabinet. The door must have a gasket that meets the requirements found in U.L.508 Table 21.1. The gasket must form a weather-tight seal between the cabinet and the door. The door, when closed, must be flush with the cabinet.

(c) Hinges. Hinges must be continuous and bolted to the cabinet and door with 1/4-20 stainless steel carriage bolts and nylock nuts. Hinges must be made of .093 inch thick aluminum. The hinge leaves must not be exposed externally when the door is closed. Only the hinge knuckles must be visible upon closing the door. The hinge pin must be .250 inch diameter stainless steel and must be capped top and bottom by weld to render it tamper-proof.

(d) Latching. The latching mechanism must be a three-point draw roller type. The pushrods must be aluminum. The rollers must be nylon with a minimum diameter of .875 inches. The center catch must be .187 inch aluminum, minimum.

(e) Handle. The handle must be stainless steel with a .750 inch diameter shank. The handle must have provision for a padlock. The lock must be keyed dead bolt #200725 or equivalent. Two (2) keys must be provided for each cabinet.

(f) Ventilation. Louvered vents must be provided in the door. Louvers must satisfy the NEMA rod entry test for 3R enclosures. A removable filter must cover the louvers from inside the door. The filter must be held firmly in place with top and bottom brackets and a spring-loaded clamp. Exhaust air must be vented out between the top of the cabinet and the door. The exhaust area must be screened with openings of .12 inch by 1.0 inch.

(g) Equipment Mounts. The cabinet must be equipped with two (2) adjustable AC@ channels on both side walls and on the back wall. The internal dimensions of the channels must be 1.075 inches high by .625 inches wide. All mounting hardware must be furnished.

(h) Workmanship. All control cabinets must be free of flaws, and must have neat, smooth exterior surfaces. All holes must be accurately located and drilled. All welds must be neatly formed and free of cracks, blow holes, or other irregularities. All inside and outside edges must be free of burrs.

(i) Painting. The cabinet, door and other parts must be treated by an iron phosphate conversion technique. After which, all the parts must be baked dry. A polyester powder coat must then be applied. The inside of the cabinet and door must be white. The outside of the cabinet and door must be green meeting No. 14110 of Federal standard Number 595, or a gloss black, or another color as specified. A paint chip must be provided upon request.

PANEL

5. (a) The panel must be composed of phenolic plastic ½ inch in thickness, or an approved equal. It must be securely bolted to the cabinet using stainless steel hardware.

(b) The panel will be sized, cut, and drilled as shown on the appropriate standard drawing. For a 100 amp and 200 amp – 2 pole controller, the panel must comply with Drawing 984. For a 100 amp and 200 amp – 3 pole controller, the panel must comply with Drawing 984. If alternate components are proposed, the panels must be sized accordingly.

ELECTRICAL COMPONENTS

6. (a) All components will be as indicated on the appropriate drawing, or will be approved equals. Circuit breakers must have thermal magnetic trips. Each breaker must be enclosed in a hard insulated housing. All breakers must be UL listed. The photo-cell relay, if required, must meet

City specifications.

(b) Wiring will be as indicated on the appropriate drawing. All wire will have stranded copper conductors, unless indicated otherwise. All wires must be insulated with an approved 125º Centigrade insulation.

(c) For a 3-wire, 1-phase, 240 volt ComEd input, components and wiring will be as indicated on Standard Drawing 983 (for either 100 amp or 200 amp service). For a 4-wire, 3-phase, 120/208 volt ComEd input, components and wiring will be as indicated on Standard Drawing 983 (for either 100 amp or 200 amp service).

THIS SPECIFICATION SHALL NOT BE ALTERED

ELECTRICAL SPECIFICATION 1608
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
REVISED OCTOBER 11, 2017

CONTROL: SMART LIGHTING, FOR ROADWAY LIGHTING, INTERNAL AND TWIST LOCK TYPE

SUBJECT

1. This specification states the requirements for smart lighting control node, consisting essentially of a control module compatible with Silver Springs Network, photocell, relay, and a surge arrester, all enclosed in an approved housing, to control the operation of roadway luminaire. The internal node is to be used for acorns, globes, gas light & teardrop luminaires. The external twist-lock node is to be used for cobra-head luminaires.

GENERAL

2. (a) Information Required. Each bidder shall submit with his proposal the following information relative to the photoelectric control he proposes to furnish.

   (1) Outline drawing.

   (2) Complete environmental, electrical, physical, and operating data on the control unit.

   (3) Data by the control node manufacturer including sensitivity, operating temperature and load rating.

   (4) Manufacturer's name and catalogue designation.

   (b) Assembly. Each control node must be delivered completely assembled, wired, and ready for installation.

   (c) Size and Weight.

   (1) Internal Node - the unit must not be more than 2.5" high, 4.25" length and 3.5" width with a maximum weight of eleven (11) ounces.

   (2) External Twist Lock Node - the unit must not be more than 5" high or 3.5" in diameter with a maximum weight of nine (9) ounces.

   (d) Smart Lighting control modules must meet or exceed all requirements of ANSI Standard C136-10-2010 for Twist Lock Controls & ANSI C136.41.2013 Dimming Control between an External Locking Type Control and Ballast or Driver. The external node must be SEL External CMS Module Part No. 8S570101-001002-1-CHI or approved equal. The internal node must be SEL Internal CMS Module Part No. 8S87138-001002-1-CHI or approved equal.

(e) Warranty. The manufacturer shall warrant every node against any defects due to design, workmanship or materials developing within a period of five (5) years after the control has been delivered. This will be interpreted particularly to mean failure of any component impairing the proper operation or protection of the unit. Any control, or part thereof, developing defects within this period must be replaced by the manufacturer at his sole expense and without cost to the City.

(f) Sample. A sample node of the manufacture intended to be furnished must be submitted within fifteen (15) business days upon receipt of a request from the Chief Procurement Officer.

(g) Compliance with Specifications. The node must conform in detail to the requirements herein stated, and to other standards and specifications, as cited, of which the most recently published revision will govern. Certified test results must be submitted to the Commissioner as indicated below, prior to shipping of nodes. All shipments not meeting specification requirements will not be accepted.

(h) Approved. Wherever "approved" is specified herein, it will be construed to mean approved by the Commissioner or the Commissioner’s authorized representative.

CONSTRUCTION

3. (a) Photoconductive Cell. The photocell shall consist of a suitable substrate, a chemically inert electrode material and a thin layer of photosensitive cadmium sulfide or other acceptable photosensitive material. It must be hermetically sealed in a glass to metal package to prevent moisture and contamination damage. Plastic cased cells are not acceptable. Filtered silicon sensors in clear epoxy cases are also acceptable. Cell dissipation over a 24 hour period must not exceed the recommended allowable levels specified by the cell manufacturer. If the cell operates on D.C. an affidavit must be submitted giving the cell manufacturer's certification that such operation will not adversely affect the sensitivity, stability, or the life of the cell. The cell must not be subject to overloading due to the demand of the design circuit nor the ambient temperatures surrounding the cell. Color response of the cell or silicon sensor must be such that maximum sensitivity is in the blue-green portion of the color spectrum.

(b) Switching Relay. The ON-OFF switching operations shall be accomplished by normally closed contacts which must be opened by means of a rugged, properly rated, magnetic relay, subject to approval. The switching shall be positive and free of chatter and/or sticking of contacts. The contractor must provide test data verifying that contact chatter does not exceed 5 milliseconds when operated under loads as herein specified. The relay must have contacts of silver alloy, tungsten, or other specifically approved material.

(c) Surge Arrestor. Over voltage protection shall be provided for the control components and the load circuit by means of a metal oxide varistor (MOV) or other specifically approved type arrestor. It must limit high voltage surges to a value at least 20% below the basic impulse insulation level (BIL in accordance with EEI-NEMA) of the control. For the button control, the MOV must be rated for a minimum of 100 joules wired line to neutral. For the twist lock control the MOV must be rated for minimum of 160 joules wired line to neutral; a secondary MOV or zener diode of at least 6 joules must be provided to protect the electronic circuit. In both the button and twist lock controls, the MOV must be mounted internally of the control housing.

(d) Printed Circuit Boards. A conformal coating shall be applied to all printed circuit boards for environmental protection.

(e) Housing. The housing shall be molded of an approved, impact resistant, UV resistant weatherproof material such as acrylic, butyrate or polycarbonate, pigmented to an approved color. The housing is required to be impact resistance greater than 1.0 ft-lbs at -40^{o} C. Year and manufacturer must be molded in cover.

(f) Fail-Safe. Relay contacts must be normally closed so that when circuit failure occurs the lights are turned on, or remain on.

(g) Dating. A weatherproof, permanent label must be attached to each unit indicating manufacturer's name, month and year of manufacture, model and serial numbers, voltage and load ratings, and, on twist lock control, provision for marking installation and removal dates.

(h) Lead Wires.

(1) Internal Node - lead wires must be #18 AWG (Min); rated for 105^{0}C; and 12" long. They must be color coded as follows:

Red - Load
White - Neutral (on 120 volt controls)
Black - Line
Yellow - Common (on 240 volt controls)

240 volt internal node must have a permanent black on orange label 0.5"x2.0" in size that reads “240 VOLT”.

(2) External Node - the base must provide an integral, 5-pin or 7-pin NEMA Twist-Lock in accordance with ANSI C136.41. A neoprene or other approved gasket must be attached to the base to effectively seal the connections against weather, insects and dust.

CHARACTERISTICS

4. (a) Electrical. The node must be stable and reliable over the range of 105 to 305 volts A.C., at 60 cycles. The external node twist lock control's direct load rating must be 1000 watts tungsten, 1800 VA ballast; the internal node control must be rated for 1000 VA ballast. Current inrush rating of the control must be not less than 100 amperes. Control nodes must turn on/off roadway luminaires and provide 0-10V dimming for roadway luminaires capable of dimming capable of dimming used by the City of Chicago.

(b) Environmental. The control must be stable and reliable over an operating temperature range of -40°C (-40°F) to + 70°C (+158 °F).

(c) Operating Levels. Each control furnished must be pre-aged in intense light for a period of not less than 10 hours, after which it must be calibrated using a photometer whose accuracy is traceable to the N.I.S.T. 100% quality control inspection must be performed after calibration and final assembly.

(1) The internal node control must be calibrated at 120 VAC for a "turn-on" setting of .50 ± 0.1 horizontal foot candles of natural illumination with a 7-15 second turn OFF delay. The "turn-off" setting must be adjusted to one and one half (1.5) times the "turn-on" setting. Internal node controls must have a 7-15 second turn ON delay.

(2) The external node control must be calibrated at 120 VAC for a "turn-on" setting of 1.50 ± 0.30 horizontal foot candles of natural illumination with a 2-5 second turn OFF delay. The "turn-off" setting must be adjusted to one and one half (1.5) times the "turn-on" setting. The external node control must have a 1-2 second turn ON delay.

(e) Network. The control nodes must operate on an open standards secure (WiSun) IEEE 802.15.4g wireless mesh IPv6 based multi-application network compatible with Silver Springs Network. The control nodes shall support Frequency-Hopping Spread Spectrum up to 300kb/s mesh networking as well as automatic data routing with self-configuration, auto-healing & redundant uplinks. The device must be FCC compliant.

The control nodes must have full application and link-layer security with full PKI, AES-128 and -256, and embedded firewall which includes integrated multi-layer security with end-to-end encryption and capability to prohibit unauthorized access.

Internal Nodes must be able to communicate with network even when installed inside a metal housing of the luminaire.

TESTS

5. (a) Procedures. Test procedures must conform to these specifications, and to ANSI Standards C136-10-2010, except as otherwise herein indicated.

(b) Performance Test. The control shall be subject to an accelerated performance test which will consist of cycling ON (30 seconds) and OFF (30 seconds) sixty times per hour at rated load for 2000 cycles. The node must not exceed the limits indicated for the nominal or rated operating levels, and relay contact points must not stick or show high resistance due to excessive pitting and/or erosion.

(c) Dielectric Strength Test. The control unit complete with enclosure shall be subject to a D.C. hypot test for dielectric strength. It must successfully withstand a 5.0 KV test for one (1) minute dry.

(d) Drop Test. The control must be capable of withstanding a drop of 3 feet to a concrete floor without causing damage to the housing or changing electrical operation.

(e) Surge Protection Test. The control shall be subject to a test for surge protection in accordance with UL 1449 and ANSI C62. By means of a surge generator, a 6.0 KV, 1.2 x 50 microsecond voltage wave impulse test must be made. The surge test must have a short circuit current average of at least 3 KA for 8.0 x 20 microseconds. The control must withstand the impulse testing, and change in calibration levels must not exceed the limits indicated for the nominal or rated operating levels.

(f) Temperature and Humidity Tests. The control will be subject to specified calibration tests immediately following conditioning of the control at extremes of temperature and humidity, as indicated below:

   (1) Condition the control for a period of 24 hours at 98% relative humidity and 70^{o} C temperature.

   (2) Condition the control for a period of 10 hours at -40^{o} C (-40^{o} F).

(g) Calibration Test. After completion of all specified testing, the control unit must be recalibrated and must be within the operating parameters of this specification. During this test, the manufacturer must demonstrate that there is no cycling during either "turn-on" or "turn-off."

(h) Testing. One (1) unit from each lot of 500 nodes, with a minimum of 2 nodes per contract, will be subject to test. In the event any node fails to meet test requirements, the entire lot will be subject to rejection, except that the manufacturer, may subject a minimum of five (5) additional nodes in the lot to test and if all fulfill the requirements, the lot will be accepted. Should any of the additional five (5) nodes fail, then the entire lot will be rejected. Certified test reports must be submitted to the Commissioner for approval prior to shipment of material. All units subjected to test will remain the property of the Contractor and may not be included as part of this contract.

PACKAGING

6. (a) Carton. Each smart lighting control node must be individually packed in a carton of adequate strength and properly secured and protected to prevent damage to the unit during shipment, handling and storage.

(b) Marking. Each carton into which a number of individually packed photoelectric units are packed must be clearly marked on the outside in letters not less than one-quarter (1/4) inch tall with the legend "SMART LIGHTING INTERNAL CONTROL NODE" or "SMART LIGHTING EXTERNAL CONTROL NODE" (as appropriate), preceded by the number of units in the carton in numbers of the same height as the letters: volt-ampere lamp load rating, voltage, manufacturer's name and catalogue number, contract or order number, and shipping date.

ELECTRICAL SPECIFICATION No. 1609
CITY OF CHICAGO
DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING
OCTOBER 20, 2017

OUTDOOR LED LUMINAIRE SPECIFICATIONS: RESIDENTIAL STREETS, ALLEYS, & ARTERIAL STREETS (Cobra Head)

I. SUBJECT

A. This specification states the requirements for non-ornamental Light Emitting Diode (LED) outdoor lighting luminaires. The LED luminaires will be integrated into a centralized lighting management system.

II. GENERAL

A. References

American National Standards Institute (ANSI)

- ANSI C78.377-2015, "American National Standard for Electric Lamps—Specifications for the Chromaticity of Solid State Lighting (SSL) Products"
- ANSI C82.77-10-2014, "American National Standard for Lighting Equipment—Harmonic Emission Limits—Related Power Quality Requirements"
- ANSI C136.2-2015, "American National Standard for Roadway and Area Lighting Equipment—Dielectric Withstand and Electrical Transient Immunity Requirements"
- ANSI C136.10-2010, "American National Standard for Roadway and Area Lighting Equipment—Locking-Type Control Devices and Mating Receptacles—Physical and Electrical Interchangeability and Testing"
- ANSI C136.15-2015, "American National Standard for Roadway and Area Lighting Equipment—Luminaire Field Identification"
- ANSI C136.22-2004 (R2009, R2014), "American National Standard for Roadway and Area Lighting Equipment—Internal Labeling of Luminaires"
- ANSI C136.25-2013, "American National Standard for Roadway and Area Lighting Equipment—Ingress Protection (Resistance to Dust, Solid Objects and Moisture) for Luminaire Enclosures"
- ANSI C136.31-2015, "American National Standard for Roadway and Area Lighting Equipment—Luminaire Vibration"
- ANSI C136.37-2011, "American National Standard for Solid State Light Sources Used in Roadway and Area Lighting"
- ANSI C136.41-2013, "American National Standard for Roadway and

Area Lighting Equipment–Dimming Control Between an External Locking Type Control and Ballast or Driver”
- ASTM B85/B85M-14, “Standard Specification for Aluminum-Alloy Die Castings”
- ASTM B117-16, “Standard Practice for Operating Salt Spray (Fog) Apparatus”
- ASTM D523-14, “Standard Test Method for Specular Gloss”
- ASTM D1654-08, “Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments”
- ASTM G154-12a, “Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials”

Illuminating Engineering Society of North America (IES)

- ANSI/IES LM-63-02, “Standard File Format for Electronic Transfer of Photometric Data”
- IES LM-79-08, “Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products”
- ANSI/IES LM-80-15, “IES Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules”
- ANSI/IES RP-8-14, “Roadway Lighting”
- IES TM-21-11 (with Addendum B), “Projecting Long Term Lumen Maintenance of LED Light Sources”

Institute of Electrical and Electronics Engineers (IEEE)

- IEEE Std 1789-2015, “IEEE Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers”

International Electrotechnical Commission (IEC)

- IEC 60929:2011 (with Amendment 1), “AC and/or DC-supplied electronic control gear for tubular fluorescent lamps - Performance requirements”

Underwriters Laboratories (UL)

- ANSI/UL 1598 (3rd Edition), "Luminaires”

B. Submittal Requirements:

The Contractor must submit the following information pertaining to each specified luminaire type within fifteen (15) days of request:

1. Completed ATTACHMENT B – Submittal Form

2. Product Data Sheets.

   a) Luminaire data sheets – including summary product description, dimensioned outline drawings, and nominal characteristics including but not limited to: initial luminous flux (lumens), input power (watts), input voltage range (volts), LED drive current (milliamps), correlated color temperature (kelvins), color rendering index, effective projected area (square feet) and weight (pounds).

   b) LED Driver data sheet – including information described in LED Driver Requirements Section III-I-3.

   c) LED light source data sheet

   d) Surge protection device data sheet - if applicable

3. Photometric Performance Data

   The manufacturer must provide photometric calculations, as part of each luminaire's submittal package, that demonstrate the luminaire's photometric performance will meet or exceed the photometric requirements listed in this specification. The submitted lighting calculations must include point-by-point illuminance, luminance and veiling luminance data, as well as listings of all indicated averages and ratios. Photometric reports must include the following information and be in accordance with the standards listed below:

   a) IES LM-79-08 photometric report that includes measured values for initial luminous flux, input power, correlated color temperature, and color rendering index.

   b) ANSI/IES LM-63-02 electronic format photometric file that corresponds to the LM-79 report.

   c) LM-63 photometric calculations that demonstrate compliance with the illumination requirements specified herein using the LM-63 file. Calculation grids and observer locations not specified herein must be in accordance with ANSI/IES RP-8-14.

   d) IES TM-21-11 calculations that derive the lumen maintenance (lamp lumen depreciation or LLD) factor applied to photometric calculations specified herein.

      - ANSI/IES LM-80-15 and in-situ temperature measurement testing (ISTMT) reports containing data used in TM-21 calculations must also be submitted.

- TM-21 calculations must apply to the maximum LED case temperature from ISTMT, shall not extrapolate beyond six times the duration of available LM-80 test data, and must be submitted in the spreadsheet format of the ENERGY STAR TM-21 calculator (https://www.energystar.gov/products/spec/luminaires_specification_version_2_0_pd).

LM-79, ISTMT, and LM-80 reports must correspond directly to submitted luminaires, and must be produced by test laboratories that satisfy the Testing Laboratory Requirements of the Design Lights Consortium (www.designlights.org/content/QPL/ProductSubmit/LabTesting).

ISTMT must be conducted in accordance with the Design Lights Consortium Manufacturer's Guide (https://www.designlights.org/content/qpl/productsubmit).

ISTMT shall be conducted in an ambient temperature of 25 ± 5 °C. Ambient temperature variations above or below 25 °C shall be respectively subtracted from or added to temperatures recorded at points on the luminaire.

4. Safety Certification - file number indicating compliance with UL 1598. Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

5. Vibration Testing - the luminaire must comply with ANSI C136.31 at Vibration Test Level 2 (3.0 G).

6. Product Samples - at least two samples of each luminaire that the contractor proposes to use must be submitted to the City. All samples must be representative production units and be supplied at no cost to the City.

C. Assembly.

Each luminaire must be delivered completely assembled, wired, and ready for installation.

D. Warranty.

The luminaire manufacturer must warrant the performance and construction of luminaires to meet the requirements of this specification, and must warrant all parts, components and appurtenances against defects due to design, workmanship or material developing within a period of ten (10) years from the date of acceptance by the City.

- The inability of a luminaire to be dimmed will constitute a luminaire failure.
- Failure of 10% or more of the LED light sources (packages or arrays/modules) in a luminaire will constitute a luminaire failure.

- The warranty must apply for application on all of the City's existing electrical systems, both grounded and ungrounded.
- During the warranty period the City may, from time to time, test a random sampling of 10-20 luminaires for verification of light output per IES LM-79 and to test dimming functionality for a given luminaire population. The percentage of luminaires not performing as required in the random sampling will be applied to the total population quantity to determine the number of new luminaire replacements that must be delivered to the City by the manufacturer, without expense to the City.

E. Manufacturing Experience and Capacity

The manufacturer must demonstrate at least a five year history of manufacturing LED roadway and outside area luminaires by providing a list of prior projects with project description, date, location, quantities and reference contact information. The manufacturer must also demonstrate the capacity to supply the quantities required for the contract in a timely manner.

III. CONSTRUCTION

A. Weight

The net weight of these luminaires must not be more than 30 pounds.

B. Housing.

The preferred luminaire housing material is die-cast aluminum alloy meeting ASTM Specification A380. Alternate materials may be considered. The housing must enclose the mounting hardware, LED arrays, control receptacle, terminal board, and electronic driver. The housing must include a surface to facilitate leveling with a spirit level. The housing must have integral heat sink characteristics, such that all enclosed components will operate within their designed operating temperatures under expected service conditions. No external or removable heat shields or heat sinks; are permitted. The housing must be designed to encourage water shedding. The housing must be designed to minimize dirt and bug accumulation on the optic surface.

C. Mounting Provisions.

The luminaire must include a heavy gauge slip fitter clamping assembly suitable for secure attachment over the end of a two (2) inch 2" IP (2.375" OD) steel pipe with an approved means of clamping it firmly in mounting bracket. The slip fitter mounting clamp must contain an approved shield around the pipe entrance to block the entry of birds.

D. Access Door-Panel.

An access door panel allowing access to the terminal strip and LED driver must be provided. A die-cast aluminum door-panel composed of aluminum alloy A380 is preferred; alternate materials may be considered. The door-panel must be hinged to the luminaire housing and suitably latched and fastened at the closing end. It must be made to be removed easily. The hinge and fastening devices must be captive parts which will not become disengaged from the door panel.

E. Hardware.

All machine screws, locknuts, pins and set screws necessary to make a firm assembly, and for its secure attachment to the mast arm, must be furnished in place. All hardware must be of stainless steel, zinc plated steel, copper silicon alloy or other non-corrosive metal, and where necessary must be suitably plated to prevent electrolytic action by contact with dissimilar metals.

F. Finish.

The luminaire must have a polyester powder coat with a minimum 2.0 mil thickness. Surface texture and paint quality will be subject to approval. Color must be as specified in the order. A paint chip must be submitted as a sample upon request. The finish must exceed a rating of six per ASTM D1654 after 1000 hours of testing per ASTM B117. The coating must exhibit no greater than 30% reduction of gloss per ASTM D523 after 500 hours of QUV testing at ASTM G154 Cycle 6.

G. Ingress Protection.

1. The luminaire electric compartment housing must have an ingress protection rating of IP54 or better as described in ANSI C136.25-2013). The optical system must have a minimum rating of IP 66.

2. The luminaire must be listed for wet locations by a U.S. Occupational Safety Health Administration (OSHA) Nationally Recognized Laboratory (NRTL) and have a safety certification and file number indicating compliance with UL 1598.

H. General Luminaire Requirements

1. The luminaire must be rated to operate between -40° to +50° Celsius.

2. The luminaire must have the option of adding a house side shield. The shield should be designed to be easily installed in the field. The house side shield must be composed of a sturdy material capable of withstanding vibrations and weather conditions. The shield must cut off light trespass at approximately one mounting height behind the pole.

3. The luminaire must meet the requirements of ANSI C136.22 for internal labeling. A bar code with pertinent information for warranty and maintenance must be attached to the inside of the housing. A separate bar code label must be on the driver

4. The luminaire must be able to provide pertinent product information, for warranty and maintenance purposes, in a digital format that is compliant with the Digital Addressable Lighting Interface (DALI) protocol. This information will be transmitted through the networked Lighting Management control system.

I. Electrical Components

1. LED Optical Arrays

a) <u>The LED arrays must be properly secured at the factory and must not require field adjustment for optimum photometric performance.</u>

2. Terminal Block

a) <u>A terminal block of high grade molded plastic of the barrier or safety type must be mounted within the housing in a readily accessible location.</u>

b) <u>Terminal block wiring; all necessary terminals, pre-wired to all luminaire components, must be provided.</u>

c) <u>Terminal block terminals must have copper plated or brass plated, clamp-type pressure connectors of an approved type for "line" connections, to accommodate wire sizes from #12 to #8 A.W.G.</u>

d) <u>Terminal block terminals for internal component connections must</u>

be either the screw-clamp or quick disconnect type.

3. LED Driver:

a) Voltage. The electronic driver must operate at an input voltage range of between 120 and 277 volts, 60 Hertz. It must automatically sense the input voltage and adjust the output accordingly. The City uses nominal input voltages of 120, 208, and 240 for street lighting. When operated at any supply voltage between 80 percent and 110 percent of its rated supply voltage and at rated input frequency, a driver shall provide current and/or voltage regulation that equals or exceeds the values specified by the manufacturer.

b) Electrical Safety. Luminaires must operate at or below the Low-Risk Level, as defined in Figure 18 of IEEE 1789-2015. This requirement must be satisfied across the dimming range.

c) Power Factor (PF). The power factor of the driver over the design range of input voltages specified above must be in accordance to ANSI C82.77-2014. PF must be ≥ 0.9.

d) Total Harmonic Distortion (THD). The driver input current must have specified THD in accordance to ANSI C82.77-2014. THD must be ≤32%.

e) Thermal Protection. The driver must be thermally protected to shut off when operating temperatures reach unacceptable levels.

f) Electromagnetic Interference. Luminaire must comply with the FCC radiation emission limits for Class B digital devices given at 47 CFR 15.109.

g) Electrical Transient Immunity.

- Dielectric Withstand Testing - luminaire must meet the performance requirements specified in ANSI C136.2-2015 for dielectric withstand, using the DC test level and configuration.
- Electrical Transient Immunity - luminaire must meet the performance requirements specified in ANSI C136.2-2015 for electrical transient immunity, using the Enhanced (10 kV / 5 kA) combination wave test level.
- Transient Immunity Testing Requirements
    - During electrical transient immunity testing, the device under test (DUT) must: be connected to the power source through a series coupler/decoupler network (CDN), using a two-wire (hot or hot/neutral) connection between both the

power supply and CDN input and the CDN output and DUT.

- If AC mains is used to power the DUT, the input waveform must be characterized and documented both before and after electrical transient immunity testing, with the DUT operating at rated full output.

- For Pre-Test DUT Characterization, the diagnostic measurements shall, at a minimum, include the following: real power, input current (RMS; Root-Means-Square), power factor, and current distortion factor (THD-I Total Harmonic Distortion) when operating at rated full output.

- Manufacturer must indicate on submittal form whether failure of the electrical transient immunity system can possibly result in disconnect of power to luminaire.

h) Dimming Capability. The driver must be capable of dimming. The dimming range must be 10% to 100% of full output. The digital lighting interface used for dimming must be DALI (Digital Addressable Lighting Interface) as per the requirements of IEC 62386. There must be a minimum of 100 dimming steps between the top and bottom of the dimming range.

4. Wiring.

a) All components must be completely factory wired with non-fading, color coded leads. These leads must be insulated with an approved class of insulation and must be #16 AWG conductor at a minimum.

b) All wires within a single circuit path must be of the same size.

c) No wire-nut splicing will be allowed.

d) No unnecessary splices will be allowed.

e) Quick disconnects must be provided for all components.

f) All wires must be properly terminated.

5. Control Device Receptacle and Cap.

a) Twist-lock Receptacle for a control device that meets ANSI C136.41 must be mounted in the top of the housing with provision for proper positioning of the control device.

b) 7-pin Receptacle. The luminaire control receptacle must be fully prewired and compliant with ANSI C136.41.

c) 3-prong Shorting Cap that meets ANSI C136.10 must be provided.

d) Receptacle Wire Leads must all be properly terminated.

e) Receptacle repositioning. The receptacle must be able to be repositioned without the use of tools.

f) Control Devices Not Included in LED Specifications. Whereas specifications for control receptacles are included, specifications for control devices are not. The control device performance requirements are part of the lighting management system specifications in the Smart Lighting Project Technology specifications.

6. Component Mounting.

All electrical components must be securely mounted in such manner that individual components can be easily maintained or replaced. Permanent straps or tie-wraps will not be permitted. The entire assembly should be easily disconnected and removed for replacement.

IV. PHOTOMETRIC REQUIREMENTS

1. Light Pollution.

To limit light pollution, the submitted luminaires must not emit any light above the horizon (0 lumens at angles ≥ 90° from luminaire nadir).

2. Lumen Maintenance.

a) LED arrays must deliver a minimum of 90% of initial lumen output at 36,000 hours of operation.

b) Light Loss Factor (LLF) < 1.0. Calculations for maintained values, i.e. LLF = LLD x LDD x LAT.

(1) Lamp Lumen Depreciation (LLD) calculated at 60,000 hours as per Section II-B-3-d above,
(2) Luminaire Dirt Depreciation (LDD) ≤0.90, and
(3) Luminaire Ambient Temperature (LAT) ≤0.96

Luminaires with less than 10,000 hours of available LM-80 test data may be submitted for consideration but must be clearly indicated as such.

3. Color Attributes

a) Color Rendering Index (CRI) shall be no less than 65.

b) Nominal Correlated Color Temperature (CCT) shall be 3000K as defined by ANSI C78.377 and described below:

Manufacturer-Rated Nominal CCT (K)	Allowable IES LM-79 Chromaticity Values	
	Measured CCT (K)	Measured Duv
3000	2870 to 3220	-0.006 to 0.006

4. City of Chicago Typical Lighting Contexts

ATTACHMENT A (below) lists the photometric performance requirements for luminaires used in the following typical municipal outdoor lighting applications:

- Modern Residential Streets - staggered poles on both sides.
- Arterial Streets – two-sided opposite pole spacing
- Arterial Streets – two-sided staggered pole spacing

ATTACHMENT A – Photometric Performance Requirements

STREET PARAMETERS				
TYPICAL LIGHTING CONTEXT	**RESIDENTIAL**	**ARTERIAL**		
POLE CONFIGURATION*	STAGGERED	OPPOSITE	STAGGERED	
RIGHT OF WAY (Width)	66 ft.	100 ft.	80 ft.	66 ft.
IES PAVEMENT CLASS	R3	R3	R3	R3
STREET WIDTH (Curb to Curb)	34 ft.	80 ft.	60 ft.	48 ft.
LANES (Incl Prking &Median)	4	7	6	4
PARKWAY (Width)	10 ft.	4 ft.	4 ft.	N/A
SIDEWALK (Width)	6 ft.	6 ft.	6 ft.	9 ft.
HEIGHT TO LUMINAIRE	18 ft.	33 ft.	33 ft.	33 ft.
MAST ARM LENGTH	8 ft.	12 ft.	12 ft.	8 ft.
POLE SETBACK (From Curb to Center of Pole)	3 ft.	3 ft.	3 ft.	3 ft.
IN-LINE POLE SPACING	220 ft.	210 ft.	210 ft.	210 ft.
MAINTAINED PERFORMANCE REQUIREMENTS				
LUMINAIRE REQUIREMENTS	STAGGERED	OPPOSITE	STAGGERED	
Max Input Power - Default /Normal Luminance (Watts)	120	180	180	180
Default/Normal AVG. Luminance (cd/m^2)	≥1.5	≥1.7	≥1.7	≥1.7
AVG/MIN Uniformity Ratio	≤ 6:1	≤ 3:1	≤ 3:1	≤ 3:1
MAX/MIN Uniformity Ratio	≤10:1	≤ 5:1	≤ 5:1	≤ 5:1
MAX Veiling Luminance Ratio	≤ 0.4	≤ 0.3	≤ 0.3	≤ 0.3
AVG. Boosted Luminance (cd/m^2) [Add-Alternate]	≥2.25	≥2.5	≥2.5	≥2.5
SIDEWALK				
Default AVG. Horizontal Illuminance (fc)	≥0.50	≥0.50	≥0.50	≥0.50
AVG.MIN Uniformity Ratio (Horizontal Illuminance)	≤ 4:1	≤ 4:1	≤ 4:1	≤ 4:1
LIGHT TRESPASS RESTRICTIONS - (as measured in a vertical plane 10' beyond ROW ≤3' height)				
MAX Vertical Illuminance	≤ 0.07	≤ 0.3	≤ 0.30	≤ 0.30

ATTACHMENT B - Product Submittal Form

Lighting Context	**e.g. Alleys**	
Product Information Description	***Product Data (Summary)***	***Submittal Reference Document***
Luminaire Designation		
Luminaire Manufacturer		
Luminaire Model Number		
Luminous Flux – initial	lumens	
Luminaire input power—initial	watts	
Luminaire input power—maintained	watts	
Luminaire input voltage- nominal range	volts	
LED drive current - initial	milliamps	
LED drive current - maintained	milliamps	
CCT (correlated color temperature)	kelvin	
CRI (color rendering index)		
EPA (effective projected area) - nominal	sq. ft.	
Luminaire Weight - nominal	lbs.	
Control Interface	☐ ANSI C136.41, 7-pin	
LED Driver – dimming capability	☐ Dimmable, 0-10V ☐ Dimmable, DALI	
LED driver- rated life	years	
Electrical transient immunity ANSI C136.2 combination wave test level	☐ Basic (6kV/3kA) ☐ Enhanced (10kV / 5kA) ☐ Elevated (20kV/10kA)	
Vibration Test-ANSI C136.31	☐ Level 2	
Luminaire warranty period	years	
IES LM-80 test duration	hours	IES LM-80-15 report
LED lumen maintenance at 36,000 hours	%	TM-21 calculator
Max. LED case temperature	degrees Celsius	ISTMT report

ELECTRICAL SPECIFICATION 1618
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
MAY 23, 2019

ACCESSIBLE PEDESTRIAN SIGNAL

SUBJECT

1. This specification states the requirements for an integrated accessible pedestrian signal assembly which will include a vibrotactile push-button with arrow, a speaker, a sign, and housing. This assembly will provide non-visual walk information for persons without sight or with low vision. The walk indications shall be both audible and vibrotactile. This assembly can be used for either actuated pedestrian signal crossings or for non-actuated pedestrian signal crossings.

GENERAL

2. (a) Specifications. The accessible pedestrian signal (APS) assembly must conform in detail to the requirements herein stated, and to the latest requirements of the Manual on Uniform Traffic Control Devices (MUTCD). The APS must also meet the most recent requirements of the Americans with Disabilities Act (ADA).

(b) Acceptance. APS assemblies not conforming to this specification will not be accepted.

(c) Bidders Submittal. Bidders must submit with their bids detailed specifications and any shop drawings that describe the physical appearance and the functionality of the APS.

(d) Sample. One complete APS assembly of the manufacture intended to be furnished must be submitted within fifteen (15) business days upon request of the Chief Procurement Officer.

(e) Warranty. The manufacturer must warrant the APS against defects due to design, workmanship, and material, for a period of five years from the date of acceptance by the City. If any assembly fails to properly function within this period, the manufacturer will replace the assembly, free of charge to the city, including shipping.

HOUSING

3. (a) The housing shall be cast aluminum. It shall be vandal resistant. The housing shall contain the speaker and the push-button, and be able to accommodate either a 9 inch by 12 inch sign or a 9 inch by 15 inch sign by the addition of an aluminum back-plate. The housing shall have a hole in the back to accommodate cable. The housing shall be mounted to a bracket with stainless steel screws.

(b) A cast aluminum mounting bracket shall be supplied. The mounting bracket will be manufactured to be mounted onto a tubular shaped pole or post using two 3/4 inch steel bands or two stainless steel screws. The mounting bracket shall accept the APS housing.

(c) The housing and bracket shall be powder coated Gloss Black with an enamel.

ELECTRICAL

4. (a) The APS shall operate on 12 volt DC.

(b) A separate power supply shall be provided. The power supply will have its own housing and be able to be mounted in the WALK/DONT WALK signal compartment.

(c) The power supply shall accept 120 volt ac input. There will be two inputs (WALK,DONT WALK) that will accept 89VAC to 250VAC at 120 VAC nominal, 27 watt maximum per input. Output shall be a maximum of 16VDC and 1.6 amps.

(d) An MOV rated at 5 joules shall provide electrical protection. Each input shall be fused at 1.5 amps.

(e) There shall be four input wires and four output wires. These wires shall be identified on the power supply: WALK, DONT WALK, NEUTRAL, and GROUND. The input wires shall be long enough to be terminated in the signal compartment. The output wires on the power supply shall have a single quick disconnect plug.

(f) The push-button switch contacts must be normally open and must be closed when the push-button is pressed, restoring immediately to a normal open position when released. The switch must be electrically insulated from the housing. The push-button output rating shall be 36VAC/DC, 100mA.

PUSH-BUTTON

5. (a) The push-button must meet ADA requirements and the requirements of the MUTCD (Chapter 4E.11-4E.12).

(b) The push-button must have a raised tactile arrow on its surface. The arrow must be adjustable, so that it can face in the direction of the associated crosswalk. The arrow will vibrate during the associated WALK interval.

(c) If there is an actuated walk, pushing the button will send a request to the controller.

SOUND

6. (a) All sounds generated by the APS must meet the requirements of the MUTCD (Chapter 4E.11-4E.12).

(b) Sound levels must be able to be manually adjusted. Sound levels must be in the 30dB to 90dB range.

(c) The APS must include an option for automatic sound adjustment due to ambient sound levels.

(d) The APS shall have a push-button locator "click" tone during DONT WALK and flashing DONT WALK intervals.

(e) The APS shall have two options for the WALK interval. The APS shall generate a rapid "click" tone during the WALK interval or shall have a programmable voice message during the WALK interval.

(f) When the push-button is pushed during the DONT WALK or flashing DONT WALK, the APS will respond with a voice message, either "wait" or another programmed voice message.

SIGN

7. (a) A 9" by 12" or a 9" by 15" reflective sign that can be mounted to the housing back-plate shall be supplied.

(b) The sign shall be an R10-2, "CROSS ONLY ON WALK (symbol) SIGNAL", an R10-3, "PUSH BUTTON FOR WALK(symbol)", or another sign as specified in the order or contract.

ENVIRONMENT

8. (a) The APS shall function correctly within the temperature range of -34ºC and +74ºC.

(b) The APS shall function correctly up to 100% non-condensing humidity.

(c) The APS shall function correctly under the power conditions from Commonwealth Edison.

PACKAGING

9. (a) General. The APS must be shipped fully assembled and ready for installation. Each assembly must be individually wrapped and boxed so that the assembly is not damaged in shipment.

(b) Labeling. Each box must be labeled in 3/8 inch high letters " ACCESSIBLE PEDESTRIAN SIGNAL". The City Commodity Code, contract number, manufacturer, and date of manufacture must be clearly labeled on the box.

ELECTRICAL SPECIFICATION 1619
DIVISION OF ENGINEERING
DEPARTMENT OF TRANSPORTATION
CITY OF CHICAGO
MAY 23, 2019

CABLE: SO CORD FOR ACCESSIBLE PEDESTRIAN SIGNAL

SUBJECT

1. This specification states the requirements for an electrical cable to be used to connect a power supply located in the compartment of a WALK signal to an accessible pedestrian signal located either on the same pole or to another pole nearby.

GENERAL

2. (a) Specifications. The cable must conform in detail to the requirements herein stated, and to the applicable portions of the latest revisions of the specifications and methods of test of the following agencies:

   (1) ASTM – American Society for Testing and Materials
   (2) ICEA – Insulated Cable Engineers Association
   (3) IEEE – Institute of Electrical and Electronics Engineers
   (4) UL – Underwriters

   (b) Acceptance. Cable not conforming to this specification will not be accepted.

   (c) Bidders Submittal. Bidders must submit with their bids detailed specifications.

   (d) Sample. If requested by the Chief Procurement Officer, a three (3) foot sample of the cable intended to be provided under this specification must be sent to the attention of the Division of Electrical Operations within fifteen (15) days of receipt of such request.

   (e) Warranty. If the cables are installed within twelve (12) months of date of shipment, the manufacturer must replace any cable failing during normal and proper use within one year of the date of installation. All replacements under this warranty must be made free of charge F.O.B. delivery point of the original contract.

CABLE

3. (a) The cable shall be rated at 600 Volts.

(b) The cable shall be classified as SOOW cord.

(c) The conductors shall consist of uncoated annealed multiple strand copper meeting the requirements of ASTM B-174. The size of each conductor shall be No. 18AWG.

(d) The cable shall contain four insulated conductors within a single jacket. The insulation for each conductor shall be ethylene propylene rubber (EPR), 30mils thick. The jacket shall be chlorinated polyethylene (CPE), 60 mils thick. Insulation and jacket shall be thermoset.

(e) The insulation for the individual conductors shall be colored as follows: red, black, white, green. The jacket shall be black.

(f) The cable shall meet the requirements of UL 62 for flexible cord.

(g) The cable shall be UL listed for outdoor use and for water resistance. It shall be rated to operate in temperatures from -40ºC to +90ºC.

PACKAGING

4. (a) General. The cable must be delivered on sound substantial, non-returnable reels. Each reel must be marked with the manufacturer's name, footage, and any other pertinent information.

APPENDIX F

VAULTED SIDEWALK PHOTO LOGS

ABC 7 – LAKE STREET – EAST
190 N STATE ST

VAULTED SIDEWALK PHOTO LOG

#0301

#0302

#0303

#0304

#0305

#0306

#0307

#0308

#0309

#0310

#0311

#0312

#0313

#0314

ABC 7 – LAKE STREET - MIDDLE
190 N STATE ST

VAULTED SIDEWALK PHOTO LOG

#0601

#0602

#0603

#0604

#0605

#0606

#0607

#0608

#0609

#0610

#0611

#0612

#0613

#0614

#0615

#0616

ABC 7 – STATE STREET
190 N STATE ST

VAULTED SIDEWALK PHOTO LOG

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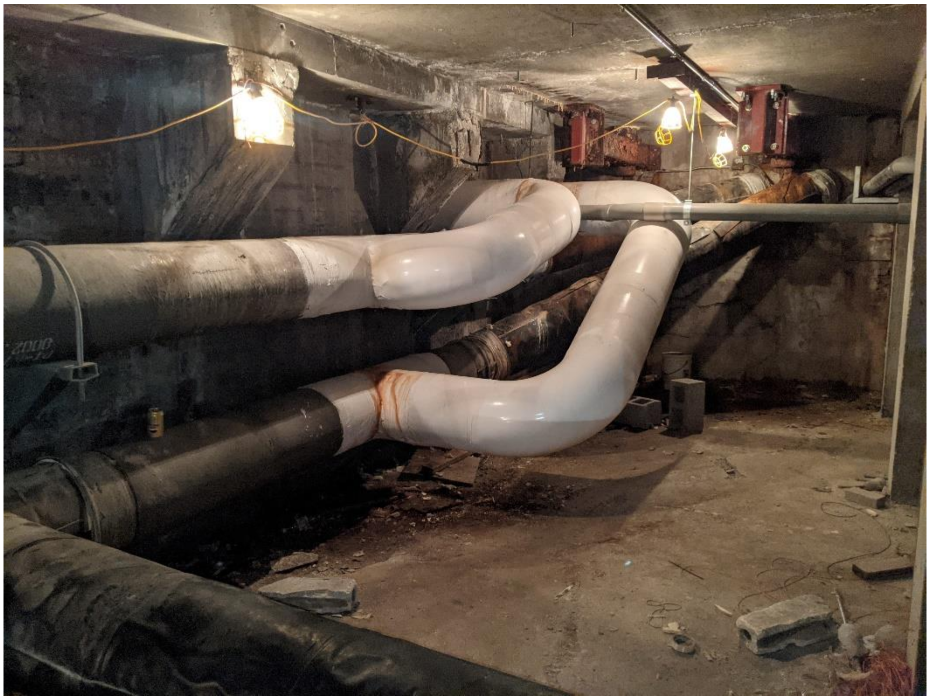
#0502

#0503



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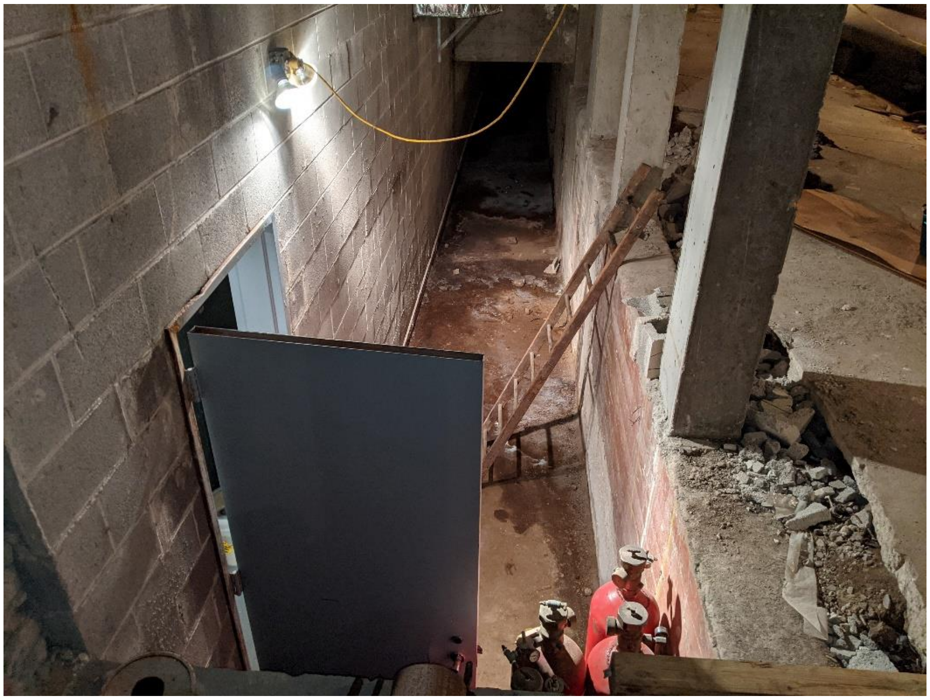

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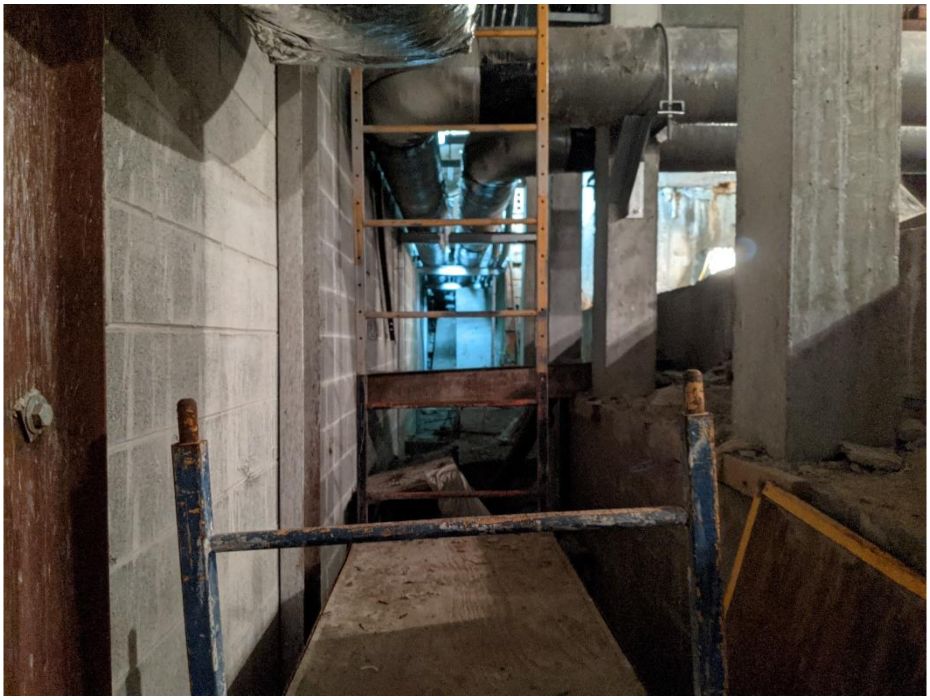

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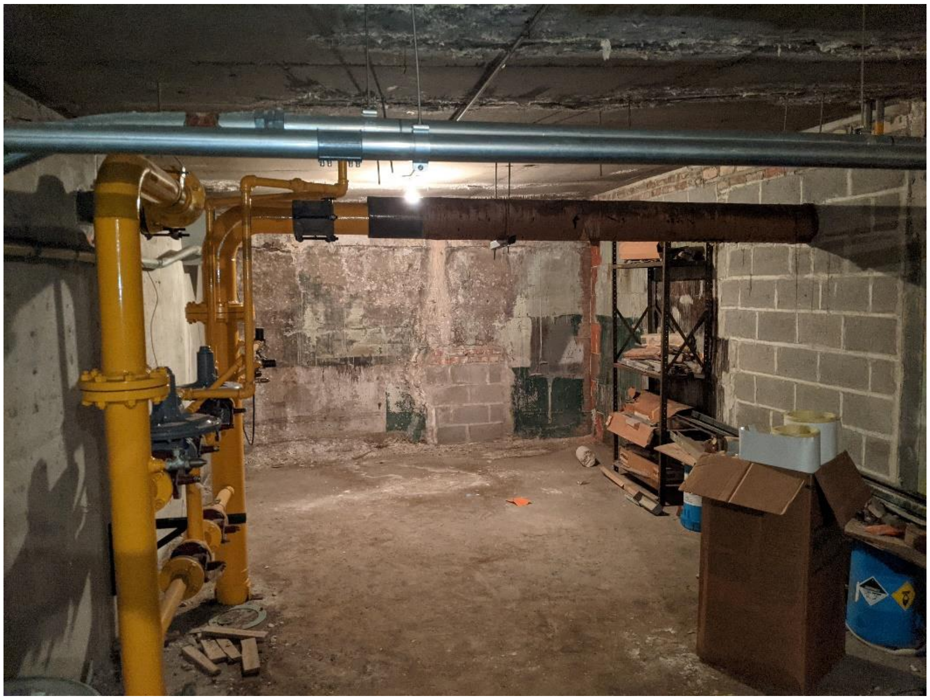
ABC 7 – LAKE STREET – WEST
190 N STATE ST

VAULTED SIDEWALK PHOTO LOG



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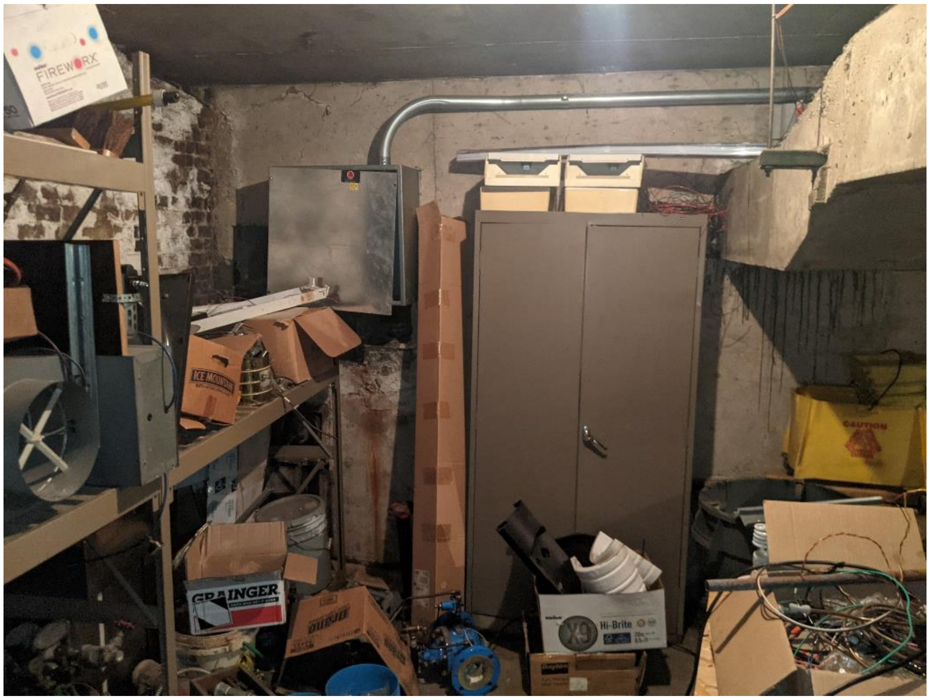

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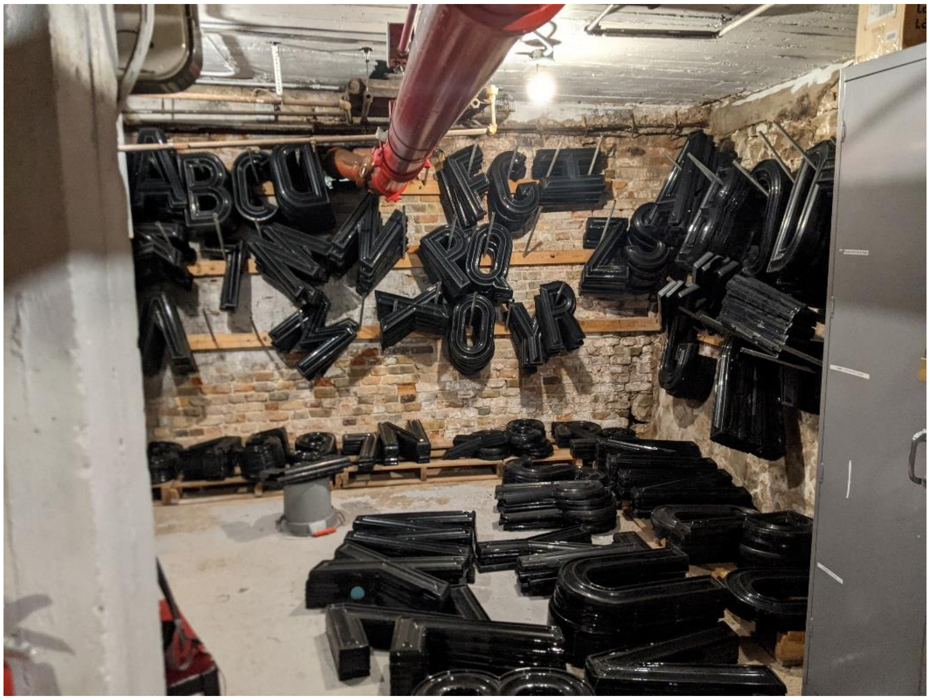
CHICAGO THEATRE
175 N STATE ST

VAULTED SIDEWALK PHOTO LOG



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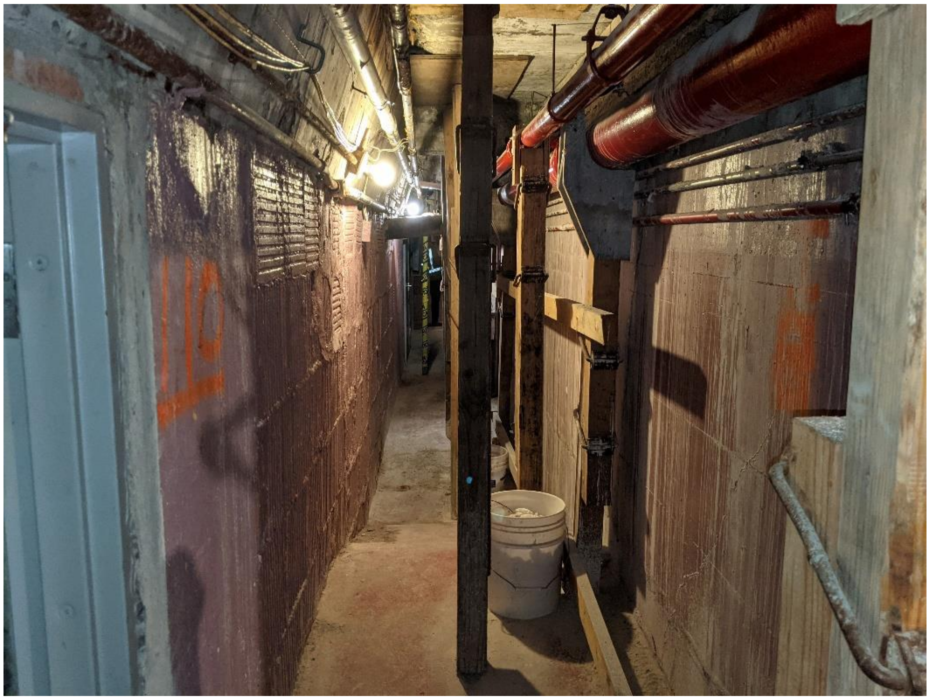

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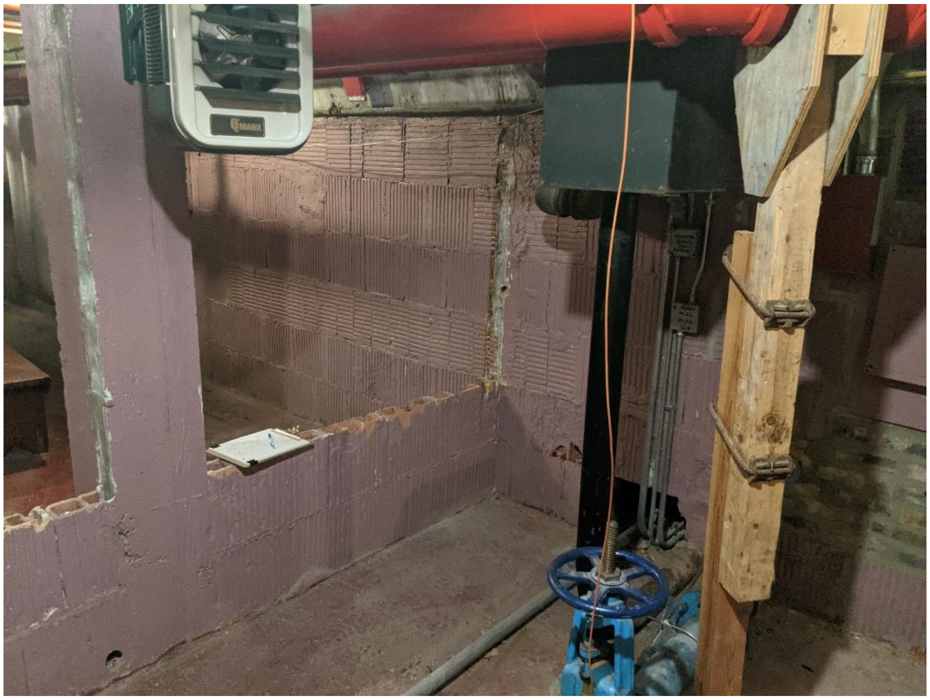

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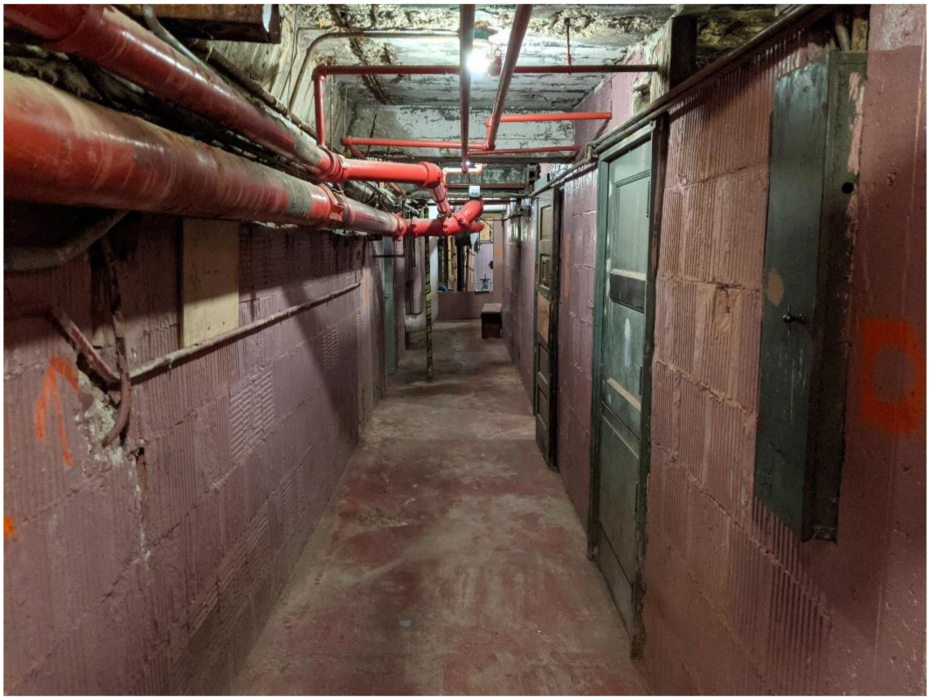

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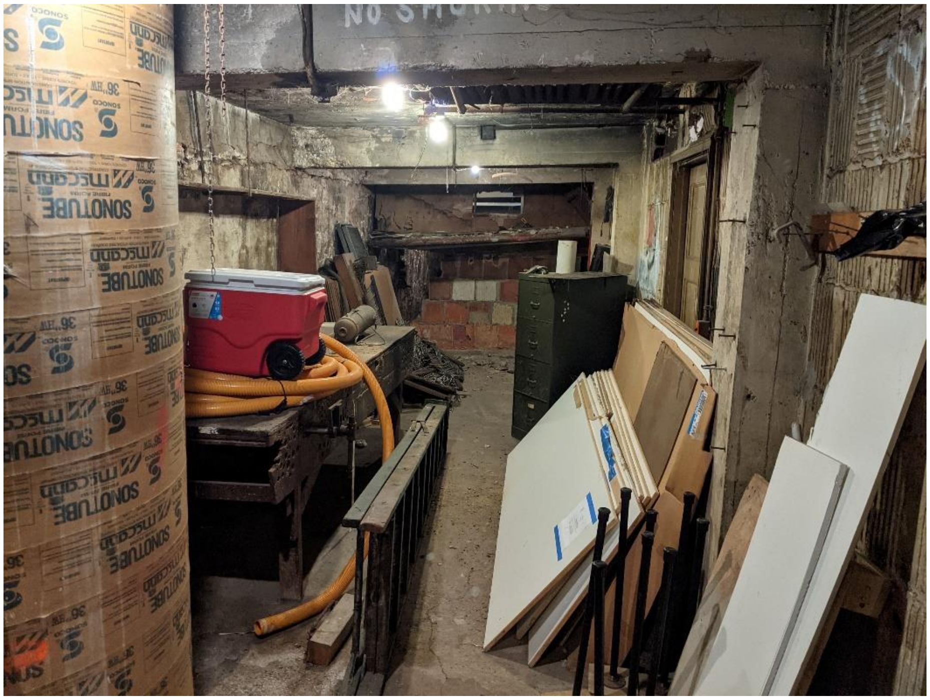

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177 N STATE ST

VAULTED SIDEWALK PHOTO LOG

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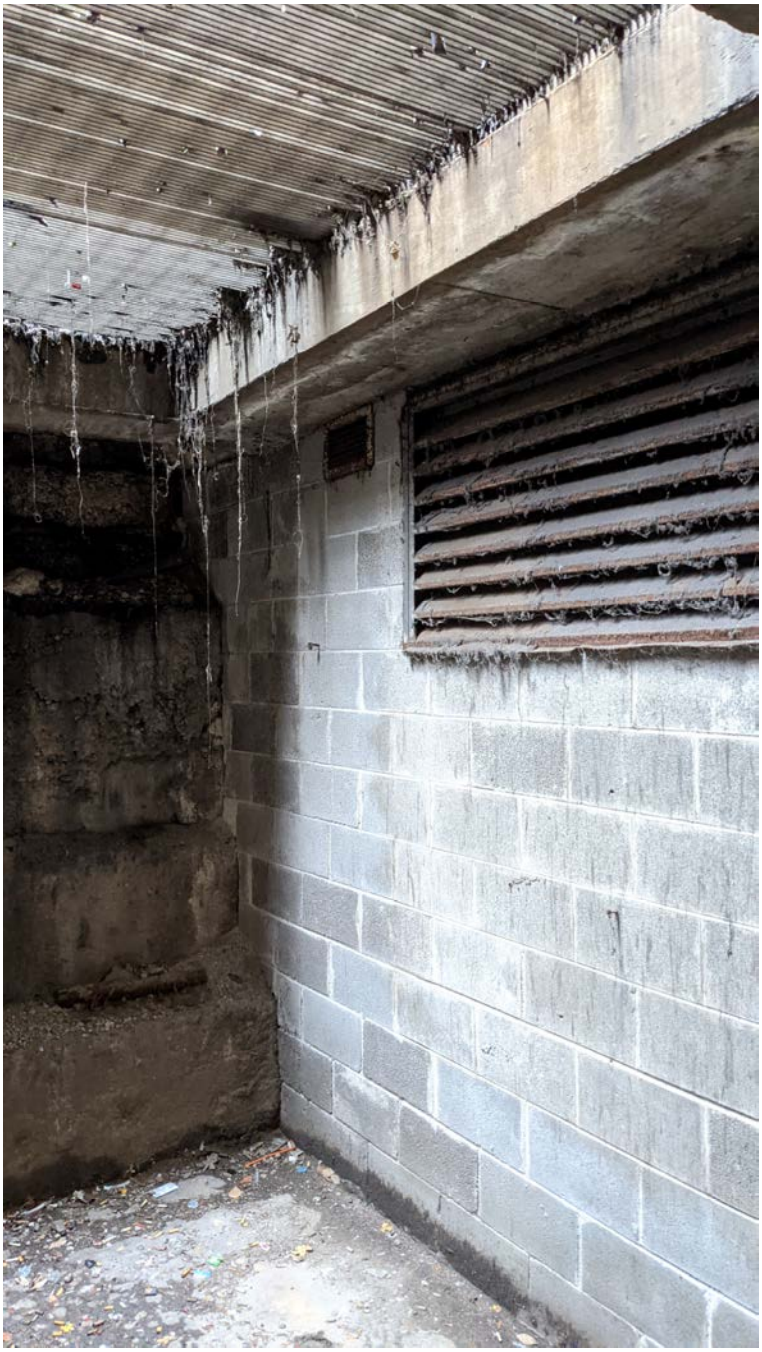

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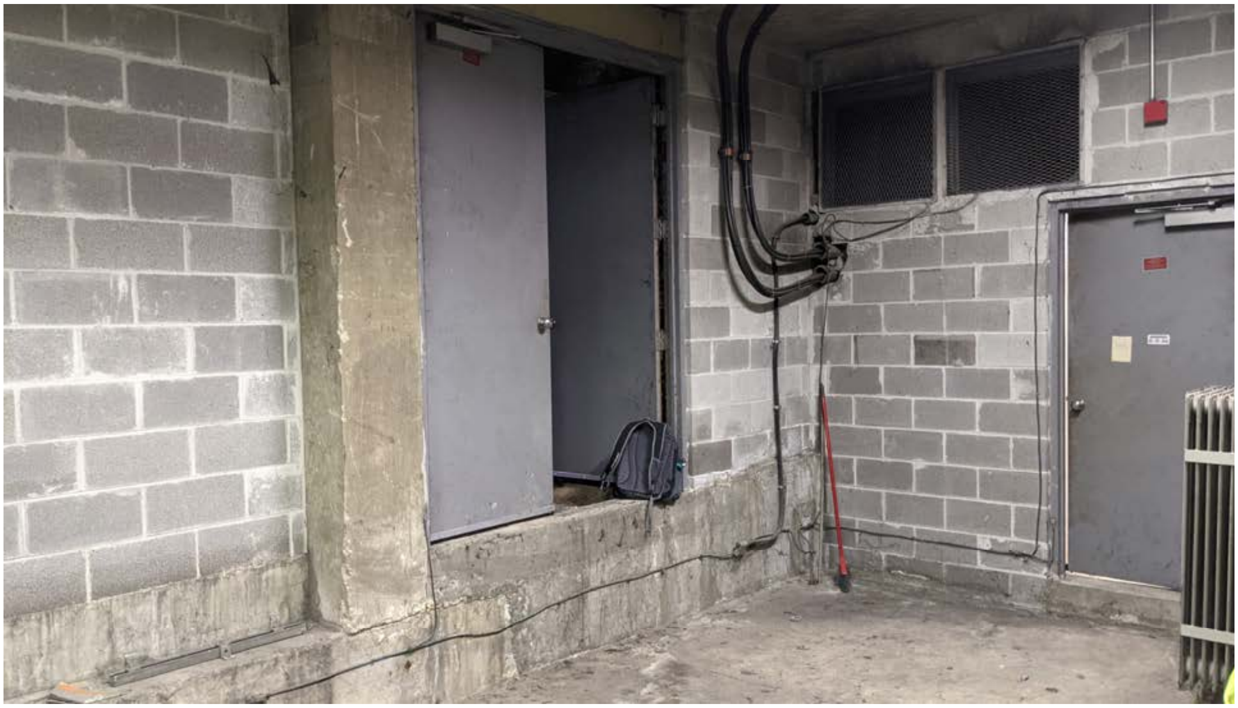

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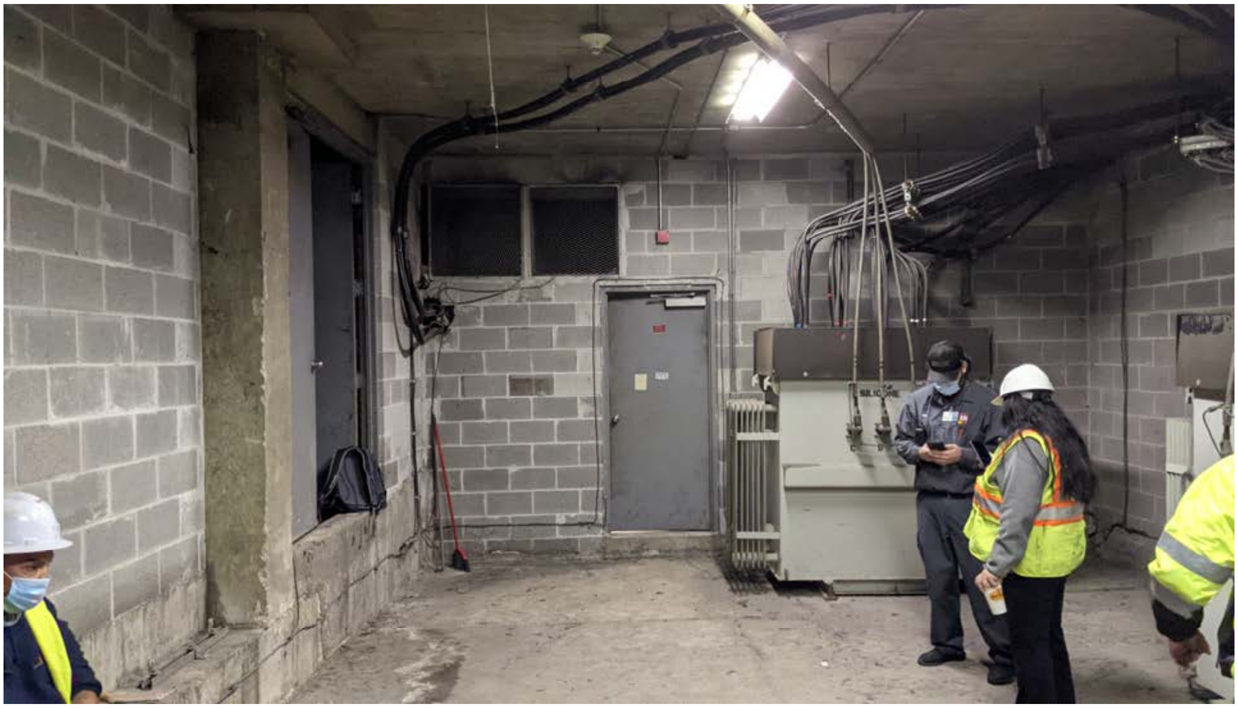

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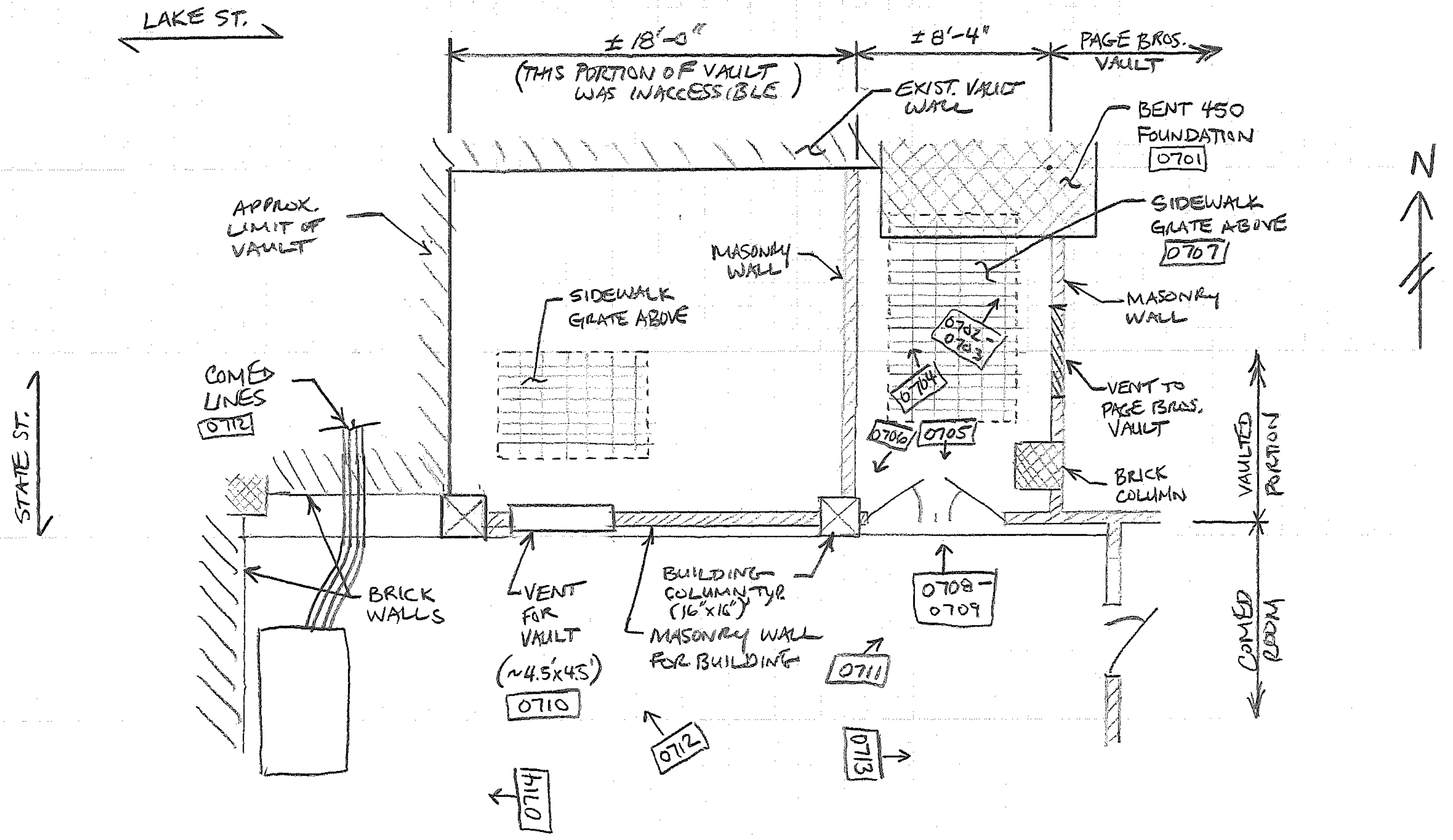

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VAULTED SIDEWALK PHOTO LOG

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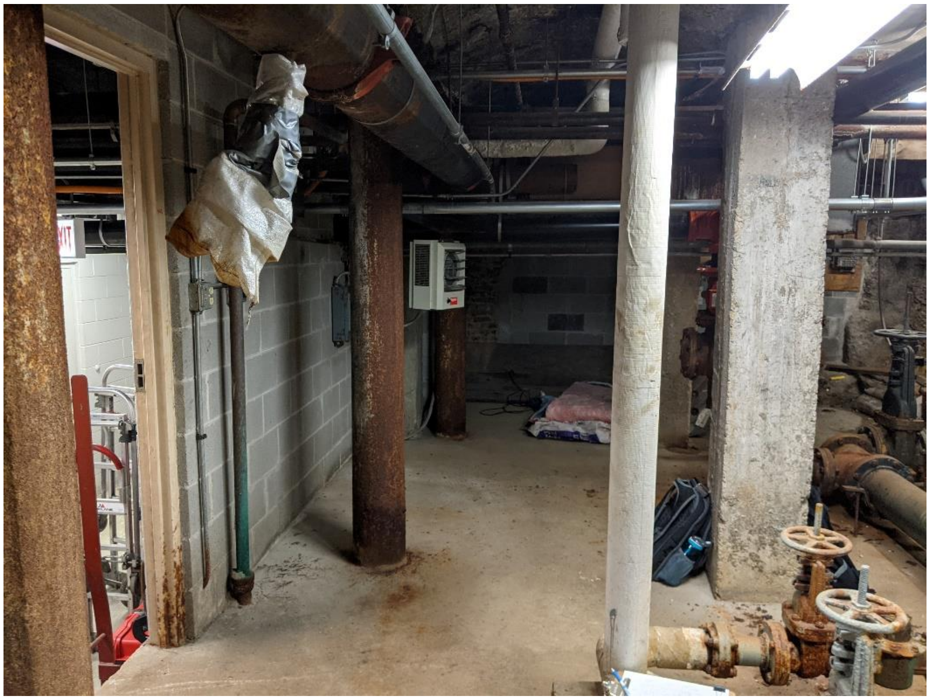

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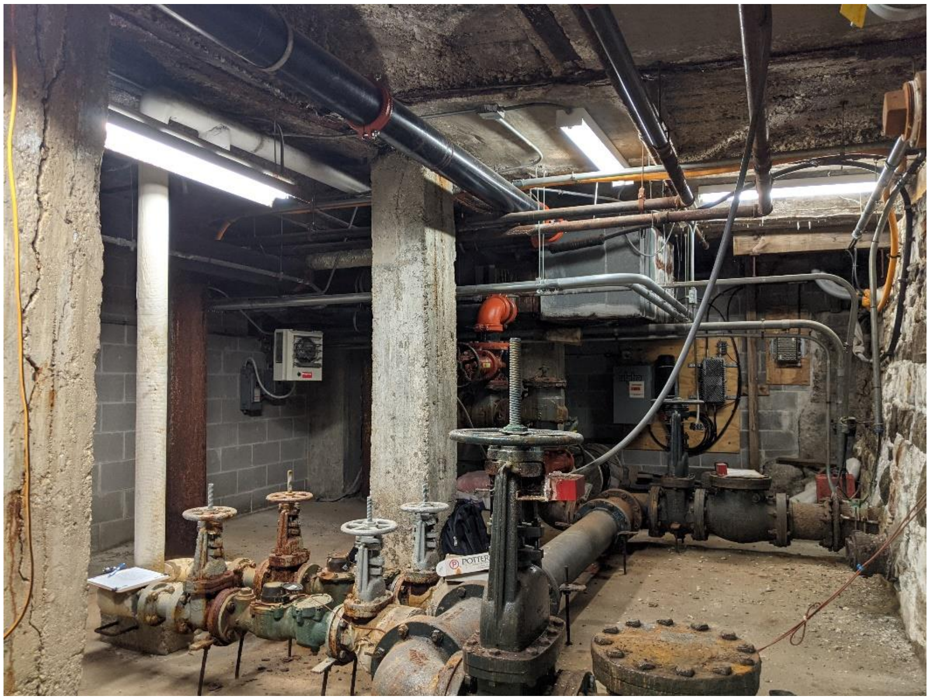

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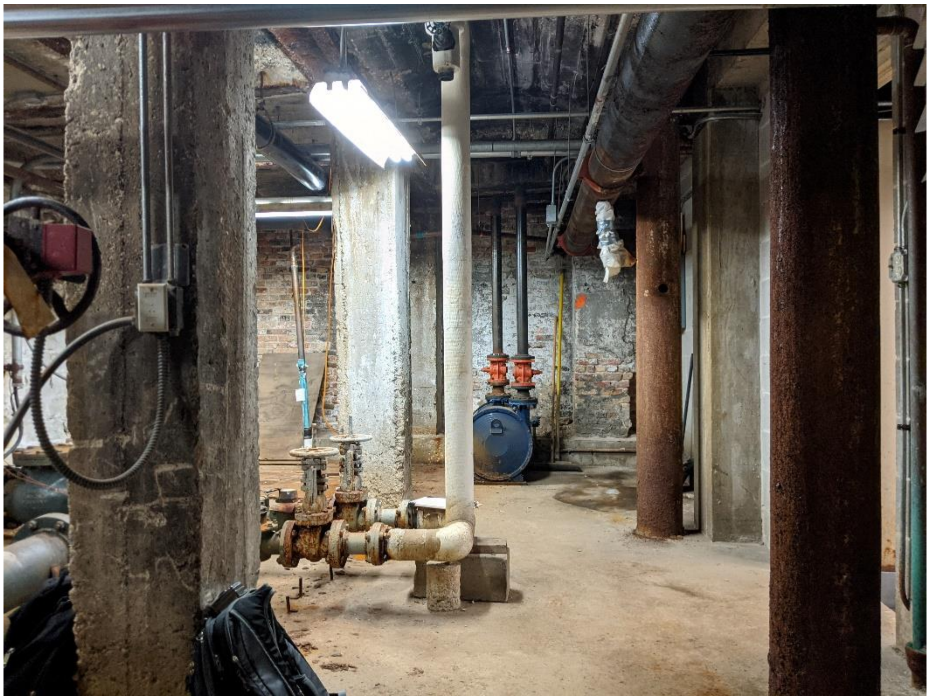

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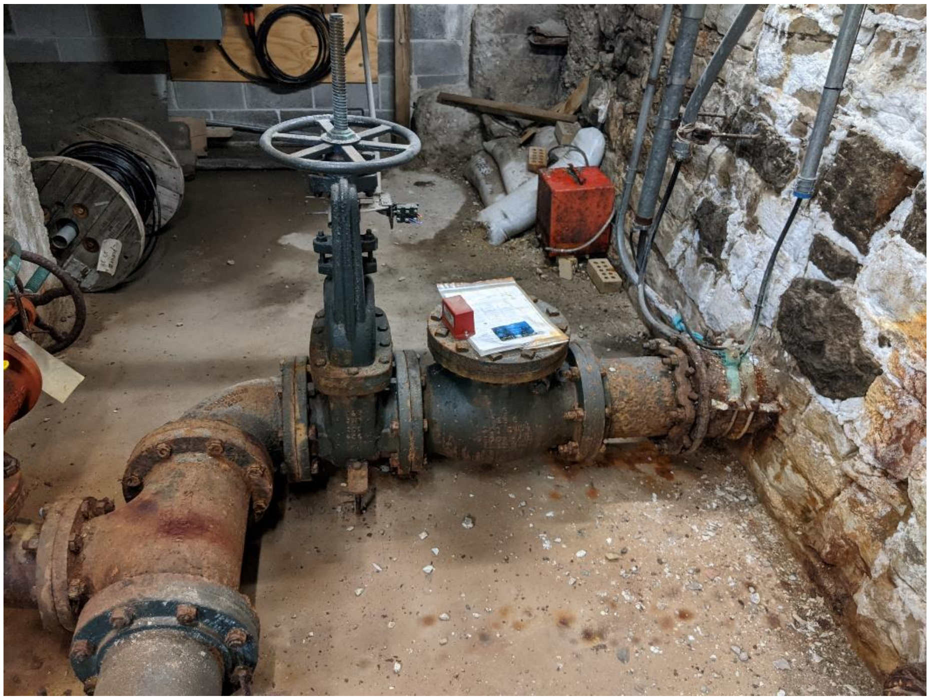

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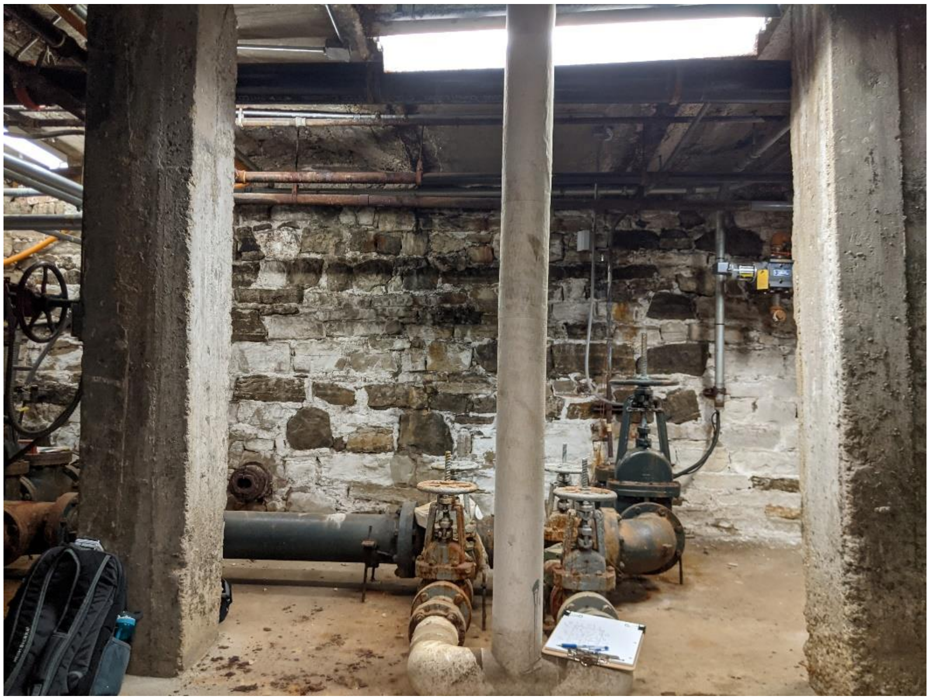

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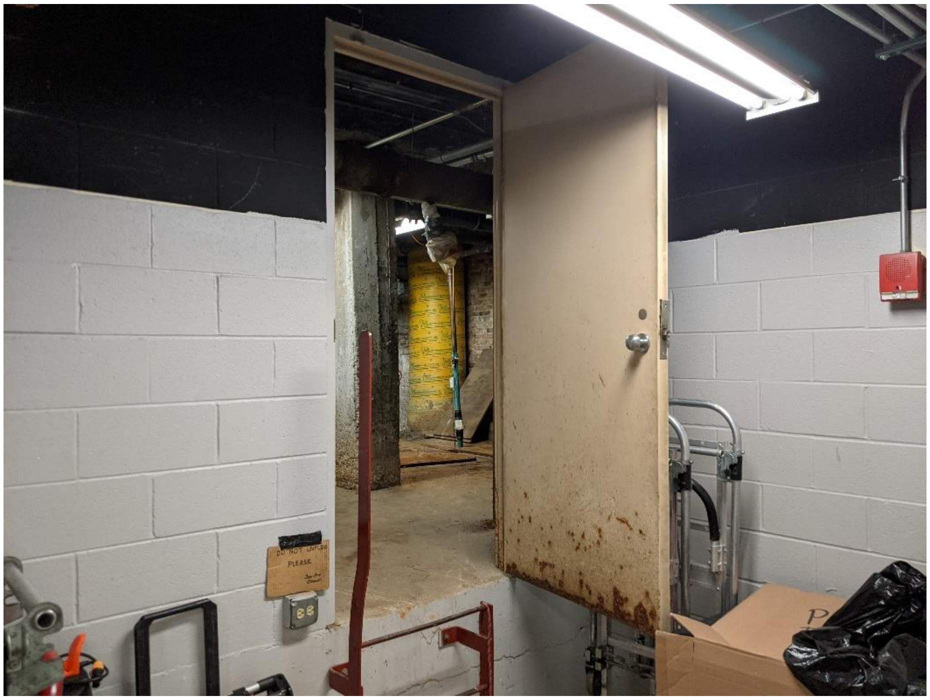

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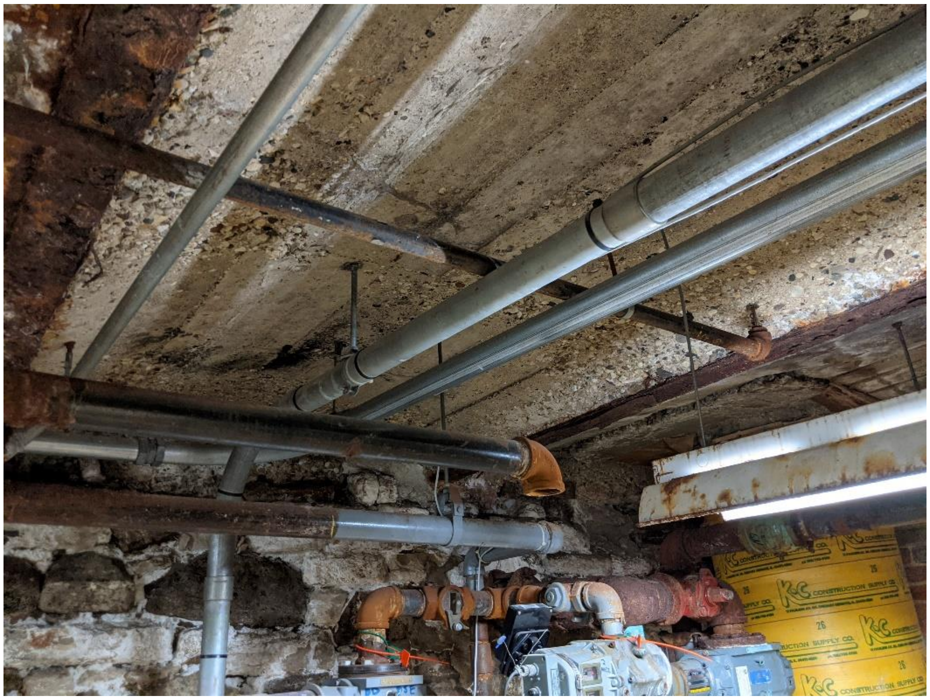

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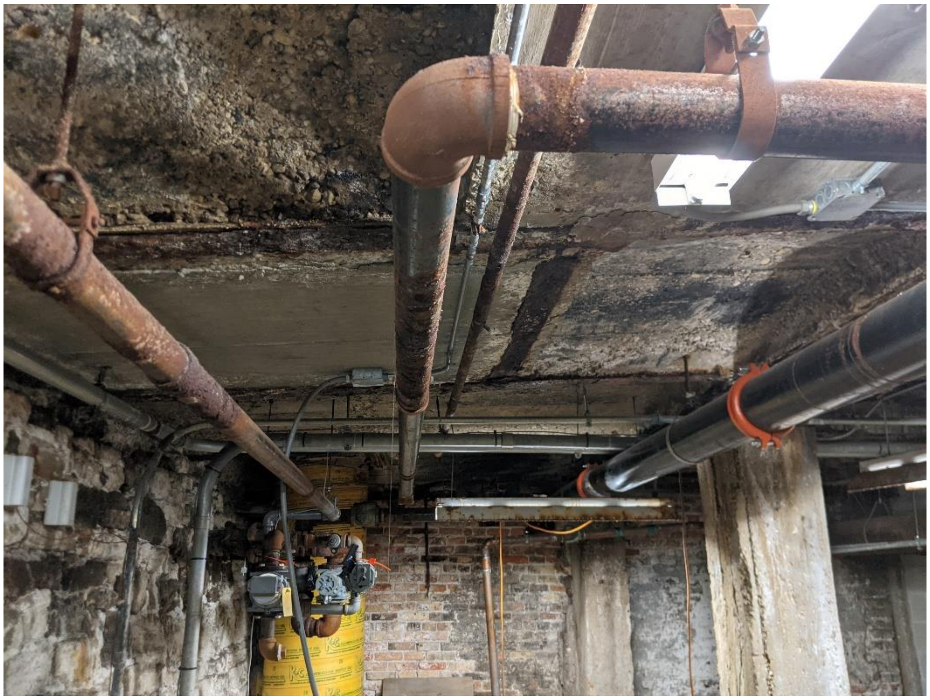

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Checked By: Date: Sheet No. 1/1

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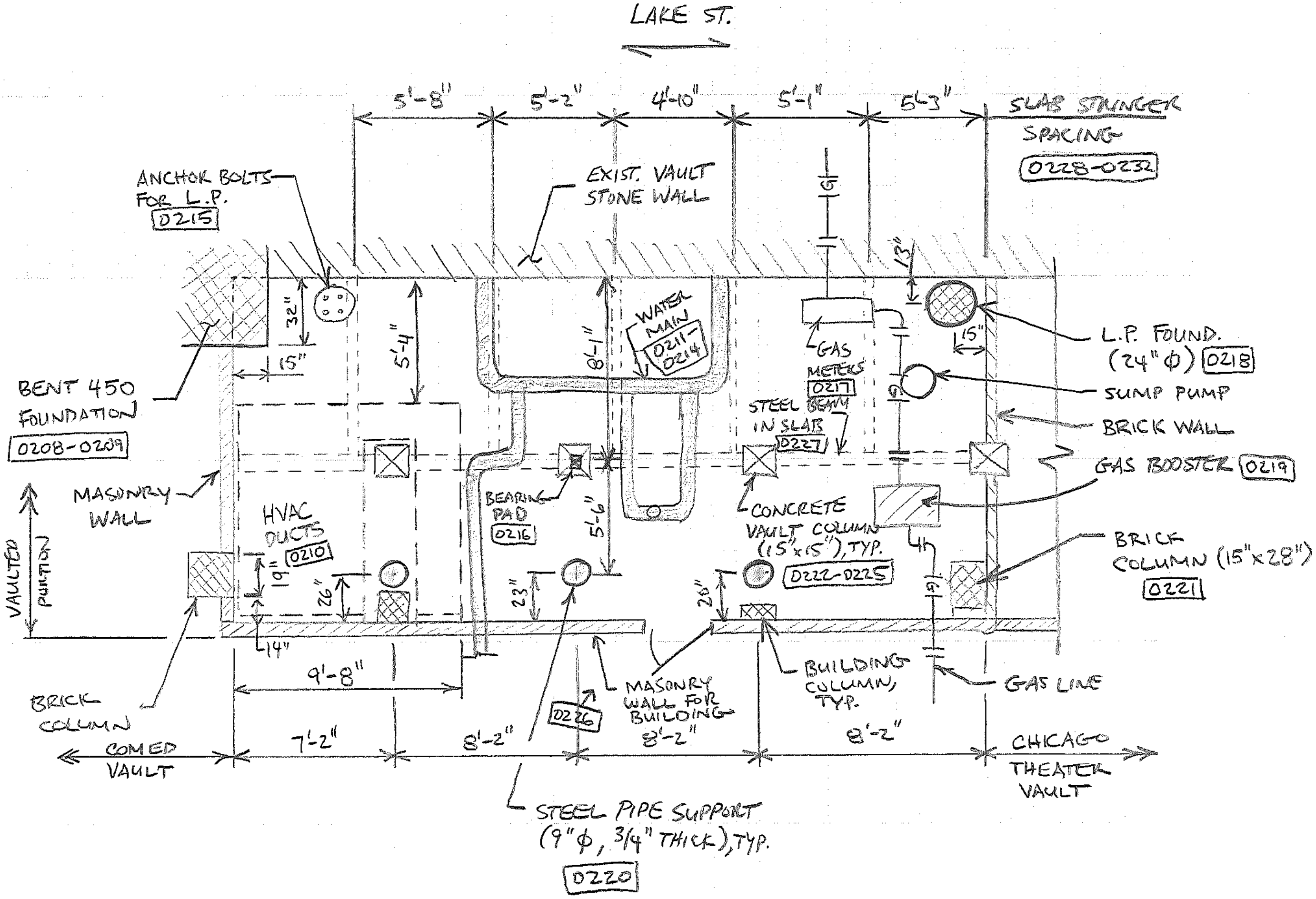

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201 N STATE ST

VAULTED SIDEWALK PHOTO LOG

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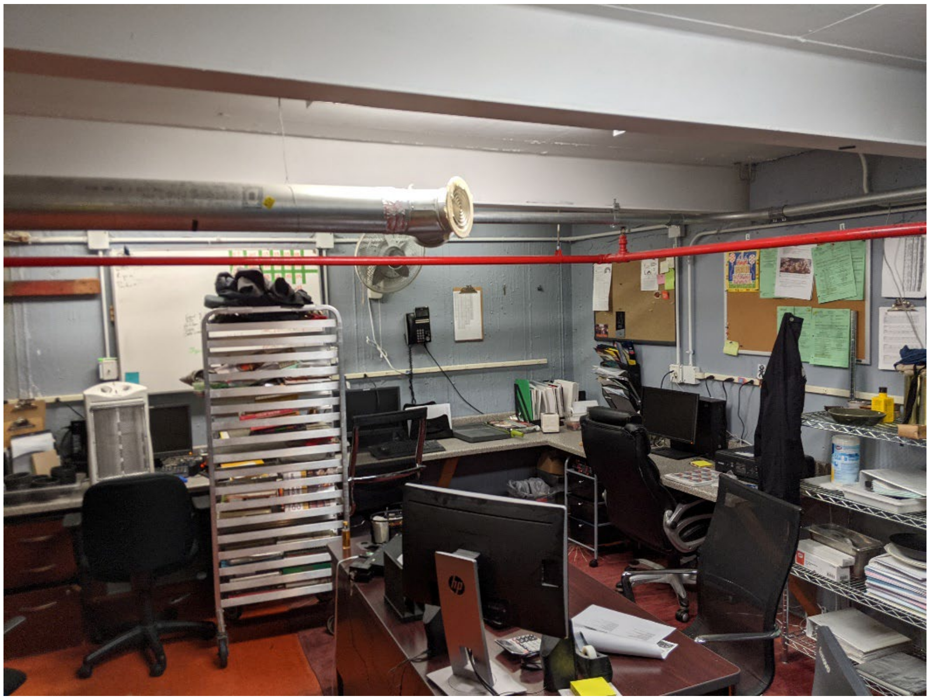

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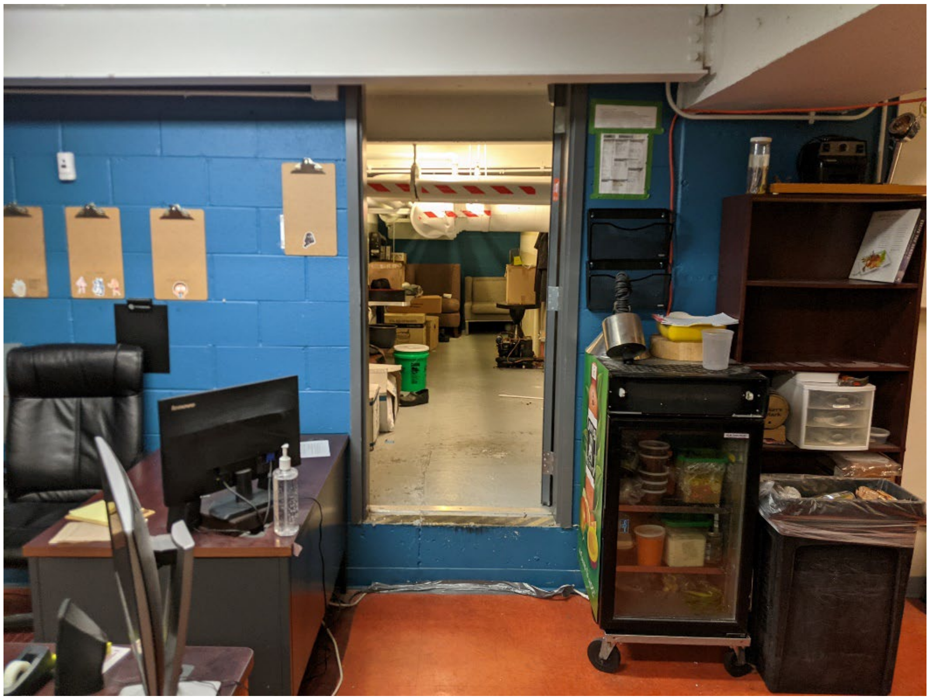

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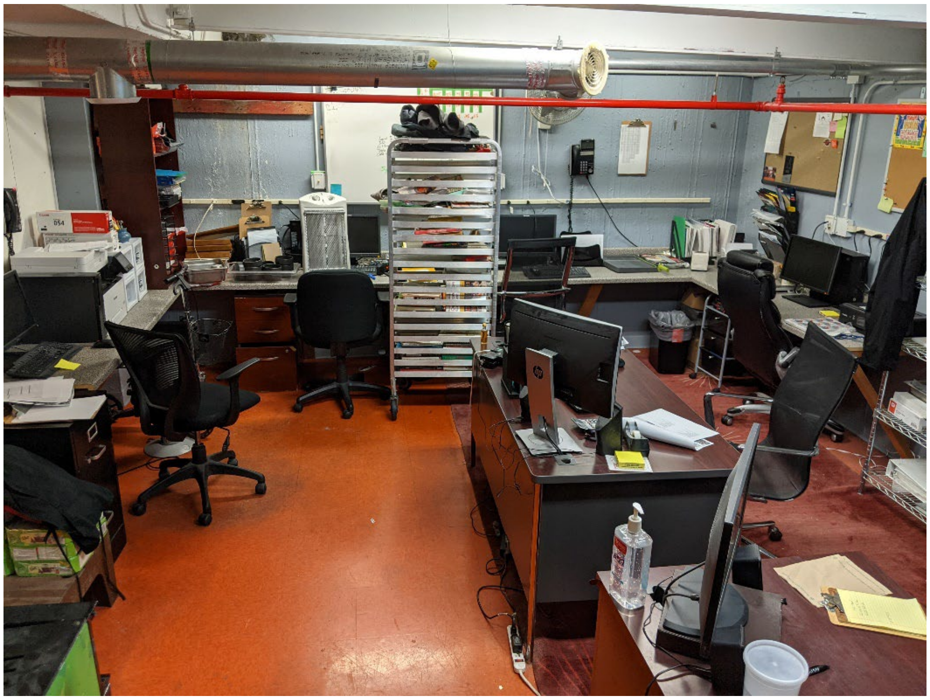

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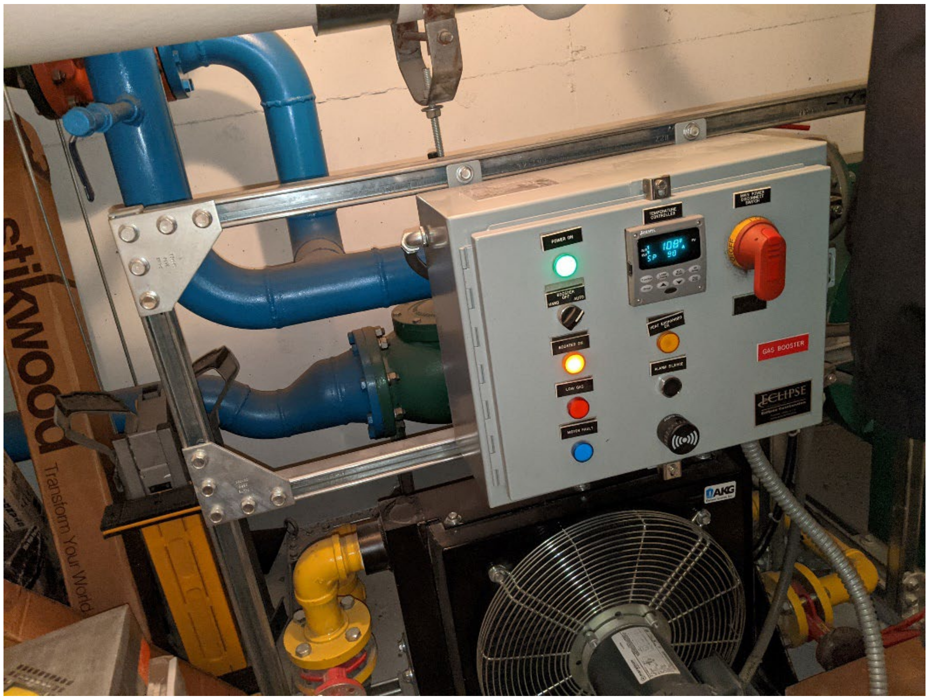

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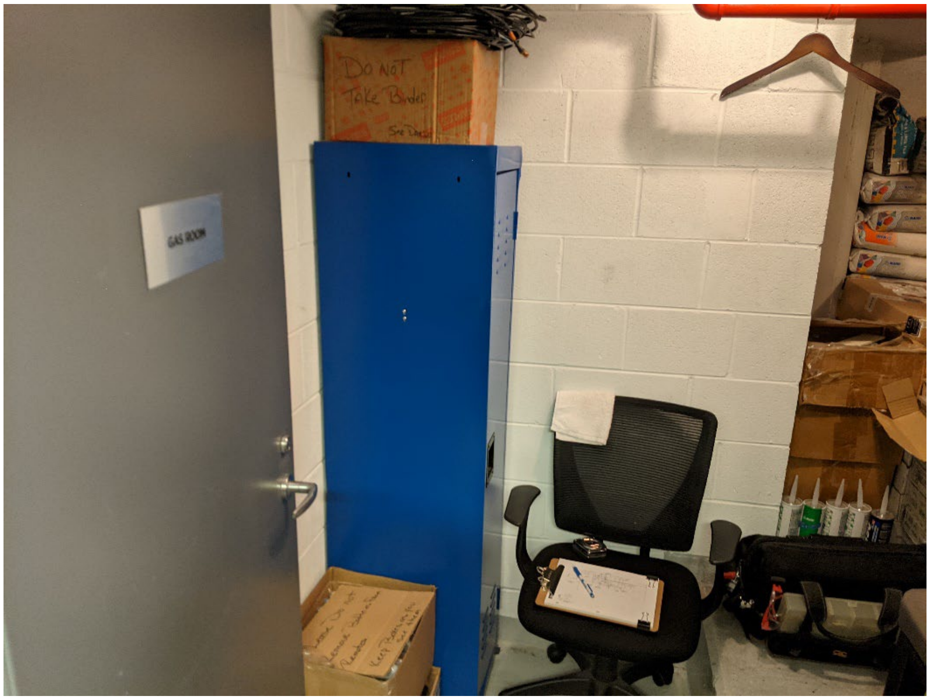

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APPENDIX G

SPECIALTY LIGHTING FIXTURES & CONTROLS

Specification Sheet

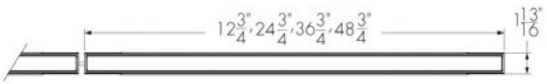
lumenfacade nano

LOGN

WHITE AND STATIC COLORS

Project Name ______________________________ **Qty** __________

Type __________ **Catalog / Part Number** ______________________________



Top view

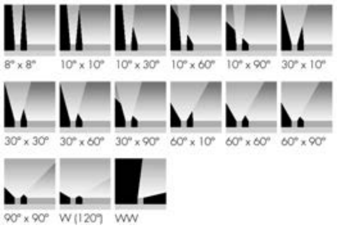
Front and side views

Photometric Summary

4ft, 4 W/ft, 4000K	Delivered output (lm)	Intensity (peak cd)
8°x8°	1,530	41,352
10°x10°	1,456	32,262
10°x30°	1,435	9,126
10°x60°	1,427	4,867
10°x90°	1,424	2,551
30°x10°	1,439	9,098
30°x30°	1,767	4,079
30°x60°	1,713	2,581
30°x90°	1,726	1,865
60°x10°	1,426	5,647
60°x60°	1,730	1,279
60°x90°	1,719	1,540
90°x90°	1,690	1,045
W (120°)	864	N/A
WW	1,524	7,393

Photometric performance is measured in compliance with IESNA LM 79-08.

Optics



Description

The Lumenfacade Nano White and Static Colors is a high-efficiency linear LED luminaire that goes where no facade lighting has gone before. Available in 12 in, 24 in, 36 in or 48 in sections, the Lumenfacade Nano is the right fit for general urban structures, historical buildings and those hardest to reach places. The Lumenfacade Nano packs all the bells and whistles of the larger members of the Lumenfacade family and can be configured with a wide number of options, including: optics for grazing, floodlighting or wall washing; a choice of outputs; various color temperatures or static colors; various mounting options, finishes, accessories and controls. The Lumenfacade Nano is also available with a unique asymmetric distribution, providing exceptional uniformity and brightness for walls and signage.

Features

Color and Color Temperature	2200K, 2700K, 3000K, 3500K, 4000K, Red, Green, Blue
Optics	8° x 8°, 10° x 10°, 10° x 30°, 10° x 60°, 10° x 90°, 30° x 10°, 30° x 30°, 30° x 60°, 30° x 90°, 60° x 10°, 60° x 60°, 60° x 90°, 90° x 90°, Wide 120°, Asymmetric Wallwash
Options	Corrosion-resistant coating for hostile environments
Power Consumption	2 W/ft, 4 W/ft
Warranty	5-year limited warranty

Performance

Delivered Output	884 lm (2 W/ft, 48 in fixture, 4000K, 30° x 30°, UCTL), 1,767 lm (4 W/ft, 48 in fixture, 4000K, 30° x 30°, UCTL)
Delivered Intensity	20,676 cd at nadir (2 W/ft, 48 in fixture, 4000K, 8° x 8°, UCTL), 41,352 cd at nadir (4 W/ft, 48 in fixture, 4000K, 8° x 8°, UCTL)
Illuminance at Distance	Minimum 1 fc at 144 ft (2 W/ft, 48 in fixture, 4000K, 8° x 8°, UCTL), Minimum 1 fc at 203 ft (4 W/ft, 48 in fixture, 4000K, 8° x 8°, UCTL)
Color Consistency	3 SDCM (2 SDCM for 8° x 8°, 10° x 10°, 10° x 30°, 10° x 60°, 10° x 90°, 30° x 10°, 60° x 10°, W and WW optics)

Specification Sheet

lumenfacade nano
LOGN
WHITE AND STATIC COLORS

Colors and Color Temperatures

●	●	●	●	●
2200K	2700K	3000K	3500K	4000K

🟥	🟩	🟦
Red	Green	Blue

Controls

ON/OFF UCTL

Ratings

IP66 IK08

Certifications

c UL us CE RoHS

Color Rendering	CRI 80+
Lumen Maintenance	L70 >90,000 hrs

Physical

Housing Material	Low copper content extruded aluminum
Lens Material	Clear tempered glass
Hardware Material	Stainless steel
End Cap Material	Machined aluminum
Gasket Material	Silicone
Surface Finish	Electrostatically applied polyester powder coat
Weight	1.4 lbs (12 in), 2.9 lbs (24 in), 4.4 lbs (36 in), 6 lbs (48 in)

Electrical and control

Voltage	48 VDC
Resolution (DMX/RDM)	Per fixture, 8-bit or 16-bit
Control	On/Off control, Universal control (compatible with 0-10V, DALI or DMX/RDM systems)

Environmental

Storage Temperature	-40 °F to 185 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-40 °F to 122 °F
Ingress Protection Rating	IP66
Impact Resistance Rating	IK08 (IK09 for 48 in fixtures)

Accessories (order separately)

Cables	Lumenfacade Nano Jumper Cable, Trunk Power Cable, Trunk Data Cable, Lumenfacade Nano Jumper Cable Joiner
Control Boxes	Low-Voltage Control Box, Low-Voltage Splitter Box
Optical Accessories	Lumenfacade Nano Radial Louver, Lumenfacade Nano Visor
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID

Specification Sheet

lumenfacade nano

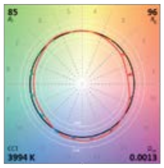
LOGN

WHITE AND STATIC COLORS

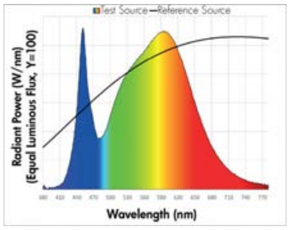
Chromaticity Data

TM-30 - 4000K

CCT	CIE		TM-30	
4000K	R_a	83	85	R_f
	R_9	14	96	R_g



Spectral Power Distribution



Optical option installation details

HFR - Half-frosted lens

- Always position frosted side toward the wall.
- Applicable for 8° x 8°, 10° x 10° or asymmetric wallwash optics only.

WW - Asymmetric wallwash

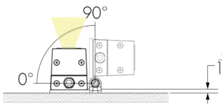
Recommended setback from wall is 1/10 of the wall height.

Example: 2 ft setback for a 20 ft wall.

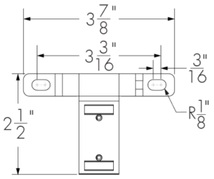
Mounting options

One mounting bracket provided for 12 in fixtures. Two mounting brackets provided for 24 in, 36 in and 48 in fixtures. See installation instructions for details.

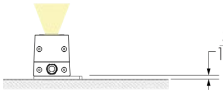
SAMN - Slim Adjustable Mounting Nano



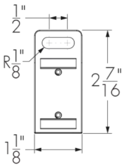
SAMN - Mounting hole pattern



UMPN - Fixed Mounting Nano



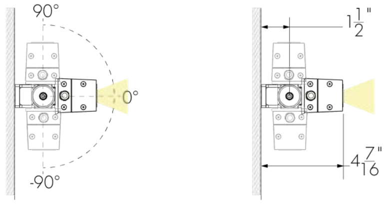
UMPN - Mounting hole pattern



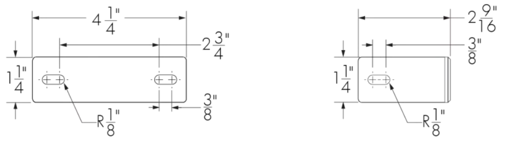
Specification Sheet

lumenfacade nano
LOGN
WHITE AND STATIC COLORS

UMASN - Universal Adjustable Mounting Nano



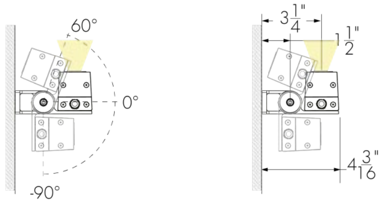
UMASN - Mounting hole pattern



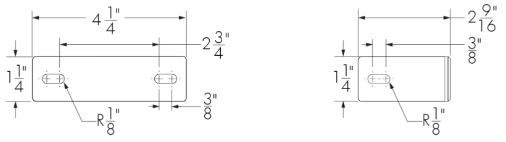
For 1 ft fixtures

For 2 ft, 3 ft and 4 ft fixtures

WAMN2 - Adjustable Extended Arm Mounting Nano 2 in



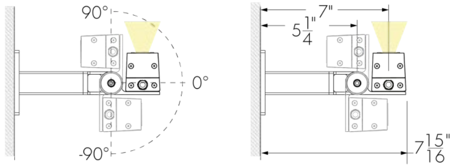
WAMN2 - Mounting hole pattern



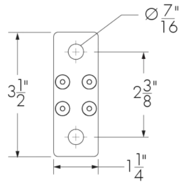
For 1 ft fixtures

For 2 ft, 3 ft and 4 ft fixtures

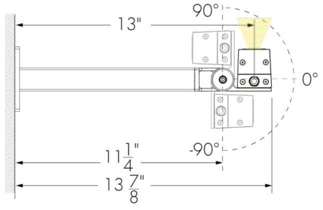
WAMN6 - Adjustable Extended Arm Mounting Nano 6 in



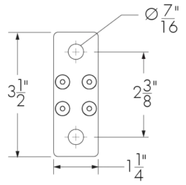
WAMN6 - Mounting hole pattern



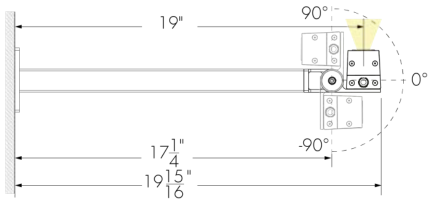
WAMN12 - Adjustable Extended Arm Mounting Nano 12 in



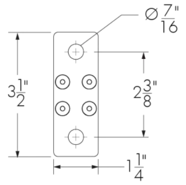
WAMN12 - Mounting hole pattern



WAMN18 - Adjustable Extended Arm Mounting Nano 18 in



WAMN18 - Mounting hole pattern

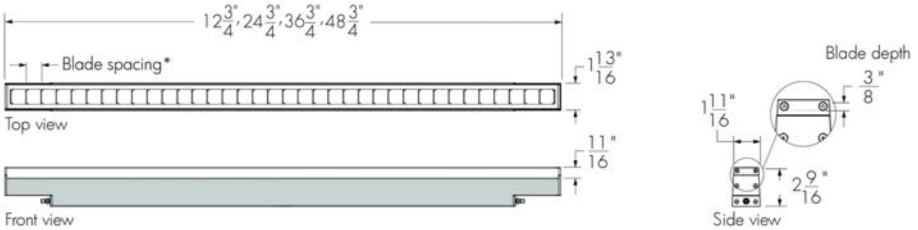


Specification Sheet

lumenfacade nano
LOGN
WHITE AND STATIC COLORS

Optical accessories (order separately)

LOGNRD - Radial louver for Lumenfacade Nano



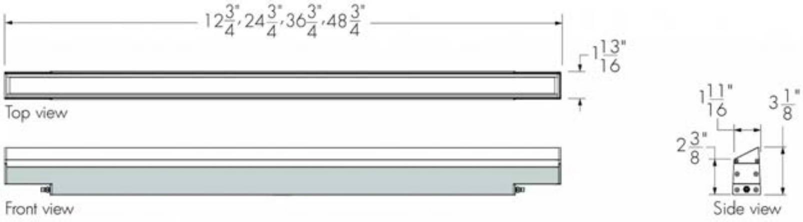
*15/16 in blade spacing for 8° x 8°, 10° x 10°, 10° x 30°, 10° x 60°, 10° x 90°, 30° x 10° and 60° x 10° optics.
*1 15/16 in blade spacing for 30° x 30°, 30° x 60°, 30° x 90°, 60° x 60°, 60° x 90° and 90° x 90° optics.

LOGNRD-**LENGTH-FINISH-OPTIONS**

Please specify:
LENGTH: 12 in, 24 in, 36 in or 48 in; **FINISH**: BK - Black Sandtex®, BRZ - Bronze Sandtex®, SI - Silver Sandtex®, WH - Smooth white or CC - custom color and finish (please specify RAL color); **OPTIONS**: CRC - Corrosion-resistant coating for hostile environments

- The addition of a louver will affect beam distribution. Consult factory for application support.
- Not suitable for wide 120° and asymmetric wallwash optics.
- Maximum one accessory per fixture. Louvers are field installable.

LOGNVS - Visor for Lumenfacade Nano



LOGNVS-**LENGTH-FINISH-OPTIONS**

Please specify:
LENGTH: 12 in, 24 in, 36 in or 48 in; **FINISH**: BK - Black Sandtex®, BRZ - Bronze Sandtex®, SI - Silver Sandtex®, WH - Smooth white or CC - custom color and finish (please specify RAL color); **OPTIONS**: CRC - Corrosion-resistant coating for hostile environments

- The addition of a visor will affect beam distribution. Consult factory for application support.
- Not suitable for wide 120° optic.
- Maximum one accessory per fixture. Visors are field installable.

Cables (order separately)

LOGNJC - Jumper cable for Lumenfacade Nano

For minimal spacing between fixtures, use a 1 ft jumper cable.

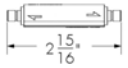
LOGNJC-**CERTIFICATION-LENGTH-CABLE COLOR**

Please specify:
CERTIFICATION: UL or CE; **LENGTH**: 1 ft to 30 ft (available in 1 ft increments) or 50 ft; **CABLE COLOR**: black or white (connectors are the same color as the specified cable color).

- Suitable for dimming/data and non-dimming applications.
- Consult Lumenfacade Nano jumper cable specification sheet for all available cable lengths and additional information.

Joiner (order separately)

LOGNJC-JOINER - Joiner for Lumenfacade Nano Jumper Cable



- Use joiners to connect and lengthen jumper cables.
- Joiners add voltage drops. Consult factory to confirm impact on run lengh.
- Available in black.

Resolution details

DMX/RDM control, resolution per fixture: each fixture is addressed independently
DMX addresses:

UCTL control option

- 48 in fixtures shown.
- Applicable for UCTL control only. A DMX/RDM enabled LCBX or LSBX is required for DMX/RDM control

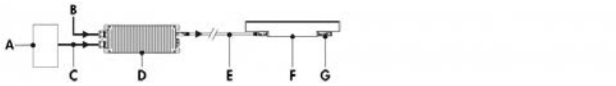
Specification Sheet

lumenfacade nano
LOGN

WHITE AND STATIC COLORS

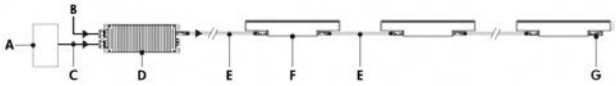
UCTL - Universal control

Single unit - LCBX 60W



A - Dimmer/controller (order separately from Lumenpulse, or by others)
B - Power input (120-277V, wiring by others)
C - Data input (wiring by others)
D - LCBX (60W)
E - Jumper cable (LOGNJC)
F - Lumenfacade Nano
G - Terminator cap

Continuous run - LCBX 60W or 120W

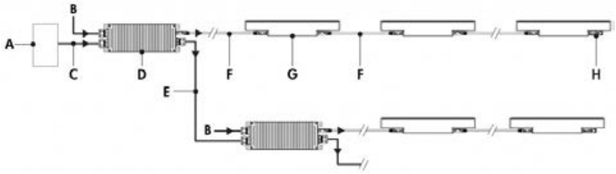


A - Dimmer/controller (order separately from Lumenpulse, or by others)
B - Power input (120-277V, wiring by others)
C - Data input (wiring by others)
D - LCBX (60W or 120W)
E - Jumper cable (LOGNJC)
F - Lumenfacade Nano
G - Terminator cap

Continuous run - LCBX 200W

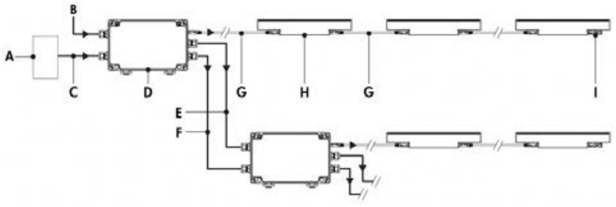
A - Dimmer/controller (order separately from Lumenpulse, or by others)
B - Power input (120-277V, wiring by others)
C - Data input (wiring by others)
D - LCBX (200W)
E - Jumper cable (LOGNJC)
F - Lumenfacade Nano
G - Terminator cap

Continuous run - Daisy chain
LCBX 60W or 120W



A - Dimmer/controller (order separately from Lumenpulse, or by others)
B - Power input (120-277V, wiring by others)
C - Data input (wiring by others)
D - LCBX (60W or 120W)
E - Data output to next LCBX (wiring by others)
F - Jumper cable (LOGNJC)
G - Lumenfacade Nano
H - Terminator cap

Continuous run - Daisy chain
LCBX 200W



A - Dimmer/controller (order separately from Lumenpulse, or by others)
B - Power input (120-277V, wiring by others)
C - Data input (wiring by others)
D - LCBX (200W)
E - Power output to next LCBX (120-277V, wiring by others)
F - Data output to next LCBX (wiring by others)
G - Jumper cable (LOGNJC)
H - Lumenfacade Nano
I - Terminator cap

Maximum Run of Fixtures per LCBX 60W, Lumenfacade Nano® LOGN White & Static Colors

Wattage	**2W/ft**	**4W/ft**
Maximum Run of Fixtures per LCBX 60W*	28ft	12ft

Maximum Run of Fixtures per LCBX 120W, Lumenfacade Nano® LOGN White & Static Colors

Wattage	**2W/ft**	**4W/ft**
Maximum Run of Fixtures per LCBX 120W*	52ft	24ft

Maximum Run of Fixtures per LCBX 200W, Lumenfacade Nano® LOGN White & Static Colors

Wattage	**2W/ft**	**4W/ft**
Maximum Run of Fixtures per LCBX 200W*	76ft	40ft

Based on 50ft jumper cable.
*Example: 2W/ft = 76ft maximum run of end to end fixtures per LCBX 200W (19 fixtures maximum for 4ft LOGN 2W/ft).

- Consult factory for specific applications and maximum fixture count/run length recommendations.
- For installations of 600W or more, consult factory to select the optimal system: either a daisy chain continuous run system with LCBXs or a trunk system with LSBXs.
- Maximum of 1 output to fixture, or fixture run, per LCBX.
- Consult the LCBX specification sheet for more information.
- UCTL can be controlled via a 0-10V dimmer, DALI controller or DMX/RDM controller.
- For 0-10V dimming applications:

- 0-10V mA ratings: Current Sink Mode: 25µA per LCBX; Current Source Mode: 2.5mA per LCBX.

- For DALI applications:

- A maximum of 64 DALI fixtures per DALI loop.

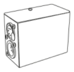
- For DMX/RDM applications:

- Each fixture requires 1 DMX channel.
- A maximum of 128 UCTL devices on the output port of the LCBX.

- 1% minimum dimming value.
- 2W version: 2 W/ft; 4W version: 4 W/ft.

Diagnostic and addressing tools (order separately)

LID - LumenID



LumenID is a diagnostic and addressing DMX/RDM tool. It must be specified on all DMX applications. Consult LID specification sheet for details.

Specification Sheet

lumenfacade nano
LOGN

WHITE AND STATIC COLORS

How to order

Housing	Wattage	Voltage	Length	Color and Color Temperature (2)	Optics
LOGN Lumenfacade™ Nano	**2W** 2 W/ft (1) **4W** 4 W/ft	**48V** 48 VDC	**12** 12 3/4 in (1.4 lbs) **24** 24 3/4 in (2.9 lbs) **36** 36 3/4 in (4.4 lbs) **48** 48 3/4 in (6 lbs)	**22K** 2200K **27K** 2700K **30K** 3000K **35K** 3500K **40K** 4000K **RD** Red (3) **GR** Green (3) **BL** Blue (3)	**8x8** 8° x 8° **10x10** 10° x 10° **10x30** 10° x 30° **10x60** 10° x 60° **10x90** 10° x 90° **30x10** 30° x 10° **30x30** 30° x 30° **30x60** 30° x 60° **30x90** 30° x 90° **60x10** 60° x 10° **60x60** 60° x 60° **60x90** 60° x 90° **90x90** 90° x 90 **W** Wide 120° (4) **WW** Asymmetric Wallwash (5)

Notes:

1. Not available for static red, green or blue color options.
2. Consult factory for availability of static Royal Blue, 6500K and 90+ CRI.
3. Static colors made to order 8-10 weeks.
4. Not compatible with louver or visor optical accessories.
5. Not compatible with louver optical accessory.

Specification Sheet

lumenfacade nano

LOGN

WHITE AND STATIC COLORS

How to order

Lens	Mounting Options (9)	Finish	Control (13)	Options	Certification
CL Clear lens (6) **FR** Frosted lens (7) **HFR** Half-frosted lens (8)	**SAMN** Slim Adjustable Mounting Nano **UMPN** Fixed Mounting Nano **UMASN** Universal Adjustable Mounting Nano **WAMN2** Adjustable Wall Mounting Nano 2 in **WAMN6** Adjustable Extended Arm Mounting Nano 6 in **WAMN12** Adjustable Extended Arm Mounting Nano 12 in **WAMN18** Adjustable Extended Arm Mounting Nano 18 in	**BK** Black Sandtex® **BRZ** Bronze Sandtex® **SI** Silver Sandtex® **WH** Smooth white **CC** Custom color and finish (please specify RAL color) (10) (11) (12)	**NO** On/Off control **UCTL** Universal control (compatible with 0-10V, DALI or DMX/RDM systems)	**CRC** Corrosion-resistant coating for hostile environments (14) (15)	**UL** UL compliant **CE** CE compliant

Notes:

6. Not available for 8x8, 10x10, W or WW optics.
7. Not available for WW optic.
8. Available for 8x8, 10x10 or WW optics only.
9. One mounting bracket provided for 12 in fixtures. Two mounting brackets provided for 24 in, 36 in and 48 in fixtures.
10. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
11. Setup charges apply for RAL colors. Consult factory for details.
12. Longer lead times can be expected for custom RAL color finishes.
13. A Low-Voltage Control Box (LCBX) or Low-Voltage Splitter Box (LSBX) and LumenID (LID) must be specified.
14. Use only when exposed to salt spray. This option is not required for normal outdoor exposure.
15. Setup charges apply. Consult factory for details.

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

PROFILE

LIGHT SOURCE	3.5 W/FT, 9.0 W/FT, 17.0 W/FT
OPTICS	7° X 60°, 10° X 10°, 10° X 60°, 10° X 90°, 20° X 20°, 20° X 60°, 40° X 40°, 40° X 60°, 40° X 90°, 60° X 60°, 90° X 90° 80° X 80°, ASY
CCT	27K, 30K, 35K, 40K, RED, GREEN, BLUE, AMBER
CRI	82 (OPTIONAL 90+)
PERFORMANCE	UP TO 117530 PEAK CANDELA
VOLTAGE	UNIVERSAL 120-277 V
POWER	REMOTE POWER SUPPLY
CONTROL	0-10V, DMX, LUTRON HI-LUME
DIMENSIONS	1.85" X 2.00"
HOUSING	PRECISION EXTRUDED ALUMINUM
LENS	HIGH DENSITY TEMPERED GLASS
FINISH	HIGH DURABILITY POWDER COATING
OPERATING TEMP	-20° C TO 50° C
WARRANTY	5-YEAR LIMITED
LUMEN MAINTENANCE	75,000 HOURS
CERTIFICATION	ETL AND cETL FOR IP67, IK07, 5G/3G OPTIONS

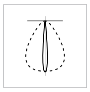
Intertek RoHS made in USA IP67 IK07 3G ANSI C136.3 5G ANSI C136.31

STANDARD FINISHES

TEXTURED WHITE	TEXTURED BLACK	TEXTURED BRONZE	TEXTURED L. BRONZE	TEXTURED GRAY	TEXTURED S. STONE

OPTICS

Not all available optics shown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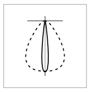
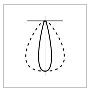
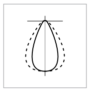
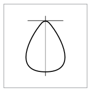

10°x 60°


20°x 60°


40°x 60°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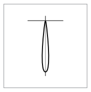
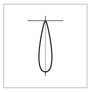
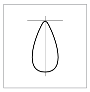

10°x 10°


20°x 20°


40°x 40°

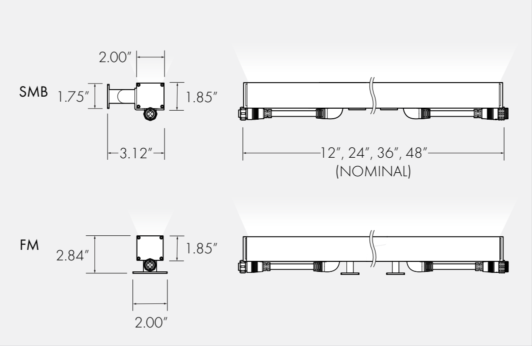
PERFORMANCE SAMPLE

Go to Performance Data >

40K, HO, 48.00"	10°X 10°	10°X 60°	20°X 20°	80°X 80°	100°
LUMENS	6316	5417	6475	6161	6459
CANDELA	117530	19943	52385	3960	2739
EFFICACY	91.2 LM/W	77.3 LM/W	93.3 LM/W	88.8 LM/W	94.4 LM/W

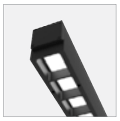
PROFILE

Go to Fixture Dimensions >



OPTIONS

*Shown with white diffusing lense


LOUVER


DIRECT VIEW DOME LENS


CONCEALED WIRING


VISOR

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

SPECIFICATION

Separate options with dashes

MER								
1	2	3	4	5	6	7	8	9

1 FIXTURE

MEDLEY EXTERIOR REMOTE	MER	

2 WATTAGE

LOW OUTPUT	LO	3.5 W/FT
MEDIUM OUTPUT	MO	9.0 W/FT
HIGH OUTPUT	HO	17.0 W/FT

3 CCT

2700K	27K
3000K	30K
3500K	35K
4000K	40K
RED	R
GREEN	G
BLUE	B
AMBER	A

4 OPTIC

7° X 60°	760	
10° X 10°	1010	10° X 10° optic is intended for a 6.00" fixture setback from the surface
10° X 60°	1060	
10° X 90°	1090	
20° X 20°	2020	
20° X 60°	2060	
20° X 90°	2090	
40° X 40°	4040	
40° X 60°	4060	
40° X 90°	4090	
60° X 60°	6060	
60° X 90°	6090	
80° X 80°	8080	
100° X 100°	100	
ASYMMETRIC DIRECT	AD	Direct = down-light Asymmetric distribution is intended for a wall height of 10.0 FT to 12.0 FT with the fixture setback 18.00" from the wall
ASYMMETRIC INDIRECT	AI	Indirect = up-light Asymmetric distribution is intended for a wall height of 10.0 FT to 12.0 FT with the fixture setback 18.00" from the wall

5 MOUNTING

SURFACE MOUNT	SM	5G Ansi C136.31 rated
GROUND MOUNT	GM	
EXTENDED ARM	EA-X	X = extended arm length specify 6", 12" or 18" 6.00" arm is 3G Ansi C136.3 rated
EXTENDED ARM, BACK	EAB-X	X = extended arm length specify 6", 12" or 18"
SURFACE BACK MOUNT	SMB	
FIXED MOUNT	FM	
END MOUNT	EM	Not intended for continuous run applications
STAKE MOUNT	STM	

6 FIXTURE LENGTH

12"	12
24"	24
36"	36
48"	48

Nominal lengths

7 CONTROL OPTIONS

NO DIMMING	NO	
0-10V DIMMING (1%)	DIM	
DMX DIMMING	DMX	DMX controls are required and must be ordered seperately **DMX Programming Kit** required - see below
LUTRON	L3DOE	L3D0E - Hi-lume Premier 0.1% EcoSystem 24V constant voltage LED driver with Soft-on, Fade to Black dimming technology All power supplies must be ordered - see below

8 FINISH

TEXTURED WHITE	TW	
TEXTURED BLACK	TB	
TEXTURED BRONZE	TBR	
TEXTURED LIGHT BRONZE	TLB	
TEXTURED GRAY	TG	
TEXTURED SANDSTONE	TS	
ANODIZED ALUMINUM	AA	Includes CRF finish
CUSTOM COLOR	CC	Contact factory for custom color - additional charges will apply

9 OPTIONS

HIGH CRI, 90+	HCRI	
LOUVER	LV	Field installable snooted louver LLF of 10% -15% depending on color
VISOR	VS	Field installable visored louver LLF of 10% -15% depending on color
DIRECT VIEW DOME LENS	DVD	Field installable Only available with 100° X 100°
WHITE LENS	WL	LLF OF 30% Only available with 100° X 100°
CONCEALED WIRING	CW	Not available with 12" fixtures
WHITE CABLING	WC	White cabling is standard with textured white finish
CORROSION RES. FINISH	CRF	Recommended for coastal or extreme exterior environments

POWER SUPPLY & CONTROL ORDER OPTIONS

Go to DMX Guide >

REMOTE POWER SUPPLY OPTIONS - WET LOCATION - REQUIRED

CONTRA EXTERIOR LOW POWER, 96W OUTPUT (120V-277V)	CEL
CONTRA EXTERIOR STANDARD POWER, 240W OUTPUT (120V-277V)	CES
CONTRA EXTERIOR HIGH POWER, (2)-240W OUTPUT (120V-277V)	CEH

Above wattage is based on 75% of the Power Supply's total wattage capacity
See page 3 for maximum fixture per power supply.
For specific and case by case requirements, please contact factory for assistance

DMX DISTRIBUTION & PROGRAMMING KIT - REQUIRED

DMX/RDM DISTRIBUTION KIT (4 OUTPUTS) - IP67	CDS-RDM

DMX/RDM **Distribution Kit** consists of four outputs
Each output is limited to (1) run per output - up to 32 fixtures max
Four terminators are included for end of line termination

EXTERIOR LEADER CABLE - REQUIRED

Go to Cable Guide >

5.0 FT LEADER CABLE	LC-5

A leader cable is required for each single fixture and for each fixture run for connection from the first fixture to the j-box
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) fixture finish is selected

EXTERIOR JUMPER CABLES

1.0 FT JUMPER CABLE	JC-1
2.0 FT JUMPER CABLE	JC-2
5.0 FT JUMPER CABLE	JC-5
10.0 FT JUMPER CABLE	JC-10
25.0 FT JUMPER CABLE	JC-25

Required if fixtures are not mounted in an end-to-end continuous manner and for line voltage only
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) fixture finish is selected

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

PERFORMANCE

Nominal lengths

CCT AND LENGTH	OPTIC	LOW OUTPUT (3.5 W/FT)			MEDIUM OUTPUT (9.0 W/FT)			HIGH OUTPUT (17.0 W/FT)		
		DELIVERED LUMENS	LUMINARE EFFICACY	PEAK CANDELA	DELIVERED LUMENS	LUMINARE EFFICACY	PEAK CANDELA	DELIVERED LUMENS	LUMINARE EFFICACY	PEAK CANDELA
4000K 24"	7° X 60°	998 LM	107.0 LM/W	3662	1685 LM	110.0 LM/W	6189	3366 LM	98.0 LM/W	12363
	10° X 10°	932 LM	100.5 LM/W	17011	1566 LM	103.0 LM/W	28686	3158 LM	91.2 LM/W	58765
	10° X 60°	804 LM	86.6 LM/W	2905	1348 LM	88.4 LM/W	4871	2709 LM	77.3 LM/W	9972
	20° X 20°	948 LM	102.1 LM/W	7658	1601 LM	102.4 LM/W	12983	3238 LM	93.3 LM/W	26193
	20° X 60°	862 LM	92.8 LM/W	1893	1451 LM	96.2 LM/W	3207	2914 LM	84.6 LM/W	6379
	40° X 40°	1001 LM	108.0 LM/W	1395	1688 LM	111.0 LM/W	2338	3392 LM	98.8 LM/W	4733
	40° X 60°	896 LM	96.7 LM/W	724	1497 LM	98.6 LM/W	1211	3039 LM	88.1 LM/W	2470
	60° X 60°	993 LM	107.1 LM/W	882	1666 LM	109.3 LM/W	1485	3354 LM	97.7 LM/W	2999
	80° X 80°	912 LM	98.2 LM/W	585	1525 LM	100.1 LM/W	976	3081 LM	88.8 LM/W	1980
	100° X 100°	620 LM	86.8 LM/W	263	1964 LM	93.3 LM/W	829	3230 LM	94.4 LM/W	1370
	ASY	888 LM	96.3 LM/W	3134	1473 LM	97.8 LM/W	5199	2890 LM	88.2 LM/W	9369
4000K 36"	7° X 60°	1496 LM	107.0 LM/W	5492	2527 LM	110.0 LM/W	9283	5048 LM	98.0 LM/W	18544
	10° X 10°	1398 LM	100.5 LM/W	25516	2349 LM	103.0 LM/W	43029	4737 LM	91.2 LM/W	88148
	10° X 60°	1205 LM	86.6 LM/W	4357	2022 LM	88.4 LM/W	7306	4063 LM	77.3 LM/W	14957
	20° X 20°	1421 LM	102.1 LM/W	11486	2402 LM	102.4 LM/W	19474	4856 LM	93.3 LM/W	39289
	20° X 60°	1292 LM	92.8 LM/W	2840	2177 LM	96.2 LM/W	4810	4371 LM	84.6 LM/W	9569
	40° X 40°	1502 LM	108.0 LM/W	2093	2531 LM	111.0 LM/W	3506	5088 LM	98.8 LM/W	7100
	40° X 60°	1344 LM	96.7 LM/W	1086	2245 LM	98.6 LM/W	1817	4559 LM	88.1 LM/W	3704
	60° X 60°	1489 LM	107.1 LM/W	1322	2499 LM	109.3 LM/W	2228	5031 LM	97.7 LM/W	4499
	80° X 80°	1368 LM	98.2 LM/W	877	2287 LM	100.1 LM/W	1464	4621 LM	88.8 LM/W	2970
	100° X 100°	929 LM	86.8 LM/W	394	2946 LM	93.3 LM/W	1244	4844 LM	94.4 LM/W	2054
	ASY	1332 LM	96.3 LM/W	4700	2209 LM	97.8 LM/W	7798	4335LM	88.2 LM/W	14053
4000K 48"	7° X 60°	1995 LM	107.0 LM/W	7323	3369 LM	110.0 LM/W	12377	6731 LM	98.0 LM/W	24725
	10° X 10°	1864 LM	100.5 LM/W	34021	3132 LM	103.0 LM/W	57372	6316 LM	91.2 LM/W	117530
	10° X 60°	1607 LM	86.6 LM/W	5809	2696 LM	88.4 LM/W	9741	5417 LM	77.3 LM/W	19943
	20° X 20°	1895 LM	102.1 LM/W	15315	3202 LM	102.4 LM/W	25965	6475 LM	93.3 LM/W	52385
	20° X 60°	1723 LM	92.8 LM/W	3786	2902 LM	96.2 LM/W	6413	5828 LM	84.6 LM/W	12758
	40° X 40°	2002 LM	108.0 LM/W	2790	3375 LM	110.7 LM/W	4675	6784 LM	98.8 LM/W	9466
	40° X 60°	1792LM	96.7 LM/W	1448	2993 LM	98.6 LM/W	2422	6078 LM	88.1 LM/W	4939
	60° X 60°	1985 LM	107.1 LM/W	1763	3332 LM	109.3 LM/W	2970	6708 LM	97.7 LM/W	5998
	80° X 80°	1824 LM	98.2 LM/W	1169	3049 LM	100.1 LM/W	1952	6161 LM	88.8 LM/W	3960
	100° X 100°	1239 LM	86.8 LM/W	525	3928 LM	93.3 LM/W	1658	6459 LM	94.4 LM/W	2739
	ASY	1776 LM	96.3 LM/W	6267	2945 LM	97.8 LM/W	10397	5780 LM	88.2 LM/W	18787

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

WIRING

MAXIMUM FIXTURES PER POWER SUPPLY (CIRCUITS MAY NOT BE LOADED OVER 10 AMPS)

Data provided is based on 75% of the Power Supply's total wattage capacity

	LOW OUTPUT (3.5 W/FT)			MEDIUM OUTPUT (9.0 W/FT)			HIGH OUTPUT (17.0 W/FT)		
NOMINAL FIXTURE LENGTH	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W
12"	27	68	136	10	26	52	5	14	28
24"	13	34	68	5	13	26	2	7	14
36"	9	23	46	3	8	16	2	4	8
48"	6	17	34	2	6	12	1	3	6

REMOTE DISTANCE LIMITS

Noncompliance with recommended remote wiring distances may void warranty

WIRE GAUGE	MAX DISTANCE
20 AWG	25.0 FT
18 AWG	30.0 FT
16 AWG	40.0 FT
14 AWG	60.0 FT
12 AWG	100.0 FT

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

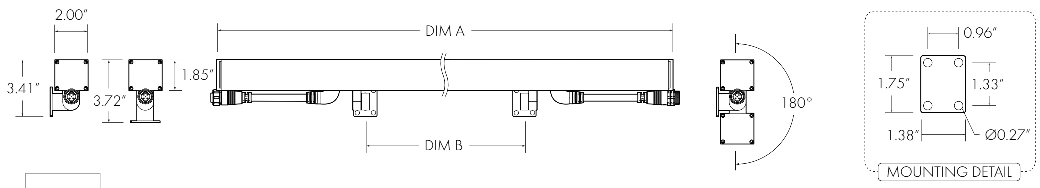
PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

DIMENSIONS

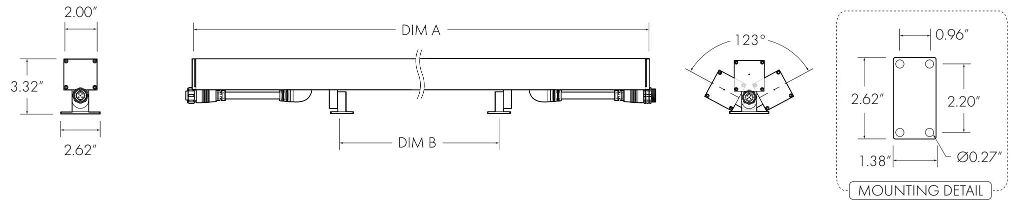
	12"	24"	36"	48"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

SURFACE MOUNT (SM)

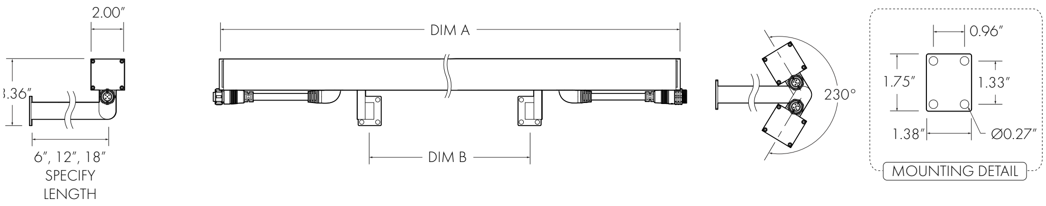


5G
ANSI C136.31

GROUND MOUNT (GM)



EXTENDED ARM (EA-X)



3G
ANSI C136.3

3G RATED WITH 6.00" ARM

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MEDLEY EXTERIOR REMOTE (MER)

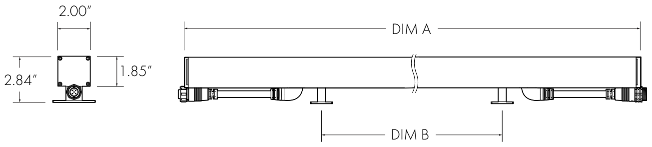
PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

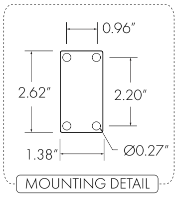
PROJECT: TYPE: CATALOG #: MER- - - - - - - -

DIMENSIONS

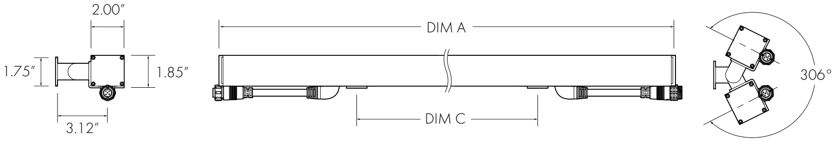
	12"	24"	36"	48"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

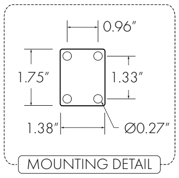
FIXED MOUNT (FM)



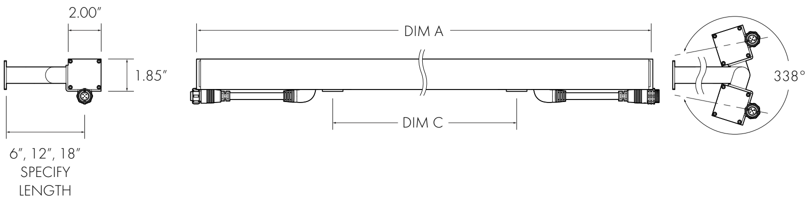


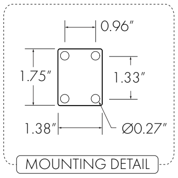
SURFACE, BACK MOUNT (SMB)





EXTENDED ARM, BACK MOUNT (EAB-X)





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MEDLEY EXTERIOR REMOTE (MER)

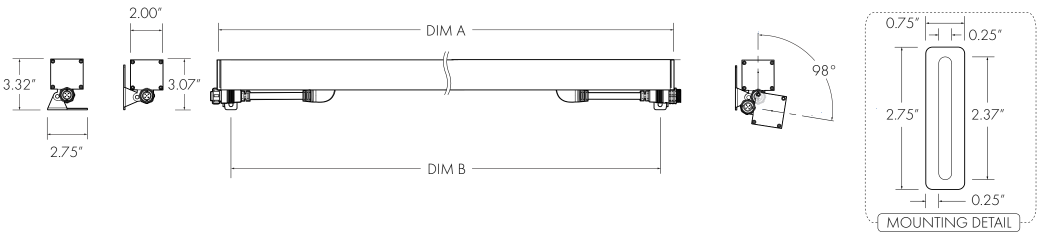
PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

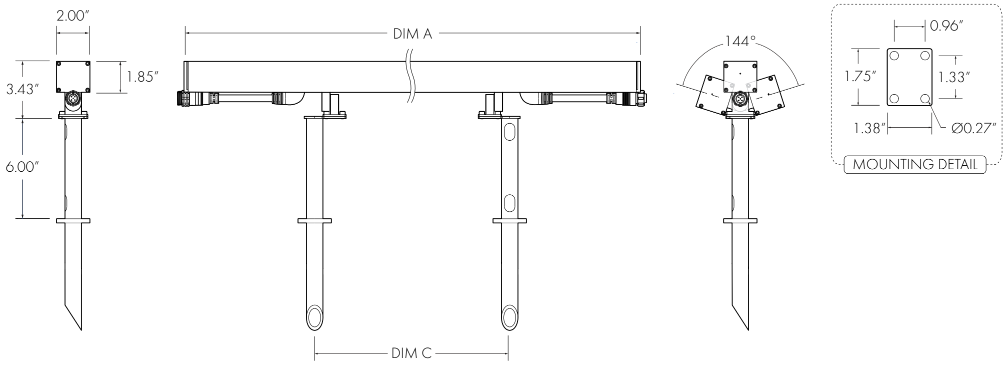
DIMENSIONS

	12.00"	24.00"	36.00"	48.00"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	11.65	22.31"	34.06"	45.81"
DIM C	10.56"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

END MOUNT (EM)



STAKE MOUNT (STM)



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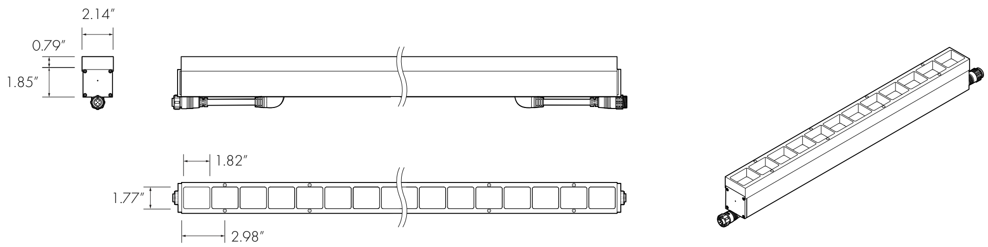
MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | WHITE LIGHT & STATIC COLOR SPECIFICATION

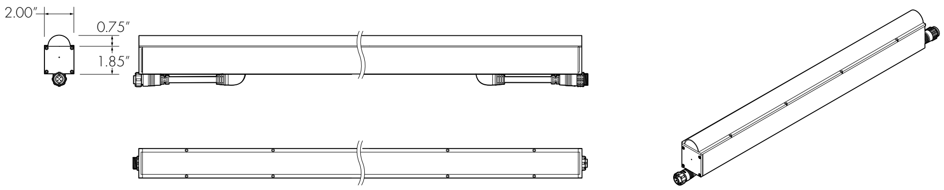
PROJECT: TYPE: CATALOG #: MER- - - - - - - -

ACCESSORIES

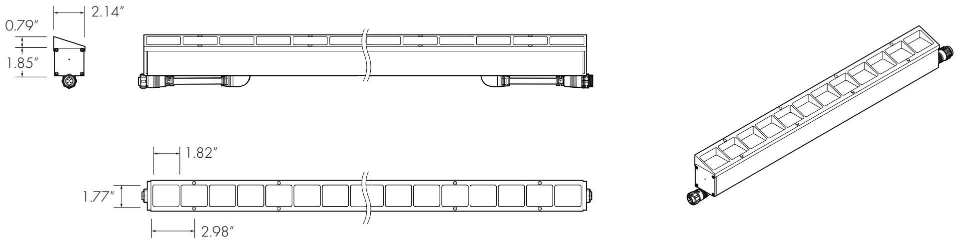
LOUVER (LV)



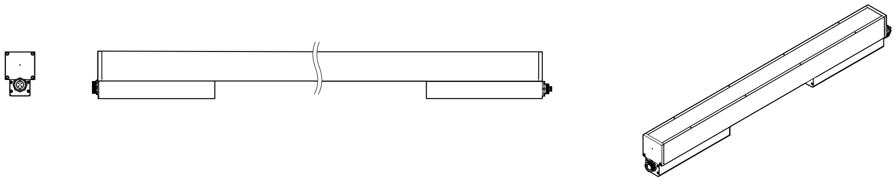
DIRECT VIEW LENS (DV)



VISOR (VS)



CONCEALED WIRING (CW)



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INTERIOR + EXTERIOR | **L50 GRAZE**

DATE	PROJECT	FIRM	TYPE

THE L50 INCLUDES PATENTED OPTICAL DESIGN THAT DELIVERS THE WIDEST RANGE OF BEAM ANGLE OPTIONS FOR PRECISE COVE, WALL GRAZING, WALL WASHING OR LINE OF LIGHT APPLICATIONS. EXCLUSIVE FLIP TO FLAT™ HINGE DESIGN PROVIDES FLEXIBILITY WHEN MANAGING SMALL COVE DETAILS. TROV OFFERS SMOOTH, FLICKER FREE DIMMING DOWN TO 0%.

FEATURES :

- DIM TO 0%, ELV REVERSE PHASE
- 24 BEAM ANGLES
- MULTI-VOLT
- FLIP TO FLAT™
- 6 CCT OPTIONS
- 80+ AND 90+ CRI OPTIONS
- IP54 INTERIOR AND IP66 EXTERIOR OPTIONS

L50

MODEL/ SIZE	INTERIOR/ EXTERIOR	LENGTH	POWER	CCT		CRI	VOLTAGE	OPTICS	
L50	I E	12″ 48″	02 04 06 08 10 12	**WHITE CCT** 22 27 30 35 40 50	**MONO COLOR** GR**** BL AM RD***	80 90* Blank For Color	MULT (120-277V)	**GRAZING** 9 x 9 9 x 17 9 x 29 9 x 59 15 x 15 15 x 23 15 x 35 15 x 65 **COVE** 120** Asym **LINE OF LIGHT** LOL	**WASHING** 25 x 25 25 x 33 25 x 45 25 x 75 39 x 9 55 x 25 40 x40 40 x 48 40 x 60 40 x 90 45 x 15 70 x 40 70 x 70

EXAMPLE: L50-I-48-10-27-90-MULT-15x65 *90 CRi not available in 2200K or 5000K **120 is only available with Exterior option. See L35 spec sheet for interior cove options. ***Red is not available in 12W or 10W. ****Green is not available in 12W.

PERFORMANCE	WATTS	OPTIC	LUMEN OUTPUT	EFFICACY
	2W	9˚x 29˚	158 lm/LF (519 lm/m)	79 lm/W
	4W	9˚x 29˚	389 lm/LF (1277 lm/m)	97 lm/W
	6W	9˚x 29˚	620 lm/LF (2035 lm/m)	103 lm/W
	8W	9˚x 29˚	864 lm/LF (2833 lm/m)	108 lm/W
	10W	9˚x 29˚	1046 lm/LF (3432 lm/m)	105 lm/W
	12W	9˚x 29˚	1217 lm/LF (3990 lm/m)	101 lm/W

ALL LUMEN DATA IS FROM 4000K 80CRI FIXTURES. PLEASE SEE PHOTOMETRY SPEC SHEET FOR ADDITIONAL LUMEN DATA.

COLOR RENDERING INDEX	80+, 90+
COLOR CONSISTENCY	2-STEP MACADAM ELLIPSE

LUMEN DEPRECIATION / RATED LIFE

WATTS	L70 @ 25C	L70 @ 50C	L90 @ 25C	L90 @ 50C
2W-12W	>150,000	>70,000	>50,000	>25,000

*CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR

* CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR

ELECTRICAL

POWER CONSUMPTION 2W*/LF (6.6W/M) ; 4W/LF (13.2W/M) ; 6W/LF (19.8W/M) ; 8W/LF (26.4W/M) ; 10W/LF (33W/M) ; 12W/FL (39.6W/M)
* 3W/LF (9.9W/M) at 220V -277V

MAX FIXTURE RUN LENGTH

	2W/LF		4W/LF		6W/LF		8W/LF		10W/LF		12W/LF	
Volts	Max Run all 1’	Max Run all 4’	Max Run all 1’	Max Run all 4’	Max Run all 1’	Max Run all 4’	Max Run all 1’	Max Run all 4’	Max Run all 1’	Max Run all 4’	Max Run all 1’	Max Run all 4’
120	214	214	186	186	152	152	114	114	91	91	76	76
220	374	392	340	340	277	277	209	209	95	167	95	139
277	374	494	374	428	349	349	263	263	95	190	95	175

POWER FACTOR	4W, 6W, 8W, 10W, 12W >0.9, 2W<0.9
OPERATING VOLTAGE	MULTIVOLT: 110-277VAC, 50/60 Hz
DRIVER	INTEGRAL TO FIXTURE; DE-RATED POWER AND SYNCHRONOUS START-UP AT FULL BRIGHTNESS
STARTUP TEMPERATURE	-40˚F TO 122˚F (-40˚C TO 50˚C)
OPERATING TEMPERATURE	-40˚F TO 122˚F (-40˚C TO 50˚C)
STORAGE TEMPERATURE	-40˚F TO 176˚F (-40˚C TO 80˚C)

NOTE: Information on this Spec Sheet is subject to change, please visit ecosenselighting.com/downloads/rise for the most updated information.

ECOSENSE®

ECOSENSE LIGHTING INC.
837 NORTH SPRING STREET
SUITE 103
LOS ANGELES, CA 90012

P • 310.496.6255
F • 310.496.6256
T • 855.632.6736
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INTERIOR + EXTERIOR | **L50 GRAZE**

DATE	PROJECT	FIRM	TYPE

CONTROL	**DIMMING**	110-277VAC, ELV TYPE 0.07%-100%, REVERSE PHASE, TRAILING EDGE ETC control systems require 0-10V control using Ecosense LDCM. TROV will not work with ETC phase dimmers.
PHYSICAL	**DIMENSIONS**	W 1.6” x H 2” x L 12”/48” ; (41.6mm x 50.5mm x 304.7mm/1201mm)
	HOUSING /LENS	EXTRUDED ALUMINUM; UV STABILIZED POLYCARBONATE; STAINLESS STEEL FASTENERS; PLASTIC ENDCAPS RUBBER OVERMOLD FOR CABLE ASSEMBLY
	WEIGHT	1.52LBS / 0.69KG (1FT) ; 4.95LBS / 2.25KG (4FT)
	CONNECTORS	INTEGRAL MALE/ FEMALE CONNECTORS
	ENVIRONMENT	INDOOR • ETL CERTIFIED FOR DRY/DAMP LOCATIONS IP54 OUTDOOR • ETL CERTIFIED FOR WET LOCATIONS IP66 IMPACT RATED TO IK10 Not intended to be used in water features such as waterfalls, fountains, etc.
	BEAM ANGLE	GRAZING, WASHING, COVE, ASYMMETRIC, LINE OF LIGHT
	MOUNTING OPTIONS	INTEGRAL MOUNTING AND ADJUSTABLE AIMING FROM 0°-180° IN 15° INCREMENTS
FIXTURE RATING & CERTIFICATIONS	**CE, ETL CERTIFIED** **RoHS COMPLIANT** **ENERGY STAR COMPLIANT** **RCM CERTIFIED**	CE Intertek RoHS COMPLIANT ENERGY STAR Title 24 JA8-2016 *90 CRI models only
LIMITED WARRANTY	**5 YEARS**	

WIRING OPTIONS (MVOLT): 110-277VAC

Power Cable Assembly, TROV, Leader/Jumper, 10 foot	CBL-3P-L-UNV-10*
Power Cable Assembly, TROV, Leader/Jumper, 50 foot	CBL-3P-L-UNV-50*
Power Cable Assembly, TROV, Jumper, 5 foot	CBL-3P-L-UNV-05**
Power Cable Assembly, TROV, Jumper, 1 foot	CBL-3P-L-UNV-01**
Power Cable Assembly, TROV, Adjustable Jumper, 0” to 7”	CBL-3P-L-UNV-ADJ
Power Cable Assembly, TROV, Male and Female terminator caps	CBL-3P-L-UNV-CAPS

*Two (2) terminators are included with the 10’ and 50’ power cable. One Leader need per circuit/fixture run. Cables are not plenum rated.
** If using the 5’ or 1’ power cable assembly as a leader to power a run one set of CBL-3P-L-UNV-CAPS will also be need per cable.

0-10V CONTROL OPTIONS

100-120VAC / 277VAC Linear Dimming Control Module 0-10V - Plenum Rated	LDCM-PL-120-277-010V-GR

All products come standard with ELV dimming capabilities. 0-10V Control options required for operation at 0-10V.

OPTIONAL ACCESSORIES

Mounting

Mounting Track and Clips Set, 48 Inch Track, 8 Clips	MNT-L-TRKCLIP-48	48” track and clips set will work with one 48” fixture or four 12” fixtures. (FOR INTERIOR USE ONLY)
Mounting Track and Clips Set, 12 Inch Track, 2 Clips	MNT-L-TRKCLIP-12	12” track will not work with 48” fixtures. (FOR INTERIOR USE ONLY)
Mounting Track Clip, TROV, Set of 2	MNT-L-CLIP	Clips needed = 12” fixtures need 1 set of 2 and 48” fixture needs 2 sets of 2.
90 Degree L bracket, TROV, Set of 2	MNT-L-LBKT	L-Brackets needed = 12” fixtures need 1 set of 2 and 48” fixture needs 1 set of 2.
Angle Locking Clip, TROV, Pack of 10	MNT-L-ANGLOCK	Angle Locks needed = 12” fixtures need 1 and 48” fixtures need 2. (Must order separately)
Mounting, Fine Adjustment Bracket, TROV	MNT-L-FAB	Fine Adjustment Brackets needed = 12” fixtures need 1 and 48” fixtures need 2.

*Fine Adjustment Bracket is highly recommended for Grazing Optics.

Mounting, Fine Adjustment L-Bracket, TROV	MNT-L-LFAB	Fine Adjustment L-Brackets needed = 12” fixtures need 1 and 48” fixtures need 2.

*Fine Adjustment L-Bracket is recommended for Asymetric Optics when aiming is needed.

Snap-on Lenses

Snap-on Lens, Frosted, 12 inch, L50	LENS-L50-FROST-12
Snap-on Lens, Frosted, 48 inch, L50	LENS-L50-FROST-48
Snap-on Lens, Clear, 12 inch, L50	LENS-L50-CLEAR-12
Snap-on Lens, Clear, 48 inch, L50	LENS-L50-CLEAR-48

Snap-on Lenses need = One 12” lens is needed per 12” fixture and one 48” lens is needed per 48” fixture. Snap on Lenses will not work with the asymmetric fixture. Clear lenses can be used to hold colored filters to customize the output color of any TROV fixture, except the ASYM. Color filters supplied by others.

Wall Mount Arm

Wall Mount Arm, 6 inch, TROV	WMA-L-CA-06
Wall Mount Arm, 12 inch, TROV	WMA-L-CA-12
Wall Mount Arm, 18 inch, TROV	WMA-L-CA-18
Wall Mount Arm, 24 inch, TROV	WMA-L-CA-24
Wall Mount Arm End Plate Set, TROV, Includes Left and Right	WMA-L-END
Wall Mount Arm Joiner Plate, TROV	WMA-L-JNR

Wall Mount Arms needed = For individual fixture installations two arms and one end set will be needed per fixture. For continuous run installation one endset will be needed per run. Each end set contains one left and one right end plate. One joining set wll be needed per joint. One arm per fixture will be need plus one extra arm to complete the run. For example: A 10ft run made with two 4ft and two 1ft fixtures will contain; 1 x WMA-L-END, 3 x WMA-L-JNR, and 5 x WMA-L-CA-12. Leader cables are not included with wall mount arms, end sets, or joiners sets.

Louvers

Louver, Asymmetric, 12 inch, L50	LV-L50-ASYM-12
Louver, Asymmetric, 48 inch, L50	LV-L50-ASYM-48
Louver, Symmetric, 12 inch, L50	LV-L50-SYM-12
Louver, Symmetric, 48 inch, L50	LV-L50-SYM-48
Louver, Honeycomb, 12 inch, L50	LV-L50-HCOMB-12
Louver, Honeycomb, 48 inch, L50	LV-L50-HCOMB-48

Louvers Needed = One 12” louver is needed per 12” fixture and one 48” louver is needed per 48” fixture. 48” louver is made up of four 12” louvers.
Louvers cannot be used with the asymmetric fixture

TRŌV®

OVERVIEW • SPECIFICATIONS • ORDERING | INTERIOR + EXTERIOR | **L50 GRAZE**

DATE	PROJECT	FIRM	TYPE

OPTIONAL ACCESSORIES

Masking Plates

Masking Plate, 3 inch high, 12 inch, L50 & L35 .... MP-L50-3H-12
Masking Plate, 3 inch high, 48 inch, L50 & L35 .... MP-L50-3H-48

Masking Plates needed = One 12" plate is needed per 12" fixture and one 48" plate is needed per 48" fixture.

Landscape Stake

Landscape Stake, 6 inch, TROV, Set of 2 .... LS-L-STK-06
Landscape Stake, 12 inch, TROV, Set of 2 .... LS-L-STK-12
Landscape Stake, 18 inch, TROV, Set of 2 .... LS-L-STK-18

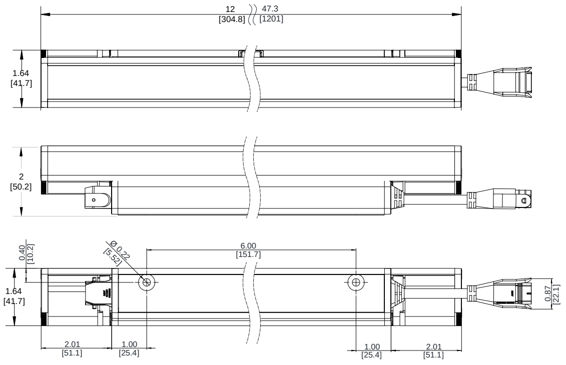
Landscape Stakes needed = 12" and 48" fixtures both need one set of 2.

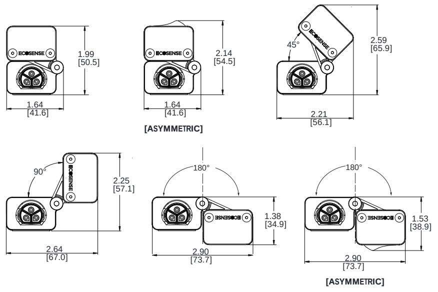
Wire Box

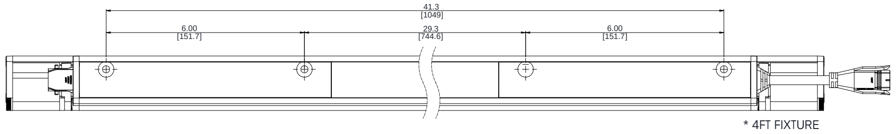
Conduit Connection, Wire Box, TROV, Interior Only, L50 ....CC-L-WIREBOX

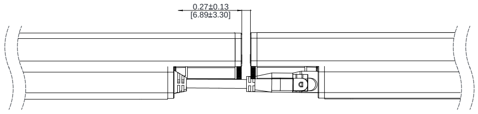
Wire box can be used instead of a leader cable to start a run. 1/2" conduit fitting can attach directly to the box on one end and the fixture to the other.

DIMENSIONS + MOUNTING

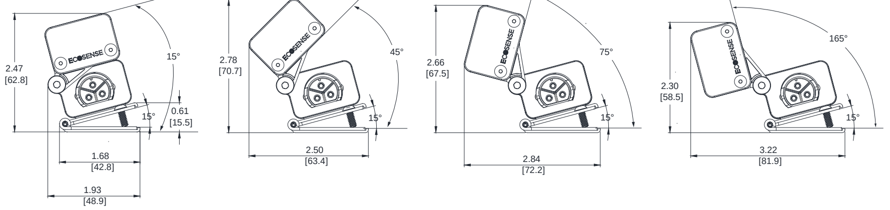








Fine Adjustable Bracket:



Specification Sheet

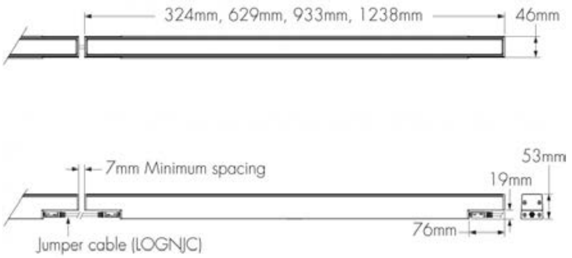
lumenfacade nano

LOGN

COLOUR CHANGING

Project Name ______________________________ **Qty** __________

Type __________ **Catalog / Part Number** ______________________________



Top view

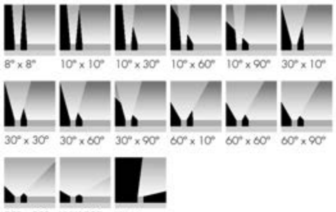
Front and side views

Photometric Summary

	Delivered output (lm)	Intensity (peak cd)
8°x8°	1006	27,187
10°x10°	957	21,211
10°x30°	943	6000
10°x60°	939	3199
10°x90°	936	1677
30°x10°	946	5982
30°x30°	875	2019
30°x60°	848	1278
30°x90°	854	923
60°x10°	937	3713
60°x60°	856	633
60°x90°	851	762
90°x90°	836	517
W (120°)	568	N/A
WW	1002	4861

Based on RGBW40K full output, 4ft [1219mm], DMX/RDM configuration.
Photometric performance is measured in compliance with IESNA LM-79-08.

Optics



Description

The Lumenfacade Nano Colour Changing is a high-efficiency linear LED luminaire that goes where no facade lighting has gone before. Available in 305 mm, 610 mm, 914 mm or 1219 mm sections, the Lumenfacade Nano Colour Changing packs all the bells and whistles of the larger members of the Lumenfacade family and can be configured with a wide number of options, including: optics for grazing, floodlighting, or wall washing; RGB, RGBW, or RGBA colour mixing; various mounting options, finishes, and controls; as well as Legacy or Custom output modes.

Features

Colour and Colour Temperature	Additive RGB, Additive RGB + white 3000K, Additive RGB + white 4000K, Additive RGB + amber
Optics	8° x 8°, 10° x 10°, 10° x 30°, 10° x 60°, 10° x 90°, 30° x 10°, 30° x 30°, 30° x 60°, 30° x 90°, 60° x 10°, 60° x 60°, 60° x 90°, 90° x 90°, Wide 120°, Asymmetric Wallwash
Options	Corrosion-resistant coating for hostile environments
Power Consumption	13.1 W/m
Warranty	5-year limited warranty

Performance

Maximum Delivered Output	895 lm (1219 mm fixture, RGB full output, 8° x 8°, UCTL), 986 lm (1219 mm fixture, RGBW30K full output, 8° x 8°, UCTL), 1,006 lm (1219 mm fixture, RGBW40K full output, 8° x 8°, UCTL), 878 lm (1219 mm fixture, RGBA full output, 8° x 8°, UCTL)
Maximum Delivered Intensity	24,186 cd at nadir (RGB full output, 8°x8°, UCTL), 26,643 cd at nadir (RGBW30K full output, 8°x8°, UCTL), 27,187 cd at nadir (RGBW40K full output, 8°x8°, UCTL), 23,722 cd at nadir (RGBA full output, 8°x8°, UCTL)
Illuminance at Distance	Minimum 1 fc at 47.5 m (RGB full output, 8°x8°, UCTL), Minimum 1 fc at 49.7 m (RGBW30K full output, 8°x8°, UCTL), Minimum 1 fc at 50.3 m (RGBW40K full output, 8°x8°, UCTL), Minimum 1 fc at 46.9 m (RGBA full output, 8°x8°, UCTL)

Specification Sheet

lumenfacade nano

LOGN

COLOUR CHANGING

Colours and Colour Temperatures

RGB (Red Green Blue) | RGBW 30K (Red Green Blue White) | RGBW 40K (Red Green Blue White) | RGBA (Red Green Blue Amber)

Controls

UCTL

Ratings

IP66 IK08

Certifications

cULus CE RoHS

Lumen Maintenance	L70 >90,000 hrs

Physical

Housing Material	Low copper content extruded aluminium
Lens Material	Clear tempered glass
Hardware Material	Stainless steel
End Cap Material	Machined aluminium
Gasket Material	Silicone
Surface Finish	Electrostatically applied polyester powder coat
Weight	0.64 kg (305 mm), 1.32 kg (610 mm), 2 kg (914 mm), 2.72 kg (1219 mm)

Electrical and control

Voltage	48 VDC
Resolution (DMX/RDM)	Per foot or per fixture (configured with LumenID V3 software), 8-bit or 16-bit, 3 channels (RGB) or 4 channels (RGBW30K, RGBW40K and RGBA)
RGB Colour Mixing	12 LEDs per 305 mm (4x Red, 4x Green, 4x Blue)
RGBW30K Colour Mixing	12 LEDs per 305 mm (3x Red, 3x Green, 3x Blue, 3x White 3000K)
RGBW40K Colour Mixing	12 LEDs per 305 mm (3x Red, 3x Green, 3x Blue, 3x White 4000K)
RGBA Colour Mixing	12 LEDs per 305 mm (3x Red, 3x Green, 3x Blue, 3x Amber)
Control	Universal control (compatible with DMX/RDM or DALI-2 Type 8 systems)

Environmental

Storage Temperature	-40 °C to 85 °C (device must reach start-up temperature value before operating)
Start-up Temperature	-25 °C to 50 °C
Operating Temperature	-40 °C to 50 °C
Ingress Protection Rating	IP66
Impact Resistance Rating	IK08 (IK09 for 1219 mm fixtures)

Accessories (order separately)

Cables	Lumenfacade Nano Jumper Cable, Trunk Power Cable, Trunk Data Cable, Lumenfacade Nano Jumper Cable Joiner
Control Boxes	Low-Voltage Control Box, Low-Voltage Splitter Box
Optical Accessories	Lumenfacade Nano Visor
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID

Specification Sheet

lumenfacade nano

LOGN

COLOUR CHANGING

Optical option installation details

HFR - Half-frosted lens

- Always position frosted side toward the wall.
- Applicable for 8° x 8°, 10° x 10° or asymmetric wallwash optics only.

WW - Asymmetric wallwash

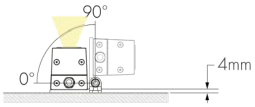
Recommended setback from wall is 1/10 of the wall height.

Example: 0.6 m setback for a 6.1 m wall.

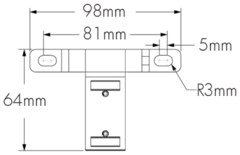
Mounting options

One mounting bracket provided for 305 mm fixtures. Two mounting brackets provided for 610 mm, 914 mm and 1219 mm fixtures. See installation instructions for details.

SAMN - Slim Adjustable Mounting Nano

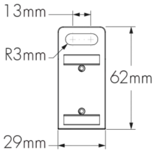


SAMN - Mounting hole pattern



UMPN - Fixed Mounting Nano

UMPN - Mounting hole pattern



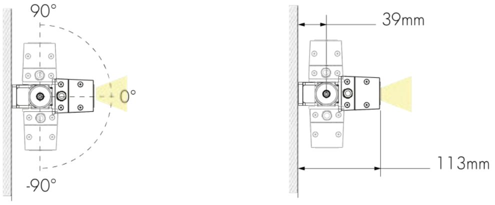
Specification Sheet

lumenfacade nano

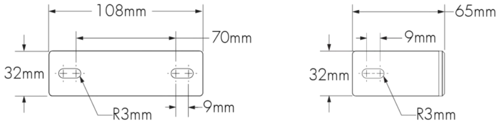
LOGN

COLOUR CHANGING

UMASN - Universal Adjustable Mounting Nano



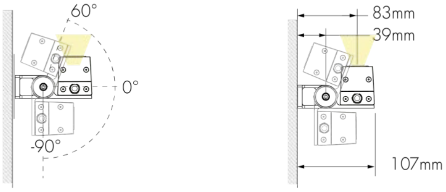
UMASN - Mounting hole pattern



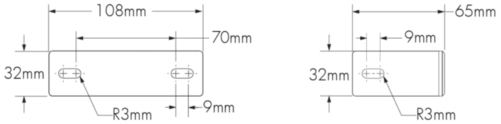
For 305 mm fixtures

For 610 mm, 914 mm
and 1219 mm fixtures

WAMN2 - Adjustable Extended Arm Mounting Nano 51 mm



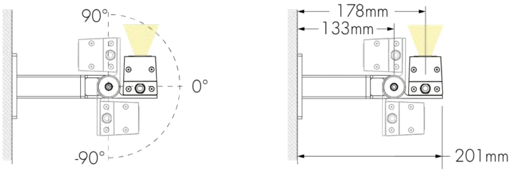
WAMN2 - Mounting hole pattern



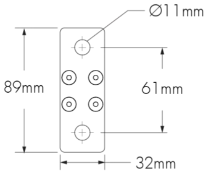
For 305 mm fixtures

For 610 mm, 914 mm
and 1219 mm fixtures

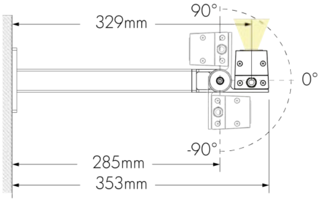
WAMN6 - Adjustable Extended Arm Mounting Nano 152 mm



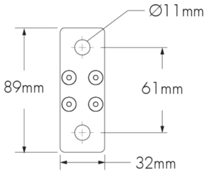
WAMN6 - Mounting hole pattern



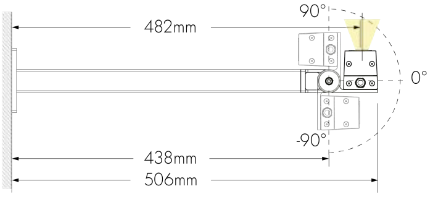
WAMN12 - Adjustable Extended Arm Mounting Nano 305 mm



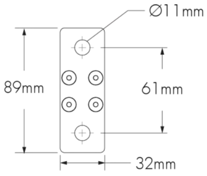
WAMN12 - Mounting hole pattern



WAMN18 - Adjustable Extended Arm Mounting Nano 457 mm



WAMN18 - Mounting hole pattern

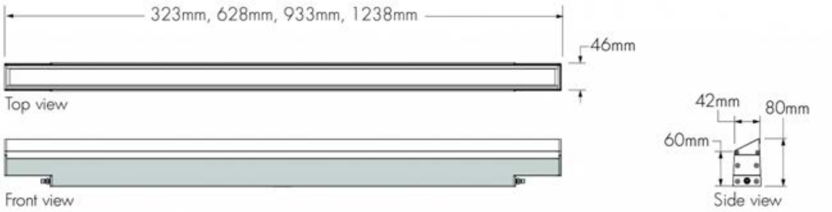


Specification Sheet

lumenfacade nano
LOGN
COLOUR CHANGING

Optical accessories (order separately)

LOGNVS - Visor for Lumenfacade Nano



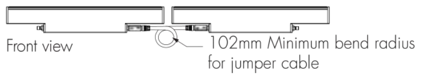
LOGNVS-**LENGTH-FINISH-OPTIONS**

Please specify:
LENGTH: 305 mm, 610 mm, 914 mm or 1219 mm; **FINISH**: BK - Black Sandtex®, BRZ - Bronze Sandtex®, SI - Silver Sandtex®, WH - Smooth white or CC - custom colour and finish (please specify RAL colour); **OPTIONS**: CRC - Corrosion-resistant coating for hostile environments

- The addition of a visor will affect beam distribution. Consult factory for application support.
- Not suitable for wide 120° optic.
- Maximum one accessory per fixture. Visors are field installable.

Cables (order separately)

LOGNJC - Jumper cable for Lumenfacade Nano



For minimal spacing between fixtures, use a 0.3 m jumper cable.

LOGNJC-**CERTIFICATION**-**LENGTH**-**CABLE COLOUR**

Please specify:
CERTIFICATION: UL or CE; **LENGTH**: 0.3 m to 9.1 m (available in 0.3 m increments) or 15.2 m; **CABLE COLOUR**: black or white (connectors are the same colour as the specified cable colour).

- Suitable for dimming/data and non-dimming applications.
- Consult Lumenfacade Nano jumper cable specification sheet for all available cable lengths and additional information.

Joiner (order separately)

LOGNJC-JOINER - Joiner for Lumenfacade Nano Jumper Cable

- Use joiners to connect and lengthen jumper cables.
- Joiners add voltage drops. Consult factory to confirm impact on run lengh.
- Available in black.

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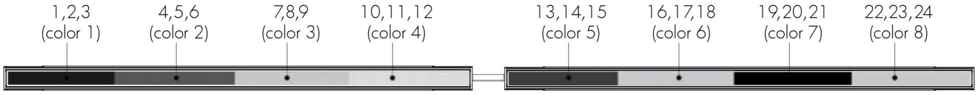
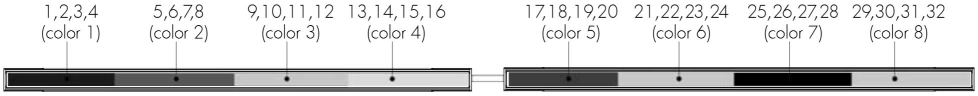
EM - R8
7 / 14

Resolution details

DMX/RDM control, resolution per foot: each 305 mm section is addressed independently
DMX addresses:



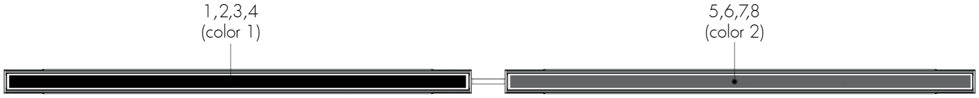
UCTL control option, RGB colour mixing option.



UCTL control option, RGBW30K, RGBW40K and RGBA colour mixing options.

DMX/RDM control, resolution per fixture: each fixture is addressed independently
DMX addresses:

UCTL control option, RGB colour mixing option.



UCTL control option, RGBW30K, RGBW40K and RGBA colour mixing options.

- 1219 mm fixtures shown.
- Fixture resolution can be configured on-site within the LumenID V3 software. A DMX/RDM enabled LCBX or DMX/RDM LSBX is required for DMX/RDM control.

Specification Sheet

lumenfacade nano

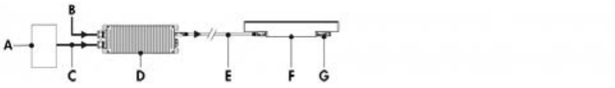
LOGN

COLOUR CHANGING

Typical wiring diagrams

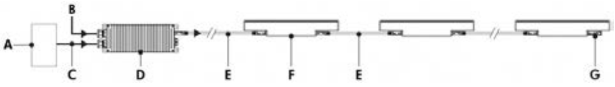
UCTL - Universal control

Single unit - LCBX 60W



- **A -** Controller (order separately from Lumenpulse, or by others)
- **B -** Power input (120-277V, wiring by others)
- **C -** Data input (wiring by others)
- **D -** LCBX (60W)
- **E -** Jumper cable (LOGNJC)
- **F -** Lumenfacade Nano
- **G -** Terminator cap

Continuous run - LCBX 60W or 120W

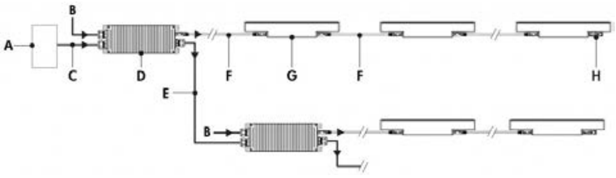


- **A -** Controller (order separately from Lumenpulse, or by others)
- **B -** Power input (120-277V, wiring by others)
- **C -** Data input (wiring by others)
- **D -** LCBX (60W or 120W)
- **E -** Jumper cable (LOGNJC)
- **F -** Lumenfacade Nano
- **G -** Terminator cap

Continuous run - LCBX 200W

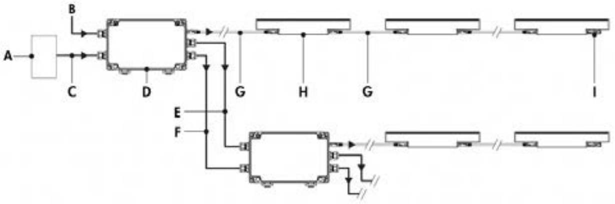
- **A -** Controller (order separately from Lumenpulse, or by others)
- **B -** Power input (120-277V, wiring by others)
- **C -** Data input (wiring by others)
- **D -** LCBX (200W)
- **E -** Jumper cable (LOGNJC)
- **F -** Lumenfacade Nano
- **G -** Terminator cap

Continuous run - Daisy chain
LCBX 60W or 120W



- **A -** Controller (order separately from Lumenpulse, or by others)
- **B -** Power input (120-277V, wiring by others)
- **C -** Data input (wiring by others)
- **D -** LCBX (60W or 120W)
- **E -** Data output to next LCBX (wiring by others)
- **F -** Jumper cable (LOGNJC)
- **G -** Lumenfacade Nano
- **H -** Terminator cap

Continuous run - Daisy chain
LCBX 200W



- **A -** Controller (order separately from Lumenpulse, or by others)
- **B -** Power input (120-277V, wiring by others)
- **C -** Data input (wiring by others)
- **D -** LCBX (200W)
- **E -** Power output to next LCBX (120-277V, wiring by others)
- **F -** Data output to next LCBX (wiring by others)
- **G -** Jumper cable (LOGNJC)
- **H -** Lumenfacade Nano
- **I -** Terminator cap

Specification Sheet

lumenfacade nano
LOGN

COLOUR CHANGING

Maximum Run of Fixtures per LCBX 60W, Lumenfacade Nano® LOGN Color Changing

Wattage	**13.1W/m**
Maximum Run of Fixtures per LCBX 60W*	3.6m

Maximum Run of Fixtures per LCBX 120W, Lumenfacade Nano® LOGN Color Changing

Wattage	**13.1W/m**
Maximum Run of Fixtures per LCBX 120W*	7.3m

Maximum Run of Fixtures per LCBX 200W, Lumenfacade Nano® LOGN Color Changing

Wattage	**13.1W/m**
Maximum Run of Fixtures per LCBX 200W*	12.2

Based on 15.2m jumper cable.
*Example: 13.1W/m = 12.2m maximum run of end to end fixtures per LCBX 200W
(10 fixtures maximum for 1238mm LOGN 13.1W/m).

- Consult factory for specific applications and maximum fixture count/run length recommendations.
- For installations of 600W or more, consult factory to select the optimal system: either a daisy chain continuous run system with LCBXs or a trunk system with LSBXs.
- A maximum of 128 UCTL devices on the output port of the LCBX.
- Maximum of 1 output to fixture, or fixture run, per LCBX.
- Consult the LCBX specification sheet for more information.
- RGB colour mixture option requires 3 DMX channels. RGBW30K and RGBW40K colour mixture options require 4 DMX channels. RGBA colour mixture option requires 4 DMX channels.
- Fixtures can be controlled via a DMX/RDM or DALI controller.
- For DALI-2 Type 8 applications: The LCBX responds to RGBWAF control.
- 13.1 W/m.

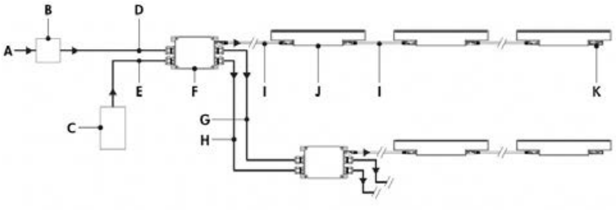
Specification Sheet

lumenfacade nano

LOGN

COLOUR CHANGING

Trunk system - LSBX

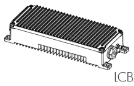


A - Power input (120-277V, wiring by others)
B - Power supply (48V, by others)
C - Controller (order separately from Lumenpulse, or by others)
D - Power input (48V, order separately from Lumenpulse - Trunk Power Cable (TKPWR), or equivalent by others)
E - Data input (order separately from Lumenpulse - Trunk Data Cable (TKDMX), or equivalent by others)
F - LSBX
G - Power output to next LSBX (48V, order separately from Lumenpulse - Trunk Power Cable (TKPWR), or equivalent by others)
H - Data output to next LSBX (order separately from Lumenpulse - Trunk Data Cable (TKDMX), or equivalent by others)
I - Jumper cable (LOGNJC)
J - Lumenfacade Nano
K - Terminator cap

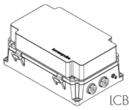
- Consult factory for specific applications and maximum fixture count/run length recommendations.
- For installations of 600W or more, consult factory to select the optimal system: either a daisy chain continuous run system with LCBXs or a trunk system with LSBXs.
- A maximum of 128 UCTL devices on the output port of the LSBX.
- Maximum of 1 output to fixture run per LSBX.
- Consult the LSBX specification sheet for more information.
- Consult factory for power supply recommendations.
- RGB colour mixture option requires 3 DMX channels. RGBW30K and RGBW40K colour mixture options require 4 DMX channels. RGBA colour mixture option requires 4 DMX channels.
- 13.1 W/m.

Control boxes (order separately)

LCBX - Low-Voltage Control Box



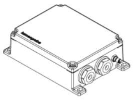
LCBX 60W & 120W



LCBX 200W

Low-voltage control and power box. One power and data output to fixture, or fixture run. Refer to LCBX specification sheet for details.

LSBX - Low-Voltage Splitter Box



Low-voltage control and power splitter box. One power and data output to fixture run. Refer to LSBX specification sheet for details.

Control systems (order separately)

LTN2 - Lumentone™ 2

Lumentone 2 is a simple pre-programmed DMX 512 controller with a push button rotary dial and live feedback.

PHAROS - Pharos® kit

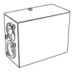
The Pharos kit, available for 1 or 2 DMX universes, allows for complete control of large lighting installations. 2 DMX universes kit shown.

Specification Sheet

lumenfacade nano
LOGN
COLOUR CHANGING

Diagnostic and addressing tools (order separately)

LID - LumenID



LumenID is a diagnostic and addressing DMX/RDM tool. It must be specified on all DMX applications. Consult LID specification sheet for details.

Specification Sheet

lumenfacade nano
LOGN

COLOUR CHANGING

How to order

Housing	Wattage	Voltage	Length	Colour and Colour Temperature	Optics
LOGN Lumenfacade™ Nano	**4W** 13.1 W/m	**48V** 48 VDC	**12** 324 mm (0.64 kg) **24** 629 mm (1.32 kg) **36** 933 mm (2 kg) **48** 1238 mm (2.72 kg)	**RGB** Additive RGB **RGBW30K** Additive RGB + white 3000K (1) **RGBW40K** Additive RGB + white 4000K (1) **RGBA** Additive RGB + amber	**8x8** 8° x 8° **10x10** 10° x 10° **10x30** 10° x 30° **10x60** 10° x 60° **10x90** 10° x 90° **30x10** 30° x 10° **30x30** 30° x 30° **30x60** 30° x 60° **30x90** 30° x 90° **60x10** 60° x 10° **60x60** 60° x 60° **60x90** 60° x 90° **90x90** 90° x 90 **W** Wide 120° (2) **WW** Asymmetric Wallwash

Notes:

1. 2700K, 3500K and Royal Blue available, consult factory. Longer lead times apply.

2. Not compatible with visor optical accessory.

Specification Sheet

lumenfacade nano

LOGN

COLOUR CHANGING

How to order

Lens	Mounting Options [6]	Finish	Control [10]	Options	Certification
CL Clear lens [3] **FR** Frosted lens [4] **HFR** Half-frosted lens [5]	**SAMN** Slim Adjustable Mounting Nano **UMPN** Fixed Mounting Nano **UMASN** Universal Adjustable Mounting Nano **WAMN2** Adjustable Wall Mounting Nano 51 mm **WAMN6** Adjustable Extended Arm Mounting Nano 152 mm **WAMN12** Adjustable Extended Arm Mounting Nano 305 mm **WAMN18** Adjustable Extended Arm Mounting Nano 457 mm	**BK** Black Sandtex® **BRZ** Bronze Sandtex® **SI** Silver Sandtex® **WH** Smooth white **CC** Custom colour and finish (please specify RAL colour) [7] [8] [9]	**UCTL** Universal control (compatible with DMX/RDM or DALI-2 Type 8 systems)	**CRC** Corrosion-resistant coating for hostile environments [11] [12]	**UL** UL compliant **CE** CE compliant

Notes:

3. Not available for 8x8, 10x10, W or WW optics.
4. Not available for WW optic.
5. Available for 8x8, 10x10 or WW optics only.
6. One mounting bracket provided for 305 mm fixtures. Two mounting brackets provided for 610 mm, 914 mm and 1219 mm fixtures.
7. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colours with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colours, other RAL textures and glosses, or to match alternate colour charts. Final colour matching results may vary.
8. Setup charges apply for RAL colours. Consult factory for details.
9. Longer lead times can be expected for custom RAL colour finishes.
10. A Low-Voltage Control Box (LCBX) or Low-Voltage Splitter Box (LSBX) and LumenID (LID) must be specified.
11. Use only when exposed to salt spray. This option is not required for normal outdoor exposure.
12. Setup charges apply. Consult factory for details.

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

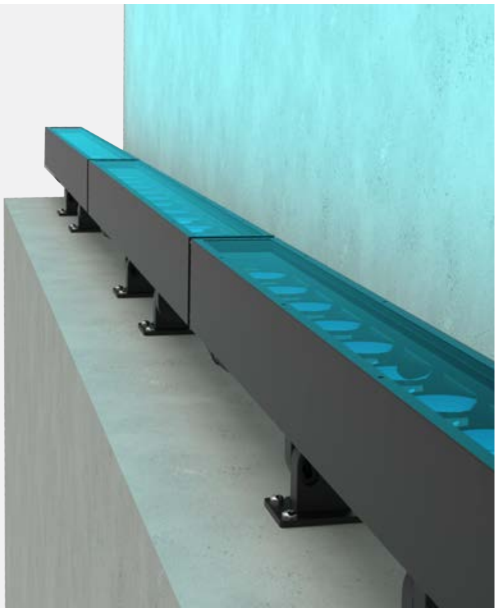
PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

PROFILE

OUTPUT	LO (3.5W/FT), MO (9.0 W/FT), HO (17.0 W/FT)
OPTICS	10° X 10°, 10° X 60°, 10° X 90°, 20° X 20°, 20° X 60°, 40° X 40°, 40° X 60°, 40° X 90°, 60° X 60°, 90° X 90° 80° X 80°, ASY
CCT	RGBWq, RGBAq, AWHq (27K-65K), LIFTED FULL SPECTRUM
PERFORMANCE	UP TO 28771.0 PEAK CANDELA
VOLTAGE	UNIVERSAL 120-277V
POWER	REMOTE POWER SUPPLY
CONTROL	0-10V, DMX, LUTRON HI-LUME
DIMENSIONS	1.85" X 2.00"
HOUSING	PRECISION EXTRUDED ALUMINUM
LENS	HIGH DENSITY TEMPERED GLASS
FINISH	HIGH DURABILITY POWDER COATING
OPERATING TEMP	-20° C TO 50° C
WARRANTY	5-YEAR LIMITED
LUMEN MAINTENANCE	75,000 HOURS
CERTIFICATION	ETL AND cETL FOR IP67, IK07, 5G/3G OPTIONS

ETL Intertek | RoHS | made in USA | IP67 | IK07 | 3G ANSI C136.31 | 5G ANSI C136.31

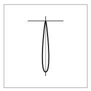


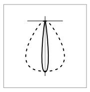
STANDARD FINISHES

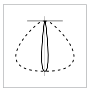
⬜	⬛	⬛	▨	⬛	▨
TEXTURED WHITE	TEXTURED BLACK	TEXTURED BRONZE	TEXTURED L. BRONZE	TEXTURED GRAY	TEXTURED S. STONE

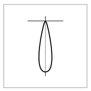
OPTICS

Not all available optics shown


10° X 10°


10° X 60°


10° X 90°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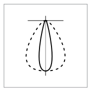
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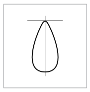
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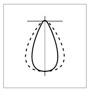
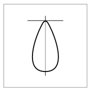

40° X 60°


40° X 90°

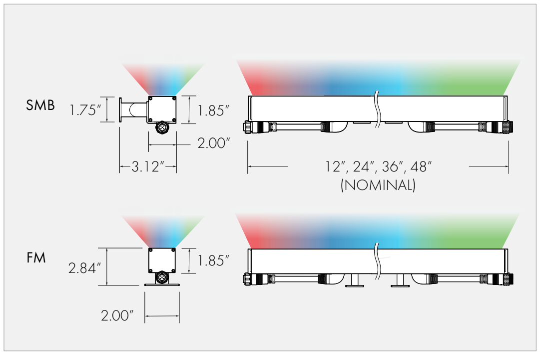
PERFORMANCE SAMPLE

Go to Performance Data >

RGBWq, HO, 48.00"	10°X 60°	20°X 60°	40°X 60°	60°X 60°
LUMENS	2545 LM	2735 LM	2694 LM	2679 LM
CANDELA	8040	6159	2647	2167
EFFICACY	37.1 LM/W	37.9 LM/W	39.3 LM/W	36.5 LM/W

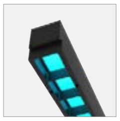
PROFILE

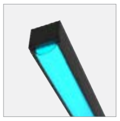
Go to Fixture Dimensions >



OPTIONS

Shown with white diffusing lense


LOUVER


DIRECT VIEW DOME LENS


CONCEALED WIRING


VISOR

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

PROJECT: TYPE: CATALOG #: MER- - - - - - - - -

SPECIFICATION

MER

1 2 3 4 5 6 7 8 9

1 FIXTURE

MEDLEY EXTERIOR REMOTE	MER

2 WATTAGE

LOW OUTPUT 3.5 W/FT	LO
MEDIUM OUTPUT 9.0 W/FT	MO
HIGH OUTPUT 17.0 W/FT	HO

3 CCT

RED, GREEN, BLUE, 40K	RGBWq
RED, GREEN, BLUE, AMBER	RGBAq
ACTIVE WHITE	AWHq
LIFTED FULL SPECTRUM	LFSq

LFS is available with Asymmetric optics only
For custom CCT's contact factory

4 OPTIC

10° X 10° 10° X 10° optic is intended for a 6.00" fixture setback from the surface	1010
10° X 60°	1060
10° X 90°	1090
20° X 20°	2020
20° X 60°	2060
20° X 90°	2090
40° X 40°	4040
40° X 60°	4060
40° X 90°	4090
60° X 60°	6060
60° X 90°	6090
80° X 80°	8080
ASYMMETRIC DIRECT Direct = down-light Asymmetric distribution is intended for a wall height of 10.0 FT to 12.0 FT with the fixture setback 18.00" from the wall	AD
ASYMMETRIC INDIRECT Indirect = up-light Asymmetric distribution is intended for a wall height of 10.0 FT to 12.0 FT with the fixture setback 18.00" from the wall	AI

5 MOUNTING

SURFACE MOUNT 5G Ansi C136.31 rated	SM
GROUND MOUNT	GM
EXTENDED ARM X = extended arm length specify 6", 12" or 18" 6.00" arm is 3G Ansi C136.3 rated	EA-X
EXTENDED ARM, BACK X = extended arm length specify 6", 12" or 18"	EAB-X
SURFACE BACK MOUNT	SMB
FIXED MOUNT	FM
END MOUNT Not intended for continuous run applications	EM
STAKE MOUNT	STM

6 FIXTURE LENGTH

12"	12
24"	24
36"	36
48"	48

Nominal lengths

7 CONTROL OPTIONS

DMX FIXTURE RESOLUTION	DMXFX
DMX SYSTEM RESOLUTION	DMXSY
DMX FT BY FT RESOLUTION	DMXFT

DMX control system must be ordered seperately
DMX Programming Kit required - see below
See DMX Guide for Wireless DMX options
All power supplies must be ordered - see below

8 FINISH

TEXTURED WHITE	TW
TEXTURED BLACK	TB
TEXTURED BRONZE	TBR
TEXTURED LIGHT BRONZE	TLB
TEXTURED GRAY	TG
TEXTURED SANDSTONE	TS
ANODIZED ALUMINUM Includes CRF finish	AA
CUSTOM COLOR Contact factory for custom color - additional charges will apply	CC

9 OPTIONS

LOUVER Field installable snooted louver LLF of 10% - 15% depending on color	LV
VISOR Field installable visored louver LLF of 10% - 15% depending on color	VS
DIRECT VIEW DOME LENS Field installable Only available with 80° X 80°	DVD
WHITE LENS LLF OF 30% Only available with 80° X 80°	WL
CONCEALED WIRING Not available with 12" fixture	CW
WHITE CABLING White cabling is standard with textured white finish	WC
CORROSION RES. FINISH Recommended for coastal or extreme exterior environments	CRF

POWER SUPPLY & CONTROL ORDER OPTIONS

Go to DMX Guide >

REMOTE POWER SUPPLY OPTIONS - WET LOCATION - REQUIRED

CONTRA EXTERIOR LOW POWER, 96W OUTPUT (120V-277V)	CEL
CONTRA EXTERIOR STANDARD POWER, 240W OUTPUT (120V-277V)	CES
CONTRA EXTERIOR HIGH POWER, (2)-240W OUTPUT (120V-277V)	CEH

Above wattage is based on 75% of the Power Supply's total wattage capacity
See page 3 for maximum fixture per power supply.
For specific and case by case requirements, please contact factory for assistance

DMX DISTRIBUTION & PROGRAMMING KIT - REQUIRED

DMX/RDM DISTRIBUTION KIT (4 OUTPUTS) - IP67	CDS-RDM

DMX/RDM **Distribution Kit** consists of four outputs
Each output is limited to (1) run per output - up to 32 fixtures max
Four terminators are included for end of line termination

EXTERIOR LEADER CABLE - REQUIRED

Go to Cable Guide >

5.0 FT LEADER CABLE	LC-5

A leader cable is required for each single fixture and for each fixture run for connection from the first fixture to the j-box
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) fixture finish is selected

EXTERIOR JUMPER CABLES

1.0 FT JUMPER CABLE	JC-1
2.0 FT JUMPER CABLE	JC-2
5.0 FT JUMPER CABLE	JC-5
10.0 FT JUMPER CABLE	JC-10
25.0 FT JUMPER CABLE	JC-25

Required if fixtures are not mounted in an end-to-end continuous manner and for line voltage only
Black cables are standard unless White Cabling (**WC**) option or Textured White (**TW**) fixture finish is selected

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

PROJECT: TYPE: CATALOG #: MER- - - - - - - - -

PERFORMANCE

CCT AND LENGTH	OPTIC	LOW OUTPUT (3.5 W/FT) DELIVERED LUMENS	LOW OUTPUT (3.5 W/FT) LUMINARE EFFICACY	LOW OUTPUT (3.5 W/FT) PEAK CANDELA	MEDIUM OUTPUT (9.0 W/FT) DELIVERED LUMENS	MEDIUM OUTPUT (9.0 W/FT) LUMINARE EFFICACY	MEDIUM OUTPUT (9.0 W/FT) PEAK CANDELA	HIGH OUTPUT (17.0 W/FT) DELIVERED LUMENS	HIGH OUTPUT (17.0 W/FT) LUMINARE EFFICACY	HIGH OUTPUT (17.0 W/FT) PEAK CANDELA
RGBW 24"	10° X 10°	290.0 LM	41.3 LM/W	2949	736.0 LM	41.3 LM/W	7480	1415.5 LM	41.3 LM/W	14386
	10° X 60°	261.0 LM	37.1 LM/W	824	662.0 LM	37.1 LM/W	2090	1272.5 LM	37.1 LM/W	4020
	20° X 20°	310.0 LM	42.0 LM/W	1664	787.0 LM	42.0 LM/W	4221	1513.0 LM	42.0 LM/W	8117
	20° X 60°	280.0 LM	37.9 LM/W	631	711.0 LM	37.9 LM/W	1601	1367.5 LM	37.9 LM/W	3080
	40° X 40°	308.0 LM	43.8 LM/W	439	781.0 LM	43.8 LM/W	1113	1502.0 LM	43.8 LM/W	2141
	40° X 60°	276.0 LM	39.3 LM/W	271	700.0 LM	39.3 LM/W	688	1347.0 LM	39.3 LM/W	1324
	60° X 60°	275.0 LM	36.5 LM/W	222	697.0 LM	36.5 LM/W	563	1339.5 LM	36.5 LM/W	1084
	80° X 80°	167.0 LM	23.8 LM/W	82	425.0 LM	23.8 LM/W	209	816.5 LM	23.8 LM/W	402
RGBW 36"	10° X 10°	435.0 LM	41.3 LM/W	4424	1104.0 LM	41.3 LM/W	11221	2123.0 LM	41.3 LM/W	21578
	10° X 60°	391.0 LM	37.1 LM/W	1236	993.0 LM	37.1 LM/W	3136	1909.0 LM	37.1 LM/W	6030
	20° X 20°	465.0 LM	42.0 LM/W	2496	1180.0 LM	42.0 LM/W	6331	2270.0 LM	42.0 LM/W	12175
	20° X 60°	421.0 LM	37.9 LM/W	947	1067.0 LM	37.9 LM/W	2402	2051.0 LM	37.9 LM/W	4619
	40° X 40°	462.0 LM	43.8 LM/W	658	1172.0 LM	43.8 LM/W	1670	2253.0 LM	43.8 LM/W	3211
	40° X 60°	414.0 LM	39.3 LM/W	407	1051.0 LM	39.3 LM/W	1030	2021.0 LM	39.3 LM/W	1985
	60° X 60°	412.0 LM	36.5 LM/W	333	1045.0 LM	36.5 LM/W	845	2009.0 LM	36.5 LM/W	1625
	80° X 80°	251.0 LM	23.8 LM/W	123	637.0 LM	23.8 LM/W	313	1225.0 LM	23.8 LM/W	602
RGBW 48"	10° X 10°	580.0 LM	41.3 LM/W	5898	1472.0 LM	41.3 LM/W	14961	2831.0 LM	41.3 LM/W	28771
	10° X 60°	522.0 LM	37.1 LM/W	1648	1323.0 LM	37.1 LM/W	4181	2545.0 LM	37.1 LM/W	8040
	20° X 20°	620.0 LM	42.0 LM/W	3328	1574.0 LM	42.0 LM/W	8441	3026.0 LM	42.0 LM/W	16233
	20° X 60°	561.0 LM	37.9 LM/W	1263	1422.0 LM	37.9 LM/W	3203	2735.0 LM	37.9 LM/W	6159
	40° X 40°	616.0 LM	43.8 LM/W	878	1562.0 LM	43.8 LM/W	2226	3004.0 LM	43.8 LM/W	4281
	40° X 60°	552.0 LM	39.3 LM/W	543	1401.0 LM	39.3 LM/W	1376	2694.0 LM	39.3 LM/W	2647
	60° X 60°	549.0 LM	36.5 LM/W	444	1393.0 LM	36.5 LM/W	1127	2679.0 LM	36.5 LM/W	2167
	80° X 80°	335.0 LM	23.8 LM/W	164	849.0 LM	23.8 LM/W	418	1633.0 LM	23.8 LM/W	803

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

WIRING

MAXIMUM FIXTURES PER POWER SUPPLY (CIRCUITS MAY NOT BE LOADED OVER 10 AMPS)

Data provided is based on 75% of the Power Supply's total wattage capacity

	LOW OUTPUT (3.5 W/FT)			MEDIUM OUTPUT (9.0 W/FT)			HIGH OUTPUT (17.0 W/FT)		
NOMINAL FIXTURE LENGTH	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W	CONTRA STAND. POWER 96W OUTPUT	CONTRA HIGH POWER 240W OUTPUT	CONTRA DUAL HIGH POWER (2)-240W
12"	27	68	136	10	26	52	5	14	28
24"	13	34	68	5	13	26	2	7	14
36"	9	23	46	3	8	16	2	4	8
48"	6	17	34	2	6	12	1	3	6

REMOTE DISTANCE LIMITS

Noncompliance with recommended remote wiring distances may void warranty

WIRE GAUGE	MAX DISTANCE
20 AWG	25.0 FT
18 AWG	30.0 FT
16 AWG	40.0 FT
14 AWG	60.0 FT
12 AWG	100.0 FT

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

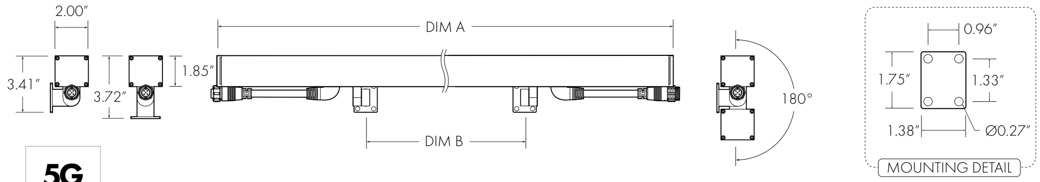
PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

DIMENSIONS

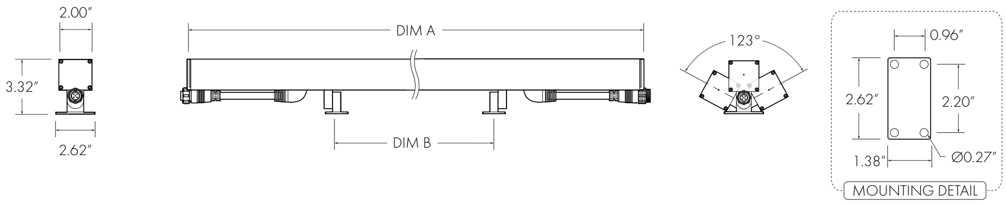
	12"	24"	36"	48"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

SURFACE MOUNT (SM)

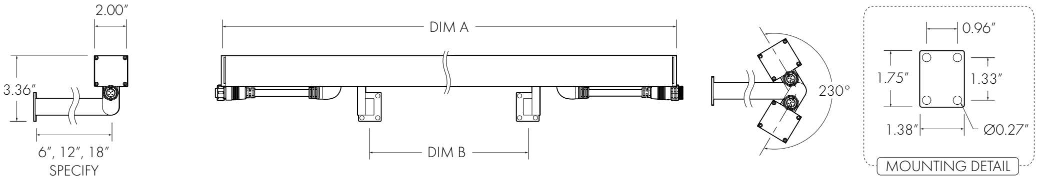


5G
ANSI C136.31

GROUND MOUNT (GM)



EXTENDED ARM (EA-X)



6″, 12″, 18″
SPECIFY
LENGTH

3G
ANSI C136.3

3G RATED WITH 6.00" ARM

insight lighting

MEDLEY EXTERIOR REMOTE (MER)

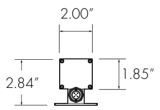
PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

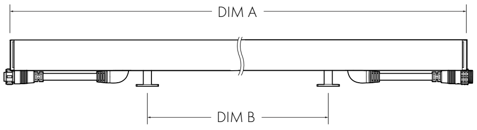
PROJECT: TYPE: CATALOG #: MER- - - - - - - - -

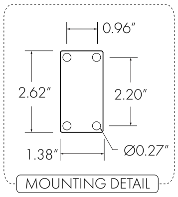
DIMENSIONS

	12"	24"	36"	48"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	9.28"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

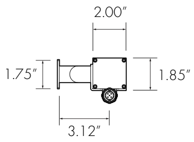
FIXED MOUNT (FM)

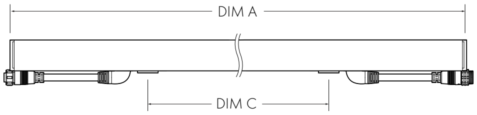


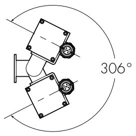


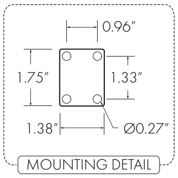


SURFACE, BACK MOUNT (SMB)

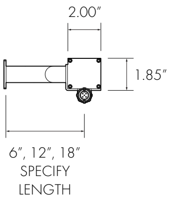


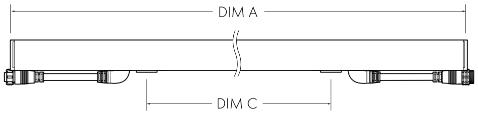


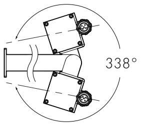


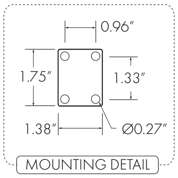


EXTENDED ARM, BACK MOUNT (EAB-X)









insight lighting

MEDLEY EXTERIOR REMOTE (MER)

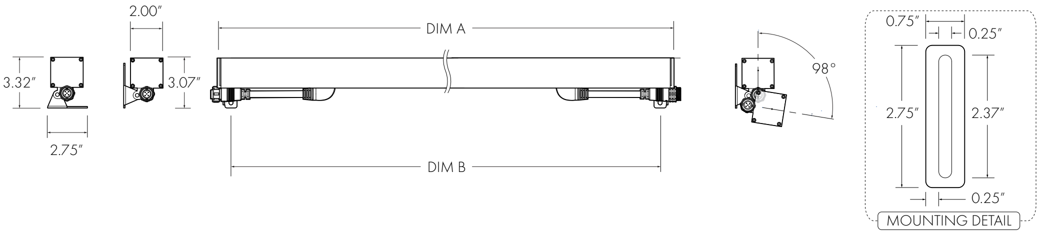
PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

PROJECT: TYPE: CATALOG #: MER- - - - - - - -

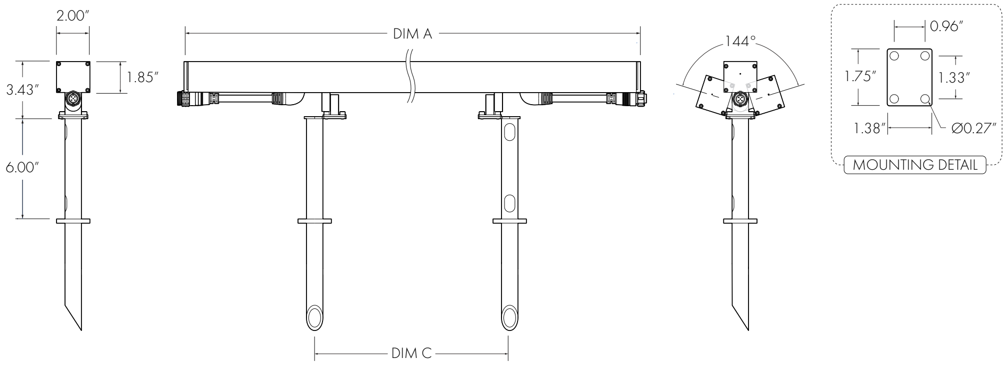
DIMENSIONS

	12"	24"	36"	48"
DIM A	12.10"	23.85"	35.60"	47.35"
DIM B	11.65	22.31"	34.06"	45.81"
DIM C	10.56"	4.00" MIN | 6.00" MAX	12.00" MIN | 18.00" MAX	18.00" MIN | 30.00" MAX

END MOUNT (EM)



STAKE MOUNT (STM)



insight lighting

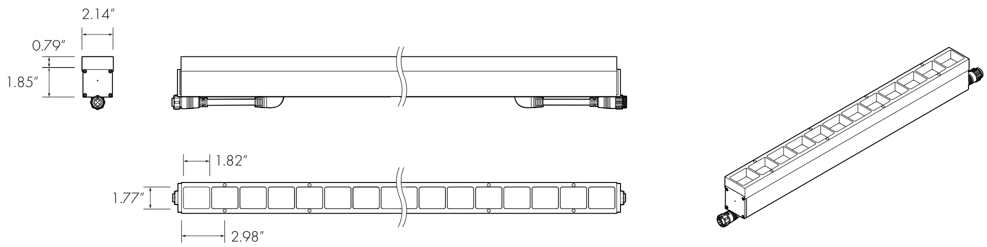
MEDLEY EXTERIOR REMOTE (MER)

PERFORMANCE LINEAR | COLOR CHANGING + ACTIVE WHITE

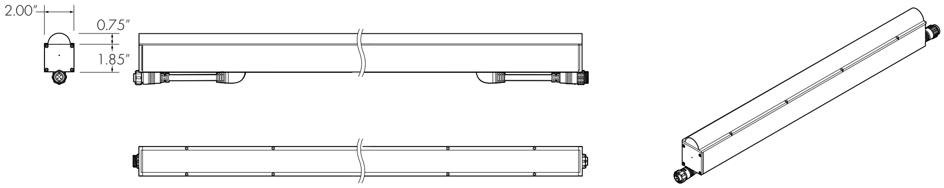
PROJECT: TYPE: CATALOG #: MER- - - - - - - -

ACCESSORIES

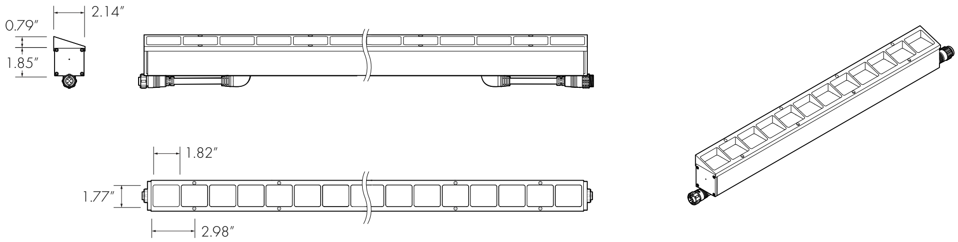
LOUVER (LV)



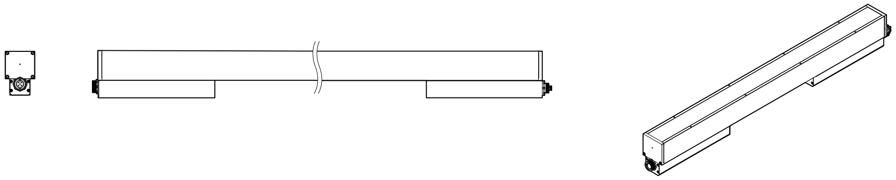
DIRECT VIEW LENS (DV)



VISOR (VS)

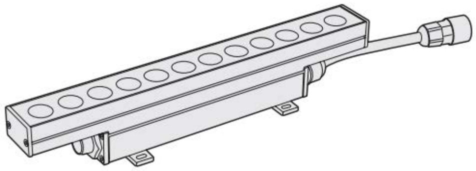


CONCEALED WIRING (CW)



AL Graze DC DMX

ACCLAIM
LIGHTING



Client:	
Project:	
Type:	
Order Code:	
Quantity:	

The **AL Graze DC DMX** is a mid-range output, low profile, outdoor linear LED fixture.
Available in 1' and 4' sections, it offers multiple configurations, including RGB, RGBW, and Dynamic White.
Featuring a robust IP66 housing, on-board DMX driver with RDM addressing, and linkable cable system, it is the perfect option for any structure that calls for indoor or outdoor linear grazing.

Specifications

Color	RGB, RGBW, RGBA, Dynamic White (2200K-5000K), 2700K, 3000K, 3500K, 4000K
Beam Angle	10º x 60º, 30º x 60º, 15º x 15º, 60º x 60º
Max Fixtures In Series	12'
Total Lumens	419 per foot (4000K, 30º x 60º)
Control	DMX + RDM
Mounting	30º Swivel Mount and Fixed Flat Mount Included
Power Consumption	9W (1'), 36W (4')
Operating Voltage	24VDC
Lumen Maintenance	L70 @ 150,000 Hours (25º C)
Finish	Anodized Brushed Aluminum
Housing Material	Aluminum; Glass Top Lens
Operating Temperature	-4°F to 123°F (-20°C to 50°C)
IP Rating	IP66, Wet or Dry Location
Fixture Connectors	Multipin IP66 Connectors, End to end jumpers attached to each fixture
Warranty	5 Years
Weight	1.25 lbs. / 0.6 kg (1'), 5 lbs / 2.3 kg (4')
Dimensions	L: 12" / 48" W: 1.5" H: 2.3" (L: 305mm / 1220mm W: 38mm H: 59mm)
Certifications	

Specification Sheet 2.1.5
www.acclaimlighting.com

AL Graze DC DMX

ACCLAIM
LIGHTING

Order Codes

* Indicates Special Order

Model		Control	Housing Color	Lens Cover		Length	Beam	Color	Input voltage
AGD	**-**	**2**	**4**	**1**	**-**	**#**	**#**	**#**	**N**

Input Voltage:
N = Normal (24VDC)

Color:
A = 2700K*
B = 3000K*
D = 3500K*
E = 4000K*
H = RGB
L = RGBW (W=4000K)
J = RGBA
M = Dynamic White (2200K-5000K)

Beam:
D = 15° x 15°*
K = 60° x 60°*
P = 10 x 60°
Q = 30 x 60°

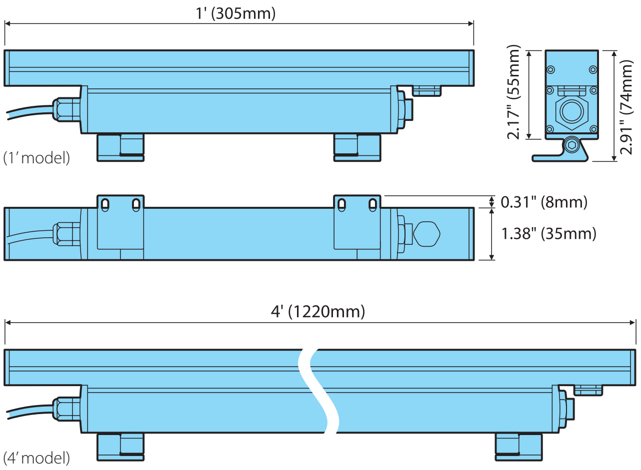
Length:
A = 1'
D = 4'

Lens Cover:
1 = Clear

Housing Color:
4 = Aluminum

Control:
2 = DMX

Dimensions



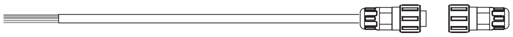
Specification Sheet 2.1.5
www.acclaimlighting.com

AL Graze DC DMX

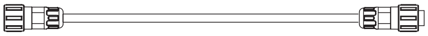
ACCLAIM
LIGHTING

Related Components

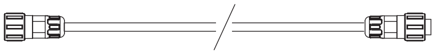
Connection Cables



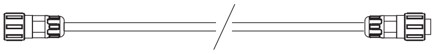
AGDFC10-V2
10' Feed Cable For AL Graze DC DMX + End Cap
Powers up to 12'



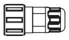
AGDLC1-V2
1' Link Cable for AL Graze DC DMX



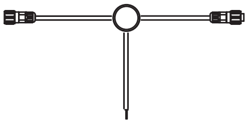
AGDLC5-V2
5' Link Cable for AL Graze DC DMX



AGDLC10-V2
10' Link Cable for AL Graze DC DMX

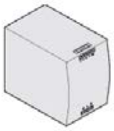


AGDEC-V2
End Cap for AL Graze DC DMX

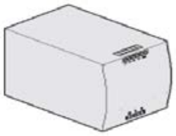


AGDT1-V2
1' DMX "T" Jumper for AL Graze DC DMX

Power Supplies



APS-240-24
Powers 2 x 12' Runs
240W, 24VDC, Dry location, DIN Rail Mount
115-230VAC (47-63Hz) Input



APS-480-24
Powers 4 x 12' Runs
480W, 24VDC, Dry location, DIN Rail Mount
115-230VAC (47-63Hz) Input

Glare Shields

AGS1
12" Single Sided Glare Shield for AL Graze DC

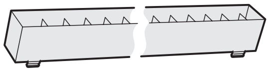
AGS4
48" Single Sided Glare Shield for AL Graze DC

AL Graze DC DMX

ACCLAIM
LIGHTING

Related Components (Con't)

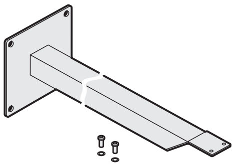
Louvers



AGLV12
12" Louver for AL Graze DC DMX

AGLV48
48" Louver for AL Graze DC DMX

Extender Bars



AGEB12
12" Extender Bar for AL Graze DC DMX

AGEB24
24" Extender Bar for AL Graze DC DMX

Mounting Accessories

AG90
90 Degree Mounting Bracket for AL Graze DC DMX

Fixture Setup Accessories

XMT350
DMX + RDM Addressing and Testing Tool

AL Graze DC DMX

ACCLAIM
LIGHTING

Photometrics

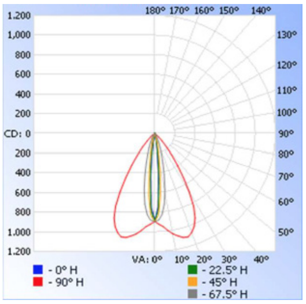
For additional color data and IES files, please visit acclaimlighting.com

RGB 10° x 60° 1'

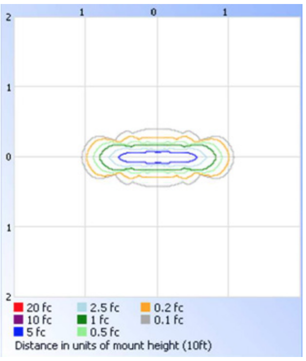
Zonal Lumen Summary

Zone	Lumens	%
0-60	233.9	99.2
60-90	1.8	0.7
90-180	0.1	0.0
Total	**235.7**	**100**

Polar Candela Distribution



Isofootcandle Plot

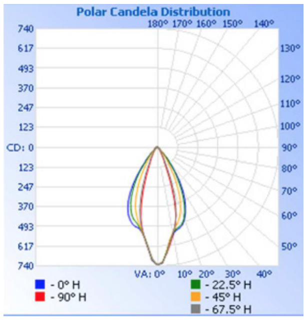


4000K 30° x 60° 1'

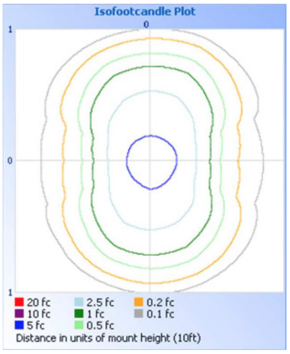
Zonal Lumen Summary

Zone	Lumens	%
0-60	404.7	98.8
60-90	5.0	1.2
90-180	0.0	0.0
Total	**419.7**	**100**

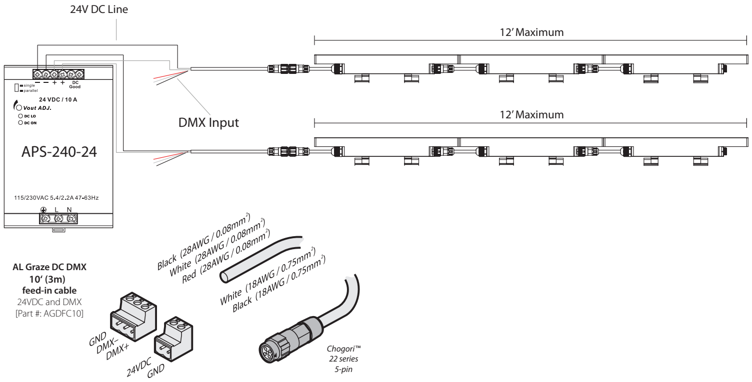
Polar Candela Distribution



Isofootcandle Plot



Wiring



GINKO 2.0

designplan

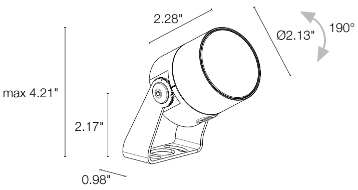
datasheet

The Ginko series IP66, IP69K projectors are small and versatile. Available in a variety of finishes, optics (some models have integral adjustable optics), and 80 or 90 CRI.

TECHNICAL DATA

Wattage / Input	3.5W (only 5° optics), 5W, 7W (24VDC)
Power Supply	Remote, not included. See page 2.
Construction	Body: Anti-corrosive Aluminum Alloy or 316L SS Bracket: 316L SS Lens: Tempered extra-clear glass Cable Length: 4.92’ standard
CCT	2700K, 3000K, 4000K *(3500K on request, not available on 5° optic)*
CRI	2700K, 3000K, 4000K: CRI >80, 90 *Note: 3.5W 4000K is CRI 80 only*
Delivered Lumens	See Delivered Lumens Chart
Efficacy	57-70 lm/W (5W), 53-66 lm/W (7W)
Optics	12 Standard (see below)
Finishes	7 Standard, Custom RAL (see below)
Fixture Dimensions	Ø2.13” x 2.28” x 2.17” h *(max 4.21” h fully extended),* 0.98” wide bracket
Fixture Weight	0.84 lbs
LED Source	1 Power LED (3.5W), 1 High Intensity Power LED
Lumen Maintenance	L90,B10 >50,000hrs (Ta 25°C)
Color Consistency	1/4 ANSI BIN (3.5W), 3-Step MacAdam
Operating Temp.	-4°F to +113°F
IP Rating	IP66, IP69K
Impact Rating	IK07

Fixture Dimensions



Delivered Lumens (3000K, 34°)	5W	7W
CRI 80	352 lm	463 lm
CRI 90	284 lm	374 lm

ORDERING INFORMATION

Example: GN200115SE or GN200115SE-2. Accessories / Power Supplies ordered separately.

GN200						-	

Model #	**Wattage**	**CRI**	**CCT**	**Optics**		**Finish**	**Cable Length**
GN200	**0** - 3.5W **1** - 5W **2** - 7W	**0** - CRI 80 **1** - CRI 90	**F** - 2700K **5** - 3000K **9** - 4000K* **3.5W 4000K for CRI 80 only*	**U** - 5° *(3.5W only)* **V** - 8° **T** - 11° **S** - 17° **P** - 21° sharp **M** - 34° **L** - 45° **J** - 47° **Q**- 61° sharp	**K** - 68° **W** - 13° v x 52° h **X** - 54° v x 15° h	**I** - Stainless Steel **E** - White **N** - Black Anodized **G** - Gray **H** - Anthracite **T** - Corten **5** - Jasper Green **C** - Custom RAL *(consult factory for “C”)*	4.92’ standard **1** - 16.40’ **2** - 32.81’ **3** - 49.21’ **4** - 65.62’

Job Name/Date:

Fixture Type Designation:

GINKO 2.0

designplan
datasheet

SUGGESTED POWER SUPPLIES

3.5W - 24VDC

Part Number	Description	Input/Output	# of Fixtures
PPLT00194	Non-Dim	120-277VAC to 24VDC, 12W, Class 2	1-2
PPLT00632	0-10V Dimming (Dim to Off)	120-277VAC to 24VDC, 12W, Class 2	1-2
PPLT00056	Non-Dim	120-277VAC to 24VDC, 26W, Class 2	1-5
PPLT00157	Non-Dim	120VAC to 24VDC, 60W, Class 2	1-13
PPLT00599	ELV / TRIAC & 0-10V Dimming (100 to 0%)	120-277VAC to 24VDC, 96W, Class 2	1-21
PPLT00284	Non-Dim	120-277VAC to 24VDC, 100W, Class 2	1-22
PPLT00543	0-10V Dimming to 15% (-40°C / -40°F cold weather start)	120-277VAC to 24VDC, 100W, Class 2	3-22

SUGGESTED POWER SUPPLIES

5W - 24VDC

Part Number	Description	Input/Output	# of Fixtures
PPLT00194	Non-Dim	120-277VAC to 24VDC, 12W, Class 2	1-1
PPLT00632	0-10V Dimming (Dim to Off)	120-277VAC to 24VDC, 12W, Class 2	1-1
PPLT00056	Non-Dim	120-277VAC to 24VDC, 26W, Class 2	1-4
PPLT00157	Non-Dim	120VAC to 24VDC, 60W, Class 2	1-9
PPLT00599	ELV / TRIAC & 0-10V Dimming (100 to 0%)	120-277VAC to 24VDC, 96W, Class 2	1-15
PPLT00284	Non-Dim	120-277VAC to 24VDC, 100W, Class 2	1-16
PPLT00543	0-10V Dimming to 15% (-40°C / -40°F cold weather start)	120-277VAC to 24VDC, 100W, Class 2	2-16

SUGGESTED POWER SUPPLIES

7W - 24VDC

Part Number	Description	Input/Output	# of Fixtures
PPLT00194	Non-Dim	120-277VAC to 24VDC, 12W, Class 2	1-1
PPLT00632	0-10V Dimming (Dim to Off)	120-277VAC to 24VDC, 12W, Class 2	1-1
PPLT00056	Non-Dim	120-277VAC to 24VDC, 26W, Class 2	1-2
PPLT00157	Non-Dim	120VAC to 24VDC, 60W, Class 2	1-6
PPLT00599	ELV / TRIAC & 0-10V Dimming (100 to 0%)	120-277VAC to 24VDC, 96W, Class 2	1-10
PPLT00284	Non-Dim	120-277VAC to 24VDC, 100W, Class 2	1-11
PPLT00543	0-10V Dimming to 15% (-40°C / -40°F cold weather start)	120-277VAC to 24VDC, 100W, Class 2	2-11

For other power supply options consult factory.

Job Name/Date:

Fixture Type Designation:

GINKO 2.0

datasheet

ACCESSORIES
Installation

WP0100
Ground Spike
(Length 10.12")

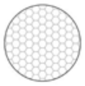
WP1006__ (Length 19.69")
WP1007__ (Length 31.50")
Ground Spike with Bracket
Include one of the below finishes:
I - Stainless Steel
E - White
N - Black anodized
F - Gray
H - Anthracite
T - Cor-ten
5 - Jasper Green
C - Custom RAL

WP1004
Fastener Strap
(Length 16.4')

WF3301
Cable Protection Sheath
(Length 6.0")

Additional Cable Lengths
Consult factory

Anti-Glare



WH0201
Honeycomb Louvre
Not available for Sharp Optics.

WB8012__
Standard Snoot

WB8022__
Asymmetric Snoot

For Snoots include one of the below finishes:
E - White
N - Black anodized
F - Gray
H - Anthracite
T - Cor-ten
5 - Jasper Green
C - Custom RAL

Job Name/Date:

Fixture Type Designation:

TARGETTI

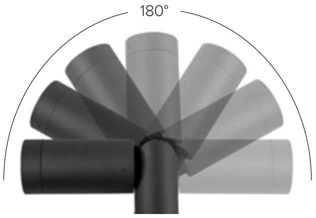
BULLETTO

Compact Adjustable Flood Light Projector

Concept: Compact projector flood light for high intensity applications.
Materials: Aluminum body and joints for maximum heat dissipation with powder coated finish. Modular body for toolless maintenance. Lens cover assembly for simple toolless field interchangeability of accessories. [A]Fixture suitable for use in marine grade environments.
Optics: NSP, SP, FL, MW, and WF use high efficiency LED Chip on Board. Equipped with collimating optic with angle specific holigraphic spread lens.
Mounting: Adjustable up to 180° on the vertical surface with aim lock set screw, 360° rotatable on the horizontal axis. Brass counter nut with ½" NPS mounting stem suitable for direct j-box mount. Optional installation accessories for additional mountings.
Installation: Pre-cabled with 10' Belden direct burial 18ga 3 Conductor Cable for Connection to remote power supply.
Finish: Textured Standard Finishes – Ferrite Grey / Heritage Brown / Bronze RAL 8019 / White / Black / Sandstone Grey
Power Supply: Remote Class 2, 120V-277VAC power supply required, ordered separately.
Wattage: 10W (NSP) / 12W (SP/FL/MF/WF)
Color Temperature: 2700K / 3000K / 3500K / 4000K
CRI: Ra84, Ra90 available upon request
Delivered Lumens: **3000K**
Narrow Spot 10° = 473Lm IMax: 24,196cd/klm
Spot 15° = 858Lm IMax: 7,292cd/klm
Flood 25° = 812Lm IMax: 2,883cd/klm
Medium Wide Flood 30° = 819Lm IMax: 1,916cd/klm
Wide Flood 43° = 801Lm IMax: 1,009cd/klm
Lumen Maintenance (L70): 50,000hrs
Calculation for LED fixtures are based on measurements that comply with IES LM-80.
CRI: Ra84
Voltage: 24V DC
Weight: 1.37lbs
IK Rating: IK10
IP Rating: IP66
Certifications: cULus Class 2 Wet Location Listed
Tested in accordance with LM-79-08
Energy efficient for California installations.
Warranty: 5 year limited warranty

Bulletto Shown in Ferrite Grey Finish

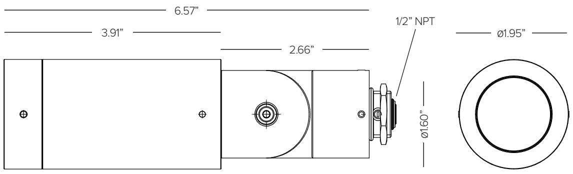
Marine [A] IP66 cULus Class 2



[A]*Not to be in direct contact with salt for extended periods of time or used with corrosive agents.*

PRODUCT CODE	DRIVER	FINISH	OUTPUT	OPTICS	COLOR TEMP	+	POWER SUPPLY
BLT — BULLETTO	**RP** — Remote Power	**FE** — Ferrite Grey	**L1** — 10W	**NS** — Narrow Spot 10°	**27** — 2700K		*See page 4*
		HB — Heritage Brown	**L2** — 12W	**SP** — Spot 15°	**30** — 3000K		
		BZ — Bronze RAL8019		**FL** — Flood 25°	**35** — 3500K		
		WT — White Textured		**MF** — Medium Wide Flood 30°	**40** — 4000K		
		BT — Black Textured		**WF** — Wide Flood 43°			
		SG — Sandstone Grey					

Views



TARGETTI

BULLETTO

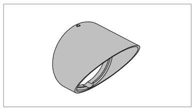
INTERNAL OPTICAL ACCESSORIES:	
Maximum of two internal optical accessories per fixture.	
1E3798	Chromatic filter Red. Dimensions Ø50mm
1E3799	Chromatic filter Green. Dimensions Ø50mm
1E3800	Chromatic filter Blue. Dimensions Ø50mm
1E3801	Chromatic filter Yellow. Dimensions Ø50mm
1E3802	Chromatic filter Magenta. Dimensions Ø50mm
1E3790	'Blade of Light' linear spread lens filter. Dimensions Ø50mm
1E3792	Honeycomb filter. Dimensions Ø50mm


Chromatic FiltBLTrs


1E3790


1E3792

EXTERNAL OPTICAL ACCESSORIES:						
● **Ferrite**	● **Heritage Brown**	● **Bronze RAL 8019**	○ **White**	● **Black**	● **Sandstone Grey**	*Description*
1E3788	**1E3788HB**	**1E3806**	**1E3788WT**	**1E3788BT**	**1E3788SG**	Asymmetric screen. Powder coated finish.

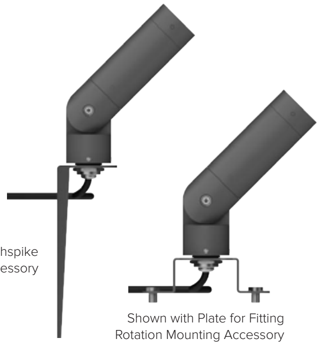

Asymmetric Screen

INSTALLATION ACCESSORIES:						
Maximum of one installation accessory per fixture.						
● **Ferrite**	● **Heritage Brown**	● **Bronze RAL 8019**	○ **White**	● **Black**	● **Sandstone Grey**	*Description*
1E3786	**1E3786HB**	**1E3804**	**1E3786WT**	**1E3786BT**	**1E3786SG**	Plate for fitting rotation. Powder coated stainless steel.
1E3785	**1E3785HB**	**1E3803**	**1E3785WT**	**1E3785BT**	**1E3785SG**	Earthspike. Powder coated stainless steel.
1BLTSMCVRFE	**1BLTSMCVRHB**	**1BLTSMCVRBZ**	**1BLTSMCVRWT**	**1BLTSMCVRBT**	**1BLTSMCVRSG**	Low Profile surface canopy. Powder coated aluminum with ½" NPT to mount over 4" Dia.


Plate for Rotation


Earthspike


Surface Mount Canopy


Shown with Earthspike Mounting Accessory

Shown with Plate for Fitting Rotation Mounting Accessory

TARGETTI

BULLETTO

Power Supply (REQUIRED)	Type	Wattage	Input/Output Voltage	Dimmable	IP Rating	Output	Dimensions
DMLE301242UD	EMCOD MLE-UD ELECTRONIC DRIVER WITH WIRING COMPARTMENT.	30W	120-277V / 24V	FWD / REV PHASE / TRIAC / 0-10V / PWM	NEMA3R ENCLOSURE	UL CLASS 2	4.47” X 6.79” X 1.38”
DMLE601242UD	EMCOD MLE-UD ELECTRONIC DRIVER WITH WIRING COMPARTMENT.	60W	120-277V / 24V	FWD / REV PHASE / TRIAC / 0-10V / PWM	NEMA3R ENCLOSURE	UL CLASS 2	4.47” X 6.79” X 1.38”
DMLE961242UD	EMCOD MLE-UD ELECTRONIC DRIVER WITH WIRING COMPARTMENT.	96W	120-277V / 24V	FWD / REV PHASE / TRIAC / 0-10V / PWM	NEMA3R ENCLOSURE	UL CLASS 2	5.16” X 7.73” X 1.54”
DMLE1922242UD	EMCOD MLE-UD ELECTRONIC DRIVER WITH WIRING COMPARTMENT.	2X96W	120-277V / 24V	FWD / REV PHASE / TRIAC / 0-10V / PWM	NEMA3R ENCLOSURE	UL CLASS 2	5.04” X 10.94” X 1.81”
DMLE2882242UD	EMCOD MLE-UD ELECTRONIC DRIVER WITH WIRING COMPARTMENT.	3X96W	120-277V / 24V	FWD / REV PHASE / TRIAC / 0-10V / PWM	NEMA3R ENCLOSURE	UL CLASS 2	5.04” X 10.94” X 1.81”
DELV30124DJBX	MAGNITUDE SOLIDRIVE ELECTRONIC DRIVER WITH BUILT-IN JUNCTION BOX.	30W	120-277V / 24V	0-10V 1%	IP66	UL CLASS 2	12.1” X 2.36” X 1.4”
DELV30124D	MAGNITUDE SOLIDRIVE ELECTRONIC STANDALONE DRIVER. **UL LISTED ENCLOSURE PROVIDED BY OTHERS.**	30W	120-277V / 24V	0-10V 1%	IP66	UR CLASS 2	7.5” X 2.36” X 1.4”
DELV60124DJBX	MAGNITUDE SOLIDRIVE ELECTRONIC DRIVER WITH BUILT-IN JUNCTION BOX.	60W	120-277V / 24V	0-10V 1%	IP66	UL CLASS 2	12.1” X 2.36” X 1.4”
DELV60124D	MAGNITUDE SOLIDRIVE ELECTRONIC STANDALONE DRIVER. **UL LISTED ENCLOSURE PROVIDED BY OTHERS.**	60W	120-277V / 24V	0-10V 1%	IP66	UR CLASS 2	7.5” X 2.36” X 1.4”
DELV96124DJBX	MAGNITUDE SOLIDRIVE ELECTRONIC DRIVER WITH BUILT-IN JUNCTION BOX.	96W	120-277V / 24V	0-10V DIMMING 1%	IP66	UL CLASS 2	12.1” X 2.36” X 1.4”
DELV96124D	MAGNITUDE SOLIDRIVE ELECTRONIC STANDALONE DRIVER. **UL LISTED ENCLOSURE PROVIDED BY OTHERS.**	96W	120-277V / 24V	0-10V DIMMING 1%	IP66	UR CLASS 2	7.5” X 2.36” X 1.4”
PS060	LUTRON HI-LUME PREMIER 0.1% CONSTANT VOLTAGE DRIVER WITH UL LISTED ENCLOSURE	96W	UNIVERSAL 120-277 VAC	HI-LUM DIMMABLE 0.1%	IP20/NOM CERTIFIED	UL CLASS 2	10.5” x 5.5” x 2”[1]

[1] Dimensions include enclosure with mounting bracket.
*** Constant voltage drivers 50/60HZ, voltage regulated with short circuit protection. Operating temperature -40 C- 80° C**
*** Installation of power supply must be compliant to Class 2 installation standards. Refer to NEC and local building code requirements.**
*** Consult factory for additional driver options (ie: DMX, DALI, wattage, size, shape, Lutron, ELDO, or others).**

TARGETTI

BULLETTO

Max Fixtures Per Driver

Fixture Wattage		Driver Wattage				
		30W	**60W**	**96W**	**100W**	**2X100W**
	10W	2	5	8	8	16
	12W	2	4	7	7	14

Driver Wattage	Watt	No. Fixtures	Voltage	18 AWG	16 AWG	14 AWG	12 AWG	10 AWG
30W Driver	10W	(1) 10W Fixture	24V DC	135 feet	215 feet	342 feet	544 feet	866 feet
	12W	(1) 12W Fixture	24V DC	135 feet	215 feet	342 feet	544 feet	866 feet
	20W	(2) 10W Fixtures	24V DC	75 feet	120 feet	190 feet	302 feet	480 feet
	24W	(2) 12W Fixtures	24V DC	67 feet	108 feet	171 feet	272 feet	432 feet
60W Driver	30W	(3) 10W Fixtures	24V DC	52 feet	82 feet	131 feet	209 feet	333 feet
	36W	(3) 12W Fixtures	24V DC	45 feet	72 feet	114 feet	181 feet	288 feet
	40W	(4) 10W Fixtures	24V DC	40 feet	63 feet	100 feet	160 feet	254 feet
	48W	(4) 12W Fixtures	24V DC	34 feet	54 feet	85 feet	136 feet	216 feet
	50W	(5) 10W Fixtures	24V DC	32 feet	51 feet	81 feet	130 feet	206 feet
96/100W Driver	60W	(5) 12W Fixtures	24V DC	27 feet	43 feet	68 feet	108 feet	173 feet
	60W	(6) 10W Fixtures	24V DC	27 feet	43 feet	68 feet	108 feet	173 feet
	72W	(6) 12W Fixtures	24V DC	22 feet	36 feet	57 feet	91 feet	144 feet
	70W	(7) 10W Fixtures	24V DC	22 feet	36 feet	57 feet	91 feet	144 feet
	84W	(7) 12W Fixtures	24V DC	19 feet	30 feet	48 feet	77 feet	123 feet
	80W	(8) 10W Fixtures	24V DC	20 feet	31 feet	50 feet	80 feet	127 feet

RISE™

OVERVIEW • SPECIFICATIONS • ORDERING

INTERIOR + EXTERIOR | **F080 SINGLE ROUND**

DATE	PROJECT	FIRM	TYPE

RISE IS A SYSTEM OF BEAUTIFULLY DESIGNED OUTDOOR RATED LUMINAIRES THAT PROVIDE EFFICIENT AND POWERFUL LIGHT USING THE LATEST IN LED TECHNOLOGY. RISE F080 SINGLE IS A POWERFUL AND COMPACT LED LIGHT FIXTURE, DELIVERING UP TO 1170 LUMENS, THAT CAN BE USED IN SPOT, ACCENT, LANDSCAPE AND FLOODLIGHT APPLICATIONS. ITS UNIQUE MACRO™ LOCK FEATURE ALLOWS FOR FULL 180 DEGREE TILT AND 360 DEGREE PAN AIMABILITY USING ONLY ONE TWIST.

FEATURES :

- POWERFUL CBCP
- EXTREMELY COMPACT
- POWERFUL OUTPUT UP TO 1170 LUMENS
- MACRO™ LOCK - 180° TILT AND 360° PAN
- 12 UNIQUE BEAM ANGLES
- MULTIVOLT (110V-277V)
- 8 CCTS: 2200K THROUGH 6500K
- 80+ AND 90+ CRI
- DIMMABLE TO 5%
- IP66 RATED

F080

FIXTURE MODEL	**FIXTURE CONFIG.**	**POWER/ LUMEN OUTPUT**	**CCT/ COLOR**	**CRI**	**BEAM ANGLE**	**FINISHES**	**ACCESSORIES**	**WIRING AND MOUNTING**
F080	1R - Single Round	LO - Low Output MO - Medium Output HO - High Output	22 - 2200K 25 - 2500K 27 - 2700K 30 - 3000K 35 - 3500K 40 - 4000K 50 - 5000K 65 - 6500K RD - Red GR - Green BL - Blue AM - Amber *2200K and 2500K not available in 40°, 60°, 70° and 90°	8 - 80 9 - 90* X - For RD, GR, BL, AM *90 CRI not available in 2500K, 5000K, and 6500K	05 - Laser Spot (5°) 10 - Very Narrow Spot (10°) 15 - Narrow Spot (15°) 20 - Spot (20°) 40 - Flood (40°) 60 - Medium Flood (60°) 70 - Wide Flood (70°) 90 - Very Wide Flood (90°) E1 - Elliptical 1 (15°x60°) E2 - Elliptical 2 (30°x60°) E3 - Elliptical 3 (60°x15°) E4 - Elliptical 4 (60°x30°)	K - Black Z - Bronze S - Silver W - White C - Custom* *Provide RAL #	X - No Accessory H - Half Snoot F - Full Snoot Will ship as X if not specified	A - 19" Flying Leads - Internal Cable IC; Bottom Exit; 1/2" NPT ; UL/CE Listed B* - 10' External Cable Side Exit; Surface Mount ; UL Listed C* - 10' External Cable Bottom Exit; Surface Mount - 1/2" NPT ; UL Listed D* - 10' External Cable Side Exit; Surface Mount ; CE Listed E* - 10' External Cable Bottom Exit; Surface Mount - 1/2" NPT; CE Listed *Will ship as A if not specified

EXAMPLE: F080-1R-LO-22-8-05-S-X-A

*SEE PHOTOMETARY CHART FOR LUMEN DATA

PERFORMANCE	WATTS	POWER	LUMEN OUTPUT		EFFICACY		CBCP	
			5°	40°	5°	40°	5°	40°
	4	Low Output	309	429	76	107	21,991	705
	7.5	Medium Output	531	761	71	101	37,824	1,251
	11.5	High Output	744	1,120	65	99	53,048	1,874

ALL LUMEN DATA IS FROM 4000K 80CRI FIXTURES. PLEASE SEE PHOTOMETRY SPEC SHEET FOR ADDITIONAL LUMEN DATA.

COLOR RENDERING INDEX	80+, 90+
COLOR CONSISTENCY	3-STEP MACADAM ELLIPSE

LUMEN DEPRECIATION

WATTS	L70 @ 25C	L70 @ 50C	L90 @ 25C	L90 @ 50C
LOW	>60,500* >(109,000)**	>60,500* >(109,000)**	>60,500* >(109,000)**	>60,500* >(109,000)**
MEDIUM	>60,500* >(109,000)**	>60,500* >(109,000)**	>60,500* >(109,000)**	>60,500* >(109,000)**
HIGH	>60,500* >(181,000)**	>36,300*	>60,500* >(69,800)**	>33,200*

* ENERGY STAR REPORTED TESTING HOURS TO DATE. CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR

** ESTIMATED HOURS

NOTE: Information on this Spec Sheet is subject to change, please visit ecosenselighting.com/downloads/rise for the most updated information.

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INTERIOR + EXTERIOR | **F080 SINGLE ROUND**

DATE	PROJECT	FIRM	TYPE

ELECTRICAL	**WATTAGE**	LOW OUTPUT = 4W; MEDIUM OUTPUT = 7.5W; HIGH OUTPUT = 11.5W
	POWER FACTOR	>0.9 for 120V (HO, MO, LO), 230V (HO, MO), 277V (HO)
	THD	<0.2 for 120V (HO, MO, LO), 230V (HO, MO), 277V (HO)
	OPERATING VOLTAGE	MULTIVOLT: 110-277VAC, 50/60 Hz
	DRIVER	INTEGRAL TO FIXTURE; DE-RATED POWER AND SYNCHRONOUS START-UP AT FULL BRIGHTNESS
	STARTUP TEMPERATURE	-40˚F TO 122˚F (-40˚C TO 50˚C)
	OPERATING TEMPERATURE	-40˚F TO 122˚F (-40˚C TO 50˚C)
	STORAGE TEMPERATURE	-40˚F TO 176˚F (-40˚C TO 80˚C)
	SURGE PROTECTION	SURGE PROTECTION DEVICES WITH A MINIMUM DISCHARGE CURRENT RATING OF 20kA, THAT MEET UL1449, CSA C22.2 No. 269.1, AND IEC TR 62066, SHOULD BE INSTALLED ON EACH BRANCH CIRCUIT.
CONTROL	**DIMMING**	110-277VAC, ELV TYPE, REVERSE PHASE, TRAILING EDGE
PHYSICAL	**DIMENSIONS**	W 3.15" x H 7.6" x L 2.49" ; (80mm x 194.1mm x 63.25mm)
	HOUSING/LENS	EXTRUDED ALUMINUM; UV STABILIZED POLYCARBONATE; STAINLESS STEEL FASTENERS
	WEIGHT	2.0LBS ; (0.9KG)
	ENVIRONMENT	OUTDOOR • UL CERTIFIED FOR WET LOCATIONS IP66 IMPACT RATED TO IK10 MEETS 3G ANSI C136.31 VIBRATION STANDARD FOR BRIDGE APPLICATIONS
	MOUNTING OPTIONS	A - FLYING LEADS - INTERNAL CABLE IC; BOTTOM EXIT; 1/2" NPT ; UL/ CE RATED B - EXTERNAL CABLE SIDE EXIT; SURFACE MOUNT ; UL LISTED SURFACE MOUNT PLATE INCLUDED C - EXTERNAL CABLE BOTTOM EXIT; 1/2" NPT ; UL LISTED SURFACE MOUNT PLATE INCLUDED D - EXTERNAL CABLE SIDE EXIT; SURFACE MOUNT ; CE LISTED SURFACE MOUNT PLATE INCLUDED E - EXTERNAL CABLE BOTTOM EXIT; SURFACE MOUNT ; CE LISTED SURFACE MOUNT PLATE INCLUDED
	WIRING	LENGTH OF FLYING LEADS 19" (482.6mm) LENGTH OF EXTERNAL CABLE 10' (3.05m)
	TOOLS	2.5mm HEX KEY AND PHILLIPS #0 SCREWDRIVER FOR INTERCHANGEABLE LENS + SNOOTS 4mm HEX KEY FOR AIMING 5mm HEX KEY FOR MAIN TILT ARM
	WIND LOAD (EPA)	EFFECTIVE PROJECTED AREA 0.14ft²
	CORROSION RESISTANT	RISE HAS A HIGH-PERFORMING, CORROSION-RESISTANT FINISH THAT USES HIGH DURABILITY TRIGLYCIDYL ISOCYANURATE (TGIC) POWDER COATINGS SPECIFICALLY DESIGNED FOR NATATORIUMS AND EXTERIOR WEATHER EXPOSURE. THIS FINISH HAS BEEN TESTED AND APPROVED TO **MARINE GRADE** CORROSION RESISTANCE STANDARD IN UL1598A, ASTM B117 SALT FOG TEST FOR 200 HOURS.
FIXTURE RATING & CERTIFICATIONS	**CE, UL CERTIFIED** **RoHS COMPLIANT, IK10**	CE c UL US LISTED RoHS COMPLIANT IK10
LIMITED WARRANTY	**5 YEARS**	

0-10V CONTROL OPTIONS

100-120VAC / 277VAC Linear Dimming Control Module 0-10V - Plenum Rated	LDCM-PL-120-277-010V-GR

All products come standard with ELV dimming capabilities. 0-10V Control options required for operation at 0-10V.

OPTIONAL ACCESSORIES

Snoots

Round Half Snoot, Color Finish (K=Black, Z=Bronze, S=Silver, W=White, C=Custom)	F080-RH-(K,Z,S,W,C)
Round Full Snoot, Color Finish (K=Black, Z=Bronze, S=Silver, W=White, C=Custom)	F080-RF-(K,Z,S,W,C)

Interchangeble Lens

5 Degree	F080-LENS-05
10 Degree	F080-LENS-10
15 Degree	F080-LENS-15
20 Degree	F080-LENS-20
40 Degree	F080-LENS-40
60 Degree	F080-LENS-60
70 Degree	F080-LENS-70
90 Degree	F080-LENS-90
15x60 or 60x15 Degree	F080-LENS-E1E3
30x60 or 60x30 Degree	F080-LENS-E2E4
Full Set of Beam Angle Lens Degree (5, 10, 15, 20, 40, 60, 70, 90, 15X60 or 60X15, 30X60 or 60X30)	F080-LENS-FULLSET

NOTE: Information on this Spec Sheet is subject to change, please visit ecosenselighting.com/downloads/rise for the most updated information.

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OVERVIEW • SPECIFICATIONS • ORDERING

INTERIOR + EXTERIOR | **F080 SINGLE ROUND**

DATE	PROJECT	FIRM	TYPE

Honeycomb Louver

Honeycomb Louver F080	F080-LV-HComb

Canopy Plate (Not for use with Option B or D - External Cable Side Exit)

RISE Canopy Plate (K=Black, Z=Bronze, S=Silver, W=White, C=Custom)	RISE-CANOPY-04-(K,Z,S,W,C)

Color Filters

Red	F080-FILTER-RED
Blue	F080-FILTER-BLUE
Green	F080-FILTER-GREEN
Amber	F080-FILTER-AMBER

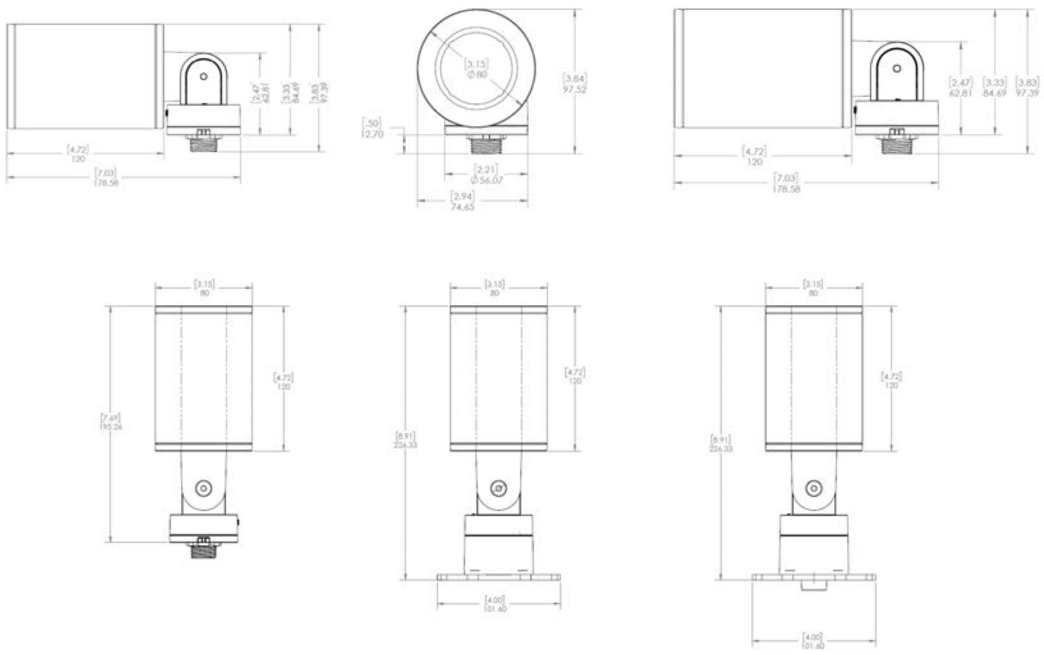
F080 Wall Mount Arm (for use only with Wiring Option C – External Cable Bottom Exit and not for use with multi-up fixtures)

Wall Mount Arm, 6 inch, Color Finish (K=Black, Z=Bronze, S=Silver, W=White, C=Custom)	F080-WMA-06-(K,Z,S,W,C)
Wall Mount Arm, 12 inch, Color Finish (K=Black, Z=Bronze, S=Silver, W=White, C=Custom)	F080-WMA-12-(K,Z,S,W,C)
Wall Mount Arm, 18 inch, Color Finish (K=Black, Z=Bronze, S=Silver, W=White, C=Custom)	F080-WMA-18-(K,Z,S,W,C)
Wall Mount Arm, 24 inch, Color Finish (K=Black, Z=Bronze, S=Silver, W=White, C=Custom)	F080-WMA-24-(K,Z,S,W,C)

Ground Stake (for use only with Wiring Option C – External Cable Bottom Exit and not for use with multi-up fixtures)

Landscape Stake, 12in (for use with F080 Single Head only, not for use with multi-fixture units)	F080-LS-1S-STK-12

DIMENSIONS



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OVERVIEW • SPECIFICATIONS • ORDERING

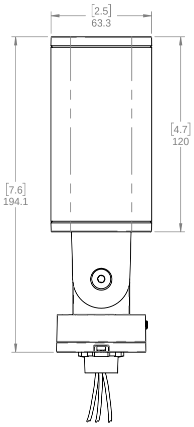
INTERIOR + EXTERIOR | **F080 SINGLE ROUND**

DATE	PROJECT	FIRM	TYPE

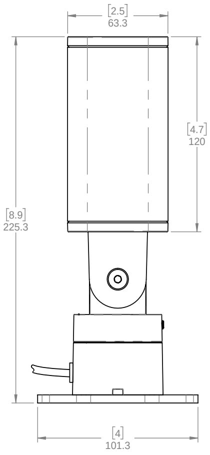
WIRING GUIDE

RISE is and exterior rated (IP66) fixture that is available in three different wiring options:

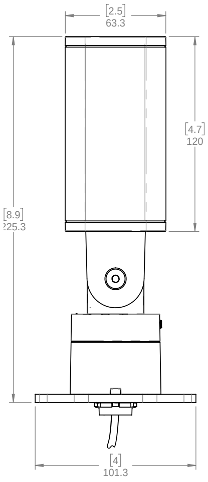
Flying Leads - Internal Cable
(UL Listed or CE Listed)



External Cable Side Exit
(UL Listed or CE Listed)



External Cable Bottom Exit
(UL Listed or CE Listed)



- For use with standard junction boxes
- 1/2” NPT Taper, Cable Length is 19”
- Compatible with EcoSense Canopy junction Box Cover
- 18 AWG Stranded Copper Cable - 3 Conductors

- For use when external, exterior rated cable is required to run to remote junction box or mains
- Cable exits the side of the base
- Comes with a Surface Mount Plate, for mounting direct to surface
- Cable Length is 10’ (3.05m)

- For use when external, exterior rated cable is required to run to remote junction box or mains
- Cable exits the bottom for use with various accessories such as Wall Mount Arm and Ground Stake
- 1/2” NPT taper for mounting
- Comes with a Surface Mount Plate, for mounting direct to surface
- Cable Length is 10’ (3.05m)

NOTE: Information on this Spec Sheet is subject to change, please visit ecosenselighting.com/rise for the most updated information.

State/Lake Loop Elevated Station

CDOT Project No. D-1-209

Issued for Bid

TYPE G5

July 3rd, 2023

KALYPSO IP67 Static White/Tunable White/RGB

LED LINEAR™

24V, IP67 protected and IK10 certified, linear surface-mounted LED luminaire with small form factor. Polyurethane encapsulation offering a premium water proof sealing, UV resistance, chemical stability and protection against abrasion. Extruded H-shaped aluminum body powder coated in white with cable runway on the back. Delivered with male/female mini IP67 connectors and translucent end caps for a perfect light continuity. Allows the use of 3 linear lenses (15°, 30° or 60°) integrated in the encapsulation material. Ideal solution for wall grazing (10°) or wide flood illumination (30° and 60°) with precise light control for outdoor or humid environments. Light source assembled using Reel to Reel (R2R) production process supporting LED Linear™ Tj Away® thin flexible circuit board technology. Outstanding lifetime of >60,000hrs L80/B10 (>30,000 hrs RGB). Embeds high quality japanese LEDs with 3 step MacAdams (SDCM3) binning centered on target CCT (One Bin Only) with an extended photometric code of Wxxx/339 ensuring exceptional color consistency over the rated lifetime. Premium color rendition with CRI up to 95 and TM-30-15 up to $R_f = 91$ / $R_g = 101$. Consistent light intensity all along the luminaire length. Fully dimmable. Engineered and produced in Germany.

Project name

Fixture type

Phase

Specifier

Date

TITLE 24
Select Models Only

Intertek
ETL Listed

Integrated Circuit Driver
Up to 1330 lm/ft 120 lm/W Constant Light Output

Reel-to-Reel R2R Production
High Quality Solder Free Reels

TjAway® Thermal Management
Exceptional Thermal Dissipation

One Bin Only
3 MacAdam up to 95 CRI

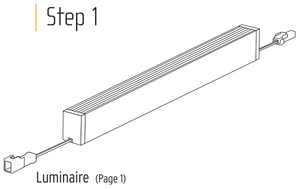
L/B Lifetime
L80/B10 >60,000 hrs /RGB >30,000 hrs

6 Digit Photometric Code
Wxxx/339

IES LM79/LM80
LM79/LM80 Compliant

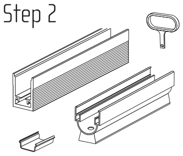
Ordering Process

Step 1



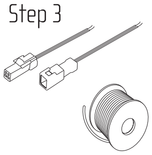
Luminaire (Page 1)

Step 2



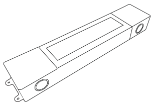
Mounting Accessories (Page 5)

Step 3



Cables and Connectors (Page 6)

Step 4



Drivers and Controllers (Page 7)

Luminaire Order Code

Family	Model	Lumen package[A]	Color rendering	Color temperature		Custom length[C]	Optic	Ingress
KALYPSO	_ _ _ _ _	_ _ _ _	W_	_ _		_ _ _ _	_ _	IP67
	HYDRA - Static White	HD06–145 lm/ft	W8–85CRI	20–2000K	30–3000K	L_{min}: 264 mm (10-3/4")	10–10° Optic	
		HD10–240 lm/ft	W9–95CRI[B]	22–2200K	35–3500K	L_{max}: 3952 mm (13')	30–30° Optic	
		HD15–480 lm/ft		25–2500K	40–4000K	Increment: 62.5 mm (2-1/2")	60–60° Optic	
		HD25–775 lm/ft		27–2700K	50–5000K			
		HD36–1130 lm/ft						
	IQW ATON - Tunable White	HD12–210 lm/ft	–	–				
	(2200K - 4000K)	HD24–440 lm/ft	–	–				
	RGB - 622nm (R) 532nm (G) 466nm (B)	HD20–210 lm/ft	–	–				

[A] Lumen Values represent 3000K (W930) and with 60° optic.

[B] Only available with HD06 and HD10 lumen packages with 2700K, 3000K, 3500K and 4000K.

[C] See page 4 for all available lengths.

				HD6		HD10		HD15		HD25		HD36	
			Color temperature[A]	Lumen/ft	W/ft[B]	Lumen/ft	W/ft[B]	Lumen/ft	W/ft[B]	Lumen/ft	W/ft[B]	Lumen/ft	W/ft[B]
Static White	●	W820	2,000 K	120	1.5	200	3.0	325	4.6	530	7.6	770	11
	●	W822	2,200 K	140	1.5	230	3.0	370	4.6	600	7.6	880	11
	●	W825	2,500 K	160	1.5	265	3.0	425	4.6	690	7.6	1000	11
	●	W827/W927	2,700 K	140	1.5	235	3.0	450	4.6	730	7.6	1070	11
	●	W830/W930	3,000 K	145	1.5	240	3.0	480	4.6	775	7.6	1130	11
	●	W835/W935	3,500 K	150	1.5	250	3.0	500	4.6	815	7.6	1190	11
	●	W840/W940	4,000 K	150	1.5	255	3.0	515	4.6	830	7.6	1215	11
	●	W850	5,000 K	210	1.5	350	3.0	560	4.6	910	7.6	1330	11

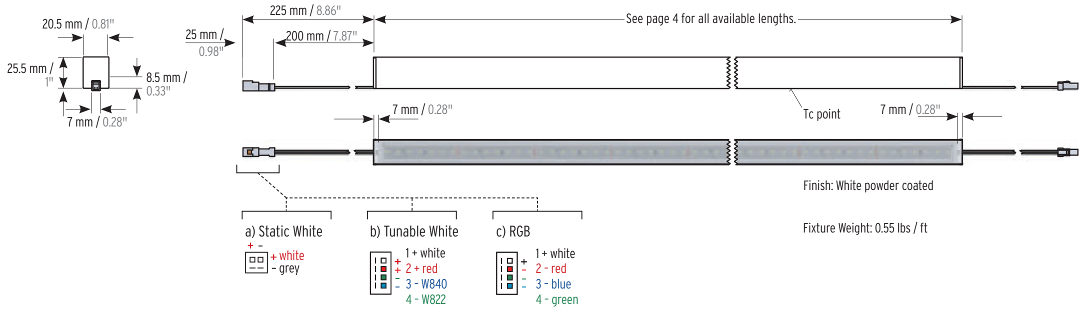
[A] CCT Tolerances occur in IP67 products due to the encapsulation of the fixture.

[B] The given data are typical values. Due to tolerances of the production process and the electrical components, values for light output and electrical power can vary up to 10%.

KALYPSO IP67 Static White/Tunable White/RGB

LED LINEAR™

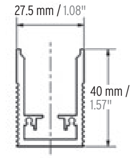
Mechanical Details



Finish: White powder coated

Fixture Weight: 0.55 lbs / ft

Inground Channel
(Accessory)



Mounting

Easy and clean installation due to internal mounting clips. ADONIS / KALYPSO housing also acts as cable raceway. Therefore you do not see any clips or cables from the outside.

UV protected
Resistant to solvents
Saltwater resistant
Temporary immersion protection
IK10 Impact resistant

Technical Details

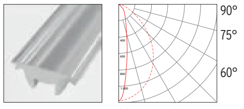
	Static White	Tunable White	RGB
Voltage	24 Volt (23 V_{min}, 25 V_{max})	24 Volt (23 V_{min}, 25 V_{max})	24 Volt (23 V_{min}, 25 V_{max})
Case temperature[A]	Tc_{min} = -13°F, Tc_{max} = specific, see Table below	Tc_{min} = -13°F, Tc_{max} = 158°F	Tc_{min} = -13°F, Tc_{max} = 158°F
Storage temperature	Ts_{min} = -22°F, Ts_{max} = 185°F	Ts_{min} = -22°F, Ts_{max} = 185°F	Ts_{min} = -22°F, Ts_{max} = 185°F
Ambient temperature	Ta_{min} = -13°F, Ta_{max} = specific, see Table below	Ta_{min} = -13°F, Ta_{max} = specific, see Table below	Ta_{min} = -13°F, Ta_{max} = specific, see Table below

[A] The position of the Tc-point is marked on each step of the LED strip. The Tc-point should be measured in thermal equilibrium according to IEC EN 60598-1.

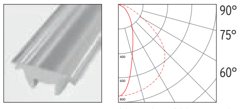
	Static White					Tunable White		RGB
	HD6	HD10	HD15	HD25	HD36	HD12	HD24	HD20
Power (W/ft)[B]	1.8	3.0	4.6	7.6	11	3.7	7.3	6.7
Efficacy (lm / W)[B] @ W850	115	115	120	120	120	58	60	35
CRI / R9 @ 3000 K	95 / 80	95 / 80	85 / 30	85 / 30	85 / 30	85 / 20	85 / 20	–
Max serial run length (ft / m)	16.4 / 5	16.4 / 5	13.1 / 4	9.8 / 3	6.6 / 2	16.4 / 5	13.1 / 4	13.1 / 4
Case temperature Tc-point (Tc_{max})[B]	158°F	158°F	158°F	167°F	185°F	158°F	158°F	158°F
Max ambient temperature (Ta_{max})	122°F	122°F	122°F	113°F	95°F	122°F	104°F	113°F

[B] The given data are typical values. Due to tolerances of the production process and the electrical components, values for light output and electrical power can vary up to 10%.

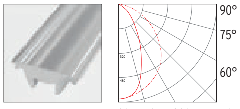
Light Distribution



10° Optic



30° Optic



60° Optic

cd/1.000 lumen
—— C0/C180
•••••• C90/C270

KALYPSO IP67 Static White/Tunable White/RGB

LED LINEAR™

LENGTH CHART - Kalypso IP67

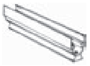
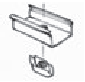
		Static White										Tunable White				RGB	
Fixture length		**HD6**		**HD10**		**HD15**		**HD25**		**HD36**		**HD12**		**HD24**		**HD20**	
inches	**mm**	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture all channels	Watts/fixture	Lumens/fixture all channels	Watts/fixture	Lumens/fixture all channels
10.4	264	2	126	3	208	4	416	7	671	10	979	3	182	6	381	5	182
12.9	327	2	155	3	257	5	514	8	830	12	1210	4	225	8	471	6	225
15.3	389	2	185	4	306	6	613	10	989	14	1442	5	268	9	562	8	268
17.8	452	3	215	4	356	7	711	11	1148	16	1674	5	311	11	652	9	311
20.2	514	3	245	5	405	8	809	13	1307	19	1906	6	354	12	742	10	354
22.7	577	3	274	6	454	9	908	14	1466	21	2137	7	397	14	832	11	397
25.2	639	4	304	6	503	10	1006	16	1625	23	2369	8	440	16	922	13	440
27.6	702	4	334	7	552	11	1105	17	1784	25	2601	9	483	17	1013	14	483
30.1	764	5	363	8	602	12	1203	19	1943	28	2832	9	526	19	1103	15	526
32.5	827	5	393	8	651	13	1302	21	2102	30	3064	10	569	20	1193	16	569
35.0	889	5	423	9	700	14	1400	22	2260	32	3296	11	613	22	1283	18	613
37.5	952	6	453	9	749	15	1498	24	2419	34	3528	12	656	23	1374	19	656
39.9	1014	6	482	10	798	16	1597	25	2578	37	3759	12	699	25	1464	20	699
42.4	1077	6	512	11	848	17	1695	27	2737	39	3991	13	742	26	1554	21	742
44.8	1139	7	542	11	897	18	1794	28	2896	41	4223	14	785	28	1644	22	785
47.3	1202	7	572	12	946	19	1892	30	3055	43	4454	15	828	29	1734	24	828
49.8	1264	7	601	12	995	19	1991	32	3214	46	4686	15	871	31	1825	25	871
52.2	1327	8	631	13	1044	20	2089	33	3373	48	4918	16	914	32	1915	26	914
54.7	1389	8	661	14	1094	21	2187	35	3532	50	5150	17	957	34	2005	27	957
57.1	1452	9	691	14	1143	22	2286	36	3691	52	5381	18	1000	35	2095	29	1000
59.6	1514	9	720	15	1192	23	2384	38	3850	55	5613	18	1043	37	2186	30	1043
62.1	1577	9	750	16	1241	24	2483	39	4008	57	5845	19	1086	38	2276	31	1086
64.5	1639	10	780	16	1291	25	2581	41	4167	59	6076	20	1129	40	2366	32	1129
67.0	1702	10	809	17	1340	26	2680	42	4326	61	6308	21	1172	41	2456	33	1172
69.4	1764	10	839	17	1389	27	2778	44	4485	64	6540	21	1215	43	2546	35	1215
71.9	1827	11	869	18	1438	28	2876	46	4644	66	6771	22	1258	44	2637	36	1258
74.4	1889	11	899	19	1487	29	2975	47	4803	68	7003	23	1301	46	2727	37	1301
76.8	1952	12	928	19	1537	30	3073	49	4962	70	7235	24	1345	47	2817	38	1345
79.3	2014	12	958	20	1586	31	3172	50	5121	73	7467	24	1388	49	2907	40	1388
81.8	2077	12	988	20	1635	32	3270	52	5280	–	–	25	1431	50	2998	41	1431
84.2	2139	13	1018	21	1684	33	3369	53	5439	–	–	26	1474	52	3088	42	1474
86.7	2202	13	1047	22	1733	34	3467	55	5598	–	–	27	1517	53	3178	43	1517
89.1	2264	13	1077	22	1783	35	3565	56	5757	–	–	27	1560	55	3268	45	1560
91.6	2327	14	1107	23	1832	36	3664	58	5915	–	–	28	1603	56	3358	46	1603
94.1	2389	14	1136	24	1881	37	3762	60	6074	–	–	29	1646	58	3449	47	1646
96.5	2452	14	1166	24	1930	38	3861	61	6233	–	–	30	1689	60	3539	48	1689

		Static White										Tunable White				RGB	
Oversize length		**HD6**		**HD10**		**HD15**		**HD25**		**HD36**		**HD12**		**HD24**		**HD20**	
inches	**mm**	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture @3000K	Watts/fixture	Lumens/fixture all channels	Watts/fixture	Lumens/fixture all channels	Watts/fixture	Lumens/fixture all channels
99.0	2514	15	1196	25	1980	39	3959	63	6392	–	–	31	1732	61	3629	49	1732
101.4	2577	15	1226	25	2029	40	4057	64	6551	–	–	31	1775	63	3719	51	1775
103.9	2639	16	1255	26	2078	41	4156	66	6710	–	–	32	1818	64	3810	52	1818
106.4	2702	16	1285	27	2127	42	4254	67	6869	–	–	33	1861	66	3900	53	1861
108.8	2764	16	1315	27	2176	43	4353	69	7028	–	–	34	1904	67	3990	54	1904
111.3	2827	17	1345	28	2226	44	4451	70	7187	–	–	34	1947	69	4080	56	1947
113.7	2889	17	1374	28	2275	45	4550	72	7346	–	–	35	1990	70	4170	57	1990
116.2	2952	17	1404	29	2324	46	4648	74	7505	–	–	36	2034	72	4261	58	2034
118.7	3014	18	1434	30	2373	46	4746	–	–	–	–	37	2077	73	4351	59	2077
121.1	3077	18	1464	30	2422	47	4845	–	–	–	–	37	2120	75	4441	61	2120
123.6	3139	19	1493	31	2472	48	4943	–	–	–	–	38	2163	76	4531	62	2163
126.0	3202	19	1523	32	2521	49	5042	–	–	–	–	39	2206	78	4622	63	2206
128.5	3264	19	1553	32	2570	50	5140	–	–	–	–	40	2249	79	4712	64	2249
131.0	3327	20	1582	33	2619	51	5239	–	–	–	–	40	2292	81	4802	65	2292
133.4	3389	20	1612	33	2669	52	5337	–	–	–	–	41	2335	82	4892	67	2335
135.9	3452	20	1642	34	2718	53	5435	–	–	–	–	42	2378	84	4982	68	2378
138.3	3514	21	1672	35	2767	54	5534	–	–	–	–	43	2421	85	5073	69	2421
140.8	3577	21	1701	35	2816	55	5632	–	–	–	–	43	2464	87	5163	70	2464
143.3	3639	21	1731	36	2865	56	5731	–	–	–	–	44	2507	88	5253	72	2507
145.7	3702	22	1761	36	2915	57	5829	–	–	–	–	45	2550	90	5343	73	2550
148.2	3764	22	1791	37	2964	58	5928	–	–	–	–	46	2593	91	5434	74	2593
150.6	3827	23	1820	38	3013	59	6026	–	–	–	–	46	2636	93	5524	75	2636
153.1	3889	23	1850	38	3062	60	6124	–	–	–	–	47	2679	94	5614	77	2679
155.6	3952	23	1880	39	3111	61	6223	–	–	–	–	48	2722	96	5704	78	2722

KALYPSO IP67 Static White/Tunable White/RGB

LED LINEAR™

Mounting Accessories

	Item	Description	Dimensions (L x W x H)	Order Code
	Adonis/Kalypso IP67 Surface Mounting Clip	Stainless steel surface mounting clip with washer. Clips inside the the fixture profile for invisible look. Recommended to use every 2 feet.	1" x 3/4" x 3/8"	13000202
	Adonis/Kalypso IP67 Vertical Surface Mounting Block	Metal mounting block with set screw for vertical applications. Install inside the the fixture profile to stop the fixture from sliding. Recommended to use every 2 feet together with a surface mounting bracket.	1" x 1/2" x 1/4"	13000287
	Adonis/Kalypso IP67 Adjustable Mounting Clip	Aluminum adjustable surface mounting bracket. Tilts 60° in each direction with spring loaded mechanism. Recommended to use every 2 feet. Silver finish.	5-1/2" x 1" x 1-1/2"	13000265
	Adonis/Kalypso IP67 Wallmount Arm Kit	Metal surface mounting adjustable wall arm. The set includes mounting block, mounting clip and adjusting screws. Tilts 140° in each direction and screw locks in position. Recommended to use for every 3 feet. Silver finish.	4-3/4" x 2-3/4" x 1"	13000165
	Adonis/Kalypso IP67 Inground Mounting Kit	Aluminum mounting channel with styrofoam dummy for inground installations. Use for indoor and protected outdoor environments. 6.5 feet long.	6' 6" x 1" x 1.5"	10000576 RAL9003-FS
	Adonis/Kalypso IP67 Inground Channel Mounting Clip	Stainless steel mounting clip with mounting block and set screw. Required to install the fixture inside the inground channel. Recommended to use every 2 feet.	1" x 3/4" x 3/8"	13000288
	One Metal Endcap Adonis/Kalypso IP67 Inground Channel End Cap	Metal endcaps with screws and rubber gasket. Required to cover the ends of the inground channel before installation. Available with or without drainage outlet.	Without Drainage With Drainage	11000231 11000232
	Adonis/Kalypso IP67 Disassembly Tool	Use to take the fixture out of the inground mounting frame.	–	13100032

KALYPSO IP67 Static White/Tunable White/RGB

LED LINEAR™

Cables and Connectors

	Item	Description	Model	Dimensions	Order Code
	Cable IP68 for Static White	Outdoor rated UL approved cable. Use to extend installation distance with outdoor rated splicing box (by others).	Static White	2 x 22 AWG, 160 ft	14000030
	Mini Female Connector IP67 for Static White	Use to run cable from the driver to the first fixture of the run or to the next fixture. Female mini connector on one side and open end cable on the other side.	Static White Static White	2 x 22 Awg, 8 in 2 x 22 Awg, 6.5 ft	15000141 15000142
	Mini Male Connector IP67 for Static White	Use to run cable from the fixture to the driver or to the previous fixture. Male mini connector on one side and open end cable on the other side.	Static White	2 x 22 Awg, 8 in	15000140
	Mini Extension IP67 for Static White	Use to extend the distance between connection points. Female connector on one side and male connector on the other side.	Static White Static White	2 x 22 Awg, 4 in 2 x 22 Awg, 6.5 ft	15000143 15000144
	Mini Female Protection Cap IP67 for Static White	Use to seal unused connectors and maintain IP67 ingress protection.	Static White	–	15000218
	Cable IP68 for RGB and Tunable White	Outdoor rated UL approved cable. Use to extend installation distance with outdoor rated splicing box (by others).	RGB / Tunable White RGB / Tunable White	4 x 23 Awg, 160 ft 4 x 18 Awg, 160 ft	14000048 14000060
	Mini Female Connector IP67 for RGB and Tunable White	Use to run cable from the driver to the first fixture of the run or to the next fixture. Female mini connector on one side and open end cable on the other side.	RGB Tunable White RGB / Tunable White	4 x 23 Awg, 8 in 4 x 23 Awg, 8 in 4 x 23 Awg, 6.5 ft	15000201 15000241 15000202
	Mini Male Connector IP67 for RGB and Tunable White	Use to run cable from the fixture to the driver or to the previous fixture. Male mini connector on one side and open end cable on the other side.	RGB Tunable White	4 x 23 Awg, 8 in 4 x 23 Awg, 8 in	15000200 15000240
	Mini Extension IP67 for RGB and Tunable White	Use to extend the distance between connection points. Female connector on one side and male connector on the other side.	Static White Static White	4 x 23 Awg, 4 in 4 x 23 Awg 6.5 ft	15000203 15000204
	Mini Female Protection Cap IP67 for RGB and Tunable White	Use to seal unused connectors and maintain IP67 ingress protection.	RGB / Tunable White	–	15000219

KALYPSO IP67 Static White/Tunable White/RGB

LED LINEAR™

Drivers

Item		Specifications	Downloads
LED LINEAR™ Non-Dimmable Drivers		• UL 8750 Listed Enclosure - With Built-In Junction Boxes • Universal Input Voltage 120V - 277V • IP65 - For Both Indoor and Outdoor Use • No Minimum Load Requirement • 24V Constant Voltage Output, Class 2 • Available in three wattages 30W, 60W and 96W • Max. Dimensions: 12-1/8" x 2-3/8" x 1-3/8"	30 W SPEC SHEET 60 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
LED LINEAR™ 0-10V Dimmable Drivers		• UL 8750 Listed Enclosure - With Built-In Junction Boxes • 0-10V Dimmable - Flicker Free Down to 1% • Universal Input Voltage 120V - 277V • IP65 - For Both Indoor and Outdoor Use • 24V Constant Voltage Output, Class 2, Class P • Available in three wattages 30W, 60W and 96W • Max. Dimensions: 12-1/8" x 2-3/8" x 1-3/8"	30 W SPEC SHEET 60 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
LED LINEAR™ ELV/Triac Dimmable Drivers		• UL 8750 Listed Class 2 Enclosure • 24V constant voltage output • Compact size yet high efficiency and performance in dry and damp environments (IP67) • Multiple Inputs: 120V or 277V • Fully dimmable: ELV Dimmers - Reverse or Adaptive Phase Control, Trailing Edge • Available in two wattages 48W and 96W • Multiple Circuits are available up to 4 units (up to 384W)	48 W SPEC SHEET 96 W SPEC SHEET INSTALLATION INSTRUCTIONS
MW MEAN WELL PWM Dimmable Drivers		• Universal AC input / Full range (up to 305VAC) • Constant voltage PWM style output • Built-in 3 in 1 dimming function (0~10Vdc or PWM signal or resistance) • Dimming range : 0~100% • Class 2 power unit • Suitable for dry / damp / wet locations • UL Recognized component, 5 years warranty	40 W SPEC SHEET 60 W SPEC SHEET 90 W SPEC SHEET INSTALLATION INSTRUCTIONS
LUTRON Dimmable Drivers		• UL Listed Enclosure • Dimming Range: 100% to 1% and 0.1% (Premiere) • LED lighting turns on to any dimmed level without flashing to full brightness • Operating Voltage: 120V~ to 277V~ at 50/60 Hz • Rated lifetime of 50,000 hours at 40°C (104°F) ambient temperature and maximum loading • For rated warranty, ambient temperature not to exceed 40°C (104°F) • Open-circuit protected output	HI-LUME SPEC SHEET HI-LUME PREMIERE SPEC SHEET INSTALLATION INSTRUCTIONS
eldoLED DALI/DMX Dimmable Drivers		• Available in linear or rectangular format • 100W, DMX/DALI interface for Static White, Tunable White and RGB/W Applications • 4 control channels • 24V constant voltage, 4 x 24V outputs • Metal or plastic case options	100 W SPEC SHEET INSTALLATION INSTRUCTIONS

Controllers

Item		Specifications		Downloads
eldoLED Controllers		**180/D** **210/D** **211/D-LG** **211/D-LN** **212/D** **DimWheel**	DMX Controller for RGB/W and Tunable White Applications Dali Contoller for Static White Applications 0-10V Logarithmic Dimming Controller 0-10V Linear Dimming Controller DMX Controller for Static White and Static Color Applications DMX Wall Controller for RGB/W and Tunable White Applications	180/D SPEC SHEET 210/D SPEC SHEET 211/D-LG SPEC SHEET 211/D-LN SPEC SHEET 212/D SPEC SHEET DIM WHEEL SPEC SHEET

Click for more information

PRODUCT BROCHURE | INSTALLATION | IES FILES | DRIVERS & CONTROLS

LED LINEAR TECHNOLOGY | VOLTAGE DROP CALCULATOR

Gen3™

Gen3 is an architectural-grade, wet-location LED luminaire engineered for the illumination & highlighting of walls & surfaces

FEATURES

- Gen3 design allows for any combination of 1, 2, 3 and 4Ft LED modules to be installed for up to 10Ft from a single power feed.
- 1% low-level flicker free dimming.
- Active Thermal Management monitors LED module case temperature and discreetly dims LED module upon signs of possible overheat.
- SmartDriver technology integrated in every LED module, maintaining continuous output regardless of voltage drop, temperature or voltage fluctuations.
- Actively managed ANSI Sub-Binning to ensure accurate and consistent color matching for each LED module.

PHYSICAL

- Mil-Spec Anodized Aluminum Housing/UV Resistant Acrylic Lens.
- Weight: 12": 0.7 lb, 18": 0.9 lb, 24": 1.5 lbs, 36": 2.1 lbs, 48": 2.9 lbs.
- Protection Rating: IP66
- Warranty: 3 Years

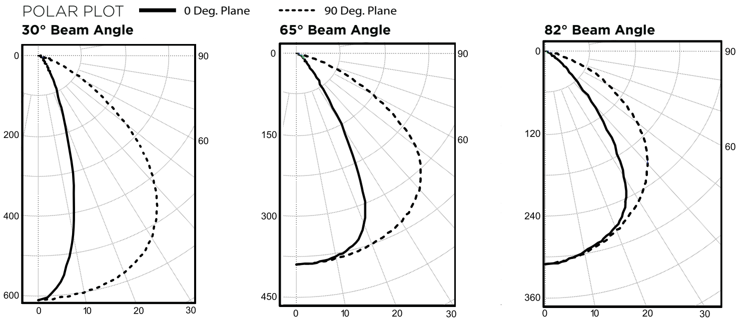
ELECTRICAL SPECIFICATIONS

Input Voltage	20-30VDC, 24V nom. Use with E05PW 75W
Input Power	3W/Ft - 7W/Ft
Max. Load	10Ft @ 7W/Ft and 25Ft @ 3W/Ft
Max. Wire Distance	50 Ft from Last Light to Power Box using 16 AWG
Temperature	Startup /Operating: -20°C to +40°C Relative Humidity: 0-95% (non-condensing)
Dimming	1% via 0 - 10 VDC
Life	60,000 hours to L70

LIGHTLINK 1% DIMMING c UL us FC RoHS compliant 2002/95/EC AMERICAN DESIGNED & MANUFACTURED

PERFORMANCE

EFFICACY: **80lms/W, 7W/Ft**



30° Beam Angle **65° Beam Angle** **82° Beam Angle**

SPECIFICATION CODE BUILDER

i2Systems will use specification code and dimensional information below to generate a full BOM that includes all parts needed for a complete installation. **To order replacement parts** refer to page 2 and 3 for a full list of components part codes.

Product	Location	Power	Color	CRI	Beam	Finish	Brackets	Accessories
V3								
	N - Indoor	**3W -** 3 Watts	**20K -** 2000K	**S -** Standard	**3 -** 30° X 65°	**B -** Black	**VLA-14 -** Adjustable	**BB -** Baffle Black
	E - Outdoor	**4W -** 4 Watts	**22K -** 2200K	**H** - High	**6 -** 65° X 65°	**S -** Silver	**VLAX2-6 -** Extend 6”	**BC -** Baffle Clear Anodize
		5W - 5 Watts	**25K -** 2500K		**8 -** 82° X 65°		**VLAX2-12 -** Extend 12”	
		6W - 6 Watts	**27K -** 2700K				**VLA-5 -** Adjustable	
V3 Gen3		**7W -** 7 Watts	**30K -** 3000K				**VLA-15 -** Fixed	
			35K - 3500K					
			40K - 4000K					
			45K - 4500K					
			50K - 5000K					
			57K - 5700K					
			65K - 6500K					
			C - Custom⁺					

Controls	Desired Length
SW - Switch On/Off	TO BE FILLED OUT BY
D1 - 0 - 10V Dimming	CONTRACTOR/DISTRIBUTOR

EXAMPLE: V3-N-7W-35K-S-6-B-VLA-14-BB-D1

+Contact factory

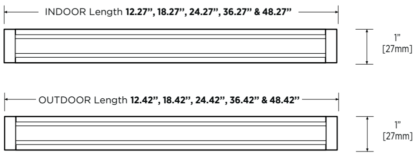
Gen3™

Gen3 is an architectural-grade, wet-location LED luminaire engineered for the illumination & highlighting of walls & surfaces

ACTIVE-THERMAL MANAGEMENT · PATENTED OPTICS · AL ALUMINUM HOUSING · IP66 WATERPROOF

LED MODULE DIMENSIONS

Available in 5 lengths "**A**" for indoor and outdoor applications:



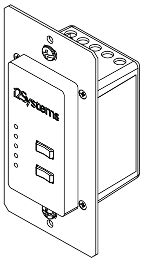
LED MODULE PART CODES

Product	Length	Location	Power	Color	CRI	Beam	Finish
V3	12"	x	xW	xxK	x	x	x
V3	18"	x	xW	xxK	x	x	x
V3	24"	x	xW	xxK	x	x	x
V3	36"	x	xW	xxK	x	x	x
V3	48"	x	xW	xxK	x	x	x

DIMMING CONTROL

LightLink ___LL-205-10V

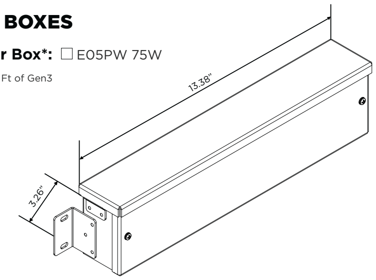
Indoor Dimming Cable: ☐ 685-01561-100
Outdoor Dimming Cable: ☐ 685-02026-100



POWER BOXES

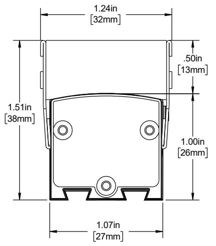
75W Power Box*: ☐ E05PW 75W

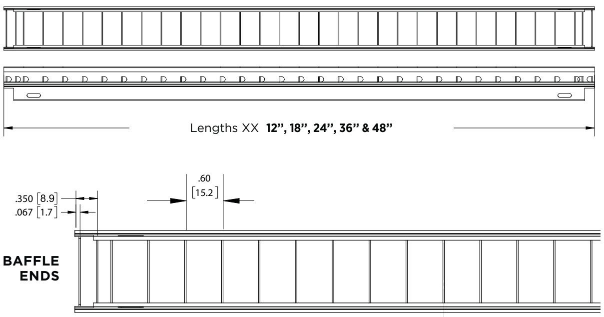
*Powers up to 10 Ft of Gen3



OPTICAL ACCESSORY

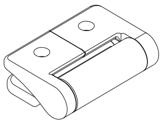
Baffle: ☐ 810-50956-XX

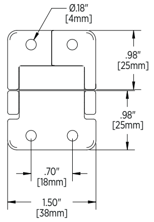


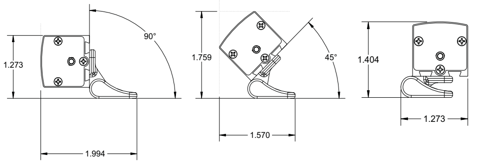


BRACKETS

Adjustable ___VLA-5







Gen3™

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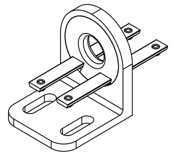
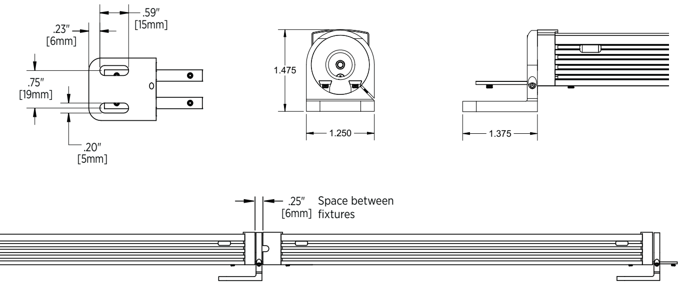
ACTIVE-THERMAL MANAGEMENT | PATENTED OPTICS | AL ALUMINUM HOUSING | IP66 WATERPROOF

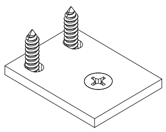
BRACKETS

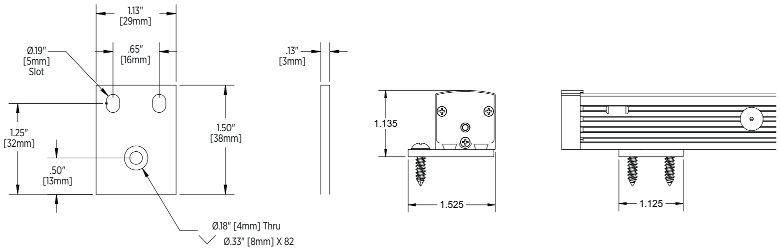
Adjustable ___VLA-14



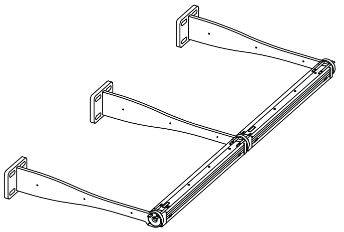


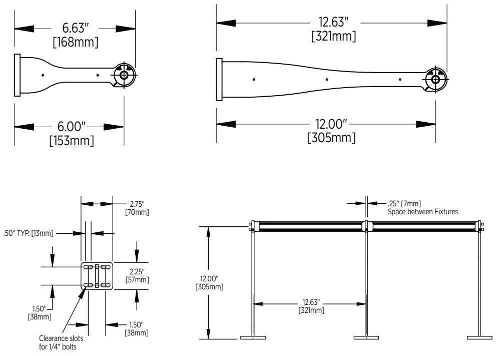
Fixed ___VLA-15





Adjustable Extension Mounting Clip ___VLAX2-6
___VLAX2-12





Refer to Luminaire Schedule for manufacturer's catalog ordering code, required lamping, finishes, modifications, and/or required accessories.

TROV® Flex

OVERVIEW • SPECIFICATIONS • ORDERING

EXTERIOR | **L09 FLEX**

DATE	PROJECT	FIRM	TYPE

THE ALL-SILICONE, FLEXIBLE LUMINAIRE WITH OPTICS, TROV FLEX L09 PACKS 2-STEP COLOR CONSISTENCY INTO A DURABLE PACKAGE SUITABLE FOR BOTH EXTERIOR AND INTERIOR USE. ITS ULTRA-DISCREET PROFILE MAKES IT AN IDEAL FIT FOR APPLICATIONS WHERE SPACE IS A PREMIUM.

FEATURES:

- DIMMABLE TO 0%
- 3 BEAM ANGLES
- FIELD CUTTABLE EVERY 6 INCHES
- 24 VDC CLASS 2
- 9
- IP67 RATED FOR OUTDOOR AND INDOOR APPLICATIONS

MODEL SIZE	INTERIOR/ EXTERIOR	LENGTH	POWER	CCT	CRI	VOLTAGE	OPTICS
	E	120			90	CV24 - 24VDC	
L09	E	120 - 120"	05 - 5W/ft 09 - 9W/ft	27 - 2700K 30 - 3000K 35 - 3500K 40 - 4000K	90 - 90CRI 80 CRI is available as Build to Order. Longer lead times apply. Consult your Ecosense Sales Rep for more information.	CV24 - 24VDC	10x10 15x40 ASYM

EXAMPLE: L09-E-120-05-27-90-CV24-15x40

PERFORMANCE	WATTS	OPTIC	LUMEN OUTPUT	EFFICACY	CBCP
	05	10x10	440 lm/FT (1,443 lm/m)	92 lm/W	4,345
		15x40	441 lm/FT (1,447 lm/m)	92 lm/W	700
		ASYM	428 lm/FT (1,405 lm/m)	89 lm/W	385
	09	10x10	714 lm/FT (2,344 lm/m)	84 lm/W	7,056
		15x40	716 lm/FT (2,350 lm/m)	84 lm/W	1,137
		ASYM	696 lm/FT (2,282 lm/m)	82 lm/W	626

ALL LUMEN DATA IS FROM 4000K 90CRI FIXTURES. PLEASE SEE PHOTOMETRY SPEC SHEET FOR ADDITIONAL LUMEN DATA.

COLOR RENDERING INDEX	90+
COLOR CONSISTENCY	2-STEP MACADAM ELLIPSE

LUMEN DEPRECIATION / RATED LIFE

WATTS	L70 @ 25C
5W-9W	>50,000

*CALCULATIONS FOR LED FIXTURES ARE BASED ON MEASUREMENTS THAT COMPLY WITH IES LM-80 TESTING PROCEDURES AND IES TM-21 CALCULATOR.

ELECTRICAL	**MAX POWER CONSUMPTION**	5W/ft = 4.8W (15.7W/m) ; 9W/ft = 8.7W/ft (28.5W/m)
	MAX FIXTURE RUN LENGTH	5W/ft = 20ft (Interior) 10ft (Exterior), 9W/ft = 10ft
	OPERATING VOLTAGE	24VDC
	DRIVER	REMOTE DRIVER SOLD SEPARATELY
	STARTUP TEMPERATURE	-4˚F TO 122˚F (-20˚C TO 50˚C)
	OPERATING TEMPERATURE	-4˚F TO 122˚F (-20˚C TO 50˚C)
	STORAGE TEMPERATURE	-40˚F TO 176˚F (-40˚C TO 80˚C)
PHYSICAL	**HOUSING/LENS**	SILICONE HOUSING AND LENS
	WEIGHT	2.22oz/ft ; (206.5g/m)
	CONNECTORS	INTEGRAL MALE AND FEMALE CONNECTORS
	ENVIRONMENT	OUTDOOR WET LOCATION IP67 FOR OUTDOOR, MARINE, AND NATATORIUM APPLICATIONS
	MOUNTING OPTIONS	STAINLESS STEEL MOUNTING BRACKET NEEDED EVERY 6 INCHES. **SOLD SEPERATELY.**
	CUT LENGTH	CUTTABLE EVERY 6 INCHES (152.4MM)
	BEND RADIUS	3IN (75MM) VERTICAL, 0IN (0MM) HORIZONTAL
CONTROL	**DIMMING**	0%-100%
FIXTURE RATING & CERTIFICATIONS	**UL AND CE LISTED** **RoHS COMPLIANT** **TITLE 24 JA8**	CE c UL us LISTED RoHS COMPLIANT 2019 TITLE 24 PART 6 COMPLIANT High Efficacy LED Light Source Requirements
LIMITED WARRANTY	**5 YEARS**	

TROV® Flex

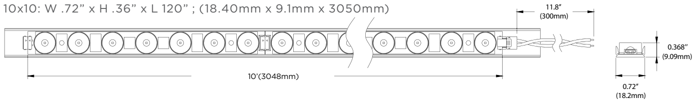
OVERVIEW • SPECIFICATIONS • ORDERING | EXTERIOR | **L09 FLEX**

DATE	PROJECT	FIRM	TYPE

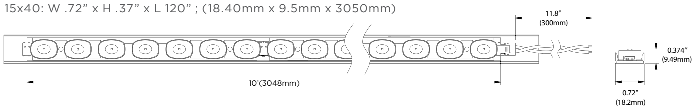
PHYSICAL

DIMENSIONS

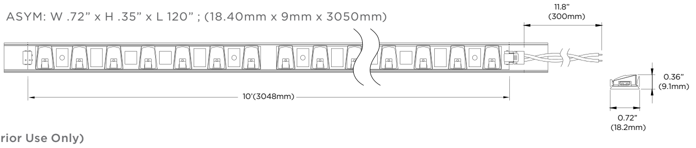
10x10: W .72" x H .36" x L 120" ; (18.40mm x 9.1mm x 3050mm)



15x40: W .72" x H .37" x L 120" ; (18.40mm x 9.5mm x 3050mm)



ASYM: W .72" x H .35" x L 120" ; (18.40mm x 9mm x 3050mm)



WIRING OPTIONS (Interior Use Only)

Cable Assembly, AVX Connector, Leader, 6 feet	CBL-AVX-LDR-6ft
Cable Assembly, AVX Connector, Jumper, 4 inches	CBL-AVX-JMP-4in
Cable Assembly, AVX Connector, Jumper, 12 inches	CBL-AVX-JMP-12in
Cable Assembly, AVX Connector, Jumper, 6 feet	CBL-AVX-JMP-6ft

L09 120 inch spools come with 12" wired leads. Leader and jumper cables are only needed when cutting to shorter lengths.

REMOTE DRIVER OPTIONS

MAGNETIC NORTH AMERICA	
Driver, Magnetic, Exterior, MLV & TRIAC, 96W, 120/277V Dual Tap	DRV-M-E-96W-120/277-SBC
Driver, Magnetic, Exterior, MLV & TRIAC, 60W, 120/277V Dual Tap	DRV-M-E-60W-120/277-SBC
Driver, Magnetic, Exterior, MLV & TRIAC, 40W, 120/277V Dual Tap	DRV-M-E-40W-120/277-SBC
ELECTRONIC NORTH AMERICA	
Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 96W, 120-277V Multi-Volt	DRV-E10-E-96W-120-277-LTF
Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 60W, 120-277V Multi-Volt	DRV-E10-E-60W-120-277-LTF
Driver, Electronic, Exterior, 0-10V & TRIAC & ELV, 40W, 120-277V Multi-Volt	DRV-E10-E-40W-120-277-LTF
ELECTRONIC INTERNATIONAL	
Driver, Electronic, Exterior, 0-10V, 100W, 100-305V Multi-Volt, CE Only	DRV-E10-E-100W-100-305-ELG
Driver, Electronic, Exterior, DALI, 100W, 100-305V, Multi-Volt, CE Only	DRV-DALI-E-100W-100-305-ELG
Driver, Electronic, Exterior, 0-10V, 120W, 90-305V Multi-Volt, CE Only	DRV-E10-E-120W-90-305-PWM
Driver, Electronic, Exterior, DALI, 120W, 90-305V Multi-Volt, CE Only	DRV-DALI-E-120W-90-305-PWM

See Remote Driver Spec Sheet for more details.
Drivers can be fully loaded.

MAXIMUM DRIVER TO FIXTURE WIRE LENGTH CHART

	Total Wattage per Run									
Wire Gauge	**10W .42 A**	**20W .83 A**	**30W 1.3 A**	**40W 1.7 A**	**50W 2.1 A**	**60W 2.5 A**	**70W 2.9 A**	**80W 3.3 A**	**90W 3.75 A**	**100W 4.2 A**
20 AWG	85 ft.	43 ft.	27 ft.	21 ft.	17 ft.	14 ft.	12 ft.	11 ft.	9 ft.	8 ft.
18 AWG	134 ft.	68 ft.	45 ft.	33 ft.	27 ft.	22 ft.	19 ft.	17 ft.	15 ft.	14 ft.
16 AWG	215 ft.	109 ft.	72 ft.	54 ft.	43 ft.	36 ft.	31 ft.	27 ft.	24 ft.	22 ft.
14 AWG	345 ft.	174 ft.	115 ft.	86 ft.	69 ft.	57 ft.	49 ft.	43 ft.	39 ft.	36 ft.
12 AWG	539 ft.	272 ft.	181 ft.	135 ft.	108 ft.	90 ft.	77 ft	68 ft.	61 ft.	56 ft.
10 AWG	784 ft.	397 ft.	263 ft.	197 ft.	158 ft.	131 ft.	112 ft.	98 ft.	97 ft.	82 ft.

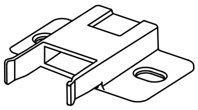
TROV® Flex

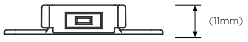
DATE	PROJECT	FIRM	TYPE

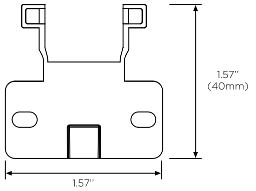
L09 MOUNTING AND CONNECTING ACCESSORIES

Terminator Cap.. **L09-A-CAP**

The terminator cap is only needed to seal the cut end of the fixture in wet locations. If the fixtures are not cut or are being installed in damp/dry locations, the terminator cap is not needed. One cap per cut is needed.

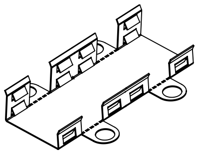


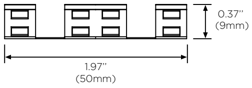


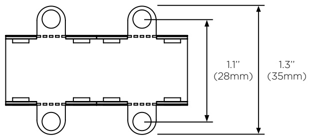


Mounting Bracket.. **L09-A-MNT-BRKT**

Mounting brackets need to be installed every 6 inches of fixtures

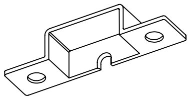


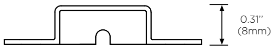


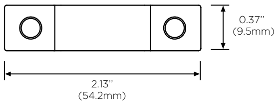


Strain Relief.. **L09-A-SR**

Strain reliefs are used to prevent accidental pull out of the AVX connector used on leader and jumper cables. They are not required but recommended for applications where the fixtures are accessible. Use one strain relief per leader cable and two per jumper cable.

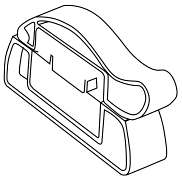






Cutting Tool.. **L09-A-CUTTOOL**

The cutting tool ensuresa clean safe cut that will not damage the optic or AVX connector. One cutter per installer is recommended.



NOTE: Information on this Spec Sheet is subject to change, please visit ecosenselighting.com/downloads/rise for the most updated information.

TROV® Flex

OVERVIEW • SPECIFICATIONS • ORDERING

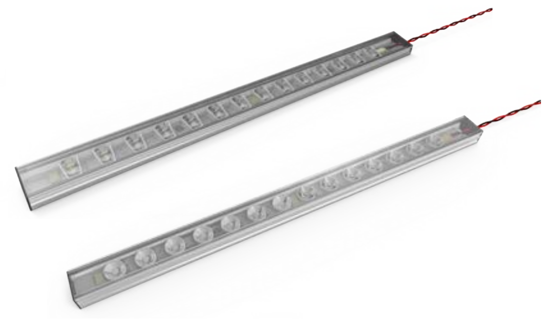
ACCESSORIES | **MOUNTING EXTRUSION**

DATE	PROJECT	FIRM	TYPE

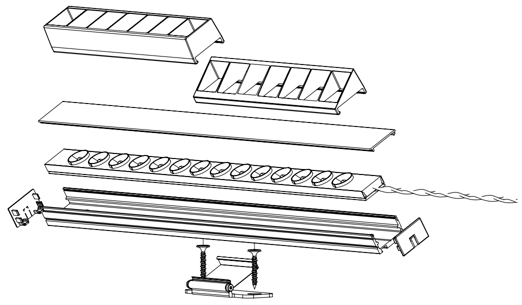
TROV FLEX L09 MOUNTING EXTRUSIONS CAN BE USED TO CREATE A CLEAN STRAIGHT RUN OF L09. THEY ARE OFFERED IN A SYMMETRIC PROFILE FOR THE 10X10 AND 15X40, AND AN ASYMMETRIC PROFILE FOR THE ASYM OPTIC. THEY COME IN CLEAR ANODIZED, WHITE, AND BLACK FINISHES. AN OPTIONAL SNAP ON CLEAR DUST COVER LENS CAN ALSO BE ADDED FOR EASY CLEANING. AIMABLE HINGE BRACKETS CAN BE ADDED TO AIM FROM 0° TO 180°.

FEATURES:

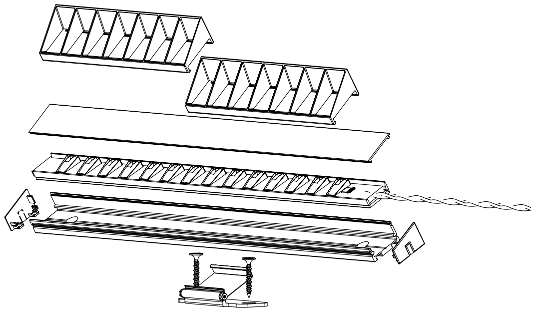
- FLAT SURFACE MOUNT WITH PRE DRILLED HOLES
- STANDARD CLEAR ANODIZED FINISH. OPTIONAL WHITE, AND BLACK FINISHES AVAILALBE AS BUILD TO ORDER.
- BLACK END CAPS WITH WIRE KNOCK OUTS INCLUDED
- OPTIONAL AIMABLE MOUNTING BRACKET
- OPTIONAL SNAP ON DUST COVER
- OPTIONAL SNAP ON LOUVERS(SEE LOUVER SPEC SHEET)



SYMMETRIC EXTRUSION ASSEMBLY



ASYMMETRIC EXTRUSION ASSEMBLY



ORDERING

PART NUMBER	DESCRIPTION
SYMMETRIC COMPONENTS	
L09-A-MNT-EXT-SYM-62IN-AL	L09 FLAT MOUNTING EXTRUSION, 62IN, SYMMETRIC, CLEAR ANODIZED ALUMINUM
L09-A-MNT-EXT-SYM-62IN-WH*	L09 FLAT MOUNTING EXTRUSION, 62IN, SYMMETRIC, WHITE
L09-A-MNT-EXT-SYM-62IN-BK*	L09 FLAT MOUNTING EXTRUSION, 62IN, SYMMETRIC, BLACK
L09-A-MNT-EXT-SYM-ENDCAPS	L09 EXTRUSION END CAP SET, SYMMETRIC, SET OF 2, BLACK
L09-A-MNT-EXT-SYM-ENDCAPS-WH*	L09 EXTRUSION END CAP SET, SYMMETRIC, SET OF 2, WHITE
L09-A-DUSTCVR-SYM-62IN	L09 CLEAR DUST COVER, 62IN, SYMMETRIC
ASYMMETRIC COMPONENTS	
L09-A-MNT-EXT-ASYM-62IN-AL	L09 FLAT MOUNTING EXTRUSION, 62IN, ASYMMETRIC, CLEAR ANODIZED ALUMINUM
L09-A-MNT-EXT-ASYM-62IN-WH*	L09 FLAT MOUNTING EXTRUSION, 62IN, ASYMMETRIC WHITE
L09-A-MNT-EXT-ASYM-62IN-BK*	L09 FLAT MOUNTING EXTRUSION, 62IN, ASYMMETRIC, BLACK
L09-A-MNT-EXT-ASYM-ENDCAPS	L09 EXTRUSION END CAP SET, ASYMMETRIC, SET OF 2, BLACK
L09-A-MNT-EXT-ASYM-ENDCAPS-WH*	L09 EXTRUSION END CAP SET, ASYMMETRIC, SET OF 2, WHITE
L09-A-DUSTCVR-ASYM-62in	L09 CLEAR DUST COVER, 62IN, ASYMMETRIC
UNIVERSAL COMPONENTS	
L09-A-MNT-EXT-ADJ-BRKTS	L09 EXTRUSION AIMING BRACKET, SYM AND ASYM, SET OF 2, CLEAR ANODIZED

EXTRUSIONS ARE FIELD CUTABLE. IF SHORTER LENGTHS ARE NEEDED, ORDER THE 62IN EXTRUSION AND CUT IT IN THE FIELD. ORDER EXTRA END CAPS AS NEEDED.
*** WHITE AND BLACK FINISHES ARE PAINTED TO ORDER. LONGER LEAD-TIMES APPLY.**

LIMITED WARRANTY **5 YEARS**

ECOSENSE

ECOSENSE LIGHTING INC.
837 NORTH SPRING STREET
SUITE 103
LOS ANGELES, CA 90012

P • 310.496.6255
F • 310.496.6256
T • 855.632.6736
855.6.ECOSEN

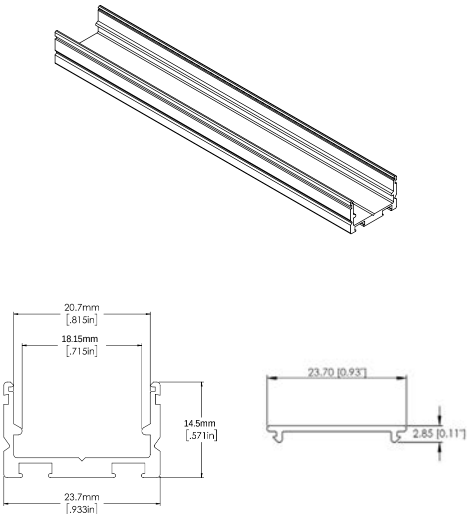
TROV® Flex

OVERVIEW • SPECIFICATIONS • ORDERING

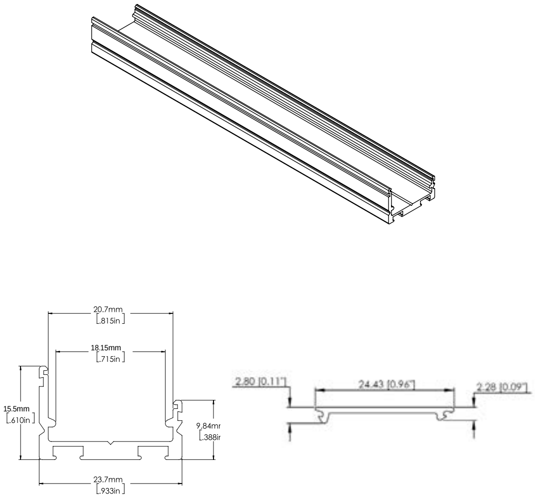
ACCESSORIES | **MOUNTING EXTRUSION**

DATE	PROJECT	FIRM	TYPE

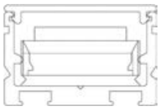
SYMMETRIC EXTRUSION



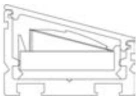
ASYMMETRIC EXTRUSION



Extrusion with fixture
and dust cover

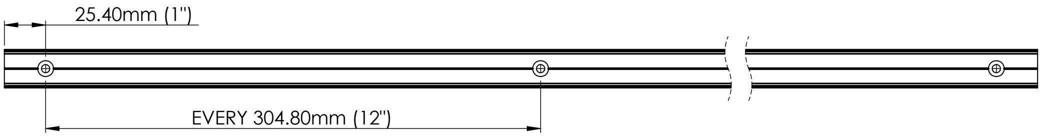


Extrusion with fixture
and dust cover



MOUNTING HOLE LOCATIONS FOR BOTH EXTRUSIONS

USE #6 FLAT HEAD SCREWS



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LOS ANGELES, CA 90012

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EXTERIOR | **L09 FLEX**

DATE	PROJECT	FIRM	TYPE

PHOTOMETRIC DATA

90 CRI

L90 5W

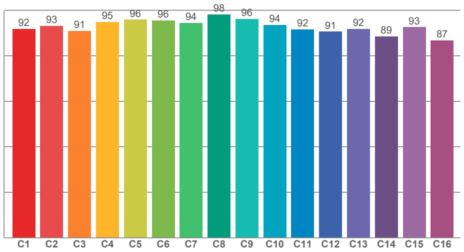
	10˚x10˚	15˚x40˚	ASYM
2700K			
Lumens	393	394	383
Efficacy	82	82	80
CBCP	3,886	720	366
3000K			
Lumens	415	416	404
Efficacy	86	87	84
CBCP	4,124	663	363
3500K			
Lumens	421	422	410
Efficacy	88	88	85
CBCP	3,420	670	272
4000K			
Lumens	440	441	428
Efficacy	92	92	89
CBCP	4,345	700	385

L90 9W

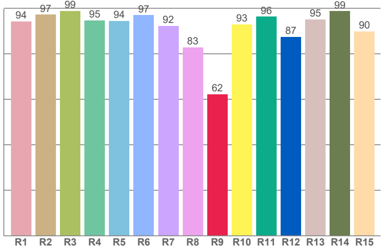
	10˚x10˚	15˚x40˚	ASYM
2700K			
Lumens	639	641	622
Efficacy	75	75	73
CBCP	6,311	1,016	560
3000K			
Lumens	674	676	656
Efficacy	79	79	77
CBCP	6,018	1,072	477
3500K			
Lumens	684	686	666
Efficacy	80	81	78
CBCP	6,371	1,088	492
4000K			
Lumens	714	716	696
Efficacy	84	84	82
CBCP	7,056	1,137	626

L09-E-012-05-27-90-CV24-ASYM (5 Watt, 2700K, 90 CRI, ASYM)

TM30: 92.9



CRI: 93.9 (R1-R8)



CRI R values, only R1-R8 are used to calculate final CRI value

R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15
94.28	97.21	98.79	94.72	94.38	96.97	92.20	82.84	62.18	92.95	96.30	87.50	95.14	98.72	89.85

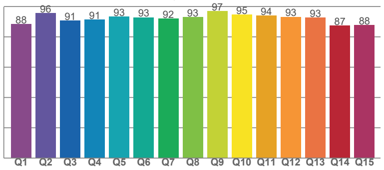
TM30 C values, 16 binned values out of total of 99 C values

C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16
91.77	93.08	91.02	94.86	95.88	95.52	94.44	98.14	96.23	93.53	91.61	90.62	91.74	88.51	92.59	86.81

CQS Q values

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
88.44	95.52	90.65	91.29	93.39	92.81	91.96	92.90	96.94	94.51	93.95	93.16	92.72	87.48	87.59

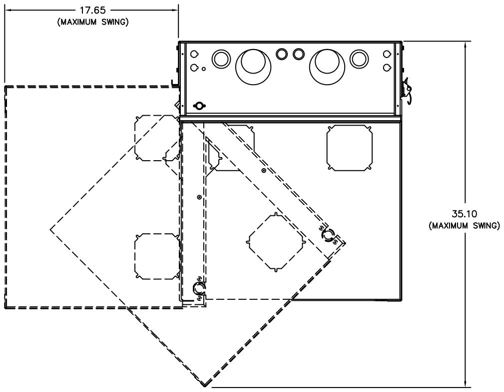
CQS: 91.6



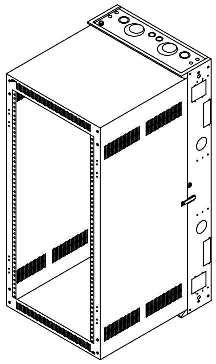
Color parameters

CCT	CRI	CRI R9	TM30 Rf	TM30 Rg	CQS	x	y	u	v	Duv
2801 K	93.9	62.2	92.9	100.0	91.6	0.5	0.4	0.3	0.3	-0.0005

TOP VIEW



ISOMETRIC VIEW
(1/2 SCALE)



PARTS LIST

ITEM	QTY.	DESCRIPTION	DESIGNATION	PART NUMBER
A	1	24U WALL RACK CENTER SECTION 20.5" USEABLE		PJE1104
B	1	24U WALL RACK, BACK PAN		PJE1105–FIN
C	1	15??????–???–C HARDWARE KIT		TL?????–ARCH?

NOTES:

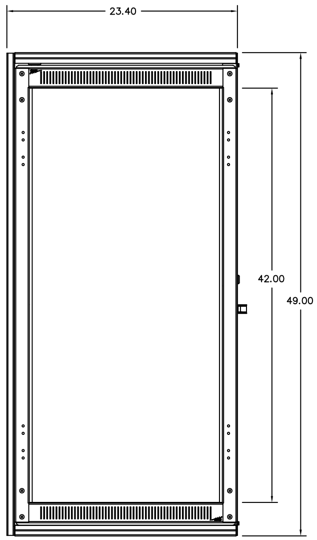
1.) EQUIPMENT RACK IS ETL LISTED.

2.) EQUIPMENT RACK IS MANUFACTURED BY MIDDLE ATLANTIC PRODUCTS, INC. AND ALL PHYSICAL SPECIFICATIONS SHALL PERTAIN TO MIDDLE ATLANTIC PRODUCTS, INC. MODEL DWR–24–26.

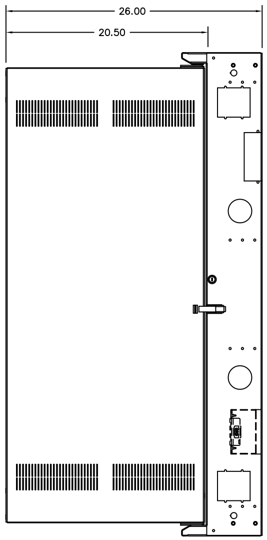
3.) EQUIPMENT RACK IS 16 GA. STEEL FINISHED IN A TEXTURED BLACK BAKED ENAMEL.

4.) EQUIPMENT RACK SHALL BE WALL–MOUNTABLE AND SHALL CONTAIN CONDUIT KNOCKOUTS ON ALL SIDES FOR EASY WIRING ACCESS.

FRONT VIEW



SIDE VIEW



ETC

ETC, Inc.
3031 Pleasant View Rd
PO Box 620979
Middleton WI 53562-0979
Tel +1 608 831 4116
Toll Free +1 800 688 4116
Fax +1 608 836 1736
etcconnect.com

UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES.

ORIGINAL FILE:
MAP–DWR–24–26.DWG

CONTRACT WITH:

REPRESENTATIVE:

PROJECT MANAGER:

APPLICATIONS ENGINEER:

DRAWING TITLE:
WALL–MOUNTED
EQUIPMENT RACK

PHYSICAL

BY	DATE	REV.

JOB:

LOCATION:

JOB NUMBER:

DRAWING:

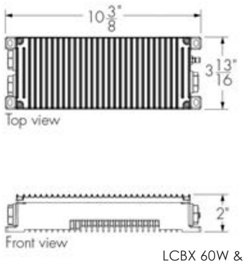
Specification Sheet

control & power supply boxes

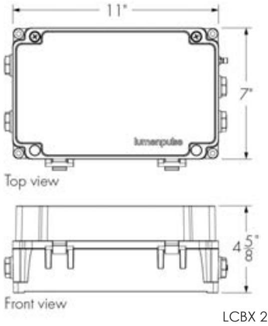
Low-Voltage Control Box

MANUFACTURER TO SUPPLY CLASS II DRIVER 96W
SPECIAL POWER SUPPLY - SPL020899
UTILIZE HOUSING DIMENSIONS AS SHOWN BELOW

LCBX 60W & 120W shown



LCBX 60W & 120W



LCBX 200W

Controls

ON/OFF 0-10V DMXrdm
DALI DALIT8

Ratings

IP66

Certifications

c UL us CE RoHS

Description

The Lumenpulse Low-Voltage Control Box is the home of our new Lumengrid technology. Containing both a power supply and a control card, it enables dimming or DMX/RDM control. It also allows you to daisy chain data in order to have full communication through the entire system to create highly scalable projects.

Features

Wattage	60 watts, 120 watts, 200 watts
Options	Corrosion-resistant coating for hostile environments
Warranty	5-year limited warranty

Electrical and control

Input Voltage	120-277 volts
Output Voltage	48 VDC
Power and Data Connections	1/2'' provision hole for 1/2" NPT, PG16 or 20mm
Control	On/Off control, 0-10V or DMX/RDM control (compatible with 0-10V or DMX/RDM systems), DALI control (compatible with DALI or DALI-2 Type 8 systems)

Physical

Housing Material	Cast aluminum
Surface Finish	Electrostatically applied polyester powder coat
Weight	2.25 lbs (60W), 2.5 lbs (120W), 9.25 lbs (200W)

Environmental

Storage Temperature	-58 °F to 185 °F
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-40 °F to 122 °F
Ingress Protection Rating	IP66

Specification Sheet

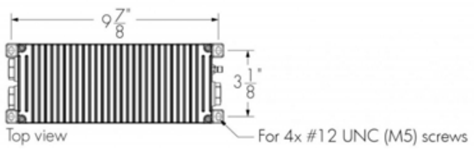
control & power supply boxes

Low-Voltage Control Box

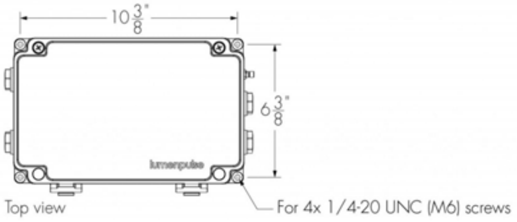
LCBX

Mounting details

LCBX 60W & 120W

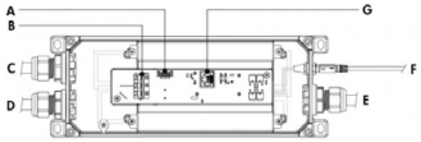


LCBX 200W



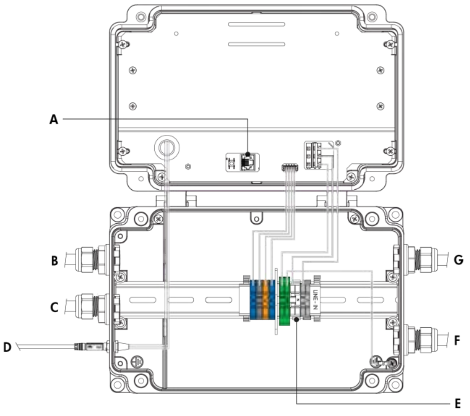
Typical layout

LCBX 60W & 120W



A - Data input/output port
Wire gauge range: 26-20 AWG [0.13-0.52mm^2]
B - AC power input port
Wire gauge range: 28-12 AWG [0.08-3.31mm^2]
C - 120-277V input
D - Data input
E - Optional data output to next LCBX
F - Output to fixture, Lumenfacade Nano Jumper Cable
G - RDM debug port

LCBX 200W



A - RDM debug port
B - Optional data output to next LCBX
C - Optional power output to next LCBX
D - Output to fixture, Lumenfacade Nano Jumper Cable
E - Terminal blocks (AC power and data)
AC power input/output wire gauge range: 20-12 AWG [0.52-3.31mm^2]
Data input/output wire gauge range: 24-16 AWG [0.20-1.31mm^2]
F - 120-277V input
G - Data input

Refer to installation instructions for additional wiring details.

0-10V mA ratings: Current Sink Mode: 25μA per LCBX; Current Source Mode: 2.5mA per LCBX.

Specification Sheet

control & power supply boxes

Low-Voltage Control Box

LCBX

How to order

Housing	Input Voltage	Output Voltage	Control	Wattage	Finish	Options	Certification
LCBX Low-voltage control box	**120/277** 120-277 volts	**48V** 48 VDC	**NO** On/Off control **DIM/DMX/RDM** 0-10V or DMX/RDM control (compatible with 0-10V or DMX/RDM systems) **DALI** DALI control (compatible with DALI or DALI-2 Type 8 systems) (1)	**60W** 60 watts **120W** 120 watts **200W** 200 watts	**BK** Black Sandtex® **BRZ** Bronze Sandtex® **SI** Silver Sandtex® **WH** Smooth white **CC** Custom color and finish (please specify RAL color) (2) (3) (4)	**CRC** Corrosion-resistant coating for hostile environments (5) (6)	**UL** UL compliant **CE** CE compliant

Notes:

1. The LCBX responds to RGBWAF for color changing fixtures and Color Temperature controls for dynamic white fixtures. DALI controller required (provided by others).

2. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.

3. Setup charges apply for RAL colors. Consult factory for details.

4. Longer lead times can be expected for custom RAL color finishes.

5. Use only when exposed to salt spray and harsh chemicals. This option is not required for normal outdoor exposure.

6. Setup charges apply. Consult factory for details.

ETC

Unison Mosaic Touchscreen

User Control Series

Type(s)

Project

Date

Notes

GENERAL INFORMATION

The Unison Mosaic Touchscreen provides touchsceen control for any Mosaic system. The 4.3-inch screen gives you the ability to control and monitor your installation using buttons, faders, buttons, color pickers and more.

APPLICATIONS

- LED lighting control
- Pixel mapping
- Show control and lighting integration

FEATURES

- Compatible with all Mosaic controllers
- Configurable user Interface supports buttons, faders, and color pickers
- Programmed and configured using Mosaic Designer Software
- PoE powered

REGULATORY AND COMPLIANCE

- cETLus Listed
  - Conforms to UL-60950-1
  - Certified to CAN/CSA-C22.2 No. 60950-1
- CE Compliant
- California Title 20/24 compliant

ORDERING INFORMATION

Touchscreen Station

MODEL	DESCRIPTION
M-TS-__	Mosaic Touchscreen

Enter station color code in __ space provided:

- 1 = Cream (RAL9001)
- 4 = Black (RAL 9004)
- 5 = White (RAL9003)
- Specify flush (FBB) or surface (SBB) mounting for proper backbox

Compatible Show Controllers

MODEL	DESCRIPTION
MTPC	Tessera Panel Controller
MSC_[1]	Mosaic Show Controller
MSCX	High Capacity Show Controller
MALC	Mosaic Atlas
MALCP	Mosaic Atlas Pro

[1] Available with one(1), two(2) or four(4) DMX universe output(s)

Related Products

MODEL	DESCRIPTION
M108-__	Button Station
MRIO-A	Audio/Timecode Remote Device
MRIO-D	DALI Remote Device
MRIO-I/O	Input/Output Remote Device w/ Serial
MSC-NET	Five-port Ethernet Switch w/ PoE

ETC

ETC

Unison Mosaic Touchscreen

User Control Series

SPECIFICATIONS

FUNCTIONAL

- Touchscreen controller with user-customizable interface with support for button, slider and color picker controls
  - 4.3″ capacitive touch display
  - 480 x 272 resolution, 24-bit color
- Provides a user interface for one or more Mosaic Controllers
- Software and configuration upload using Ethernet
- Support for up to 40 Touchscreens or Show Controllers in any combination
- Supports buttons, faders, color picker,labels, keypads, and clock control types
- Learning IR receiver compatible with 3rd-party remote
- Touchscreen configuration stores as part of the system configuration file in non-volatile, solid-state memory
- Solid-state, high-reliability components

MECHANICAL

- Metal faceplate with magnetic overlay
- Wall mounted with no visible means of attachment
- Mounts in flush or surface mount backbox provided by ETC
  - Compatible with standard 2-gang EU/UK backboxes
- IP40 ingress rating

ELECTRICAL

- RJ45 socket supporting 10/100Base-TX Ethernet with link and data LED with Static and DHCP addressing support
- PoE powered (IEEE 802.3af, Class 2) 4 W typical draw

THERMAL

- Ambient temperature: 0–50° C (32°–122° F)
- 10–50% relative humidity, non-condensing

PHYSICAL

Touchscreen Dimensions*

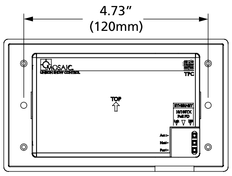
MODEL	HEIGHT		WIDTH		DEPTH	
	in	mm	in	mm	in	mm
M-TS	3.35	85	5.75	146	0.40	10
-FBB	3.00	76	5.35	136	2.50	64
-SBB	3.35	85	5.75	146	2.50	64

Touchscreen Weights*

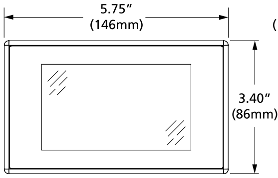
MODEL	WEIGHT		SHIPPING WEIGHT	
	lb	kg	lb	kg
M-TS	0.53	0.24	0.93	0.42

*Weights and dimensions typical

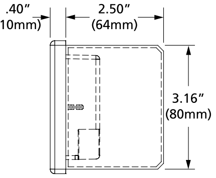
Rear View



Front View



Side View



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APPENDIX H

WIND-INDUCED STRUCTURAL RESPONSES REPORT
CLADDING WIND LOAD STUDY

FINAL REPORT

STATE & LAKE ELEVATED STATION

CHICAGO, IL

WIND-INDUCED STRUCTURAL RESPONSES
RWDI # 2100248
December 9, 2021

SUBMITTED TO

Bradley Young, PE, SE
Associate Director
Bradley.Young@SOM.com

Skidmore, Owings & Merrill
224 South Michigan Avenue
Chicago, Il 60604
T: 312.360.4646

SUBMITTED BY

Matt Gleason, B.A.Sc.
Technical Coordinator
Matt.Gleason@rwdi.com

Jonathan B. Lankin, P.Eng.
Senior Specialist / Associate Principal
Jon.Lankin@rwdi.com

Jason Garber, M.E.Sc., P.Eng.
Technical Director / Principal
Jason.Garber@rwdi.com

Kelly Baah, M.Eng., P.Eng.
Project Manager
Kelly.Baah@rwdi.com

RWDI
600 Southgate Drive
Guelph Ontario Canada N1G 4P6
T: 519.823.1311

EXECUTIVE SUMMARY

RWDI was retained to study the wind-induced structural responses of the proposed State & Lake Elevated Station in Chicago, Illinois.

Key points

- The wind tunnel test procedures met or exceeded the requirements set out in the ASCE 7-16 and ASCE 49.
- The wind tunnel study was carried out using the High Frequency Pressure Integration (HFPI) technique. Images of the model are given in Figure 1.
- A basic wind speed of 114 mph 3-second gust at 33 ft height in open terrain was adopted for the wind loading predictions for strength design. All predictions were derived using a statistical wind climate model developed for the area.
- The results provided herein are based on the natural frequencies and modal displacements for the station provided by the structural engineer and received by RWDI on June 1, 2021. They consider structural damping of 1.5% of critical.
- Wind load cases have been provided as pressure distributions. Figures 4 to 7 denote the pressure zones to which the tabulated pressures in Table 1 are provided for. Each load case represents a complete simultaneous loading scenario with pressures to apply to each independent section of the complete structure. Each case can be applied on its own – there is no need to apply multiple wind load cases simultaneously.
- The same results as provided in Table 1 have also been provided in the accompanying spreadsheet: “210824 Structural Responses RWDI 2100248.xlsx”
- The wind loads provided in this report are consistent with the ASCE ultimate limit state and are to be applied in the same manner as would wind loads calculated by code analytical methods.

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EXECUTIVE SUMMARY

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LIST OF FIGURES

LIST OF APPENDICES

1 INTRODUCTION

RWDI was retained by Skidmore, Owings & Merrill to study the wind-induced structural responses for the proposed State & Lake Elevated Station in Chicago, Illinois. This report presents the project objectives, background, approach, and provides a discussion of the results.

1.1 Project Description

The proposed project involves the re-build of the elevated Chicago Transit Authority (CTA) station located at the intersection of State Street and Lake Street, in downtown Chicago (The Loop).

1.2 Objectives

The objective of this study was to determine the overall horizontal and vertical wind-induced structural loads for the design of the structural system of the station.

2 BACKGROUND AND APPROACH

2.1 Methodology

The study was conducted using the High Frequency Pressure Integration (HFPI) technique. Appendices B and C provide additional background information on the testing and analysis procedures for this type of assessment.

2.2 Study Model and Surroundings

A 1:100 scale model of the proposed development was constructed using the architectural drawings listed in Appendix A. The model was tested in RWDI's 12 ft x 7 ft boundary layer wind tunnel facility in Guelph, Ontario.

Photographs of the wind tunnel study model are shown in Figure 1. An orientation plan showing the study site and immediate surroundings is given in Figure 2.

2.2.1 Simulation of Upwind Terrain

Beyond the modelled area, the influence of the upwind terrain on the planetary boundary layer was simulated in the testing by appropriate roughness on the wind tunnel floor and flow conditioning spires at the upwind end of the working section for each wind direction. This simulation, and subsequent analysis of the data from the model, represented terrain conditions similar to ASCE Exposure B with adjustment factors as appropriate for the particular wind direction.

Wind direction is defined as the direction from which the wind blows, measured clockwise from true north.

2.2.2 Wind Climate

For the determination of the recommended wind loads for the structural system, it is important to account for the impact of the local wind climate. By using advanced statistical methods, a wind climate model was created based upon local surface wind measurements taken at Chicago O'Hare International Airport.

A graphical representation of the statistical wind climate model is provided in Figure 3. The top two plots show the directionality of common winds on the left and design winds on the right. The common winds correspond to a return period of approximately 1 month, and the design winds correspond to a return period of 1700 years. Design winds are the strongest from the southwest. The lower plot shows the wind speeds from each data set as a function of return period.

The resulting statistical wind climate model was combined with the wind tunnel results to produce the recommended full-scale wind pressures. Therefore, while the directional wind speeds shown in Figure 3 are illustrative of the directionality of the local wind climate, they were not and should not be used directly for predictions of wind pressures.

2.3 Criteria

The governing code for this project is the American Society of Civil Engineers (ASCE) 7-16. The recommendations for wind loads provided in this report are based on wind tunnel tests employing procedures that meet or exceed the requirements set out in ASCE 49-12 Standard on Wind Tunnel Testing for Buildings and Other Structures as well as Chapter 31 of the ASCE 7.

The design wind speed for Chicago, as specified in the ASCE 7-16 Standard for a Risk Category III building, is a 3-second gust wind speed of 114 mph at a height of 33 ft in open terrain. This wind speed is also shown in Figure 3. For the wind loading predictions for strength design, the wind climate model was scaled to match the design wind speed at the 1700-year return period.

Note that the wind speeds provided in the ASCE 7 are based on design wind speed maps consistent with the ultimate event, which corresponds to a load factor of 1.0 when using the Load and Resistance Factor Design (LRFD) approach. The LRFD approach is generally employed for structural loading. The design wind loads provided in this report are derived on this basis.

3 DETERMINING STRUCTURAL WIND LOADS FROM WIND TUNNEL TESTS

The methodology for determining the wind loads involved the following steps:

1. Measurements of weighted, area-averaged pressures on a scale model of the facility in a wind tunnel from which to determine the mean, background loads and generalised aerodynamic forces acting on the modes of vibration.
2. Analysis of the wind tunnel data to determine the dynamic amplification effects on the fluctuating wind loads, caused by the motion of the structure, and also to determine the wind directions which produced the highest wind loads for the load cases of interest.
3. Determination of the effective peak pressure distributions that produce the highest wind loads for the load cases of interest.

The wind pressure patterns affecting the structure vary both spatially and with time and are very complex. The force or stress generated in any one component of the structure depends, to some extent, on the continually changing pressure pattern over the entire structure. For the design of a structural element, the relevant wind loads are those acting simultaneously over the element's tributary area. For example, assume one loading condition of interest to be, that which causes the highest uplift on a roof truss. In this case, to determine the uplift L, one would need to determine the highest instantaneous value of

$$L = p_1 A_{1p} + p_2 A_{2p} + p_3 A_{3p} + \ldots$$

where p_1, p_2, p_3, etc. are the instantaneous pressures measured at representative pressure taps 1, 2, 3, etc. and A_{1p}, A_{2p}, A_{3p}, etc. are the tributary areas associated with each of the pressure taps. Each term in the above summation is the contribution to the vertical force coming from one of the areas.

Because of lack of correlation of the wind pressures over the specific roof area, the individual terms do not all reach their peak at the same instant. Therefore, to determine the true peak uplift, it is important to carry out the above summation on a continuous and instantaneous basis. The results are usually expressed in coefficient form. For example, in the case of the uplift, the lift is divided by the reference gradient wind pressure, q_g, and the tributary area of the roof section *A*, to obtain

$$\frac{L}{q_g A} = \frac{1}{q_g}\left(\frac{p_1 A_{1p}}{A} + \frac{p_2 A_{2p}}{A} + \frac{p_3 A_{3p}}{A} + \ldots\right)$$

The summation in the brackets on the right-hand side, obtained on an instantaneous basis from the wind tunnel, is the overall uplift or down force divided by the plan area and so is an area-averaged pressure.

The above discussion represents one pressure pattern. Since it is impractical to analyse the structure for every possible wind pressure pattern that might occur, it is necessary (as is effectively done by building codes in very simplified ways) to select from the wind tunnel results certain loading scenarios that tend to be dominant and that are likely to stress the structure in important ways.

In this study, various wind loading scenarios were investigated based on discussions with the structural engineer, as well as RWDI's experience with similar structures. The primary loading scenarios of concern were:

- Global lateral loading on sections of the station
- Vertical loading on the station;

For flexible, lightly damped structures with relatively low natural frequencies, the inertial loads due to wind-induced structural motion can add a significant contribution to the overall wind loads. Therefore, measurements were also obtained for the generalized aerodynamic force or modal load, (i.e., the integral of the pressures weighted by the modal deflection shape), for the aerodynamically significant vertical and lateral modes of vibration.

Mode shapes and frequencies, obtained from dynamic analyses of the terminal conducted by the structural engineers were received as of June 1, 2021. The measured power spectra of the modal wind loads were used, along with the provided natural frequencies, to determine the contribution of the modal loading to the overall structural wind loads.

As mentioned, several load cases were derived that emphasize the various loading distributions on the structure. Appropriate wind load distributions for structural design consideration were produced by combining the mean wind load distribution with selected fluctuating dynamic load distributions, for aerodynamically important wind directions. The fluctuating dynamic loading consists of the modal and background loading components appropriately combined. The modal wind loads were distributed as inertial loads based on the provided mode shapes. The fluctuating dynamic load distributions included an allowance for dynamic amplification, based on an assumed structural damping of 1.5% of critical.

The provided wind pressures are either the instantaneous net pressure difference across elements exposed to wind on both surfaces or an external surface including an internal pressure estimate where appropriate.

For detailed explanations of the procedures and underlying theory, RWDI's Technical Reference Document – Wind Tunnel Studies for Large Span Roofs (RD4-2014.1) is available upon request.

4 RECOMMENDED STRUCTURAL DESIGN WIND LOADS

For the structural design for wind, we recommend that consideration be given to the wind load information described in the following sections. The wind loads provided in this report are based on the 114 mph (3-Second Gust) wind speed described in Section 2.3.

The key plan for the pressure zones is presented in Figures 4 to 7. The provided wind pressures are to be applied normal to the exterior surface, with “negative pressure”, or suction, defined to act outward, and “positive pressure” acting inward. In addition, the skin friction allowances should be evenly distributed over the surface of the roof in the X and Y directions as indicated.

For ease of application, an Excel spreadsheet, which contains the wind load information provided in tabular form, accompanies this report.

The wind loads provided in this report do not contain safety or load factors and are to be applied in the same manner as would wind loads calculated by code analytical methods.

4.1 Overall Structural Loads

The following summarizes the overall structural wind load cases provided for the primary structural systems. Note that for these cases, simultaneous wind pressures have been provided for all roof and wall surfaces and are to be applied simultaneously. Note that there are three main structural sections separated by expansion joints, these are designated as Struct1, Struct2 and Struct3.

- Load Case LC1 and LC2 provide the **maximum positive and negative X and Y shear on Struct1**.
- Load Case LC3 provides the **maximum vertical uplift and downforce on Struct1**.
- Load Case LC4 and LC5 provide the **maximum positive and negative X and Y shear on Struct2**.
- Load Case LC6 provides the **unbalanced Y shear on Struct2.**
- Load Case LC7 provides the **maximum vertical uplift and downforce on Struct2.**
- Load Case LC8 and LC9 provide the **maximum positive and negative X and Y shear on Struct3**.
- Load Case LC10 provides the **maximum vertical uplift and downforce on Struct3**.
- Load Case LC11 and LC12 provide the **maximum positive and negative X and Y shear on the central dome**.
- Load Case LC13 provides the **maximum vertical uplift and downforce on the central dome**.

4.2 Secondary Member Wind Loading

For the design of secondary structural members, refer to Section 3.4 of the companion Cladding Wind Load Study Report, dated December 3, 2021.

5 APPLICABILITY OF RESULTS

5.1 The Proximity Model

The structural wind loads and building motions determined by the wind tunnel tests and the associated analysis are applicable for the particular configuration of surrounding buildings modelled. City development over time can cause changes in the surroundings from those tested, resulting in loads and accelerations that could differ from those predicted in this report.

Changes in surroundings can be divided into two categories:

a) addition or demolition of buildings far upwind, having the effect of changing the roughness of the earth's surface and thereby changing the general wind exposure of the site; and

b) addition or demolition of buildings close to the site, which can cause changes in the local flow patterns about the study building.

Based on the past history of city developments it appears that, with respect to Category (a), development over time is far more likely to increase rather than reduce building density. This implies that the development over time would more likely diminish loads on the study building rather than increase them. With respect to Category (b), the wind tunnel tests were conducted to represent the current state of the development of the nearby surroundings.

If, at a later date, additional buildings besides those considered in the tested configuration are constructed near the project site, then some load changes could occur. Unless, however, a building of unusual stature is constructed nearby, the results from this study tests are expected to be adequate for design. The consequence of increased motion, should it occur, is that a greater percentage of the occupants would notice the motions or find them objectionable.

5.2 Study Model and Structural Properties Information

The results presented in this report pertain to: 1) the natural frequencies of vibration and mode shapes provided as of June 1, 2021; and 2) the scale model of the proposed development, constructed using the architectural information listed in Appendix A. Should there be any design changes that deviate substantially from the above information, the results for the revised design may differ from those presented in this report. Therefore, if the design changes, RWDI should be contacted and requested to review the impact on the wind loads.

FIGURES

Wind Tunnel Study Model

Figure: 1

State & Lake Elevated Station – Chicago, IL

Project #2100248

Date: December 1, 2021

Site Plan

True North

Drawn by: DF

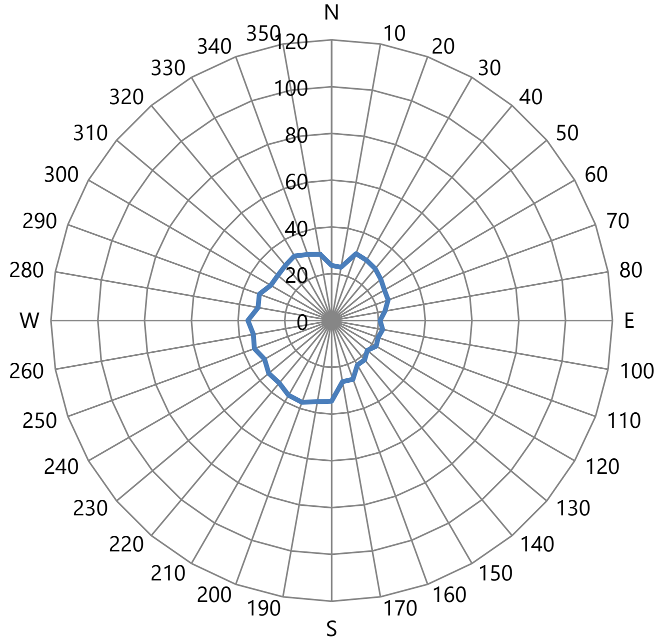
Figure: 2

Approx. Scale: 1 "=500 '

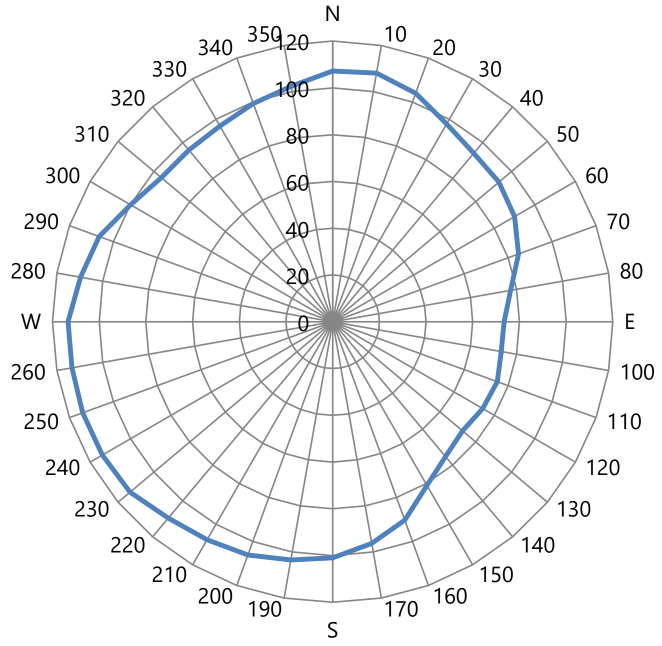
Date Revised: Aug. 25, 2021

State & Lake Elevated Station - Chicago, IL

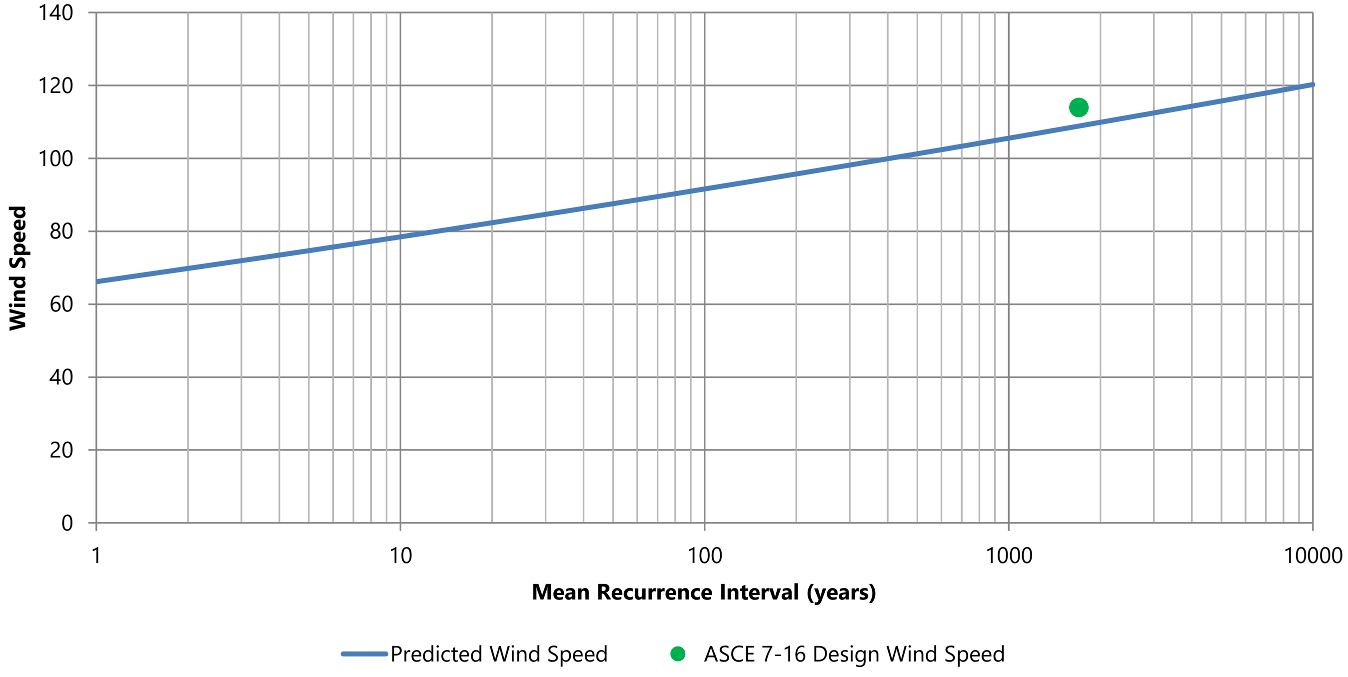
Project #: 2100248



Common Winds



Design Winds



Note: Wind Speeds shown are 3-second Gust Wind Speeds (mph) at 33 ft height in Open Terrain

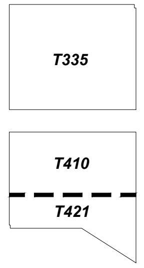
Directional Distribution of Local Wind Speeds

Figure: 3

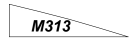
State & Lake Elevation Station – Chicago, IL

Project #2100248

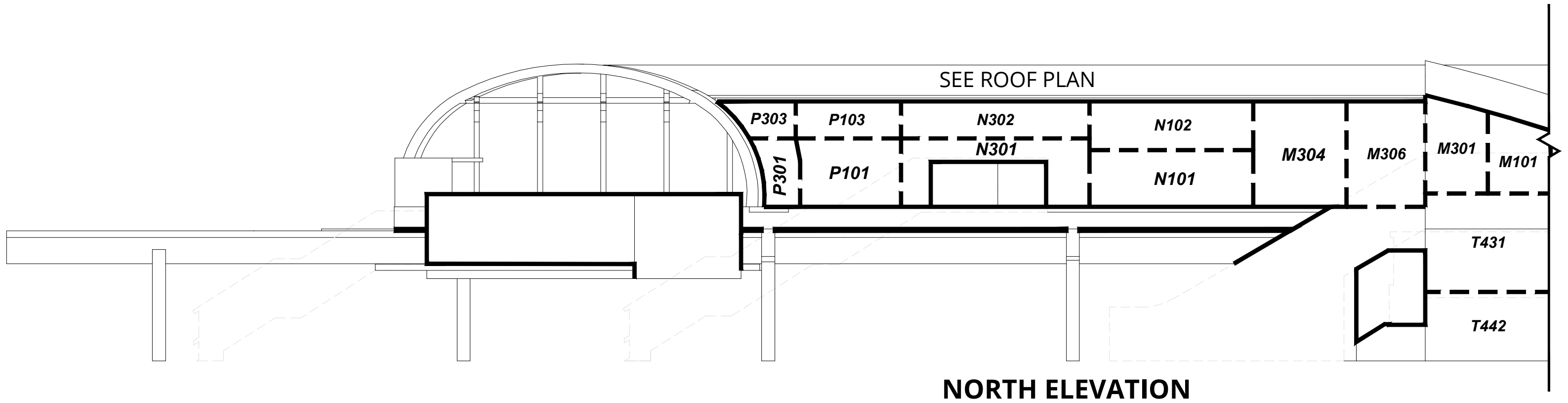
Date: December 1, 2021



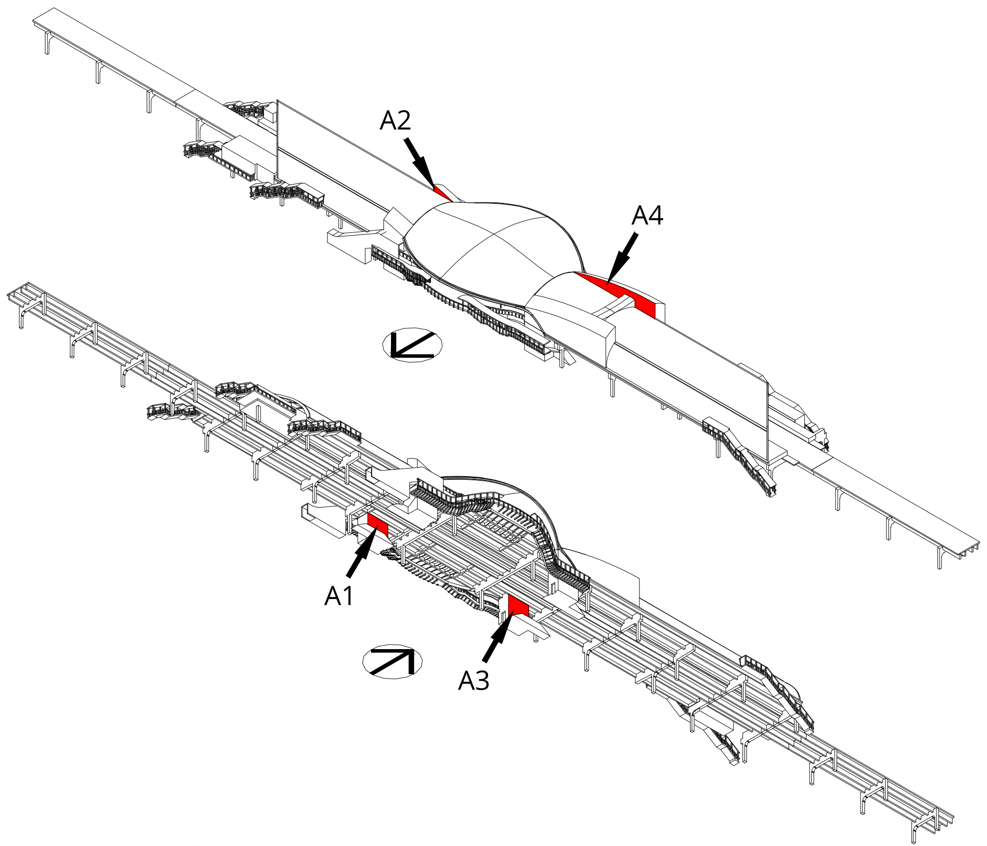
SURFACE A1



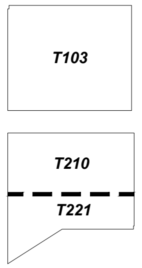
SURFACE A2



NORTH ELEVATION

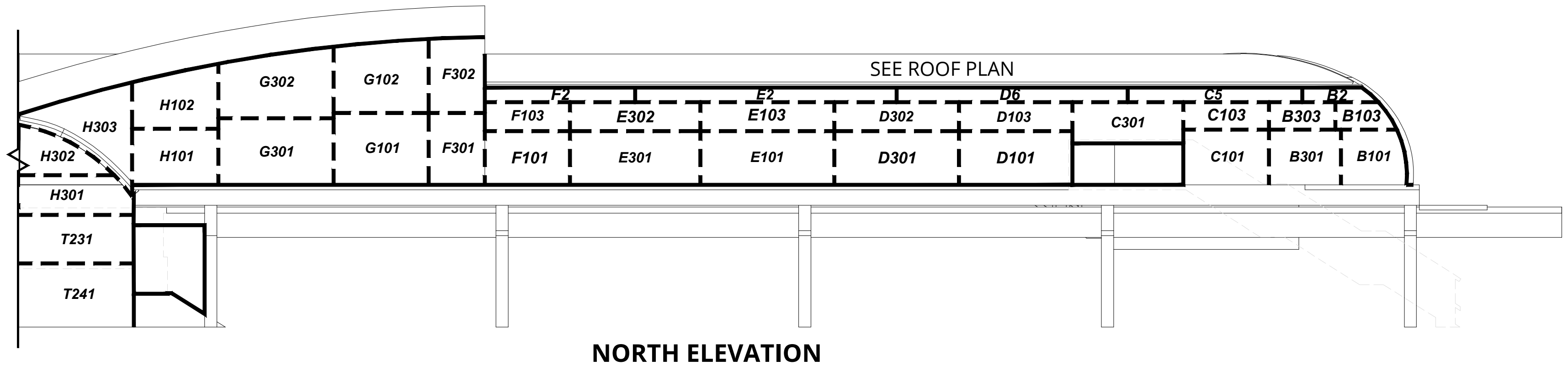


Isometric View of Wall Surfaces: North (A)

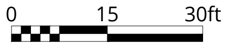


SURFACE A3

SURFACE A4



NORTH ELEVATION



Key Plan for Structural Zones

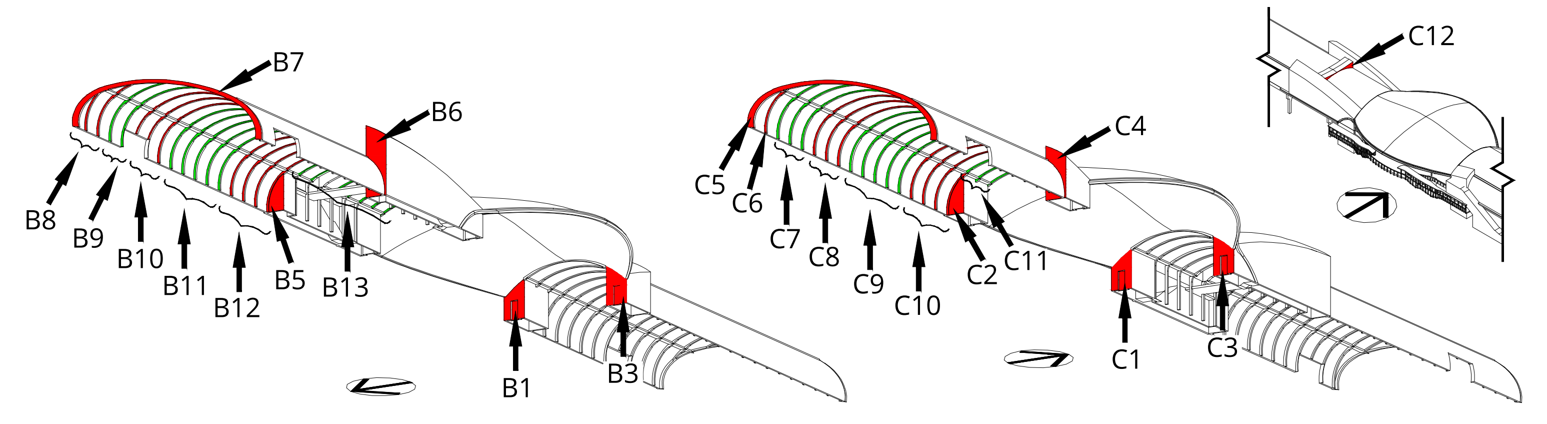
State & Lake Elevated Station - Chicago, IL

Project #2100248

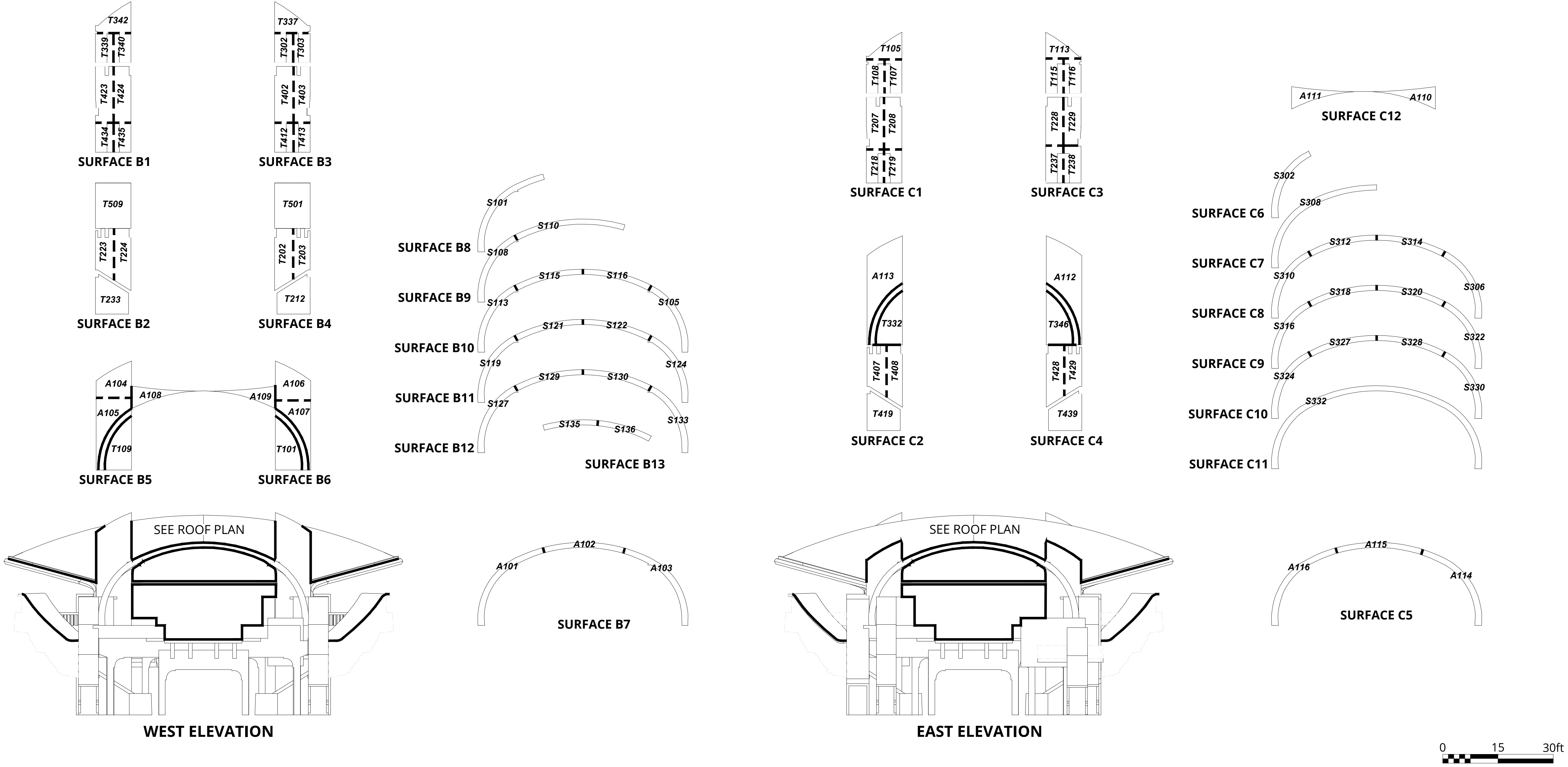
Drawn by: DBB Figure: 4

Approx. Scale: 1"=30'

Date Revised: Aug. 23, 2021



Isometric View of Wall Surfaces: West (B) and East (C)



Key Plan for Structural Zones

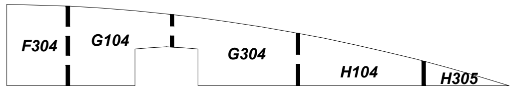
State & Lake Elevated Station - Chicago, IL

Project #2100248

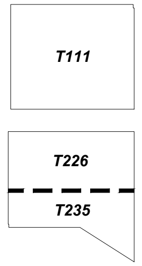
Drawn by: DBB Figure: 5

Approx. Scale: 1"=30'

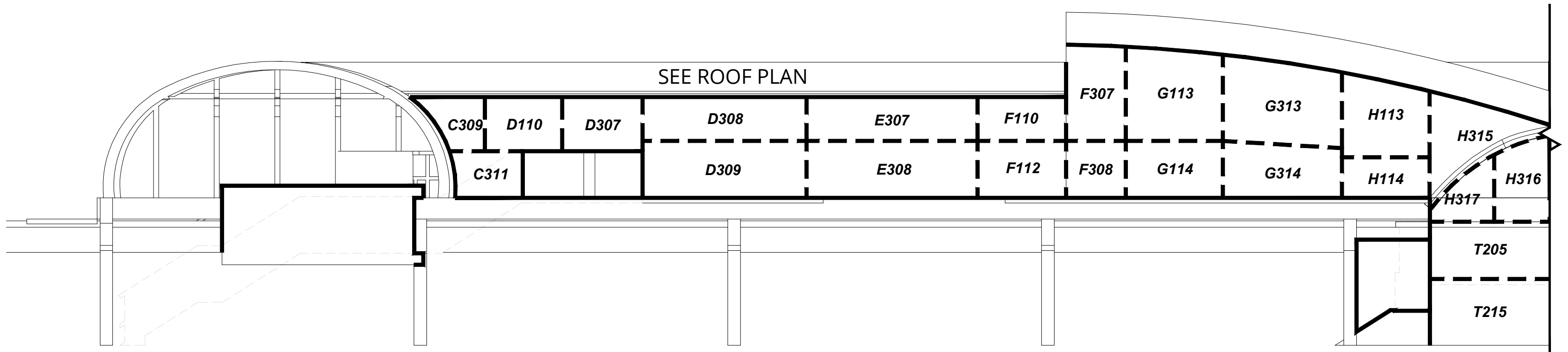
Date Revised: Aug. 23, 2021



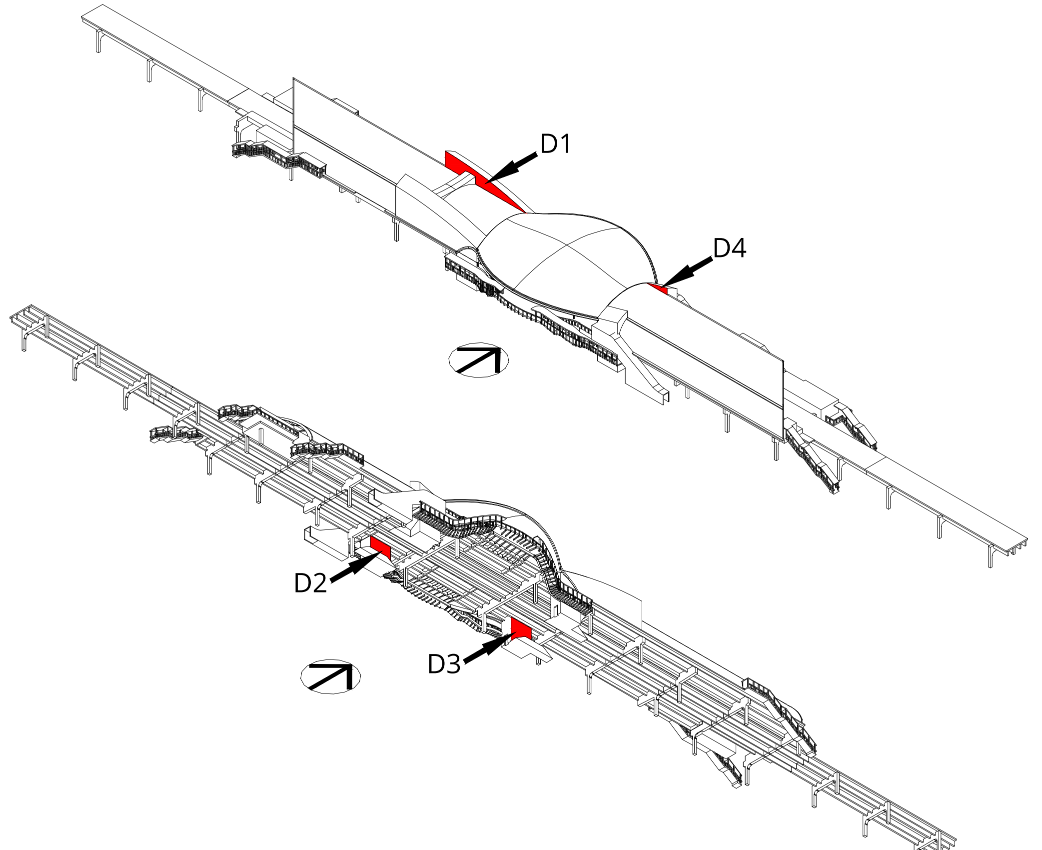
SURFACE D1



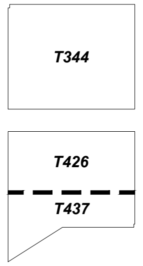
SURFACE D2



SOUTH ELEVATION

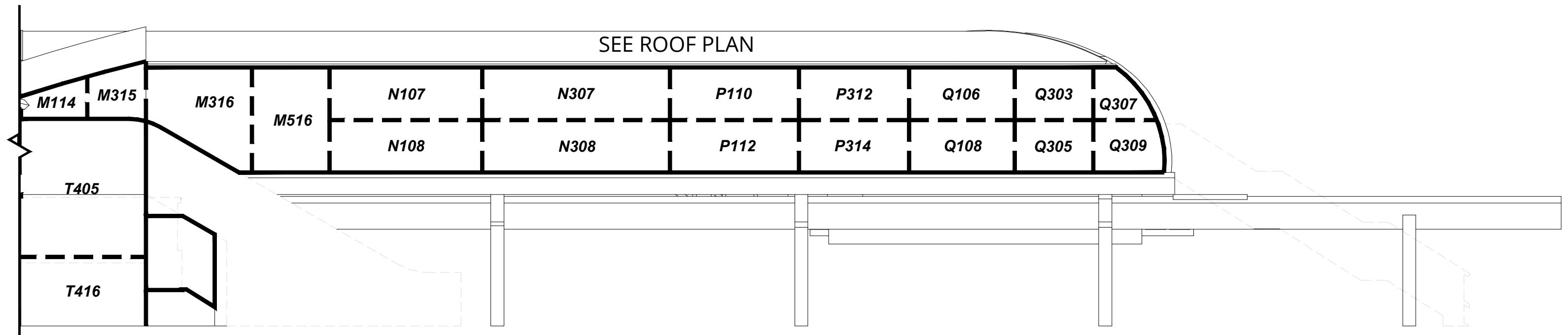


Isometric View of Wall Surfaces: South (D)

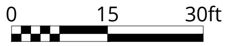


SURFACE D3

SURFACE D4



SOUTH ELEVATION

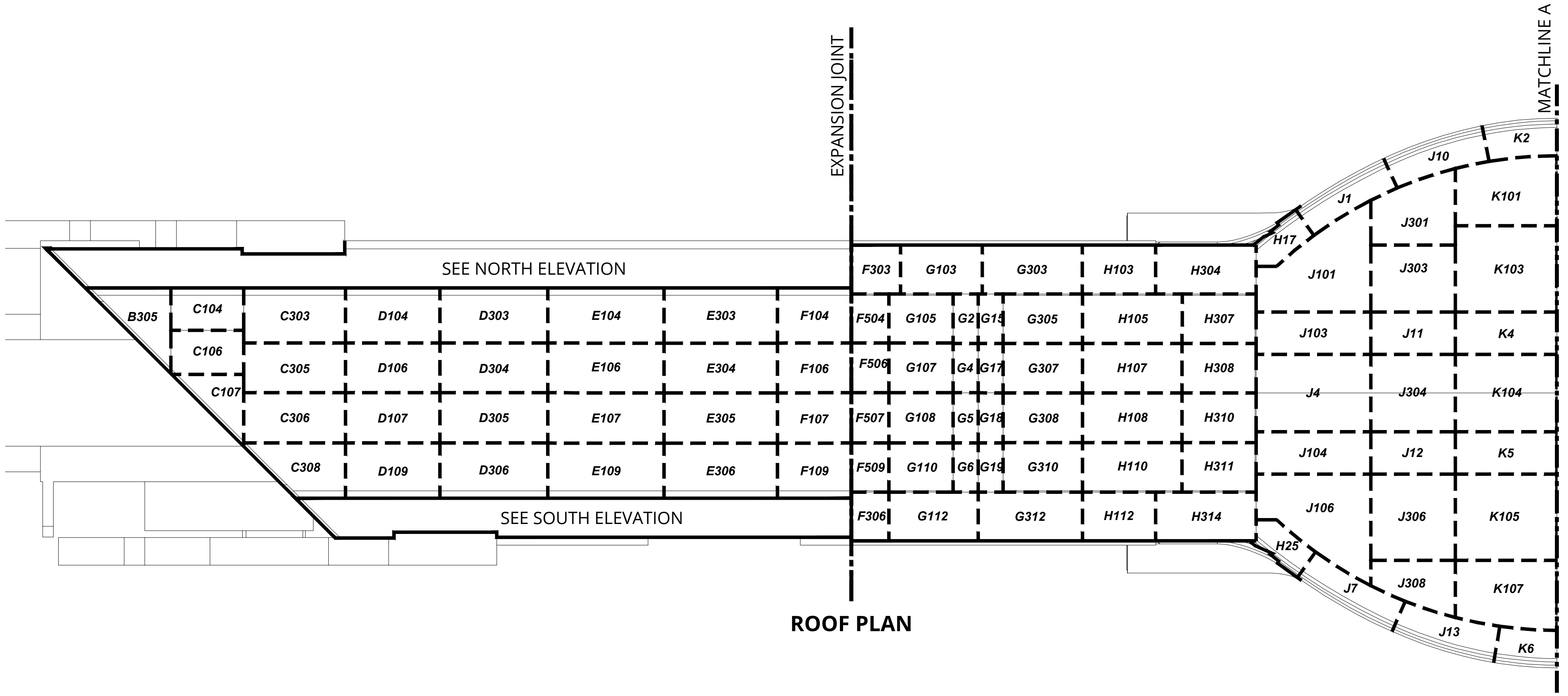


Key Plan for Structural Zones

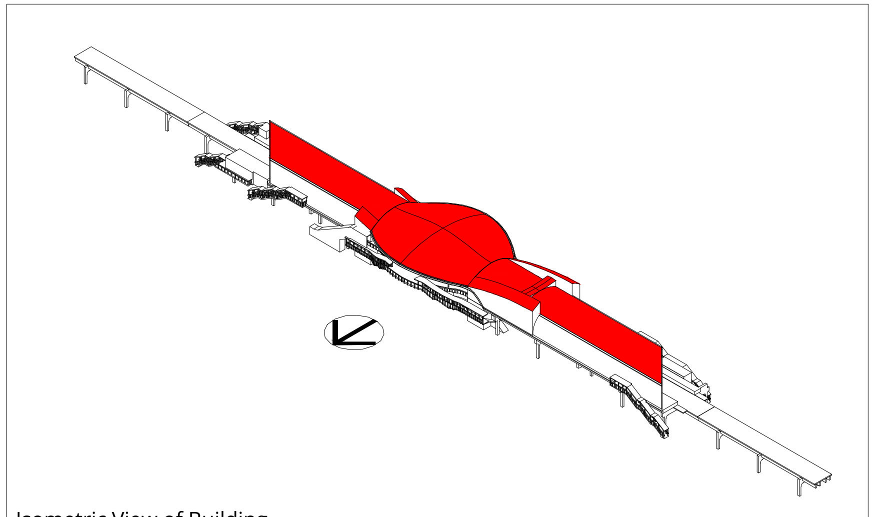
State & Lake Elevated Station - Chicago, IL

Project #2100248

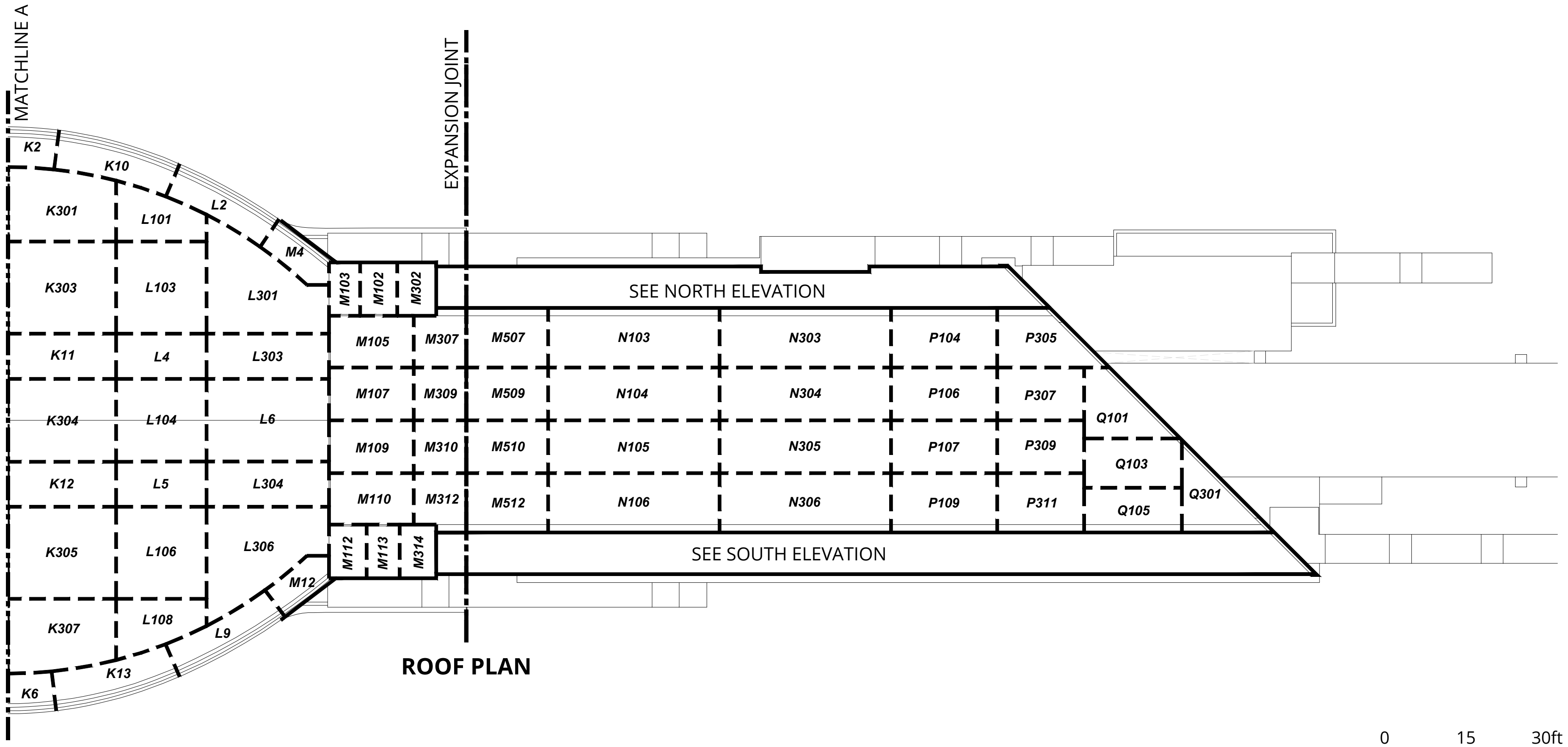
Drawn by: DBB
Figure: 6
Approx. Scale: 1"=30'
Date Revised: Aug. 23, 2021



ROOF PLAN



Isometric View of Building



ROOF PLAN

0 15 30ft

Key Plan for Structural Zones

State & Lake Elevated Station - Chicago, IL

True North

Project #2100248

Drawn by: DBB Figure: 7

Approx. Scale: 1"=30'

Date Revised: Aug. 23, 2021

APPENDIX A

APPENDIX A: DRAWING LIST FOR MODEL CONSTRUCTION

The drawings and information listed below were used to construct the scale model of the proposed State & Lake Elevation Station development. Should there be any design changes that deviate from this list of drawings, the results may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

File Name	File Type	Date Received (dd/mm/yyyy)
SL CTA STATION_Site_Platform_Stairs	Rhino	14/06/2021
2021.06.10 composite	Rhino	10/06/2021

APPENDIX B

APPENDIX B: WIND TUNNEL PROCEDURES

OVERVIEW OF WIND TUNNEL PROCEDURES FOR THE PREDICTION OF CLADDING WIND LOADS

B.1 Wind Tunnel Test and Analysis Methods

B.1.1 Wind Tunnel Tests

RWDI's boundary layer wind tunnel facility simulates the mean speed profile and turbulence of the natural wind approaching the modeled area by having a long working section with a roughened floor and specially designed turbulence generators, or spires, at the upwind end. Floor roughness and spires have been selected to simulate four basic terrain conditions, ranging from open terrain, or water, to built-up urban terrain. During the tests, the upwind profile in the wind tunnel is set to represent the most appropriate of these four basic profiles, for directions with similar upwind terrain. Scaling factors are also introduced at the analysis stage to account for remaining minor differences between the expected wind speed and turbulence properties, and the basic upwind flow conditions simulated in the wind tunnel. The full-scale properties are derived using the ESDU methodology[1,2] for predicting the effect of changes in the earth's surface roughness on the planetary boundary layer. For example, this procedure distinguishes between the flows generated by a uniform open water fetch upwind of the site, versus a short fetch of suburban terrain immediately upwind of the site with open water in the distance.

Wind direction is defined as the direction from which the wind blows in degrees measured clockwise from true north. The test model (study model and surroundings) is mounted on a turntable, allowing any wind direction to be simulated by rotating the model to the appropriate angle in the wind tunnel. The wind tunnel test is typically conducted for 36 wind directions at 10° intervals.

It is prudent to take steps to ensure that the safety of a structure is not entirely dependent on specific surrounding buildings for shelter. Building codes often contain specific provisions to address this. These may include requirements to test with the more significant surrounding buildings removed, and/or lower limits on the reduction that is permitted compared to the code analytical approach.

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[1] Wind speed profiles over terrain with roughness changes for flat or hilly sites. Item No. 84011, ESDU International London, 1984 with amendments to 1993.

[2] Longitudinal turbulence intensities over terrain with roughness changes for flat or hilly sites. Item No. 84030, ESDU International London, 1984 with amendments to 1993.

B.1.2 Measurement Techniques

This study addresses the local wind pressures that act on the exterior envelope of the building. Predictions of these loads are required in order that the cladding system can be designed to safely resist the wind loads. The technique that is used to make these predictions consists of conducting a wind pressure study. The basis of the approach is to instrument a rigid wind tunnel model of the building with pressure taps that adequately cover the exterior areas exposed to wind. The mean pressure, the root- mean-square of pressure fluctuations and the peak negative and peak positive pressures are measured at each tap using a system capable of responding to pressure fluctuations as short as 0.5 to 1 second at full scale. The measured data are converted into pressure coefficients based on the measured upper level mean dynamic pressure in the wind tunnel. Time series of the simultaneous pressures are also recorded for post-test processing if required. A typical example of an instrumented wind tunnel study model is provided in Figure 1.

B.1.3 Consideration of the Local Wind Climate

Carrying out the procedures described in the previous sections determines the peak local external pressure coefficients expected for a given wind direction. However, in order to account for the varying likelihood of different wind directions and the varying strengths of winds that may be expected from different directions, the measured pressure coefficients are integrated with statistical records of the local wind climate to produce predicted peak pressures as a function of return period. In the case of cladding loads, it is appropriate to consider peak loads associated with return periods comparable to the design life of the structure. The choice of return period will be governed by local code requirements that consider the intended use of the building. For Allowable Stress Design, return periods of 50 or 100 years are often used for cladding design, to which appropriate load or safety factors are applied. For Limit States Design, return periods of 700 or 1700 years, without load or safety factors, are used to represent the ultimate state loading.

Wind records taken from one or more locations near to the study site are generally used to derive the wind climate model. In areas affected by hurricanes or typhoons, Monte Carlo simulations are typically used to generate a better database since full scale measurements, if available for a given location, typically provide an inadequate sample for statistical purposes. The data in either case are analysed to determine the probabilities of exceeding various hourly mean wind speeds from within each of 36 wind sectors at an upper level reference height, typically taken to be 600 m (2000 ft) above open terrain. This coincides with the height used to measure the reference dynamic pressure in the wind tunnel.

In order to predict the cladding wind loads for a given return period, the wind tunnel results are integrated with the wind climate model. There are two methods typically used by RWDI to perform this integration. In one method, the historical (or simulated as is the case with hurricanes or typhoons) wind record is used to determine the full-scale cladding wind pressures for each hour, given the recorded wind speed and direction and the wind tunnel predictions for that direction. By stepping through the wind speed and direction data on an hour-by-hour basis, a time history of the resulting peak pressure is generated. Then, through the use of extreme value fitting techniques, statistically valid peak responses for any desired return period are determined.

The second method is the Upcrossing Method as described by Irwin[3] and Irwin and Sifton[4]. In simple terms, this can be thought of as an analytical representation of the first method, in which a fitted mathematical model of the wind statistics is used in place of the detailed wind records themselves. The Irwin, P.A. and Sifton, V. L., “Risk Considerations for Internal Pressures”, Journal of Wind Engineering and Industrial Aerodynamics, 77 & 78 (1998), pg. 715-723.

B.1.4 Internal Pressure Allowances Considering Localized Breaches in the Building Façade

In strong winds, air leakage effects dominate the internal pressures. Other factors that influence them, but are usually of less significance, are the operation of mechanical ventilation systems and the stack effect. Important sources of air leakage include uniformly distributed small leakage paths over the building’s envelope and larger leakage paths. These larger leakage paths include window breakage due to airborne debris in a windstorm and open doors or windows, in cases where they are operable. The internal pressure allowances can be influenced by many factors including the size and location of potential glass breakage, the internal compartmentalization of the building and the internal volumes. During a major storm event, glass breakage can be different sizes and occur at various locations. There are many types of projectiles that typically cause glass breakage, ranging in size from small rocks to tree branches. Larger projectiles impacting the building would be rare events.

To evaluate the internal pressures resulting from dominant openings in the building envelope, simultaneous measurements are taken during the wind tunnel test between pairs of pressure taps located on building walls that share the same internal volume. Of particular interest are measurements taken in areas where large pressure differences can occur such as those that are generated at the corners of the floor plate. A single opening (worst case) scenario is typically considered since multiple leakage sources tend to reduce the magnitude of the internal pressure. Using an in-house approach, these data are analyzed to determine the range of internal pressures that may occur at selected opening locations and for a range of probabilities of these openings

occurring. Lower probabilities are used in lower wind speed areas (i.e., – non-hurricane/non-typhoon areas), and higher probabilities are used in higher wind speed areas (i.e., – hurricane/typhoon areas) or for buildings that have a large number of operable windows or doors. Using these dominant opening probabilities, internal pressures are determined for the same level of risk as that assumed for the external pressures.

For buildings that use large missile impact resistant glazing everywhere, and do not have operable windows, the potential for breakage due to windborne debris is very low. As a result, the probability of an opening is also very low, and the internal pressures used are at or near the minimum considerations of a nominally sealed building.

The internal pressure allowances are applied to help reduce the possibility of subsequent facade failures due to pressure increases caused by localized breaches in the facade. Design of the cladding to the provided wind loads will not necessarily prevent breakage due to impact by wind borne debris.

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[3] Irwin, P.A., “Pressure Model Techniques for Cladding Loads”, Journal of Wind Engineering and Industrial Aerodynamics 29 (1988), pg. 69-78.

[4] Irwin, P.A. and Sifton, V. L., “Risk Considerations for Internal Pressures”, Journal of Wind Engineering and Industrial Aerodynamics, 77&78 (1998), pg. 715-723.

APPENDIX C

APPENDIX C: THEORETICAL BACKGROUND TO THE DETERMINATION OF WIND LOADS ON ROOFS

C.1 Mean and Fluctuating Loads

The load on a roof due to the wind is the net difference between the pressure on the underside and that on the topside. This net pressure difference, P, varies with position(x, y), on the roof's surface and with time, t. The fluctuations in pressure are due to wind turbulence in the oncoming wind and to turbulence caused by the structure itself. If a time average of P is taken over a period of order ten minutes to an hour then the turbulence fluctuations are averaged out and the mean pressure distribution $\bar{\mathrm{P}}(x, y)$ is obtained. At any instant the difference between the instantaneous pressure $\mathrm{P}(x, y, t)$ and the mean pressure at the same location on the roof is the fluctuating component $\rho(x, y, t)$, and we have the relationship

$$P(x, y, t) = \bar{P}(x, y) + \rho(x, y, t) \tag{1}$$

The peak pressure $\hat{\mathrm{P}}(x, y)$, reached at some instant during the averaging period is given by

$$\hat{P}(x, y) = \bar{P}(x, y) + \hat{\rho}(x, y) \tag{2}$$

Where $\hat{\rho}(x, y)$ is the peak value reached by the fluctuating component.

C.2 Peak Local Loads

The peak local load,$\hat{\mathrm{P}}(xy)$ at various positions on the roof can be determined in wind tunnel tests in a simple manner by direct measurement of the pressure difference between the top and bottom sides of the roof. For a roof enclosing a volume underneath only the topside pressure is typically measured, the internal pressure, i.e. that acting on the underside, being estimated from knowledge of the leakage in the building envelope and operation of mechanical equipment. When the underside is open to the wind, the underside pressure is measured and the difference between it and the measured topside pressure computed instant by instant. The expected maximum value of the local wind pressure load, $\hat{\mathrm{P}}(xy)$ during a sample interval of any given duration can then be estimated by statistical methods in the same way as for cladding loads (see accompanying appendix on Measurement Techniques and Data Analysis for determination of peak cladding loads).

C.2.1 Integrated Effects of Loads on the Structural System

The load effect, which could be a member force or stress for example, at a particular point in the structure depends not only on the local wind load at that point but on the integrated effect of the loads all over the entire roof. Writing the load effect in the th structural member as and assuming at this stage of the discussion that the roof responds instantaneously to applied loads, the load effect is given by

$$E_i(t) = \iint_A \mathrm{C}_i(x,y)P(x,y,t)\,dx\,dy$$

$$= \iint_A \mathrm{C}_i(x,y)\overline{\mathrm{P}}(x,y)\,dx\,dy + \iint_A \mathrm{C}_i(x,y)\mathrm{P}(x,y,t)\,dx\,dy \tag{3}$$

$$= \overline{\mathrm{E}}_i + e_i(t)$$

where the double integrals are over the whole area A of the roof, $\overline{E}_{\mathrm{i}}$ is the mean load effect in member i and $e_i(t)$ is the fluctuating part of the load effect in member i. The coefficient $C_i\ (x,y)$ is the influence coefficient for member i and gives the load effect due to a unit load applied at the point (x,y). $C\ _i(x,y)$ can be thought of an influence "surface" varying with x and y. The shape of the influence surface will be fixed for a given structural component but will vary for different components. What is required for structural design purposes is the peak load effect, $\hat{E}_{\mathrm{i}}$, which is given by

$$\hat{E}_i = \overline{E}_i + \hat{e}_i \tag{4}$$

where $\hat{e}_{\mathrm{i}}$ is the peak of the fluctuating load effect.

Since the fluctuating load effect $e_i$has the characteristics of a random variable we will be interested in its root-mean-square (RMS) value, which will be denoted by σ_{eibk} , and the variance σ_{eibk}^2. We have added the *bk* to the subscript to denote the "background" load effect, to distinguish it from the resonant load effects in different modes of vibration to be described later. The variance of the load effect is given by

$$\sigma_{eibk}^2 = \left(\overline{\iint_A \mathrm{C}_\iota(x,y)\rho(x,y,z)\,dx\,dy}\right)^2 \tag{5}$$

where the over-bar denotes a time average.

If the influence coefficients $C_i\ (x,y)$ are known then the evaluation of the mean load effect $\hat{E}_i$, is in principle straightforward. The mean pressure distribution for a particular wind direction is independent of time and can be measured once and for all in the wind tunnel. To find the mean load effect in any member i, the mean load distribution is then weighted by the influence coefficient $C_i(x,y)$ and integrated over the roof surface to obtain the first term on the right hand side of Equation 4.

However, to obtain the peak fluctuating load effect, $\hat{e}_i$, is not as straightforward because the roof experiences a wide variety of fluctuating load distributions $p\ (x,y,t)$. Also, the particular load distribution that causes the peak load effect in one structural member may be quite different from that causing the peak effect in another member. There is no single “worst case” load distribution. This situation is not unique to large span roofs and the usual approach is to design for a limited number of load distributions that are reasonably representative of the most important types of wind action on the roof. The selection of these load cases requires some knowledge of the basic structural behavior of the roof. Therefore, it is important that there is good communication between the wind tunnel laboratory and the structural designer during the selection process.

Note that the traditional approach to wind loading, used before the true behavior of wind and its turbulence was fully understood, effectively assumed that the fluctuating component of wind load, $p\ (x, y, t)$, always had the same shape as the mean component $\bar{P}\ (x, y)$. Thus, all that had to be done was to multiply the mean load by an appropriate gust factor, typically taken as about 2. In some instances this approach can be highly misleading, as for example in the case of a horizontal canopy roof. The mean loading on such a roof is typically close to zero and applying a gust factor to this still gives close to zero. However, the instantaneous uplift and downwards forces are in reality very substantial and are due to the vertical component of wind turbulence. In general it is important to measure the load fluctuations $p\ (x, y, t)$ directly since their shape is not the same as that of $\bar{P}\ (x, y)$.

C.3 Wind Tunnel Measurements

In the wind tunnel measurements can only be made at discrete points. Therefore the integrated load effects must be determined by assigning a tributary area to each pressure tap, multiplying the pressure by the tributary area and by the influence coefficient and summing the contributions from all taps. Mathematically this can be written

$$E_i(t) = P_1(t)C_{i1}\delta A_1 + \ P_2(t)C_{i2}\delta A_2 + \ \dots P_n(t)C_{in}\delta A_n = \Sigma_{j=1}^{N} P_j(t)C_{ij}\delta A_j \qquad (6)$$

Where $P_j(t)$ = net pressure at location j, C_{ij} = the influence coefficient for structural member i for a force at location j, $\delta\ A_\mathrm{j}$ = the tributary area for the tap at location j, and n = the number of pressure taps.

Up until the early 1990's digital data acquisition systems for measuring pressures were not up to the task of recording pressures at many taps simultaneously at a sufficiently fast rate and processing the signals to obtain E_i. Thus methods of “pneumatically” averaging pressures came into vogue for a while. These methods employed a technique of connecting all the pressure taps via tubing to a manifold. The output pressure from the manifold was effectively an instantaneous average of all the input pressures. Since the manifold technique provided no means of applying weighting factors to individual pressures, the weighting factors $C_{ij}\delta A_\mathrm{j}$ had to be artificially created by concentrating more pressure taps in certain areas of the roof than others.

Present day digital data acquisition systems are capable of recording several hundred time histories of pressure from a wind tunnel model simultaneously and this then allows the summation in Equation 6 to be executed computationally either on line during a test, or if data storage capacity is sufficient, after the tests have been completed. This gives much more flexibility to measure a variety of load effects on a roof.

The simplest load effect to evaluate is the overall uplift on a roof, . In this case all of the C_{ij} coefficients are equal to 1.0 and the total uplift is computed from

$$L(t) = P_1(t)\delta A_1 + P_2(t)\delta A_2 + P_3(t)\delta A_3 + \ \dots + P_n(t)\delta A_n$$

(7)

$$= \sum_{i=0}^{n} \mathrm{P}_j(t)\delta A_j$$

As another example of the use of Equation 6, suppose we are determining the wind loading on a cantilever roof supported by a series of cantilever trusses. There is little load sharing by the trusses so that each one has to take the load from a certain slice, of width b, of the roof. Probably the most important quantity for structural design in this case is the bending moment, created by roof uplift, at the root of each cantilever truss. The influence coefficients C_{Mj} giving the bending moment are the distances y_i of the taps from the root; i.e., $C_{Mj} = y_j$. The tributary areas, assuming equal spacing of the pressure taps, are all the same with a value $\frac{b\ell}{n}$where ℓ = the cantilever arm length and n = the number of taps along the cantilever. For example, suppose we have 6 taps equally spaced along the cantilever arm length. The distances are then $y_1 = \frac{\ell}{12}, y_2 = \frac{3\ell}{12}, y_3 = \frac{5\ell}{12} \dots y_6 = \frac{11\ell}{12}$, . The instantaneous bending moment M at time t is then obtained from the measured pressures using the following expression

$$M(t) = \frac{\ell^2 b}{72} \sum_{j=1}^{6} \ (2j-1)P_j(t) \tag{8}$$

C.4 Dynamic Effects

Up to this point it has been assumed that the roof's response to loading is instantaneous. This is a reasonable approximation for shorter span, stiff roofs. However, for the more flexible long span roof structures dynamic effects can be significant and this section examines these. If the roof moves under the action of wind loads then at any given instant, in addition to the wind loads acting on its surfaces, there will be inertial loads due to acceleration of the roof mass. To study these requires that we use the equation of motion for the structure. Each roof will possess a series of natural modes of vibration and these are typically evaluated by the structural engineer using structural analysis programs. To a reasonable approximation each mode of vibration can be treated as independent of the others. Thus they can be examined one at a time and their individual effects summed using the root-sum-of-squares approach. The roof's vertical deflections w in a particular mode of vibration, j, can be written

$$w(x,y,t) = \mu_j(x,y)q(t) \tag{9}$$

where $\mu_j(x,y)$ = the modal deflection shape, and $q(t)$ = the generalised coordinate for the mode.

The equation of motion for this mode of vibration is

$$M_{Gj}\left(\ddot{q} + 2\zeta\omega_j\dot{q} + \omega_j^2 q\right) = \iint_A \ p(x,y,t)\mu_j(x,y)\,dx\,dy \tag{10}$$

where M_{Gj} = the generalised mass, ζ = the damping ratio, and ω_j = the circular frequency for the mode. The above integral is over the area of the roof A. The generalised mass for mode j is defined as

$$M_{Gj} = \iint_A \ m(x,y)\mu_j^2(x,y)\,dx\,dy \tag{11}$$

where $m(x,y)$ = the mass per unit area of the roof. The integral on the right hand side of Equation 10 is the generalised aerodynamic force F_{Aj} for mode j.

$$F_{Aj} = \iint_A p(x,y,t)\mu_j(x,y)\,dx\,dy \tag{12}$$

One can also define a generalised pressure for the mode as

$$P_{Gj}(t) = \frac{F_{Aj}}{A} \tag{13}$$

There are some observations to make about the above equation of motion.

i) To a first approximation it is usually permissible to assume $p(x,y,t)$ is independent of the roof motion. This implies that measurements on a rigid model can be used to predict the motion of the roof. In cases where the roof is very flexible it is possible for the roof motions to be of sufficient magnitude to have a feedback effect on the wind forces and alter them. In some cases this can lead to the onset of unstable oscillations which it is important to avoid. The discussion in this appendix does not cover aeroelastic effects. Typically these effects are small on roofs with natural frequencies above about 1 Hz. In cases where it is suspected that aeroelastic effects could be significant it is advisable to build and test an aeroelastic model, i.e. one that simulates the roof's flexibility, mass and damping.

ii) The generalised mass M_{Gj} receives contributions not only from the roof's mass but also from the so-called "added mass" of the air accelerated by the roof when it vibrates. For very lightweight roof systems the "added mass" can be very significant. Estimates of its magnitude can be made as discussed in Reference 1.

iii) For modes involving changes in the volume enclosed under a roof, there are additional damping terms and, for well sealed buildings, additional stiffness terms. The additional damping, which affects the value of ζ, comes from having to pump air in and out of the internal volume. There is also further damping caused by the radiation of pressure waves into the atmosphere at a frequency equal to that of the roof. These effects are discussed in Reference 1 and 2.

Equation 10 can be solved by power spectrum methods and the resulting expression for the spectrum, $S_q(\omega)$, of q is

$$S_q(\omega) = \frac{S_F(\omega)}{\omega_j^4 M_{Gj}^2 |\chi_j|^2} \tag{14}$$

where $S_F(\omega)$ = the power spectrum of the generalised force F_{Aj}, ω is the circular frequency of the excitation and the mechanical admittance term $|\chi_j|^2$ is given by

$$|\chi_j|^2 = \left[1-\left(\frac{\omega}{\omega j}\right)^2\right]^2 + 4\zeta^2\left(\frac{\omega}{\omega j}\right)^2 \tag{15}$$

$$\sigma_q^2 = \sigma_{qB}^2 + \sigma_{qR}^2 \tag{16}$$

Integrating Equation 14 with respect to ω gives the variance, σ_q^2, of q. For lightly damped structures ($\zeta < 0.1$) the integral of the right hand side of Equation 14 can be approximated by two discrete contributions, in which the first term on the right is called the “background term” and the second is called the “resonant term”. The background term is given by

$$\sigma_{qB}^2 = \frac{\sigma_{Fj}^2}{\omega_j^4 M_{Gj}^2} \tag{17}$$

where σ_{Fj} root-mean-square of generalised force F_{Aj}, and the resonant term is given by

$$\sigma_{qR}^2 = \frac{\pi}{4\zeta}\,\frac{n_j S_F(n_j)}{\omega_j^4 M_{Gj}^2} \tag{18}$$

where n_j = natural frequency = $\frac{\omega}{2\pi}$. The Dynamic Amplification Factor (DAF) is defined as the ratio of the total RMS response σ_q to the RMS background response σ_{qB}.

$$DAF = \frac{\sigma_q}{\sigma_{qB}} = \sqrt{1+\frac{\pi n_j S_F(n_j)}{4\zeta\sigma_{Fj}^2}} \tag{19}$$

The DAF gives the increase in response due to the flexibility of the roof. For typical roofs it is close to 1.0 but for flexible roofs it can be 2 or higher in the lowest modes of vibration.

The inertial force on the roof due to its motion is essentially given by the resonant part of the response. At each point on the roof the vertical force per unit area is given by the product of mass per unit area times acceleration, i.e., by $\ddot{w}(x,y)m(x,y)$. Therefore the effective RMS pressure due to inertial forces in mode j, $\sigma_{pj}(x,y)$, is given by

$$\sigma_{pj}(x,y) = \sigma_{\ddot{W}} m(x,y) = \omega_j^2 \sigma_{qR} \mu_j(x,y) m(x,y)$$

$$= \sqrt{\left(DAF_j\right)^2 - 1}\,\sigma_{P_{G}j}\,\frac{A\mu_j(x,y)m(x,y)}{M_{Gj}} \tag{20}$$

Since it is the load effect on individual structural members that is important in the end, we note that for a particular structural member i the RMS load effect due to the inertial forces associated with mode j is

$$\sigma_{eij} = \sqrt{(DAF_j)^2} - 1\sigma_{P_{G}j}\alpha_{ij} \tag{21}$$

where α_{ij} is the influence coefficient giving the load effect in the member i due to unit loading in mode j. This influence coefficient is theoretically given by

$$\alpha_{ij} = \iint_A \frac{AC_i(x,y)\mu_j(x,y)m(x,y)}{M_{Gj}}\, dxdy \tag{22}$$

where $C_i(x,y)$ is the influence coefficient for the member, previously described in Section 2.

Under some circumstances Equation 20 can be simplified. If the mass distribution $m(x,y)$ is uniform then it becomes

$$\sigma_{pj}(x,y) = \sqrt{(DAF_j)^2} - 1\sigma_{P_{Gj}} \frac{A\mu_j(x.y)}{\iint_A \mu_j^2(x,y)\, dxdy} \tag{23}$$

Furthermore, if the mode shape, $\mu_j(x,y)$, is normalised such that $\iint \ \mu_j^2\, dx\, dy = A$ then Equation 23 reduces to

$$\sigma_{pj}(x,y) = \sqrt{(DAF_j)^2} - 1\sigma_{P_{Gj}}\mu_j(x,y) \tag{24}$$

Thus, once the Dynamic Amplification Factor, DAF_j, has been determined the computation of the RMS pressure distribution σ_{pj} due to inertial loading is very straightforward using Equation 24, or slightly less so from Equations 20 or 23. The peak inertial loading can be calculated once the RMS is known using

$$\hat{p}_j(x,y) = g_p\sigma_{pj}(x,y) \tag{25}$$

where g_p = a peak factor with a typical value of about 4.0 (see Section 7).

C.5 Measurement of Generalised Aerodynamic Forces and Pressures

In the preceding section the generalised aerodynamic force for a particular mode, and the corresponding generalised pressure, were given by Equations 12 and 13 respectively. It can be seen that the form of Equation 12 is similar to that of the fluctuating term in Equation 3, the only difference being that the influence coefficient $C_i(x,y)$ is replaced by $\mu_j(x,y)$. Therefore the same techniques described in Section 3 for measuring load effects can be used to measure the generalised aerodynamic force and pressure for a given mode of vibration. In place of Equation 6 we now have

$$F_{Aj} = p_1\mu_{j1}\delta A_1 + p_2\mu_{j2}\delta A_2 + \cdots + p_n\mu_{jn}\delta A_n = \Sigma_{k=1}^{n} p_k\mu_{jk}\delta A_k \tag{26}$$

where the subscript k here indicates quantities applicable to tap k.

C.6 Combining Background and Modal Loading Contributions

C.6.1. Root Sum of Squares Method

The background loads from various modes of vibration, when combined, are similar to those corresponding to quantities such as overall uplift or overall moment described in Section 3. Thus the background contributions from the various modes can be considered as already covered by the measurements of overall uplift and moment, or by similar measurements of lift on selected tributary areas of importance. What still remains to be done is to combine these background loads with the inertial load contributions from the various modes.

Since the load effects due to the background contribution and the load effects due to excitation of individual modes by aerodynamic forces are all essentially independent, they can in principle be combined using the root-sum-of-squares (RSS) method. The total variance of load effect,σ_{ei}^2 , on a structural member may thus be expressed as follows

$$\sigma_{ei}^2 = \sigma_{eibk}^2 + \sigma_{ei1}^2 + \sigma_{ei2}^2 + .. + \sigma_{eiN}^2 \tag{27}$$

where σ_{eibk} is the RMS background load effect, σ_{ei1} , is the RMS load effect due to excitation of mode 1, σ_{ei2} is the RMS load effect due to excitation of mode 2, and so on up to mode N, which is the highest mode contributing significantly to the loading member i . Note that the RMS load effect in member , σ_{eij}, due to mode j, is given by Equation 20.

If each structural member were individually to be examined as part of the wind tunnel study Equation 27 could in principle be used to evaluate σ_{ei}. However, this would require that the wind tunnel laboratory be provided with the influence coefficients C_{ij} defined in Sections 2 and 3 so that the fluctuations in background load effect could be evaluated on-line during the test. Alternatively the wind tunnel laboratory would have to provide a time history of the entire pressure field on the roof so that the designer could evaluate the fluctuations in background load effect in the design office. Either way the procedure would be cumbersome. Added to this, the contributions to the load effect from each mode would need to be determined individually for each structural member and then all load effects for member i combined using Equation 27.

C.6.2 Linearisation of the Background and Dominant Mode Contributions

The RSS method just described, while being accurate for most situations, is not convenient for most design problems where many load cases need to be considered, including other types of force such as live load, temperature, earthquake etc. It makes it difficult to formulate the wind loads into a limited number of discrete cases in the traditional manner. To make Equation 27 more readily useable it needs to be approximated by a linear relationship.

One way to do this is to use the companion load approach. Frequently, for a particular structure there will be certain general forms of influence coefficient that are known to be important, such as the triangular shaped influence coefficient already described in Section 3 for the case of a cantilevered roof, and one of the modes of vibration will also have a deflection shape with a very similar form. This being the case, we can initially focus on a load case where this mode, which will be denoted as mode 1, and the background response make the dominant contribution to the load effect in the structural member i. The remaining secondary modes will be denoted as being 2 through N. We may take the square root of Equation 27 and write it as

$$\sigma_{ei} = \left(\sigma_{eibk}^2 + \sigma_{ei1}^2\right)^{\frac{1}{2}}\left[1 + \frac{\sigma_{ei2}^2+\sigma_{ei3}^2+\ldots+\sigma_{eiN}^2}{\sigma_{eibk}^2+\sigma_{ei1}^2}\right]^{\frac{1}{2}} \tag{28}$$

The first factor on the right hand side is the dominant term. The variance of the dominant term $\sigma_{eibk}^2 + \sigma_{ei1}^2$ will be denoted by σ_{eidom}^2 and, using Equation 21, may be written

$$\sigma_{eidom}^2 = \sigma_{eibk}^2 + \sigma_{ei1}^2 = \sigma_{eibk}^2 + [(DAF_1)^2 - 1]\sigma_{P_{G1}}^2\alpha_{i1}^2 \tag{29}$$

We do not want to use Equation 29 directly to evaluate σ_{eidom}. This would require knowing C_1 and α_{if} for every structural member of interest. Rather we want to use Equation 29 to lead us to a way of linearly combining the background load with the mode 1 load distribution. Towards this end we divide both sides of Equation 29 by σ_{eidom} which yields

$$\sigma_{eidom} = \frac{\sigma_{eibk}^2+\sigma_{ei1}^2}{\sigma_{eidom}} = \left(\frac{\sigma_{eibk}}{\sigma_{eidom}}\right)\sigma_{eibk} + [(DAF_1)^2 - 1]\left(\frac{\sigma_{P_{G1}}\alpha_{i1}}{\sigma_{eidom}}\right)\sigma_{P_{G1}}\alpha_{i1} \tag{30}$$

At this point it can be noted that, although σ_{eibk} and $\alpha_{i1}\sigma_{P_{G1}}$ are not necessarily identical, they are usually very similar numerically. This is because the influence coefficient C_i used in computing σ_{eibk} is generally similar to the shape of the dominant mode we selected. This is in fact the reason we are combining them into a single dominant term. If we take the case the shapes are identical, i.e. where $C_i(x,y) = C_{\mu_1}(x,y)$ with C as a constant, we can show that σ_{eibk} and $\alpha_{i1}\sigma_{P_{G1}}$ are exactly equal. This can be seen as follows. With the assumed behaviour of C_i Equation 5 becomes

$$\sigma_{eibk}^2 = C^2\overline{\left(\iint_A p(x,y,t)\mu_1(x,y)\;dxdy\right)^2} \tag{31}$$

Also, from Equations 12, 13 and 22 we can write

$$\begin{aligned}\sigma_{P_{G1}}^2 a_{il}^2 &= \frac{1}{A^2}\overline{\left(\iint p(x,y,t)\mu_1(x,y,t)\;dx\,dy\right)^2} \times \left(\frac{A}{M_{G1}}\iint_A C_i(x,y)\mu_1(x,y)m(x,y)dxdy\right)^2 \\ &= \left(\iint p(x,y,t)\mu_1(x,y,t)dxdy\right)^2 \times \left(\frac{c}{M_G}\iint_A \mu_1^2(x,y)m(x,y)dxdy\right)^2 \qquad (32) \\ &= C^2\overline{\left(\iint_A p(x,y,t)\mu_1(x,y,t)dxdy\right)^2}\end{aligned}$$

This is the same as Equation 31, thus proving that, when $C_i(x,y)$ is of the form $C\mu_1(x,y)$, σ_{eibk} and $\alpha_{i1}\ \sigma_{P_{G1}}$ are the same. Even when this conditions is not met exactly, since σ_{eibk} and $\alpha_{i1}\ \sigma_{P_{G1}}$ are formed from integrals over the roof area of weighted pressures, they are not too sensitive to the precise form of the weighting function and thus end up being almost identical if the weighting functions are generally similar in form.

The above discussion leads to the conclusion that a reasonable approximation in many cases is to replace both σ_{eibk} / σ_{eidom} and $\alpha_{i1}\ \sigma_{P_{G1}}$ / σ_{eidom} in Equation 30 by the factor 1 / DAF_1, resulting in

$$\sigma_{eidom} = \left(\frac{1}{DAF_1}\right)\sigma_{eibk} + \left(\frac{(DAF_1)^2-1}{DAF_1}\right)\sigma_{P_{G1}}\alpha_{i1} \tag{33}$$

This equation is for the dominant RMS load effect. However, in view of its linear form it is equivalent to assuming that the dominant pressure distribution acting on the structure is made up of a linear combination of two other shapes, one for the background contribution and one for mode 1. The magnitude of this dominant pressure distribution varies with time but its shape remains fixed. At any given point (x,y) the RMS value of the dominant pressure distribution can be written

$$\sigma_{pdom}(x,y) = \left(\frac{1}{DAF_1}\right)\sigma_{pbk}C'(x,y) + \left(\frac{\left(DAF_1^2-1\right)}{DAF_1}\right)\sigma_{P_{G1}}\frac{A\mu_1(x,y)m(x,y)}{M_{G1}} \tag{34}$$

where $C'(x,y)$ is the weighting function used for the background contribution, generally quite similar to the modal deflection shape $\mu 1$ but not necessarily identical.

C.6.3 Linearisation of Secondary Mode Terms

Equation 28 for the overall load effect may be expressed as

$$\sigma_{ei} = \sigma_{eidom}\left[1+\frac{\sigma_{ei2}^2+\sigma_{ei3}^2+\cdots+\sigma_{eiN}^2}{\sigma^2{}_{eidom}}\right]^{1/2} \tag{35}$$

which may be approximated using a truncated binomial expansion

$$\sigma_{ei} \approx \sigma_{eidom} + \frac{1}{2}\frac{\sigma_{ei2}^2+\sigma_{ei3}^2+\cdots+\sigma_{eiN}^2}{\sigma_{eidom}}$$

$$= \sigma_{eidom} + \frac{1}{2}\left[\left(\frac{\sigma_{ei2}}{\sigma_{eidom}}\right)\sigma_{ei2} + \left(\frac{\sigma_{ei3}}{\sigma_{eidom}}\right)\sigma_{ei3} + \cdots + \left(\frac{\sigma_{ein}}{\sigma_{eidom}}\right)\sigma_{eiN}\right] \tag{36}$$

The factors $(\sigma_{eij}\ /\sigma_{eidom})$ in the second term on the right hand side will in general be different but if, to simplify, we replace them all by the largest of them then it can be seen that a conservative approximation is of the form

$$\sigma_{ei} \approx \sigma_{eidom} + \alpha\left[\sigma_{ei2} + \sigma_{ei3} + \cdots + \sigma_{ein}\right] \tag{37}$$

where, since the largest of the $(\sigma_{eij}/\sigma_{eidom})$ terms is less than 1.0, is a constant that is at most ½. To obtain further guidance on the value of a we can examine particular cases. Suppose, for example, that all the σ_{eij}^2 terms in Equation 35 were equal to $\sigma^2{}_{eidom}$ then the true value of σ_{ei} would be $\sigma_{eidom}\sqrt{N}$, where N is the number of modes including the dominant one. Equation 37 would give a value of $\sigma_{eidom}[1+\alpha(N-1)]$. Therefore, for this particular case we would need to have

$$\alpha = \frac{\sqrt{N-1}}{N-1} \tag{38}$$

to obtain the true load effect. Note that this formula is only applicable for $N > 1$ since if only one mode is involved it is already included in the dominant term. As it turns out, this expression for a gives reasonable, if slightly conservative estimates, of σ_{ei} over quite a wide range of situations. This is demonstrated in Table 1 which shows the ratio of σ_{ei} , as estimated by Equations 37 and 38, to the true value given by Equation 35. Results are given for a variety of N values and combinations of $(\sigma_{eij}/\sigma_{eidom})$ values. It can be seen that the error is always conservative and, for up to four active modes, it is less than 15%. In most practical cases it is less than 10%. Therefore Equation 37 with a given by Equation 38 provides a reasonable linear approximation to the true load effect.

It follows that if the RMS load effect can be represented by Equation 37 then this is equivalent to assuming an RMS load with the following pattern:

$$\sigma_{\rho TOT}(x,y) = (\frac{1}{DAF_1}\sigma_{pbk}C'(x,y) \pm \frac{DAF_1^2-1}{DAF_1}\sigma_{P_{G1}}\frac{\mathrm{A}\mu_1(x,y)m(x,y)}{M_{G1}} \tag{39}$$

$$+a\sum_{j=2}^{N}\left(\pm\sqrt{DAF_1^2-1_{\sigma P_{Gj}}}\frac{A\mu_1(x,y)m(x,y)}{M_{Gj}}\right)$$

The ± signs are necessary in Equation 39 because in equation 37 all the terms are additive i.e. each one increases the RMS load effect. Since the α_{ij} influence factors can differ in sign for each mode it is necessary to consider both signs for each of the contributions to total effective pressure.

C.7 Peak Loads

The previous section gave a method for determining the RMS fluctuating loads. To obtain the peak loads a relationship between the RMS and the peak fluctuation is needed. The expression of Davenport[3] can be used to estimate the multiplier g_p that must be applied to the RMS to obtain the peak fluctuation.

$$g_p = \sqrt{2In(vT)} + \frac{1}{\sqrt{2In(vT)}} \tag{40}$$

where v = the average cycling rate and T = time duration of the design storm (e.g. one or two hours). The average cycling rate v depends on the power spectrum $S(n)$ of the load and is given by

$$v = \sqrt{\int_o^\infty \frac{n^2 s(n)}{s(n)}dn} \tag{41}$$

where n = frequency. Typically it is found that g_p falls into the range of 3.5 to 4.5 in wind engineering problems and it simplifies analysis if a single value is used. Typically g_p is taken to have the value 4.0 but variations on this may be made on background loading terms for example, based on the actual peak values measured in the wind tunnel tests.

The total peak load variation, as a function of the coordinates (x, y), is then given by

$$\hat{P}(x,y) = \bar{P}(x,y) \pm g_p \sigma_{ptot}(x,y) \tag{42}$$

Where σ_{ptot} is given by Equation 39.

The above analysis provides a general method for the evaluation of the peak loads on a roof from pressure measurements on a rigid model. As indicated in Section 4, aeroelastic effects cannot be simulated on a rigid model. Typically aeroelastic effects are small. However, on roofs with low natural frequencies, eg. less than 1 Hz, it is advisable to consider the possibility that aeroelastic effects could be present and, if in doubt, undertake wind tunnel tests on an aeroelastic model.

References

1. Irwin, P.A., and Wardlaw, R.L. “A Wind Tunnel Investigation of a Retractable Roof for the Montreal Olympic Stadium”, Fifth International Conference on Wind Engineering, Fort Collins, Colorado, USA, July 8-14, 1979, pp 925-938.

2. Kind, R.J., “Pneumatic Stiffness and Damping in Air-Supported Structures”, J. of Wind Engineering and Industrial Aerodynamics, 17 (1984), pp. 295-304.

3. Davenport, A.G., “The Application of Statistical Concepts to the Wind Loading of Structures”, Proc. Instn. Civ. Engnrs, vol 19, Aug. 1961, pp.449-472.

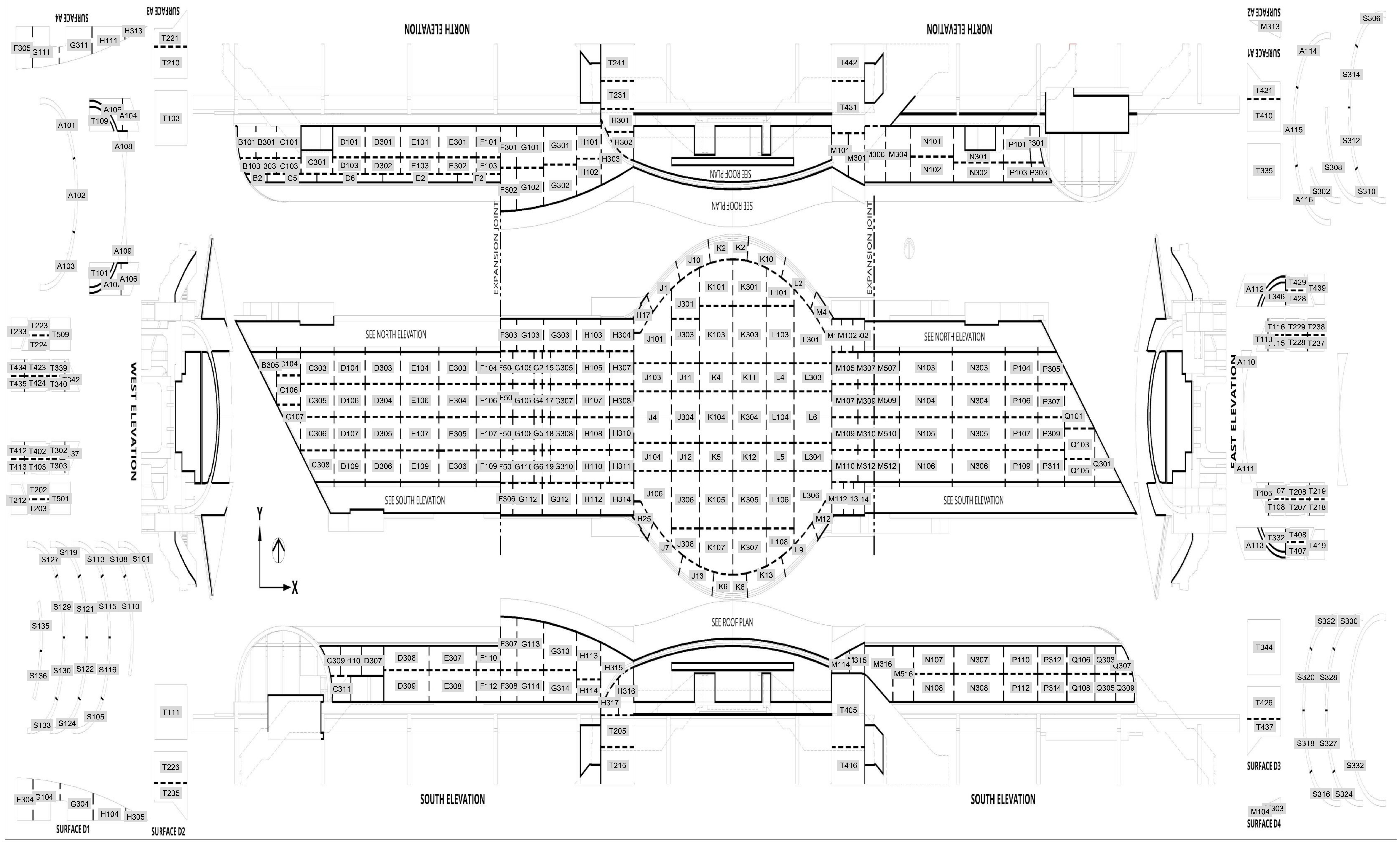
Table 1

CASE	*N*	$\sigma_{ei2} / \sigma_{eidom}$	$\sigma_{ei3} / \sigma_{eidom}$	$\sigma_{ei4} / \sigma_{eidom}$	$\sigma_{ei5} / \sigma_{eidom}$	σ_{ei} (estimated) / σ_{ei} (true)
1	2	0.1	-	-	-	1.036
2	3	0.1	0.1	-	-	1.063
3	4	0.1	0.1	0.1	-	1.084
4	5	0.1	0.1	0.1	0.1	1.102
5	2	0.25	-	-	-	1.071
6	3	0.25	0.25	-	-	1.115
7	4	0.25	0.25	0.25	-	1.147
8	5	0.25	0.25	0.25	0.25	1.171
9	2	0.5	-	-	-	1.080
10	3	0.5	0.5	-	-	1.115
11	4	0.5	0.5	0.5	-	1.134
12	5	0.5	0.5	0.5	0.5	1.144
13	2	0.75	-	-	-	1.048
14	3	0.75	0.75	-	-	1.063
15	4	0.75	0.75	0.75	-	1.067
16	5	0.75	0.75	0.75	0.75	1.069
17	2	1	-	-	-	1.000
18	3	1	0.75	-	-	1.025
19	4	1	0.75	0.5	-	1.043
20	5	1	0.75	0.5	0.25	1.045

APPENDIX D

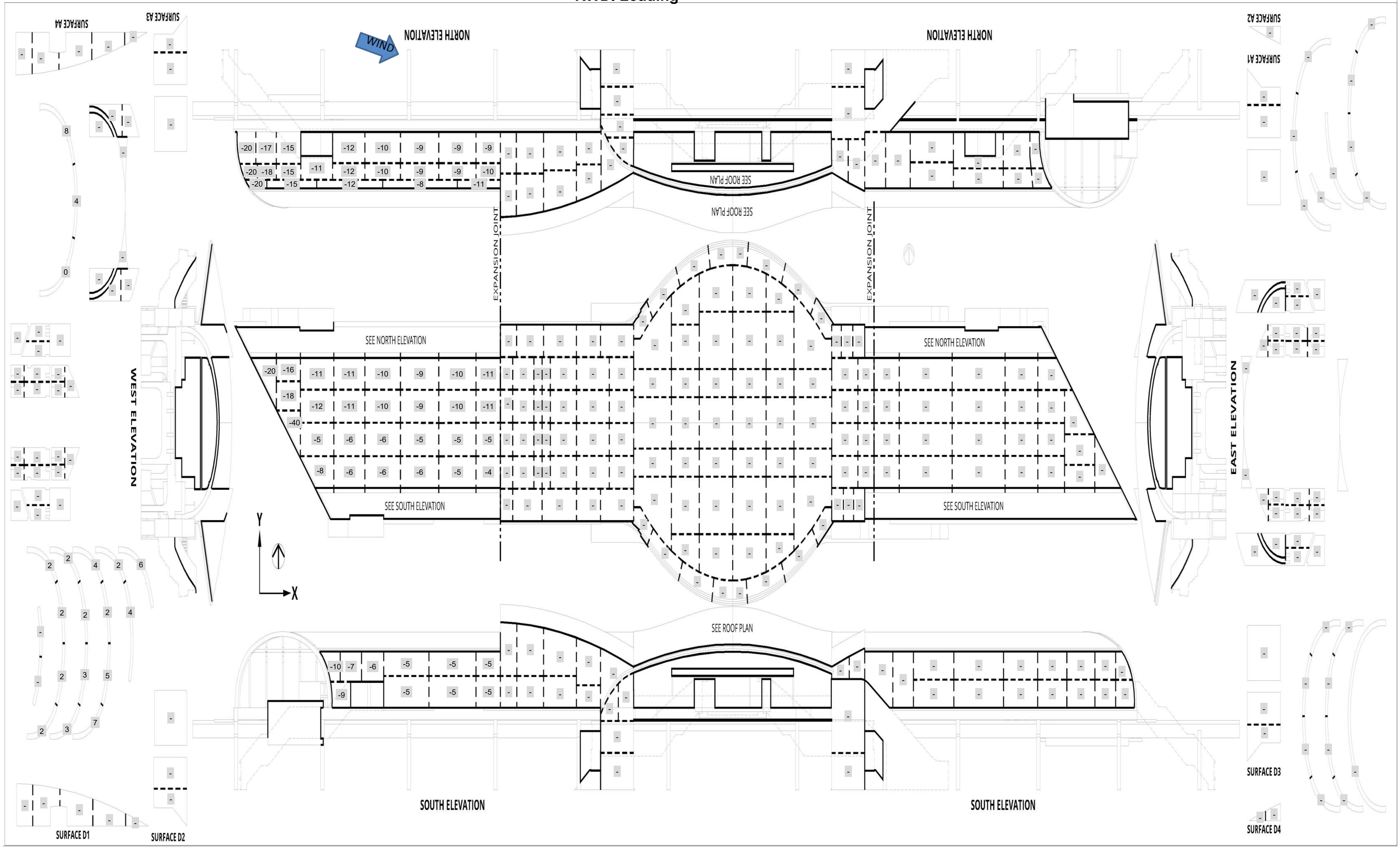
State & Lake (RWDI Project #2100248)
Approximate Key Plan

RWDI Pressures



State & Lake (RWDI Project #2100248)
Load Case : LC1a Struct1 Xdrag Positive
Wind Direction (deg): 290

RWDI Loading



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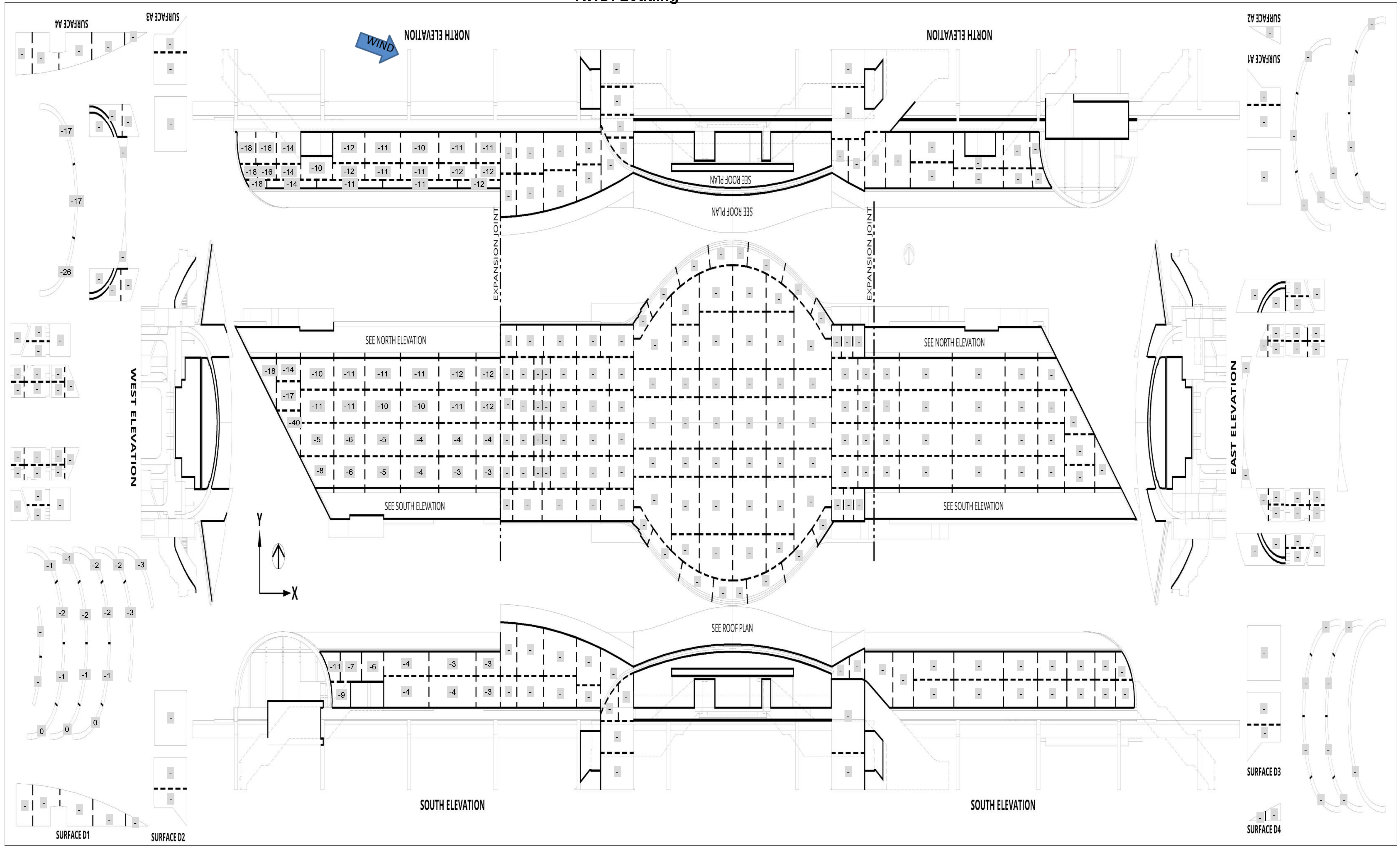
Wind Direction (deg): 290

RWDI Loading



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Wind Direction (deg): 290

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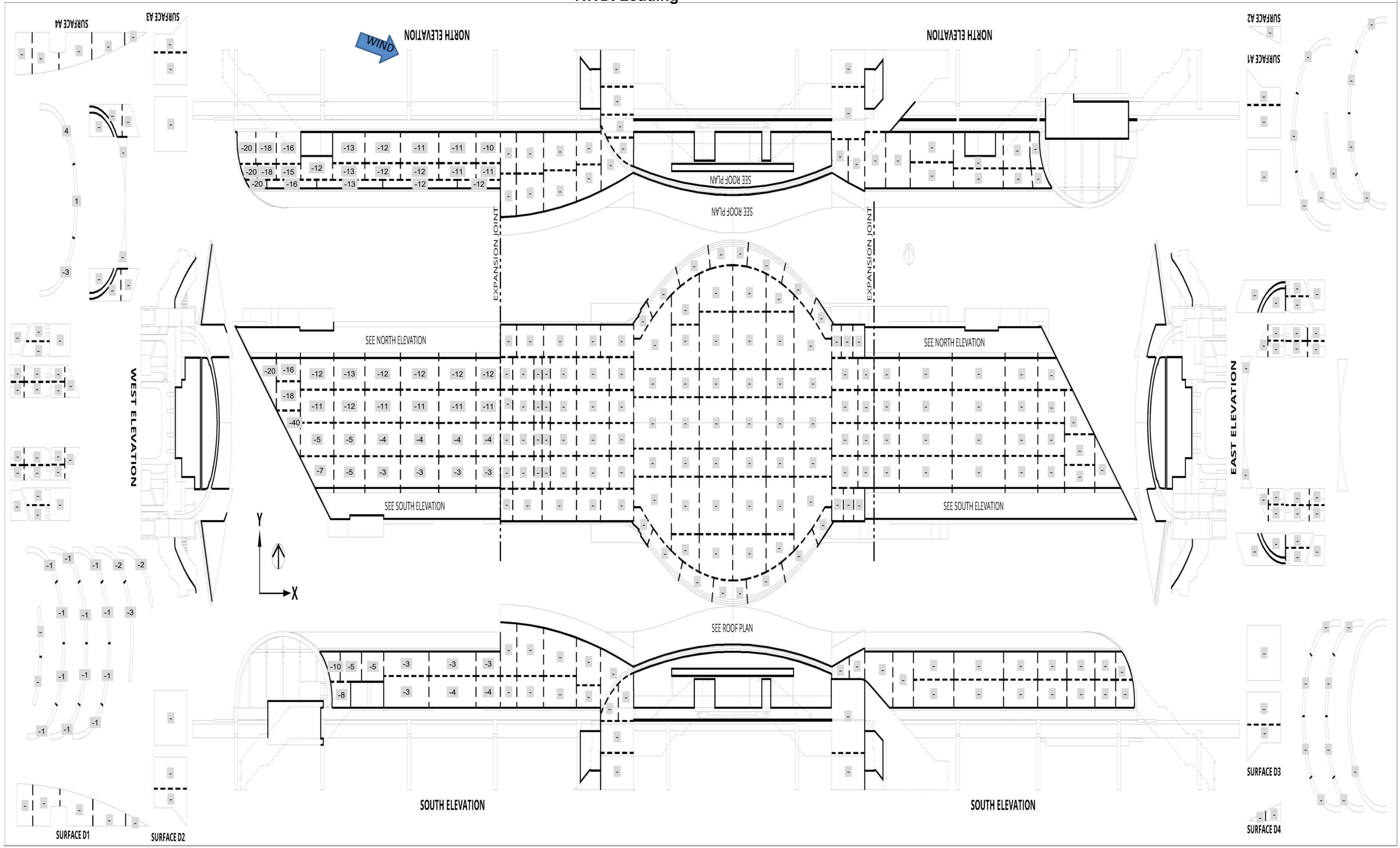

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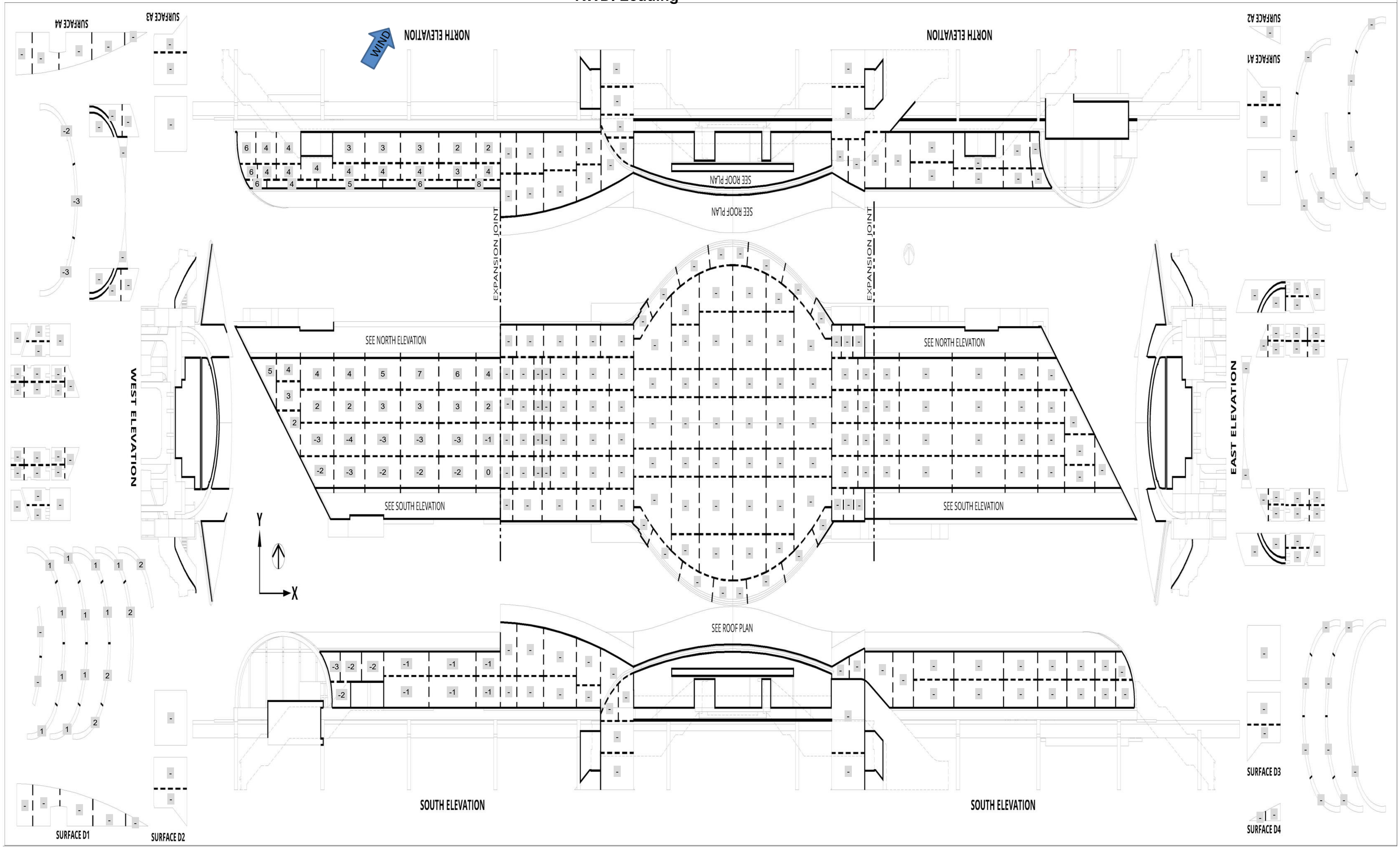
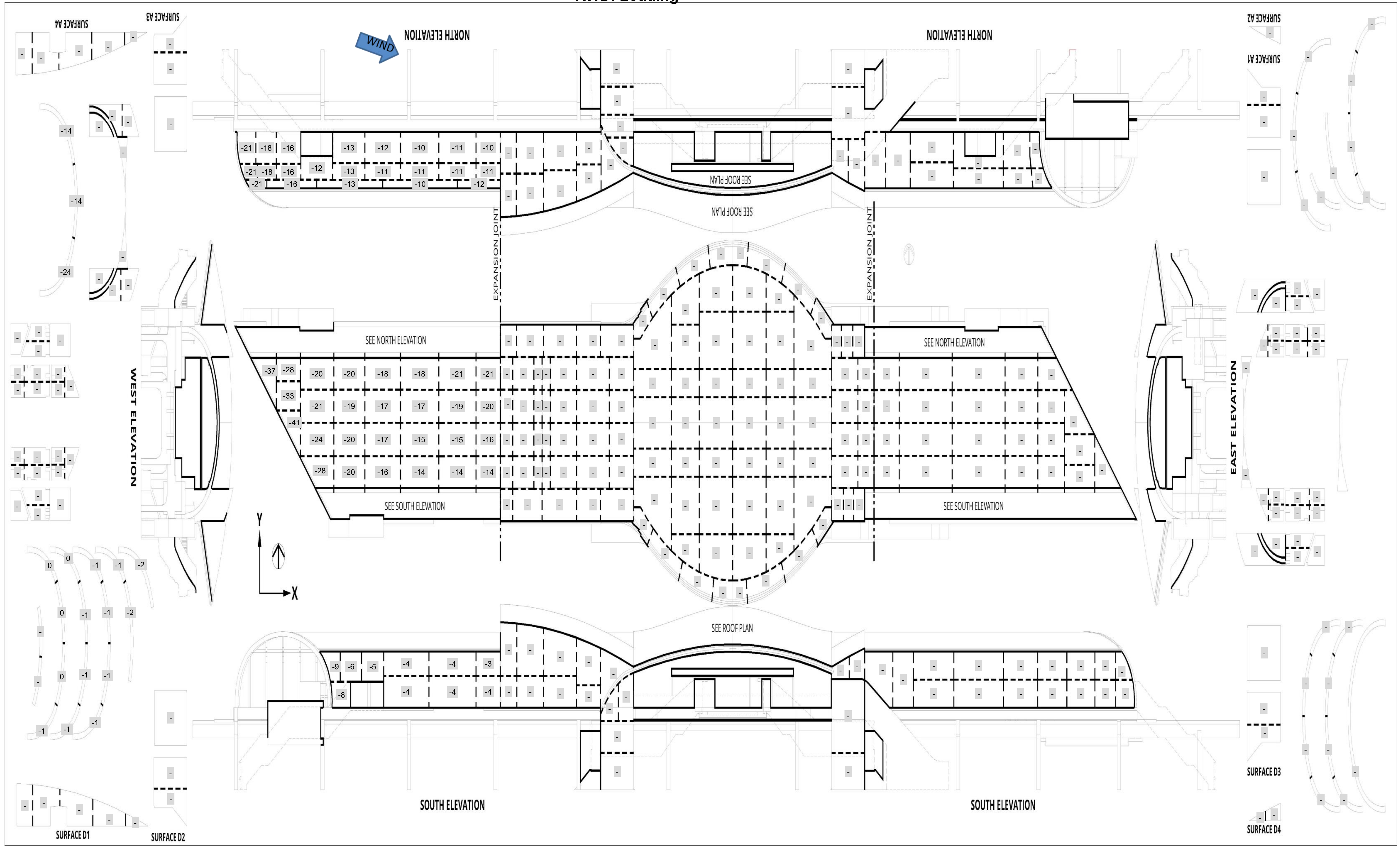
Load Case : LC2b Struct1 Ydrag Negative
Wind Direction (deg): 210

RWDI Loading



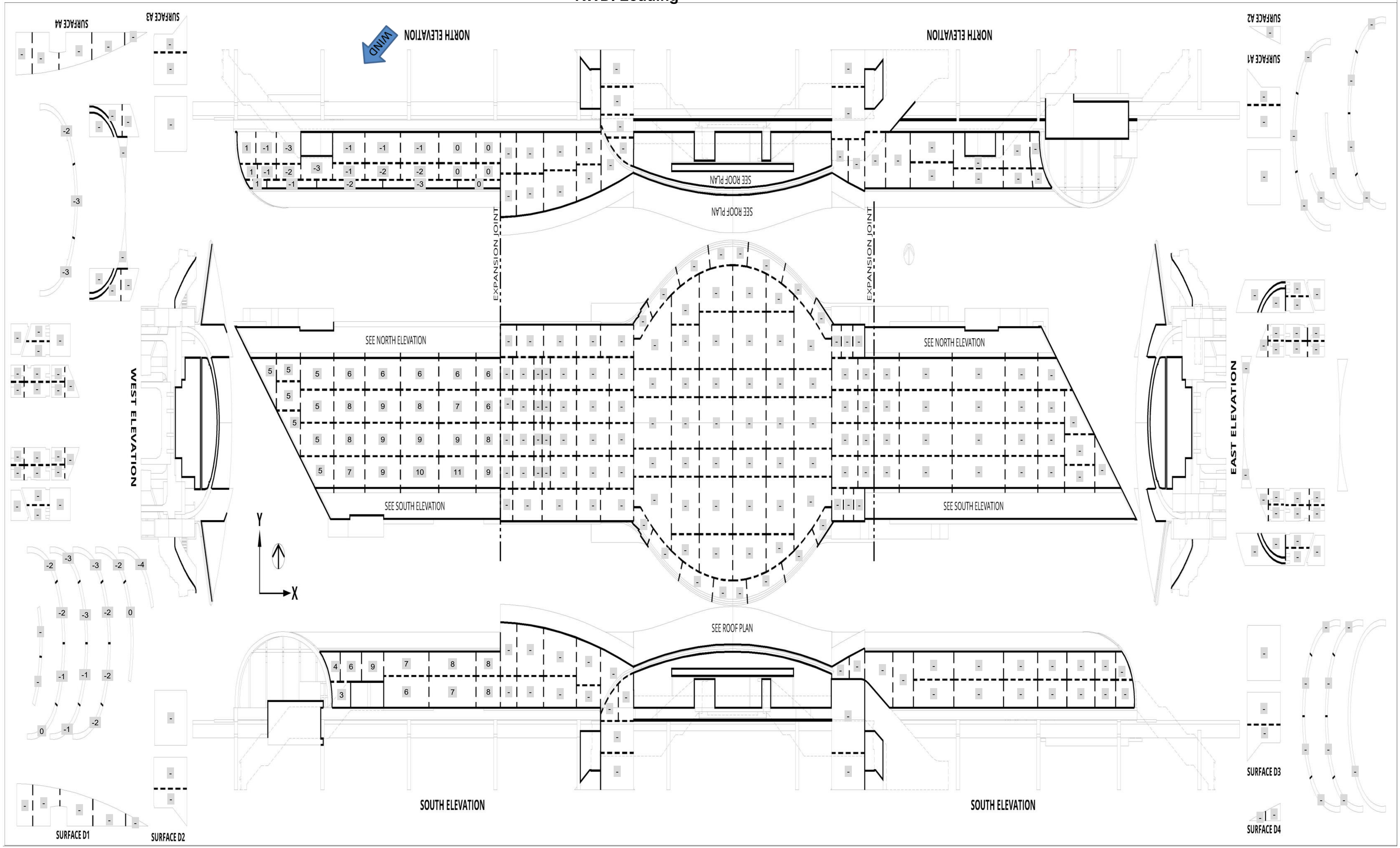
State & Lake (RWDI Project #2100248)
Load Case : LC3a Struct1 Uplift
Wind Direction (deg): 290

RWDI Loading



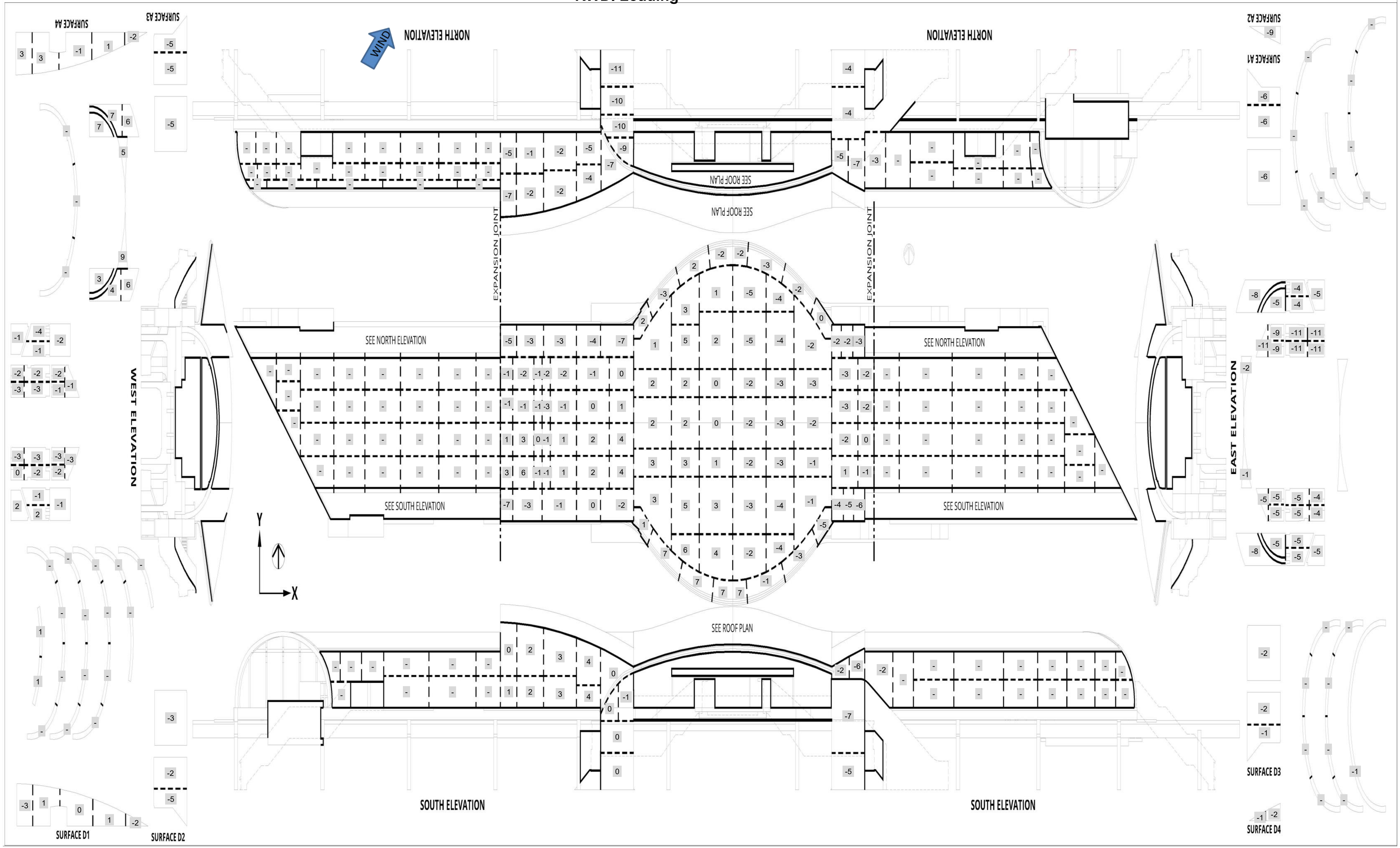
State & Lake (RWDI Project #2100248)
Load Case : LC3b Struct1 Downforce
Wind Direction (deg): 40

RWDI Loading



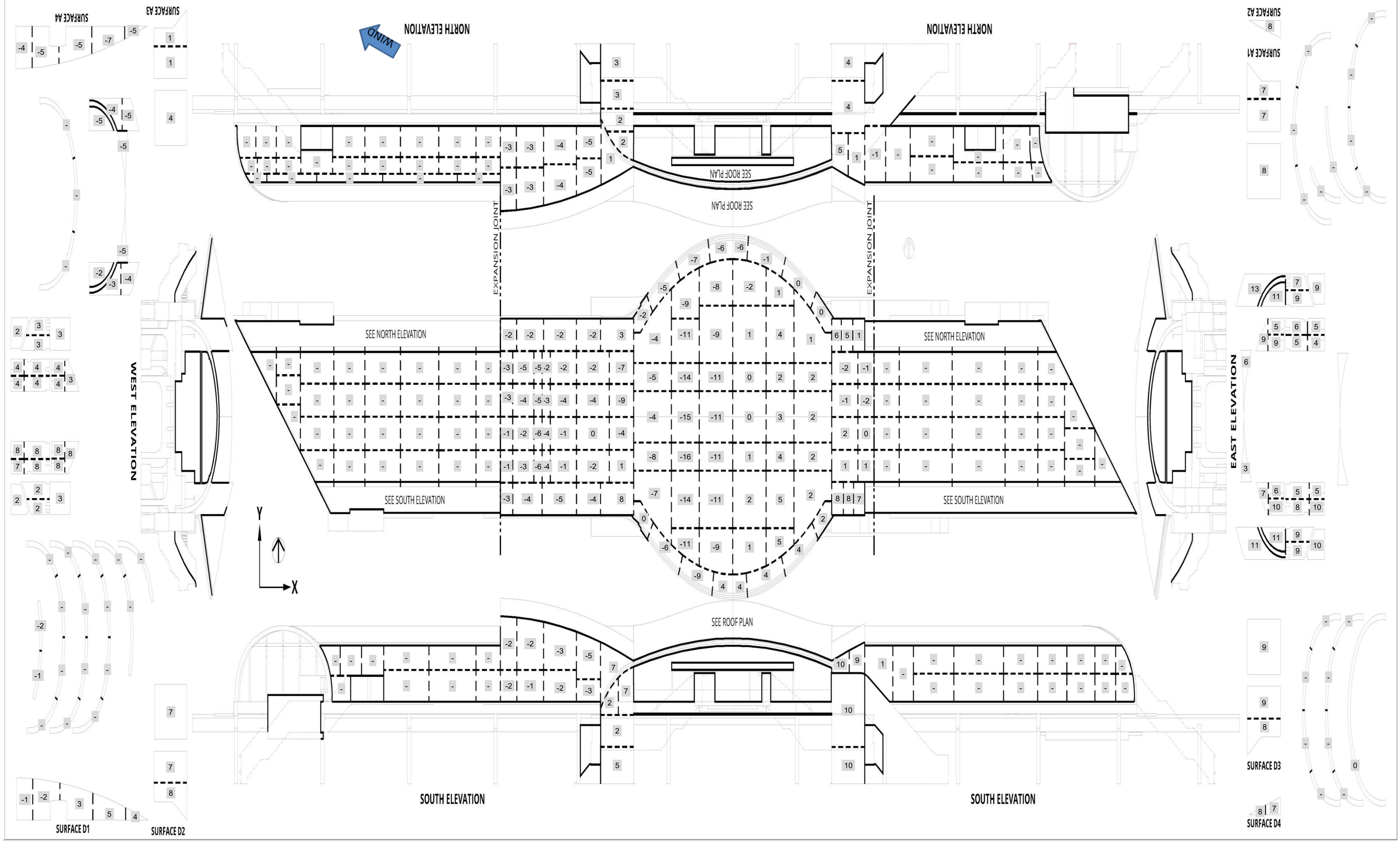
State & Lake (RWDI Project #2100248)
Load Case : LC4a Struct2 Xdrag Positive
Wind Direction (deg): 210

RWDI Loading



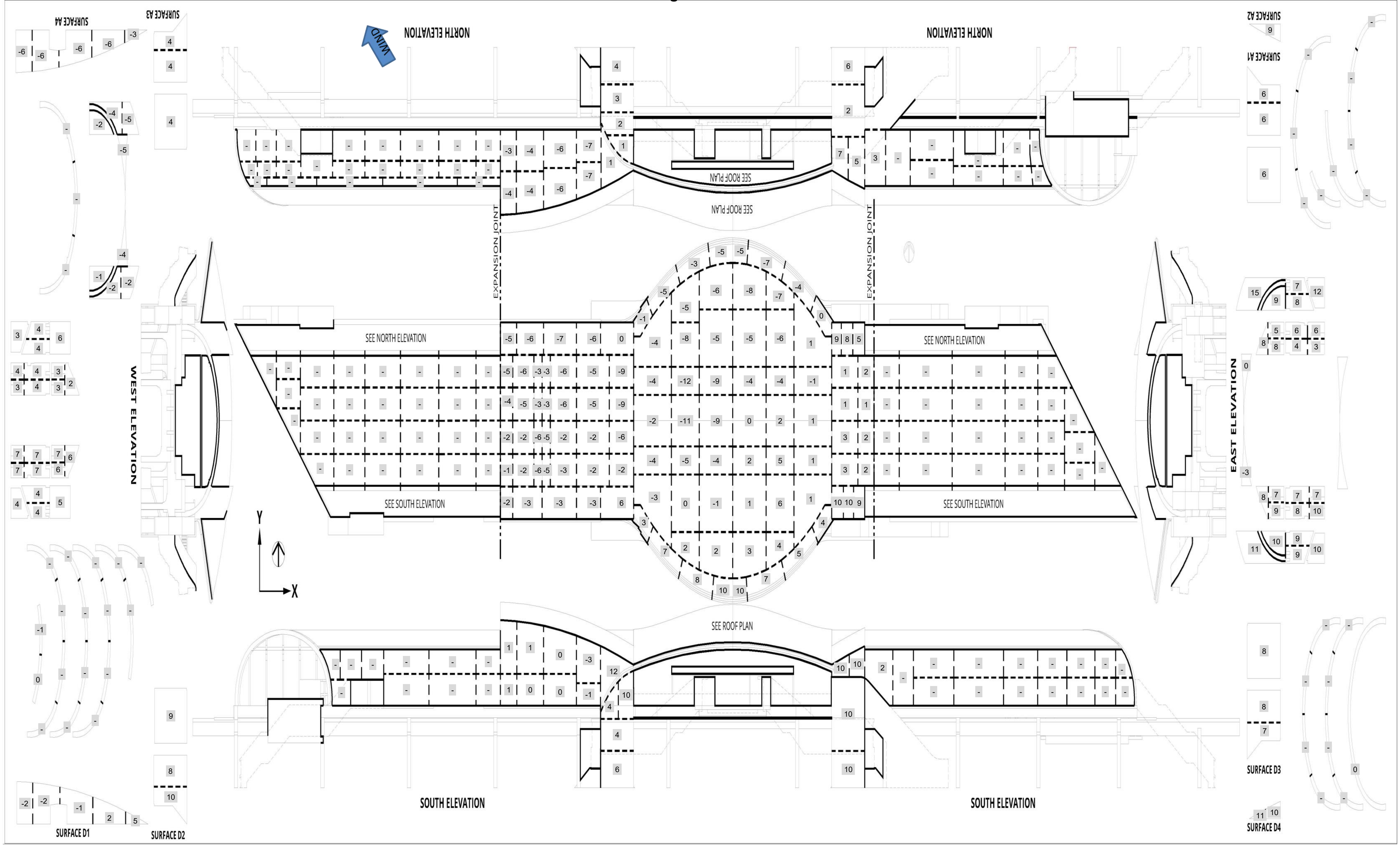
State & Lake (RWDI Project #2100248)
Load Case : LC4b Struct2 Xdrag Negative
Wind Direction (deg): 120

RWDI Loading



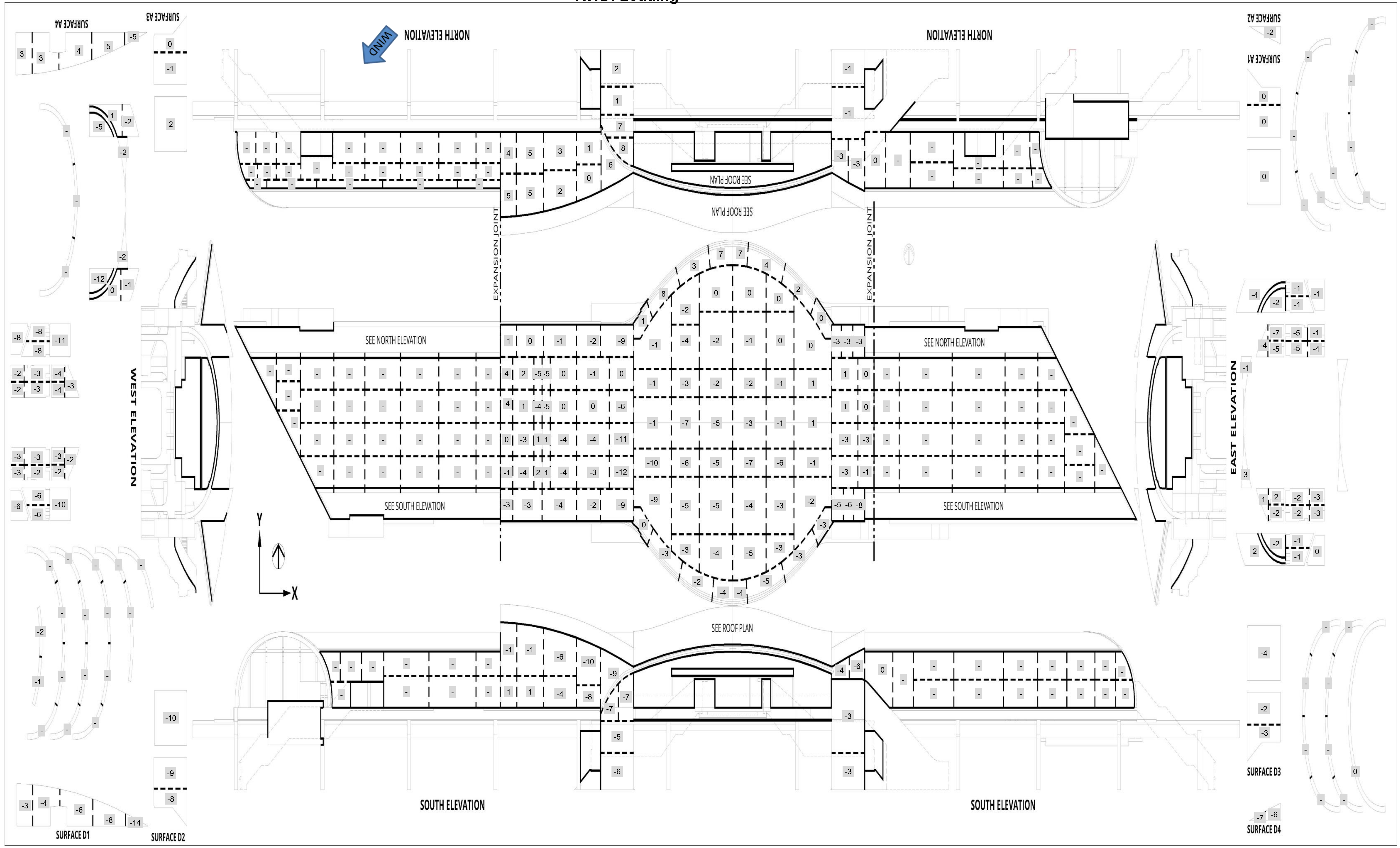
State & Lake (RWDI Project #2100248)
Load Case : LC5a Struct2 Ydrag Positive
Wind Direction (deg): 150

RWDI Loading



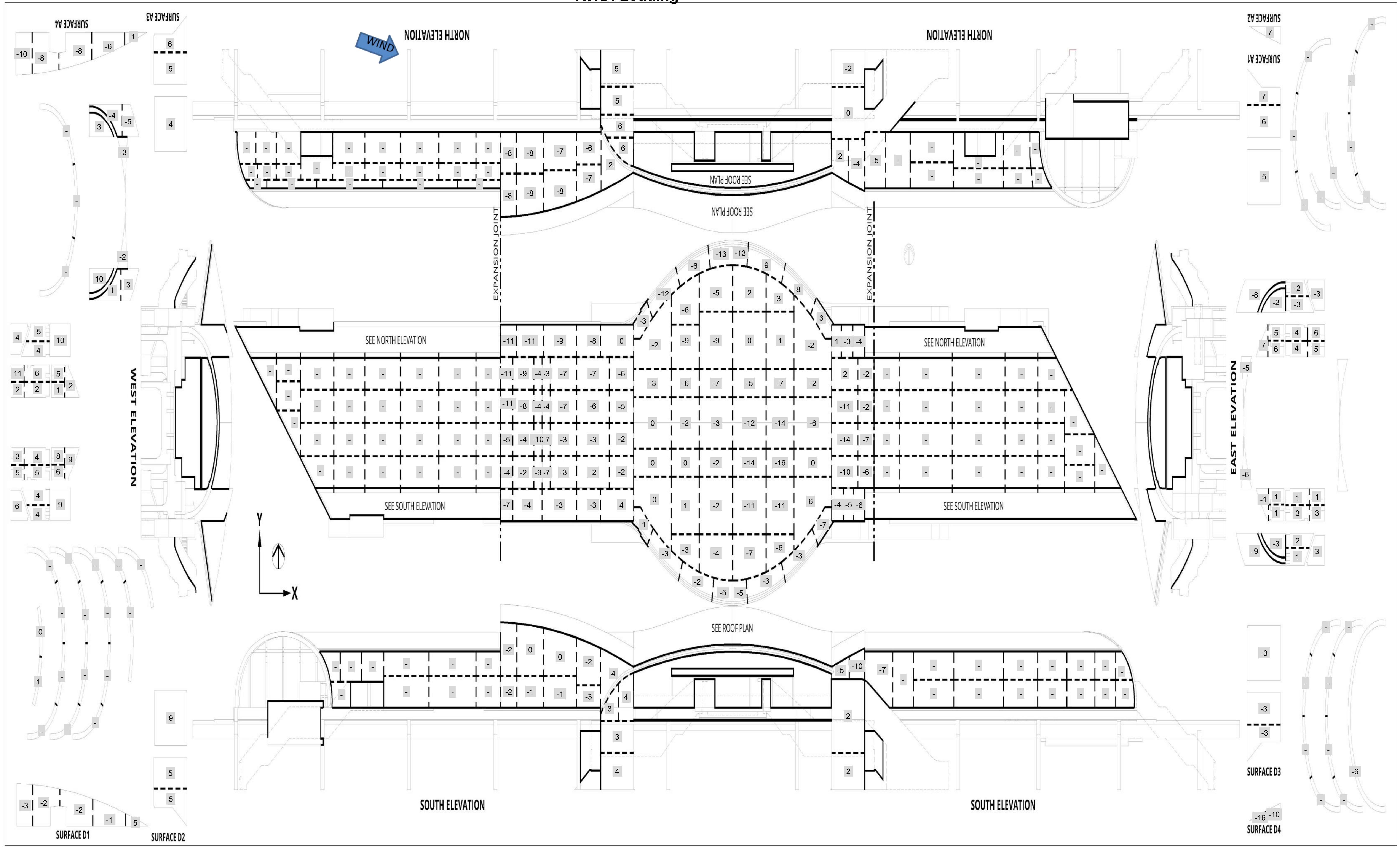
State & Lake (RWDI Project #2100248)
Load Case : LC5b Struct2 Ydrag Negative
Wind Direction (deg): 40

RWDI Loading



State & Lake (RWDI Project #2100248)
Load Case : LC6a Struct2 Y Unbalancein Drag 1
Wind Direction (deg): 290

RWDI Loading



State & Lake (RWDI Project #2100248)
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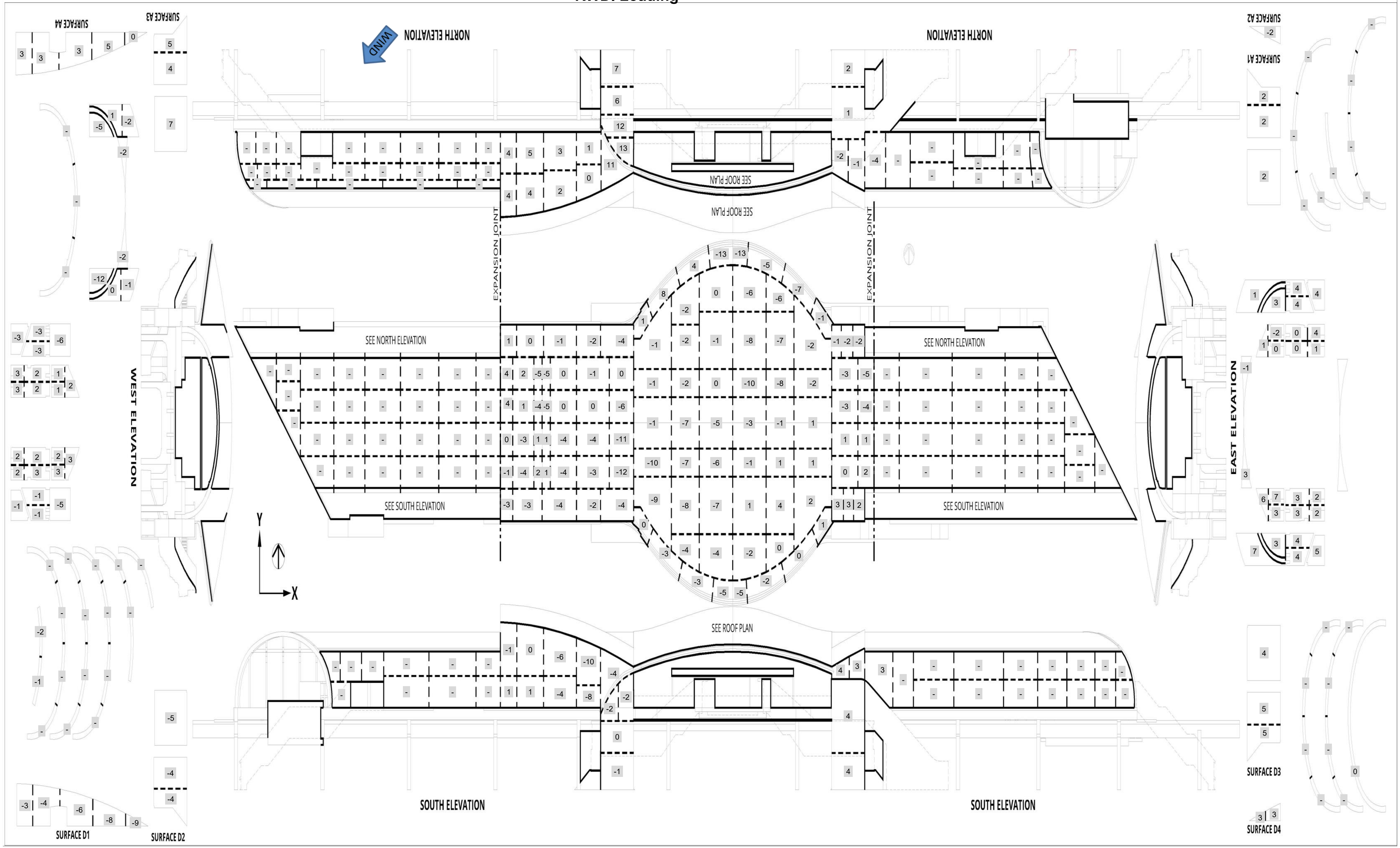
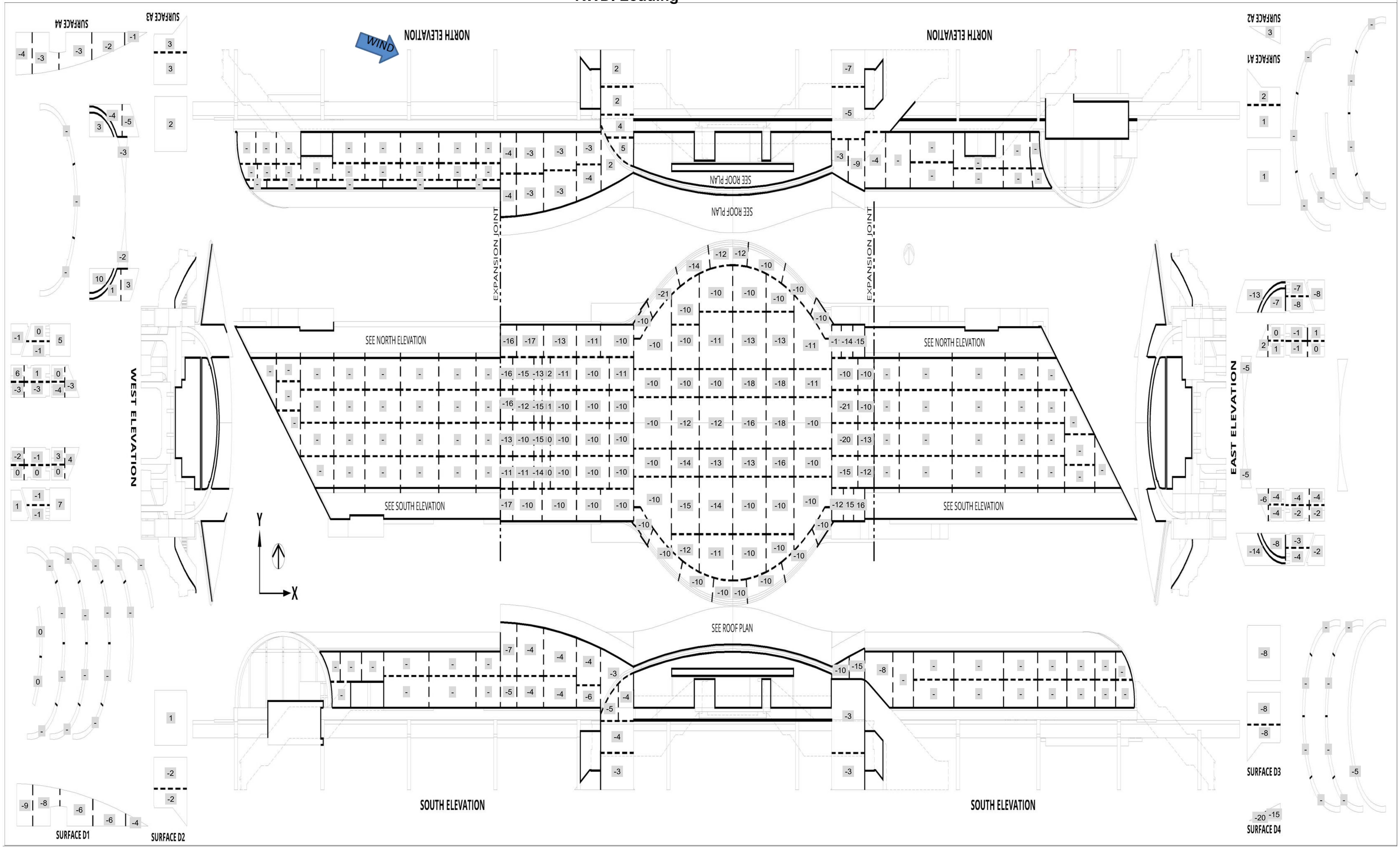
Wind Direction (deg): 40

RWDI Loading



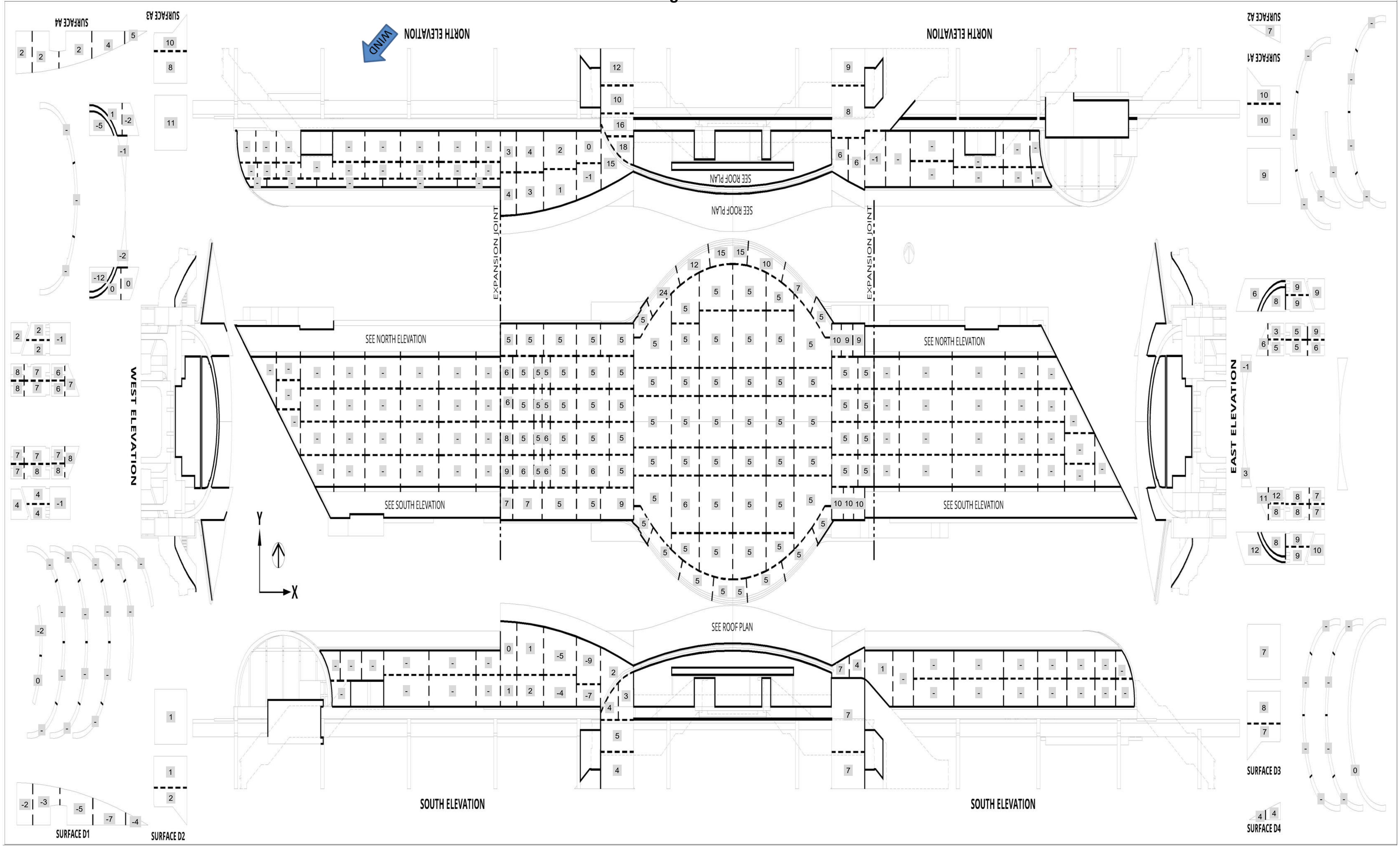
State & Lake (RWDI Project #2100248)
Load Case : LC7a Struct2 Uplift
Wind Direction (deg): 290

RWDI Loading



State & Lake (RWDI Project #2100248)
Load Case : LC7b Struct2 Downforce
Wind Direction (deg): 40

RWDI Loading



State & Lake (RWDI Project #2100248)
Load Case : LC8a Struct3 Xdrag Positive
Wind Direction (deg): 290

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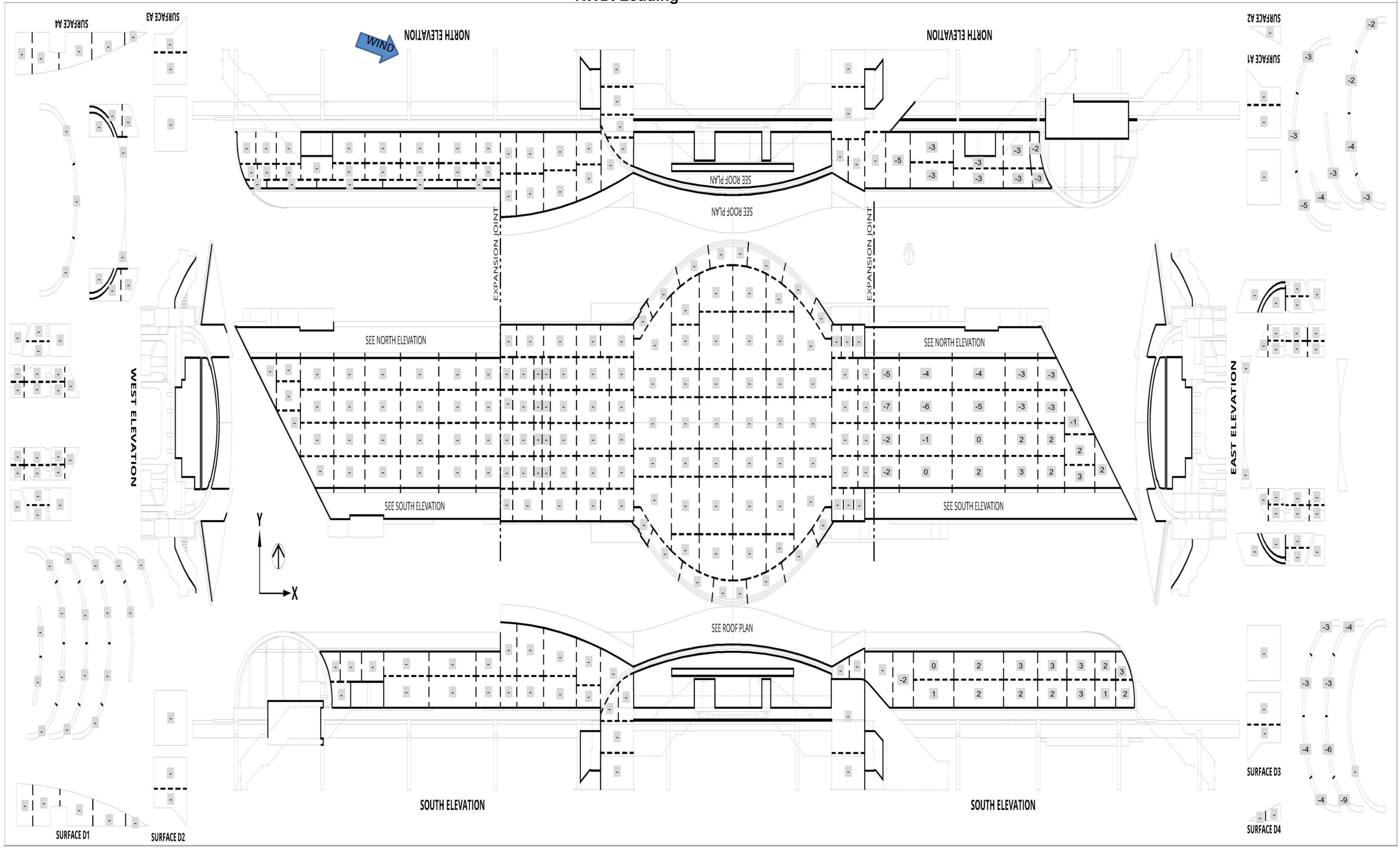
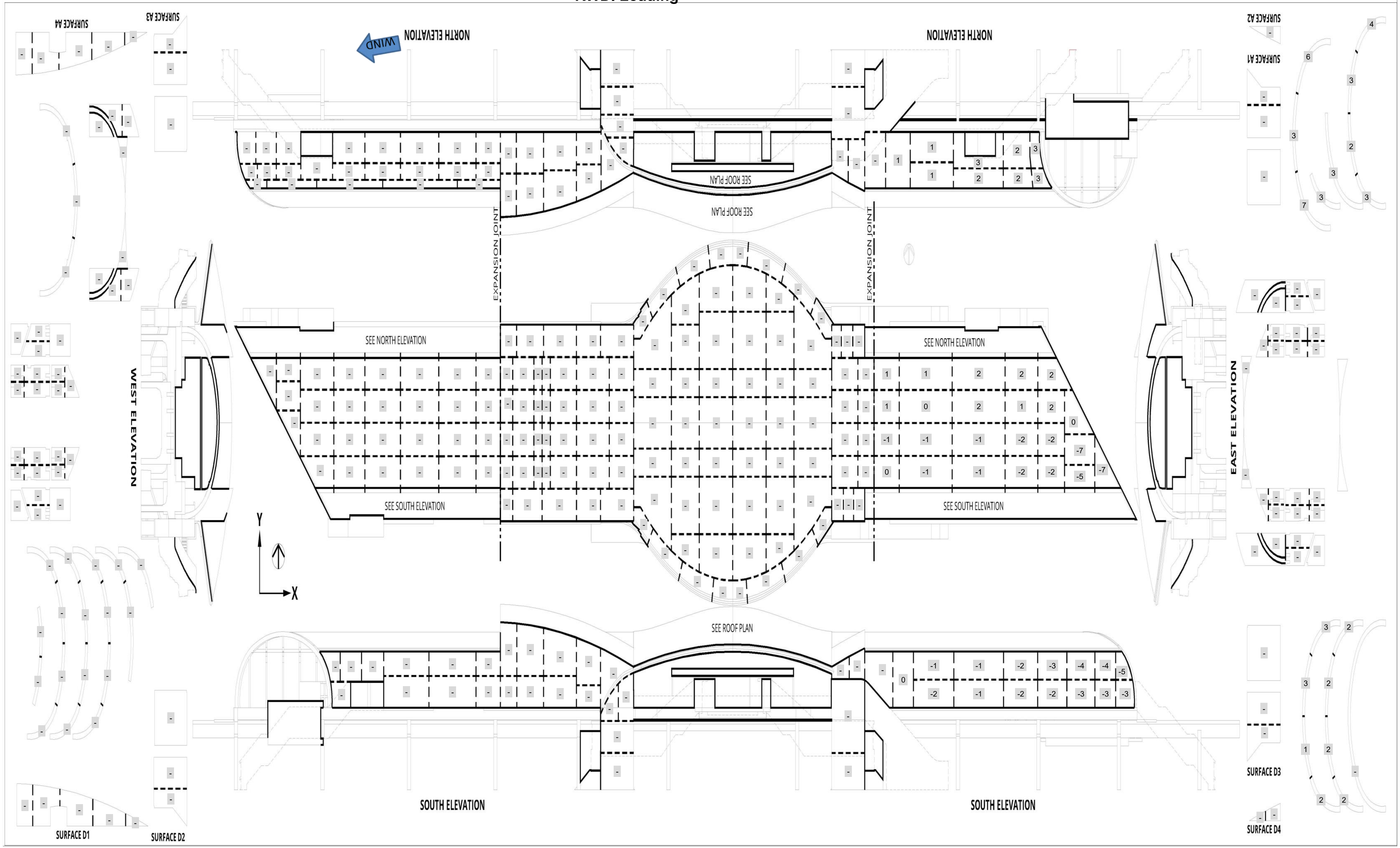


State & Lake (RWDI Project #2100248)
Load Case : LC8b Struct3 Xdrag Negative
Wind Direction (deg): 80

RWDI Loading



State & Lake (RWDI Project #2100248)
Load Case : LC9a Struct3 Ydrag Positive
Wind Direction (deg): 40

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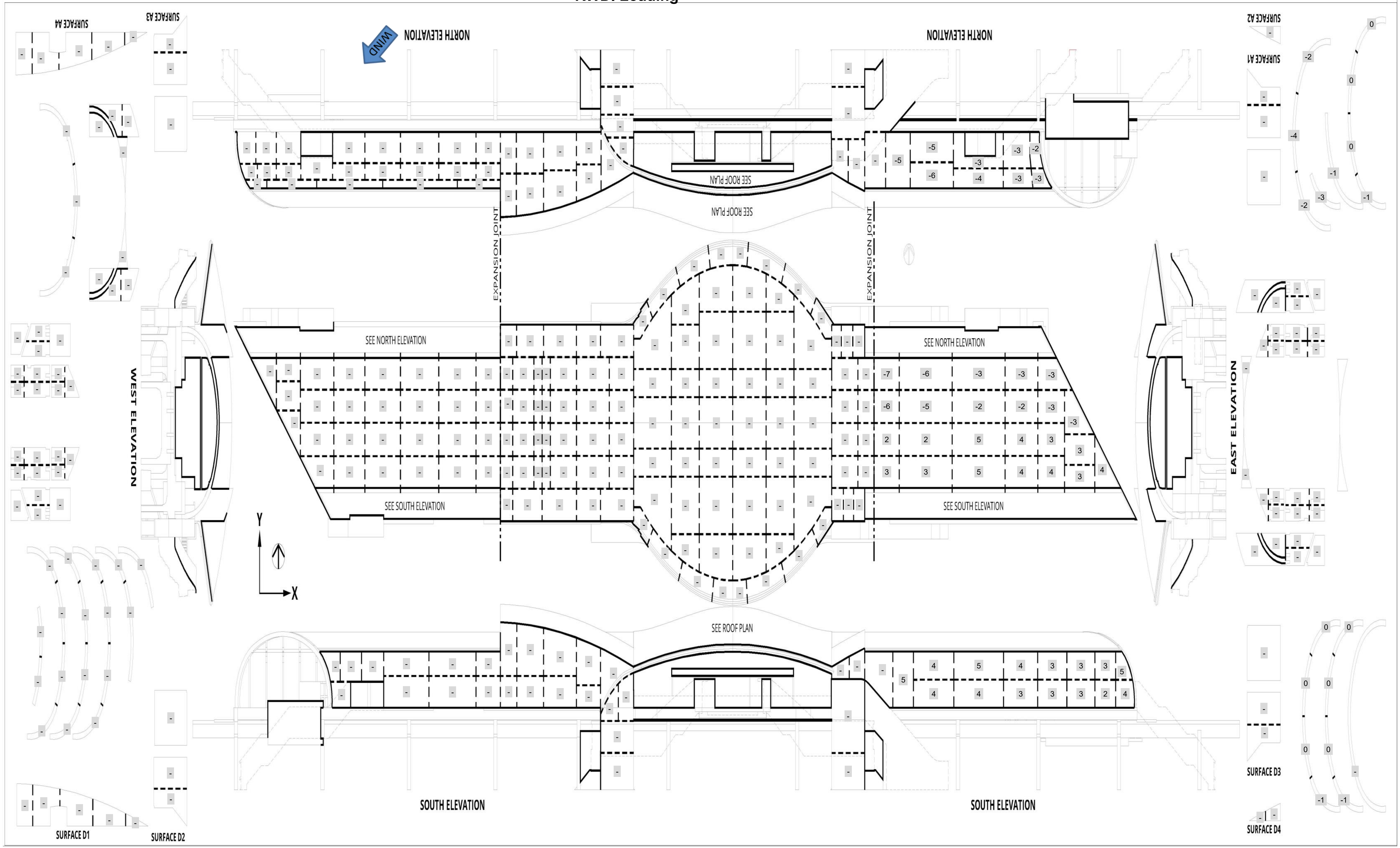

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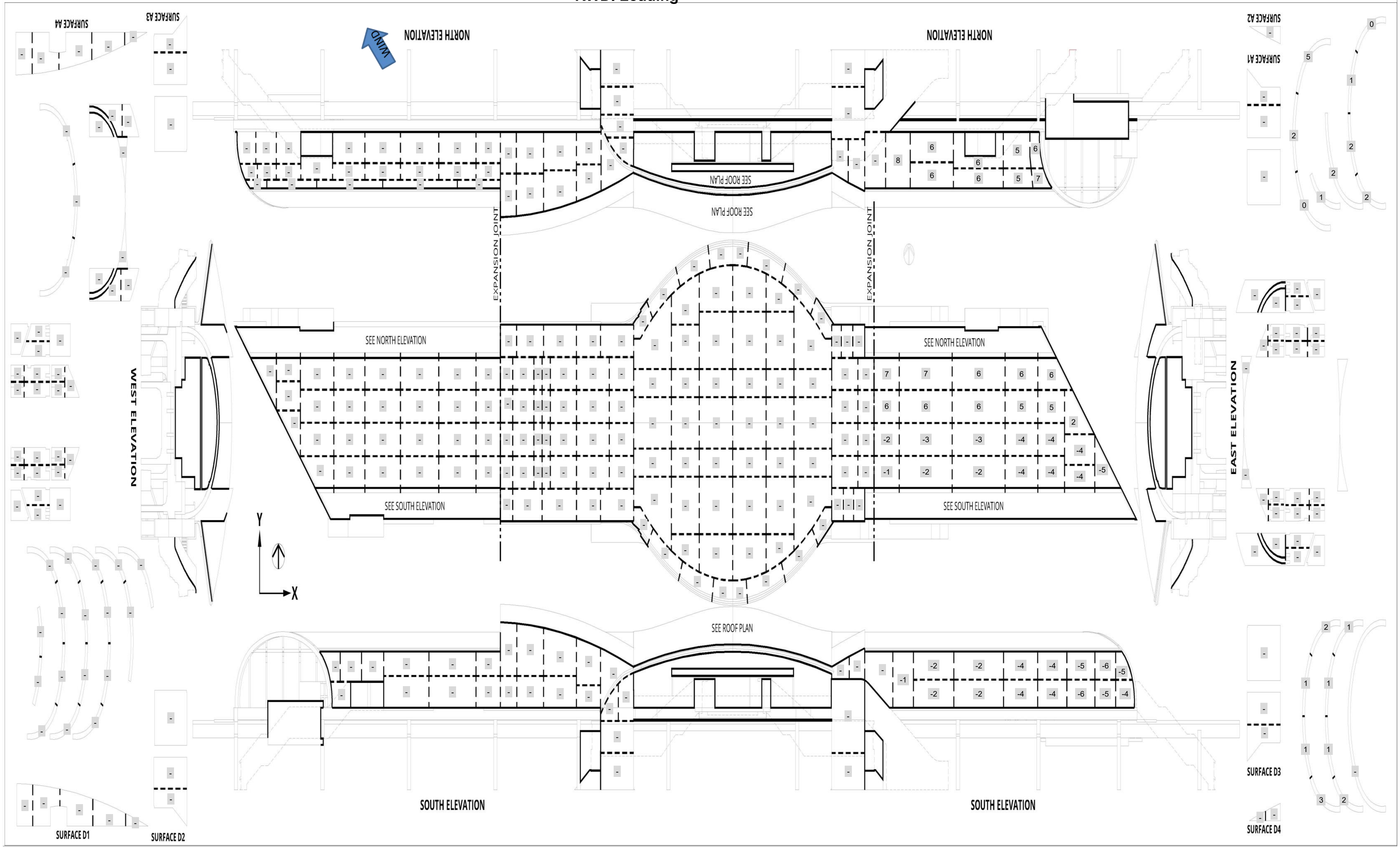
Load Case : LC9b Struct3 Ydrag Negative
Wind Direction (deg): 150

RWDI Loading



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Load Case : LC10a Struct3 Uplift
Wind Direction (deg): 290

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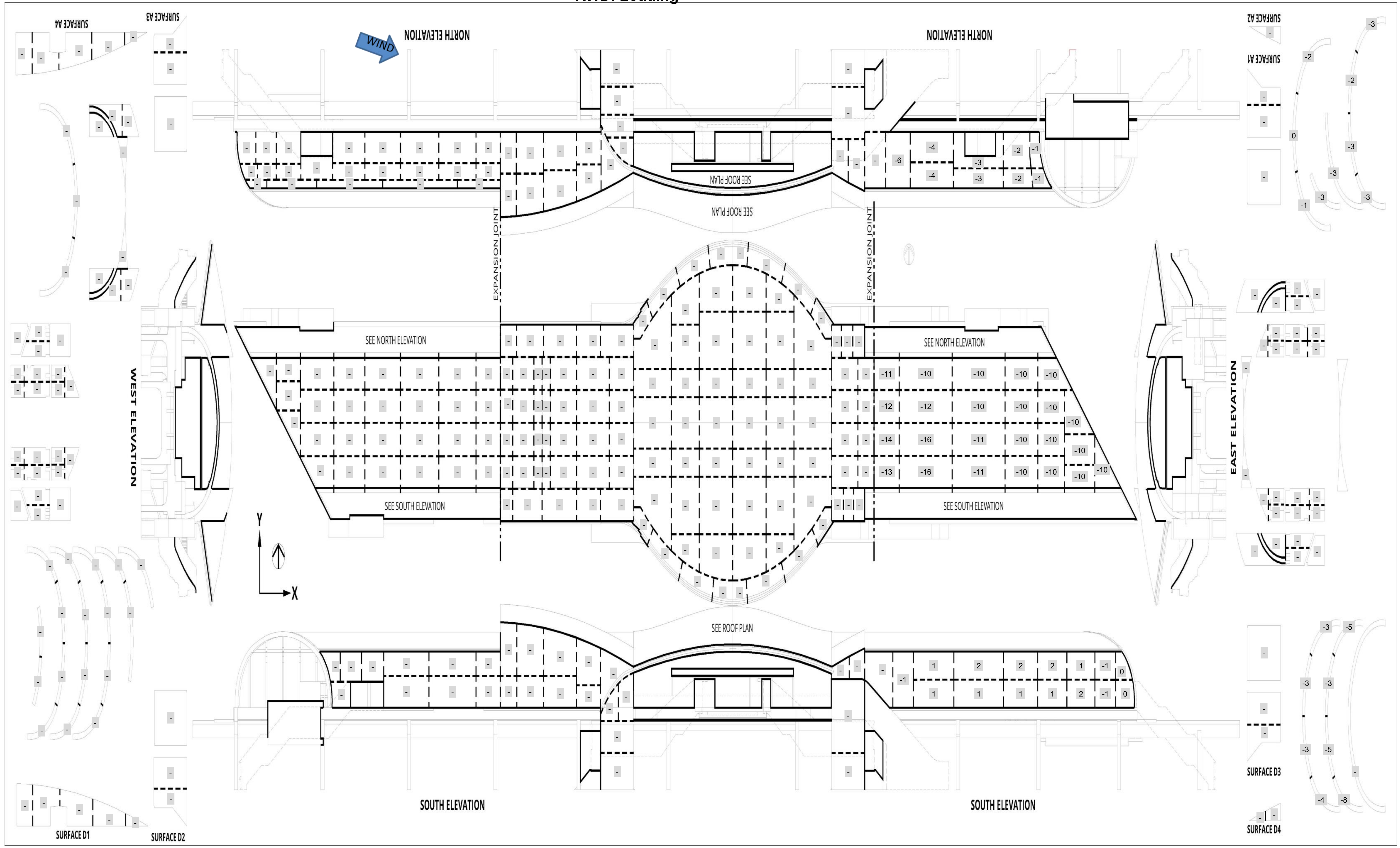

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Load Case : LC10b Struct3 Downforce
Wind Direction (deg): 150

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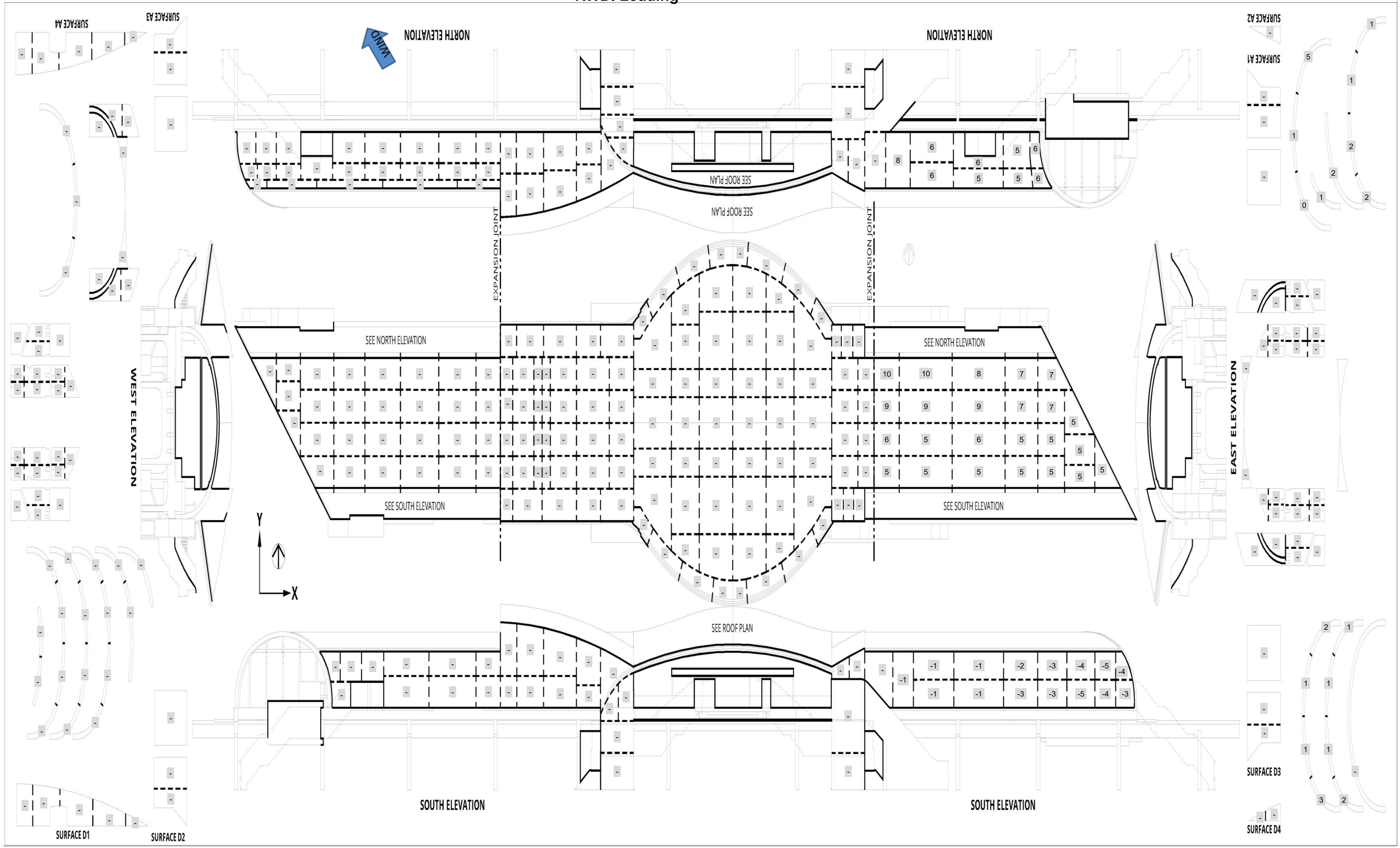
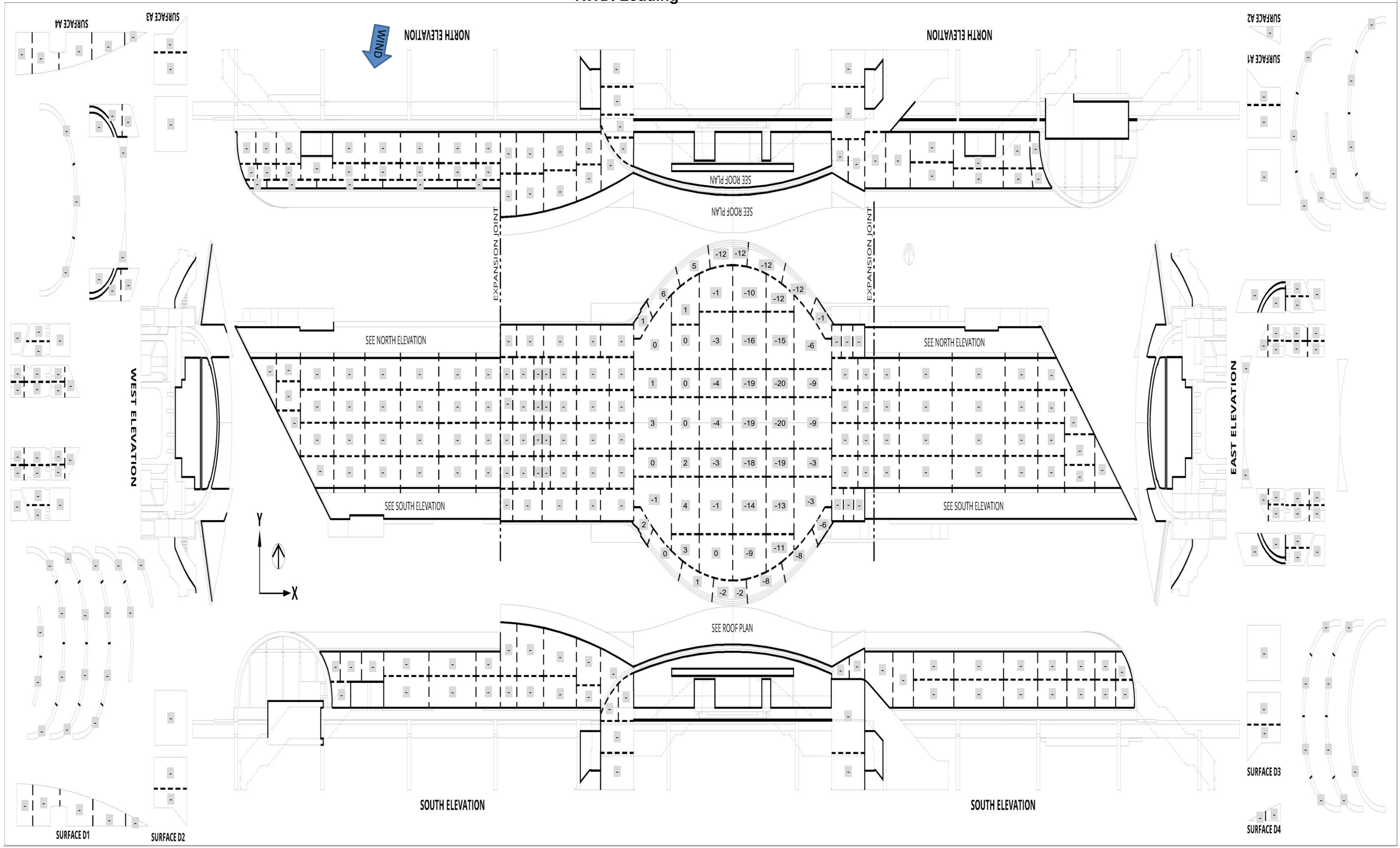


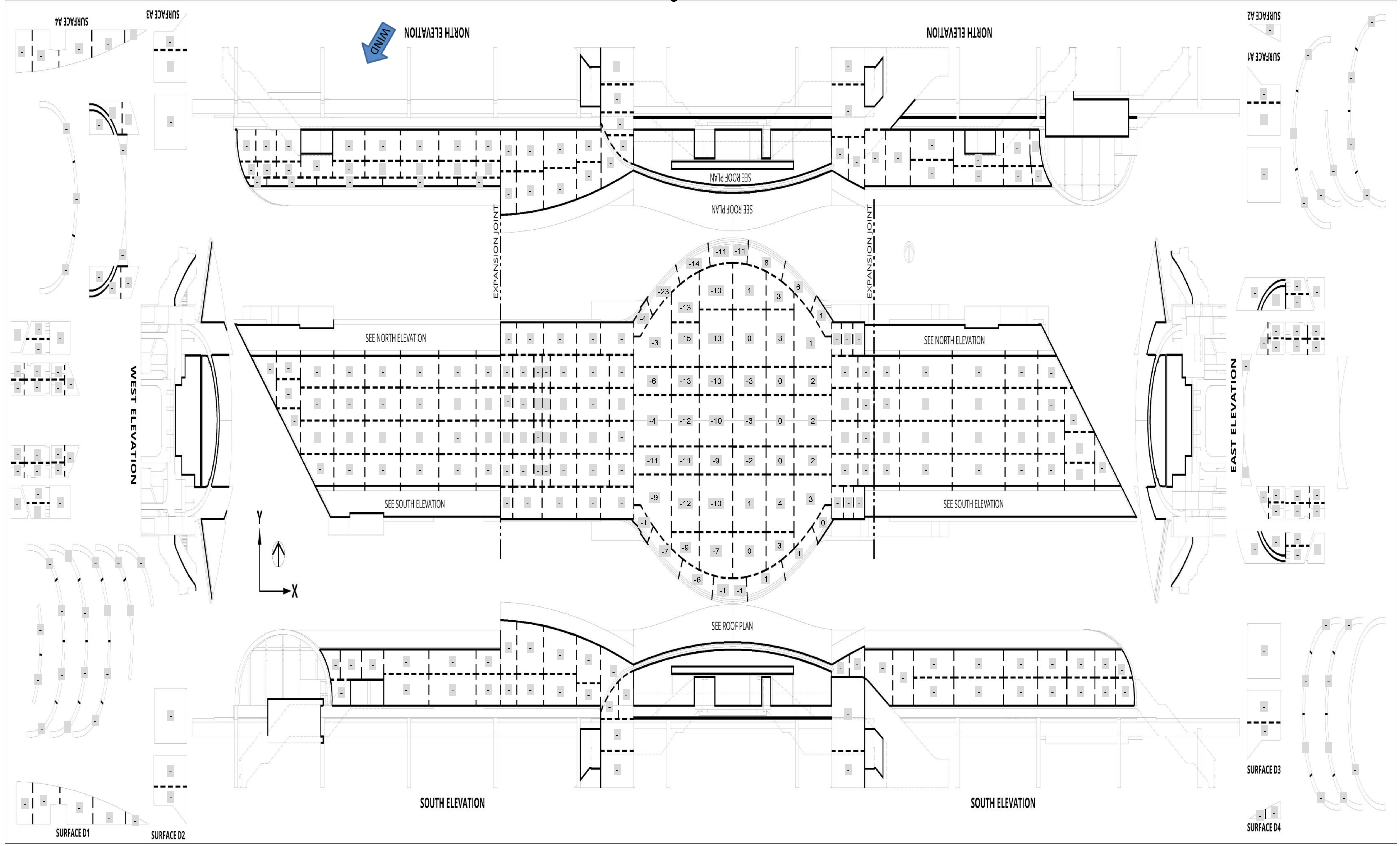
State & Lake (RWDI Project #2100248)
Load Case : LC11a Dome Xdrag Positive
Wind Direction (deg): 10

RWDI Loading



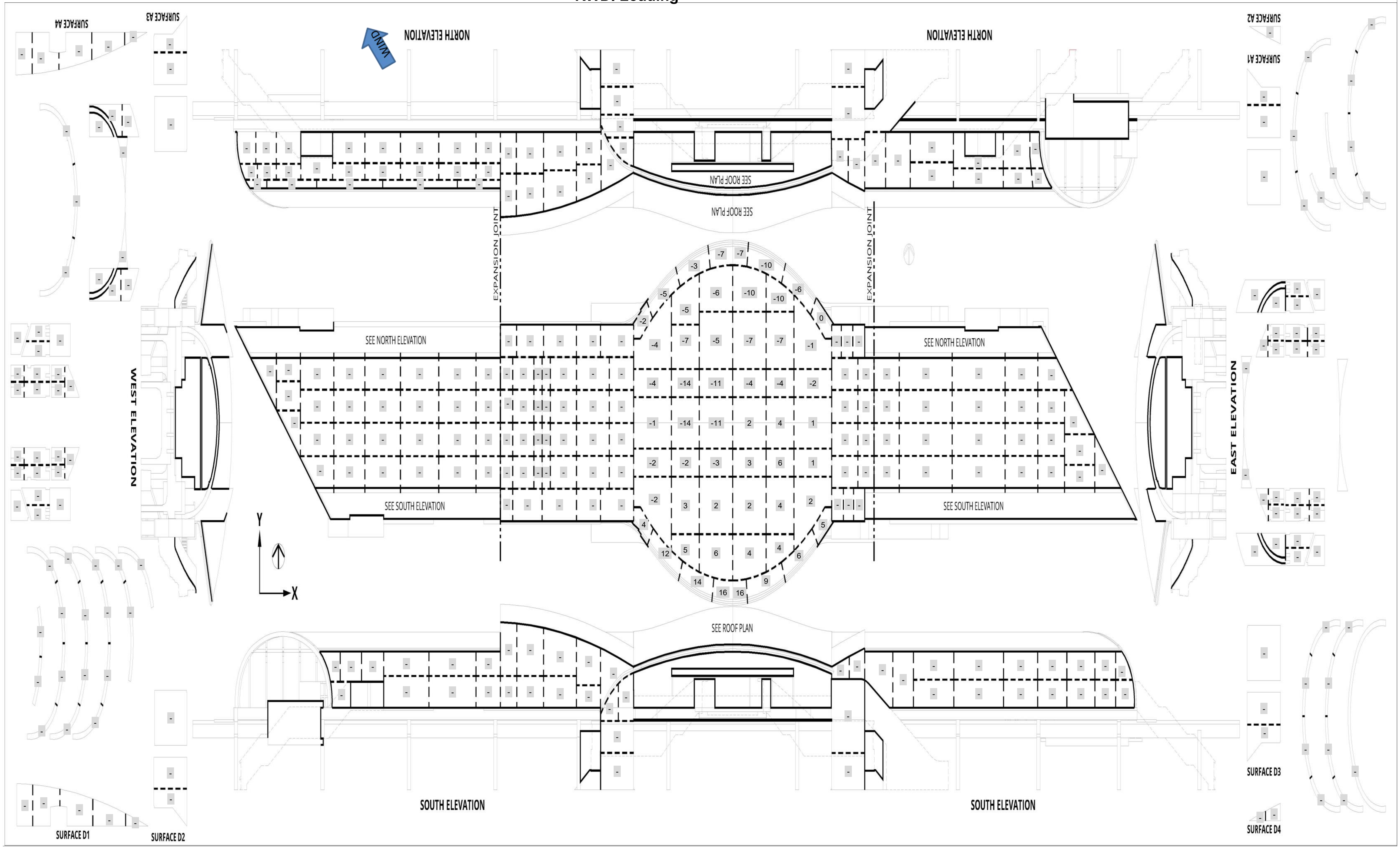
State & Lake (RWDI Project #2100248)
Load Case : LC11b Dome Xdrag Negative
Wind Direction (deg): 30

RWDI Loading



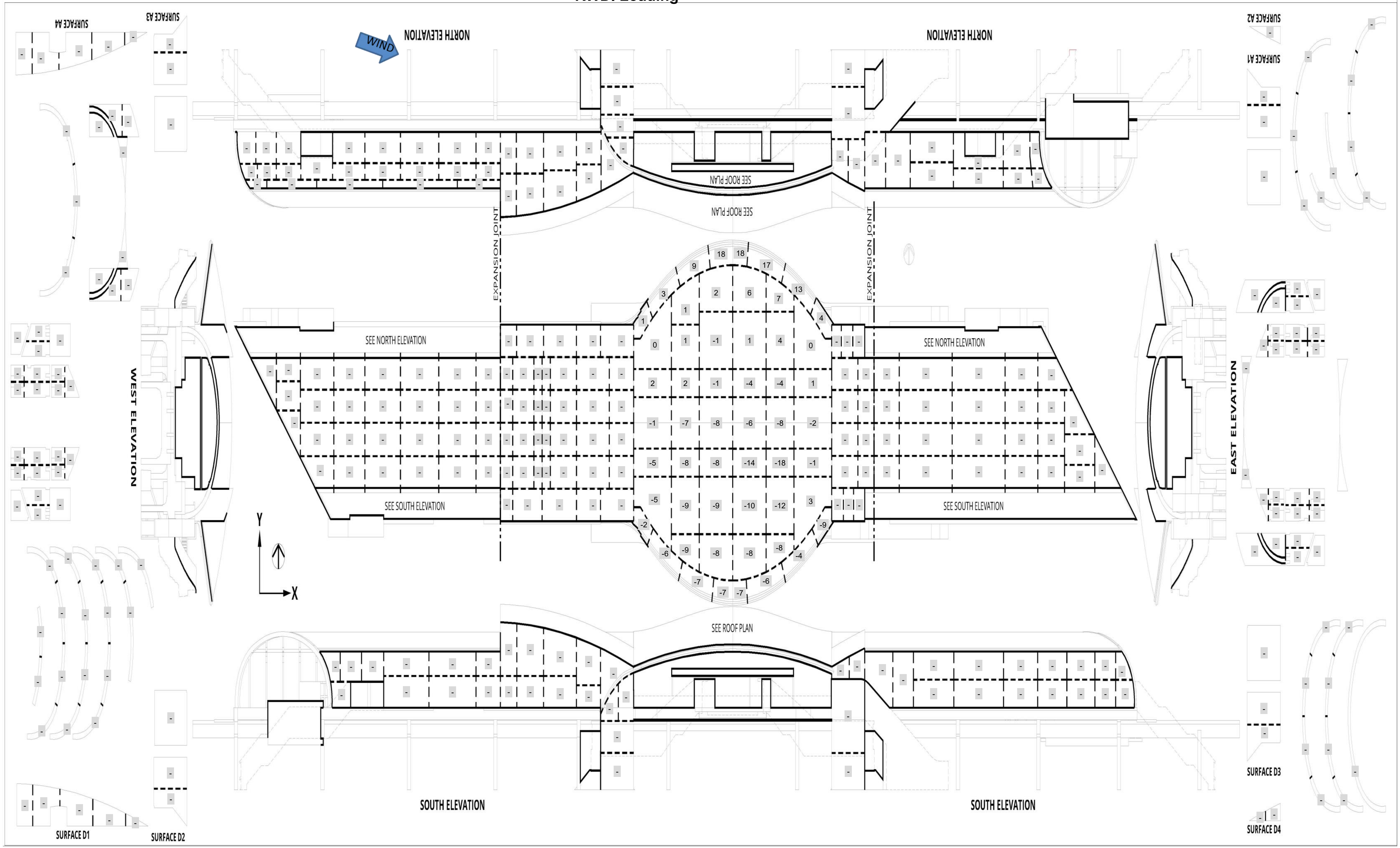
State & Lake (RWDI Project #2100248)
Load Case : LC12a Dome Ydrag Positive
Wind Direction (deg): 150

RWDI Loading



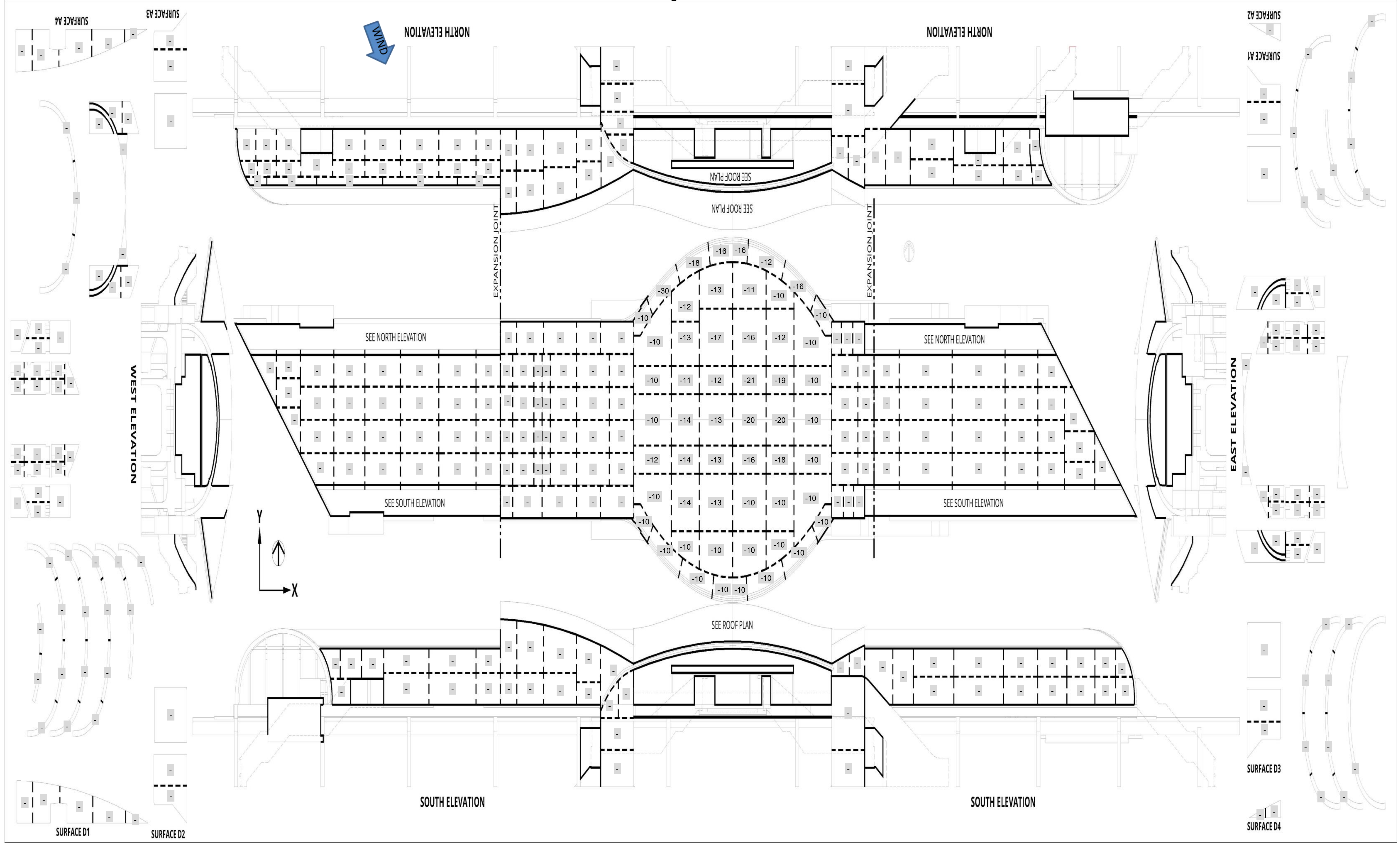
State & Lake (RWDI Project #2100248)
Load Case : LC12b Dome Ydrag Negative
Wind Direction (deg): 290

RWDI Loading



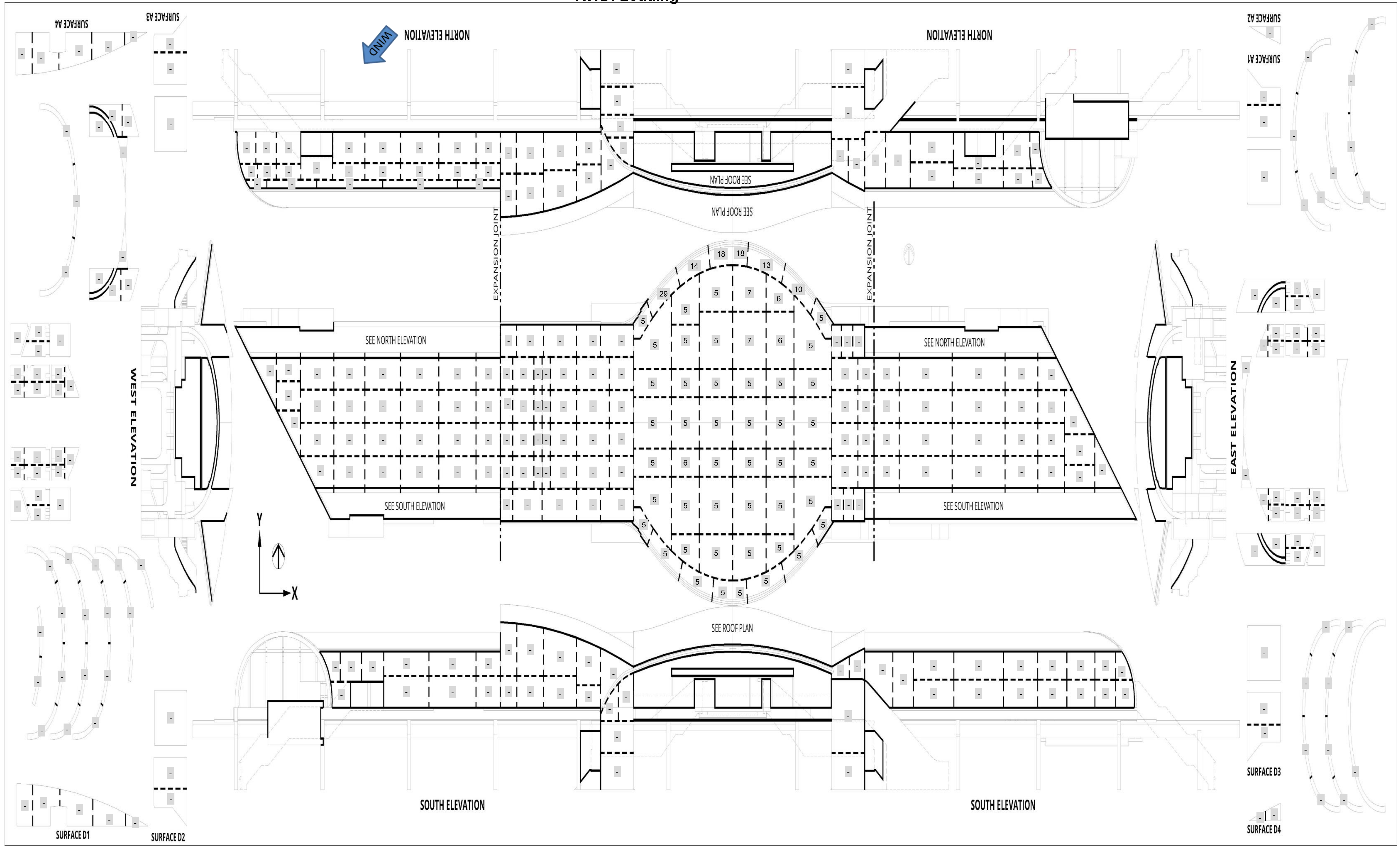
State & Lake (RWDI Project #2100248)
Load Case : LC13a Dome_Down Uplift
Wind Direction (deg): 340

RWDI Loading



State & Lake (RWDI Project #2100248)
Load Case : LC13b Dome_Down Downforce
Wind Direction (deg): 40

RWDI Loading



FINAL REPORT

STATE & LAKE ELEVATED STATION

CHICAGO, ILLINOIS

CLADDING WIND LOAD STUDY

RWDI # 2100248
December 9, 2021

SUBMITTED TO

Bradley Young
PE, SE, Associate Director
bradley.young@som.com

Skidmore, Owings & Merrill
224 South Michigan Avenue,
Chicago, Il 60604
T: 312.360.4646

SUBMITTED BY

Mahshid Nasiri, Ph.D.
Technical Coordinator
Mahshid.Nasiri@rwdi.com

Jingwen Cao, B.A.Sc.
Technical Coordinator
Jingwen.Cao@rwdi.com

Will Yakymyk, M.A.Sc.
Technical Director / Associate
Will.Yakymyk@rwdi.com

Kelly Baah, M.Eng., P.Eng.
Project Manager
Kelly.Baah@rwdi.com

RWDI
600 Southgate Drive
Guelph Ontario Canada N1G 4P6
T: 519.823.1311
F: 519.823.1316

EXECUTIVE SUMMARY

RWDI was retained to assess the wind loads for the design of the exterior envelope of the proposed State & Lake Elevated Station in Chicago, IL.

Key Points

- The wind tunnel test procedures met or exceeded the requirements set out in the ASCE 7-16 and ASCE 49.
- A Basic wind speed of 114 mph 3-second gust at 33 ft height in open terrain has been adopted for wind loading predictions. All predictions were derived using a statistical wind climate model developed for the area.
- Recommended cladding design wind pressures are provided in Figures 4 to 11.
- The wind pressures provided in this report have been factored to be consistent with an Allowable Stress Design approach. The pressures presented are equivalent to 0.6W in Section 2.4 of ASCE 7.
- The largest recommended negative cladding wind pressure was -35 psf, which occurred on Surface C4 of the East Elevation (Figure 5). The majority of the negative wind pressures were in the range of -10 psf to -25 psf.
- The largest recommended positive cladding wind pressure was +30 psf, which occurred on Surface A4 of the North Elevation (Figure 8). The majority of the positive wind pressures were in the range of +10 psf to +15 psf.
- The recommended cladding wind pressures are in line with expectations based on RWDI's experience of tests on similar structures.
- The recommended design wind pressures either include an internal pressure allowance or represent the instantaneous differential pressures across protruding elements exposed to wind on opposite sides.
- RWDI's recommended cladding design wind pressures do not go below a minimum of ±10 psf, with the exception of +10 psf and -20 psf minimums on roof areas which include the entire curved surfaces of the platforms and main station dome canopies. These minimum pressure allowances are compliant with Clause 31.4 of ASCE 7, which specifies limits on how much reduction is permissible in the loading when compared to the analytical methods in Chapter 30. Per ASCE 7, the cladding design wind pressures are not to be less than 80% of the Zone 4 (walls) and Zone 1 (roof) values.
- The design wind pressures in this report may be combined with appropriate tributary area reduction factors provided in Image 2 from Section 3.4.

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Recommended Wind Loads for Cladding Design, Peak Negative Pressures

Recommended Wind Loads for Cladding Design, Peak Positive Pressures

LIST OF APPENDICES

1 INTRODUCTION

Rowan Williams Davies & Irwin Inc. (RWDI) was retained to assess the wind loads for the design of the exterior envelope of the proposed State & Lake Elevated Station in Chicago, IL. This report presents the project objectives, background, approach, and provides a discussion of the results from RWDI's assessment. A summary of the overall recommendations from the assessment is presented in the Executive Summary.

1.1 Project Description

The proposed project involves re-build of the elevated Chicago Transit Authority (CTA) station located at the intersection of State Street and Lake Street, in downtown Chicago.

1.2 Objectives

The objective of this assessment was to determine the wind loads for design of the exterior envelope of the structure, including the cladding, components, and secondary cladding systems.

2 BACKGROUND AND APPROACH

2.1 Methodology

Appendix A provides additional background information on the testing and analysis procedures for this type of assessment.

2.1.1 Study Model and Surroundings

A 1:100 scale model of the proposed development was constructed using the architectural drawings listed in Appendix B. The model was instrumented with pressure taps and was tested in the presence of all surroundings within a full-scale radius of 1200 ft, in RWDI's 12 ft × 7 ft boundary-layer wind tunnel facility in Guelph, Ontario, Canada.

Photographs of the scale model in the boundary layer wind tunnel are shown in Figure 1. An orientation plan showing the study site and immediate surroundings is given in Figure 2.

2.1.2 Simulation of Upwind Terrain

Beyond the modeled area, the influence of the upwind terrain on the planetary boundary layer was simulated in the testing by appropriate roughness on the wind tunnel floor and flow conditioning spires at the upwind end of the working section for each wind direction. This simulation, and subsequent analysis of the data from the model, represented terrain conditions similar to ASCE 7 Exposure B as appropriate for the particular wind direction. Wind direction is defined as the direction from which the wind blows, measured clockwise from true north.

2.1.3 Wind Climate

For the determination of the recommended wind loads for the design of the façade system, it is important to account for the impact of the local wind climate. By using advanced statistical methods, a wind climate model was created based upon local surface wind measurements taken at Chicago O'Hare International Airport.

A graphical representation of the statistical wind climate model is provided in Figure 3. The top two plots show the directionality of common winds on the left and design winds on the right. The common winds correspond to a return period of approximately 1 month, and the design winds correspond to a return period of 1700 years. Design winds are the strongest from the southwest. The lower plot shows the wind speeds from each data set as a function of return period.

The resulting statistical wind climate model was combined with the wind tunnel results using the Upcrossing Method to produce the recommended full-scale wind pressures. Therefore, while the directional wind speeds shown in Figure 3 are illustrative of the directionality of the local wind climate, they were not and should not be used directly for predictions of wind pressures.

2.1.4 Determination of Cladding Design Wind Pressures

For design of cladding elements, the differential wind load acting across an element must be considered. For elements exposed to wind on the external surface only, an internal pressure allowance (determined through analytical methods and the wind tunnel test data) must be applied to the measured external pressure in order to determine the differential pressure applicable for design. In strong winds, the internal pressures are dominated by air leakage effects. Important sources of air leakage include uniformly distributed small leakage paths over the elevator shaft and larger leakage paths if applicable. These larger leakage paths might include elevator doors or envelope breaches during extreme events.

To obtain the differential peak negative cladding pressures, the negative exterior pressures are augmented by an amount equal to the positive internal pressure. Likewise, the differential peak positive pressures are obtained by augmenting the exterior positive pressure by an amount equal to the magnitude of the negative internal pressure. "Negative pressure" or suction is defined to act outward normal to the exterior surface, and "positive pressure" acts inward.

For single-surface elements exposed to wind on opposite sides, such as roof canopies, the differential pressure acting on the element is determined by measuring the instantaneous pressure difference across the element. In cases where the design details of these protruding elements are uncertain, the recommended design wind pressure is based on the worse case between the instantaneous differential pressure and the external pressure.

The cladding design wind pressures presented in this report are localized values intended for the design of small elements and do not necessarily occur simultaneously. The simultaneous application of the provided wind pressures will result in conservative forces.

2.2 Criteria

The governing code for this project is American Society of Civil Engineers (ASCE) 7-16. The recommendations for wind loads provided in this report are based on wind tunnel tests employing procedures that meet or exceed the requirements set out in the ASCE 49-12 Standard as well as Chapter 31 of the ASCE 7.

The recommended wind pressures provided in this report are based on a 3-second gust wind speed of 114 mph at a height of 33 ft in open terrain, as specified in the ASCE 7-16 Standard for a Risk Category III building in Chicago. This wind speed is shown in Figure 3 and corresponds to a nominal return period of 1700 years.

Note that the wind speeds provided in the ASCE 7 are based on basic wind speed maps consistent with the ultimate event, which corresponds to a load factor of 1.0 when using the Load and Resistance Factor Design (LRFD) approach. The LRFD approach is generally employed for structural loading.

For cladding design, an Allowable Stress Design (ASD) approach is more common and permissible following ASCE 7 provisions. Section 2.4 of ASCE 7 specifies a factor of 0.6 on the ultimate wind loads to convert from an LRFD to an ASD approach. The design wind loads provided include the 0.6 factor from the ASD load combinations.

To make some allowance for possible future changes in surroundings, RWDI's recommended cladding design wind pressures do not go below a minimum of ±10 psf, with the exception of +10 psf and -20 psf minimums on roof areas which include the entire curved surfaces of the platforms and main station dome canopies. These minimum pressure allowances are compliant with Clause 31.4 of ASCE 7, which specifies limits on how much reduction is permissible in the loading when compared to the analytical methods in Chapter 30. Per ASCE 7, the cladding design wind pressures are not to be less than 80% of the Zone 4 (walls) and Zone 1 (roof) values.

3 RESULTS AND DISCUSSION

3.1 External Wind Pressures

The range of predicted local external wind pressures are provided in the histogram below (Image 1). Peak positive and negative wind pressures are presented for both façade and roof surfaces, along with relevant code-based values for comparison.

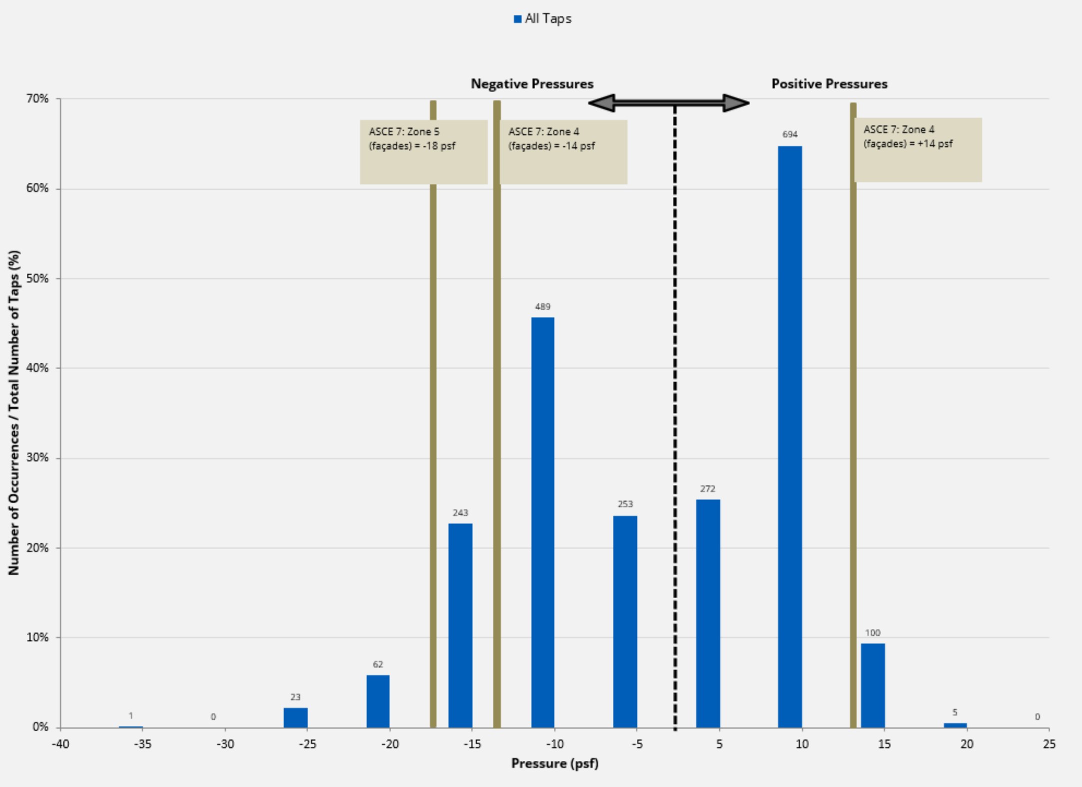


Image 1: Histogram of Local External Wind Pressures

3.2 Internal Pressures

Taking into consideration the potential for breakage or an opening occurring, the internal pressure of ±3 psf for Allowable Stress Design is considered for the elevator shafts.

The internal pressures have been assessed with the understanding that all horizontal roof surfaces are non-glazed. If this is not the case, then RWDI should be contacted.

3.3 Cladding Design Wind Pressures

The negative cladding design wind pressures were determined by combining the negative external pressures with the positive internal pressure, where applicable. Similarly, the positive cladding design wind pressures were determined by combining the positive external pressures with the negative internal pressure.

Pressure contour diagrams (or "block diagrams") of RWDI's recommended negative and positive cladding design wind pressures are presented in Figures 4 to 7 and 8 to 11, respectively. The drawings in these figures have generally been zoned using 5 psf increments so that the pressure indicated is the maximum pressure in that particular zone. For example, a 15 psf zone would have pressures ranging from 11 psf to 15 psf.

The following table provides a summary of the recommended cladding design wind pressures and the location of the largest values.

Table 1: Summary of Cladding Design Wind Pressures

Element	Negative Pressures (psf)			Positive Pressures (psf)		
	Peak Value	Location	Range of Majority	Peak Value	Location	Range of Majority
Main Facades	-35	Figure 5	-10 to -25	+30	Figure 8	+10 to +15
Roofs and Soffits	-30	Figure 7	-20	+25	Figure 11	+10 to +15

The recommended cladding design wind pressures are derived from model scale tests and appropriate for local elements with a minimum dimension of approximately 1 ft (0.3 m). For smaller elements, the provided cladding design wind pressures may be indicative of the expected loading, however, RWDI should be consulted if there are any queries regarding specific features.

The wind pressures provided in this report have been factored to be consistent with an Allowable Stress Design approach. In the context of ASCE 7 applications, the values presented in this report correspond to 0.6W in the load combinations presented in Section 2.4. To derive the equivalent wind loading for Load and Resistance Factor Design (LRFD) divide the pressured presented in this report by 0.6. The recommended wind loads are for cladding design for resistance against wind pressure, including an allowance for internal pressures. Design of the cladding to the provided wind loads will not necessarily prevent breakage due to impact by wind-borne debris, which is prevalent in hurricane, typhoon, and tornadic events.

3.4 Tributary Area Reduction Factors

For the design of cladding and secondary cladding components with tributary areas of 10 ft^2 (1 m^2) or more, the appropriate wind loading may be obtained by multiplying the local cladding design wind pressures presented in this report by the appropriate tributary area reduction factor given in the graph below. The reduction on cladding pressures does not account for added inertial loading that may be caused by the increased flexibility of large cladding elements/systems.

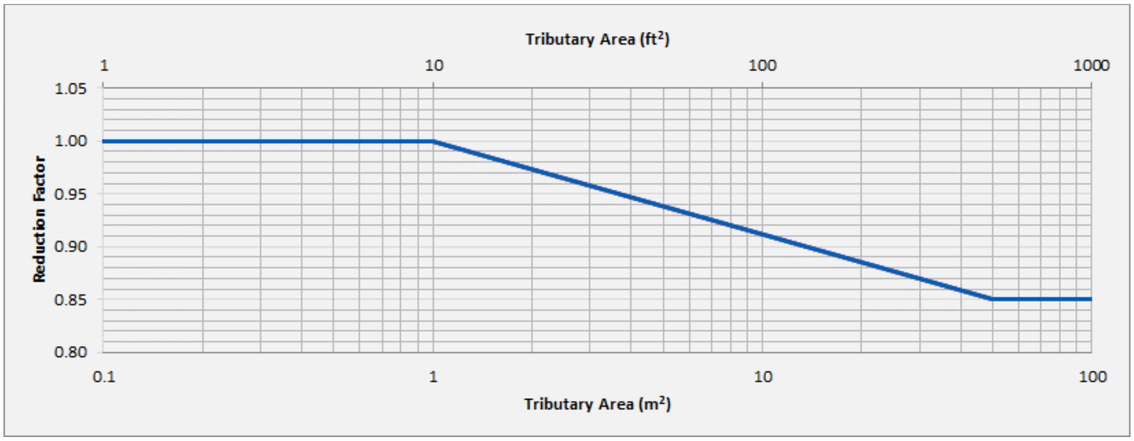


Image 2: Tributary Area Reduction Factors

3.5 Load Combinations at Corners

To design the local framing which supports the curtainwall at corners, one must know the peak loads that occur simultaneously on each face of the corner. Direct measurements of the simultaneous wind pressures were used to develop load combination factors for three significant load cases (refer to schematics below): one where the pressures on both faces reach high positive values; one where they both reach high negative values; and a third scenario where one face experiences high positive pressures at the same time that its adjacent face experiences high negative pressures (and vice versa).

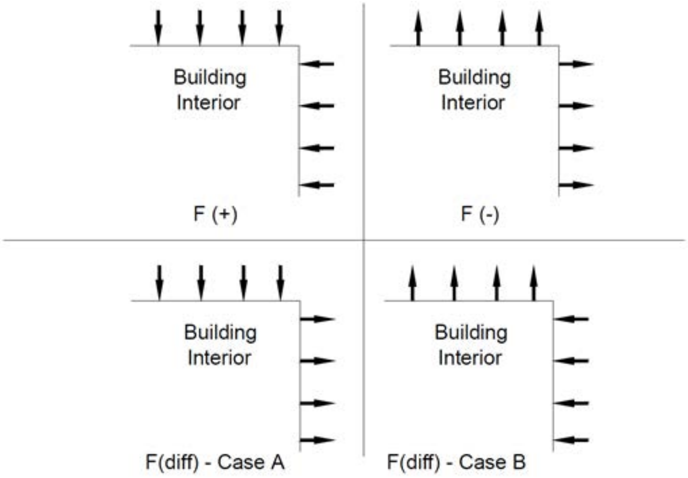


Image 3: Typical Load Cases for Corner Framing Design

Because of lack of correlation of the wind pressures at the corners, the pressures on each face do not all reach their peak pressures at the same instant. To account for this lack of correlation, the following load combination factors can be used to adjust the peak pressures:

Positive Combination Factor, F(+) = 95% ;

Negative Combination Factor, F(-) = 85% ; and,

Difference Combination Factor, F(diff) = 75% .

The simultaneous wind loads acting on a building's corner can be determined by applying the combination factors directly to the cladding design wind pressures presented in all elevation figures. For example, to determine the simultaneous wind loads for the condition where the pressures on the two faces of the corner are both positive, the loads on the two faces can be taken as 95% of those indicated in the positive pressure block diagrams. To determine simultaneous wind loads for the condition where one face is in a negative pressure zone while the other is in a positive zone, 75% of the positive load is assumed to act on one of the two faces, while 75% of the negative load is taken to act on the other face.

If applicable, the cladding design wind pressures in the figures mentioned above may be first multiplied by the appropriate tributary area reduction factor, as discussed in Section 3.4, prior to the application of combination factors.

3.6 Applicability of Results

3.6.1 Surroundings Model

The cladding design wind loads determined by the wind tunnel tests and aforementioned analytical procedures are applicable to the particular configuration of surroundings modeled. The surroundings model used for the wind tunnel tests reflected the current state of development at the time of testing and include, where appropriate, known off-site structures that have received planning approval and/or been agreed upon with the design team. If, at a later date, additional buildings besides those considered in the tested configuration are constructed or demolished near the project site, then some load changes could occur.

3.6.2 Study Model

The results presented in this report pertain to the scale model of the proposed development, constructed using the architectural information listed in Appendix B, and the construction phasing as reflected in the test configuration. Should there be any design changes that deviate substantially from the above information, the results for the revised design may differ from those presented in this report. Therefore, if the design changes, RWDI should be contacted and requested to review the impact on the wind loads.

FIGURES

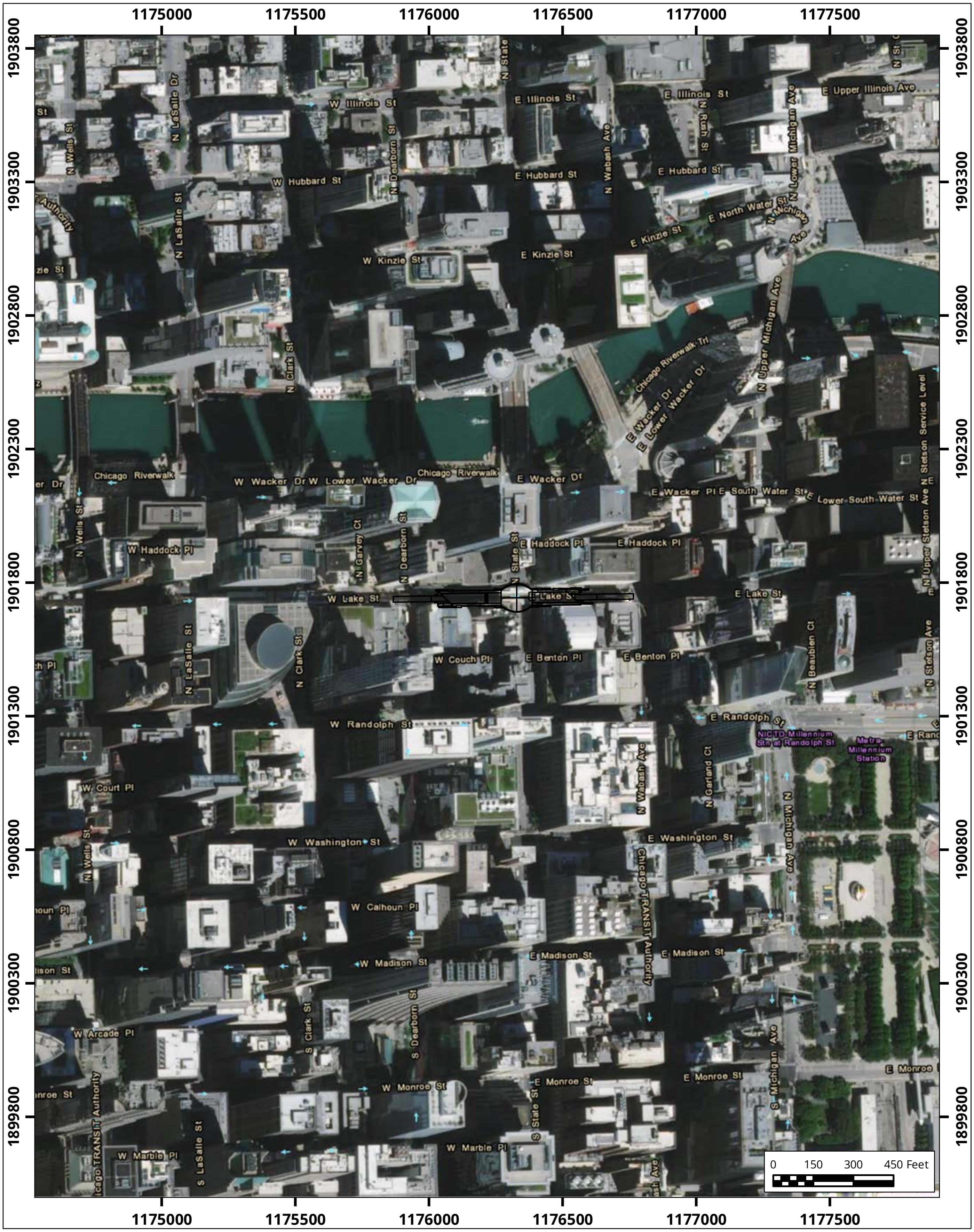
Wind Tunnel Study Model

Figure: 1

State & Lake Elevated Station – Chicago, IL

Project #2100248

Date: August 25, 2021



Site Plan

True North

Drawn by: DF

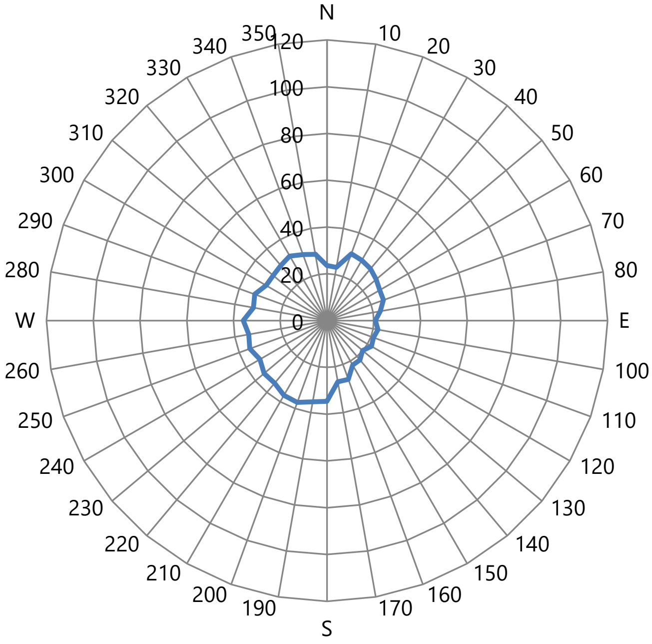
Figure: 2

Approx. Scale: 1 "=500 '

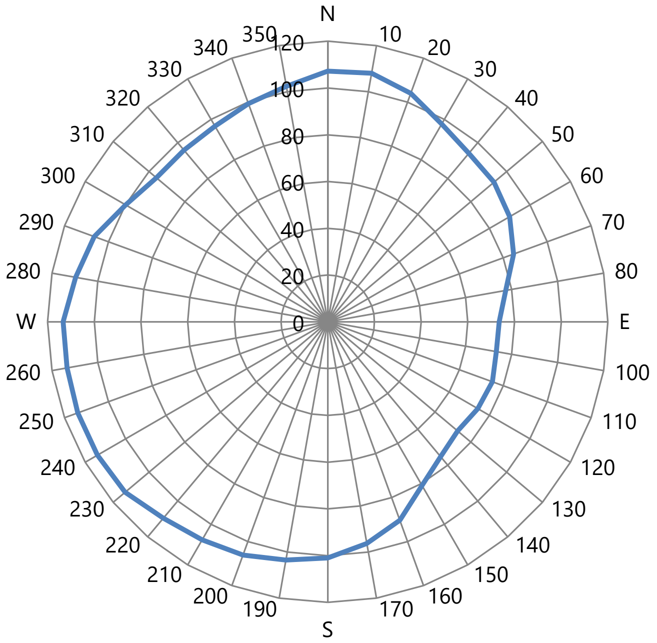
Date Revised: Aug. 25, 2021

State & Lake Elevated Station - Chicago, IL

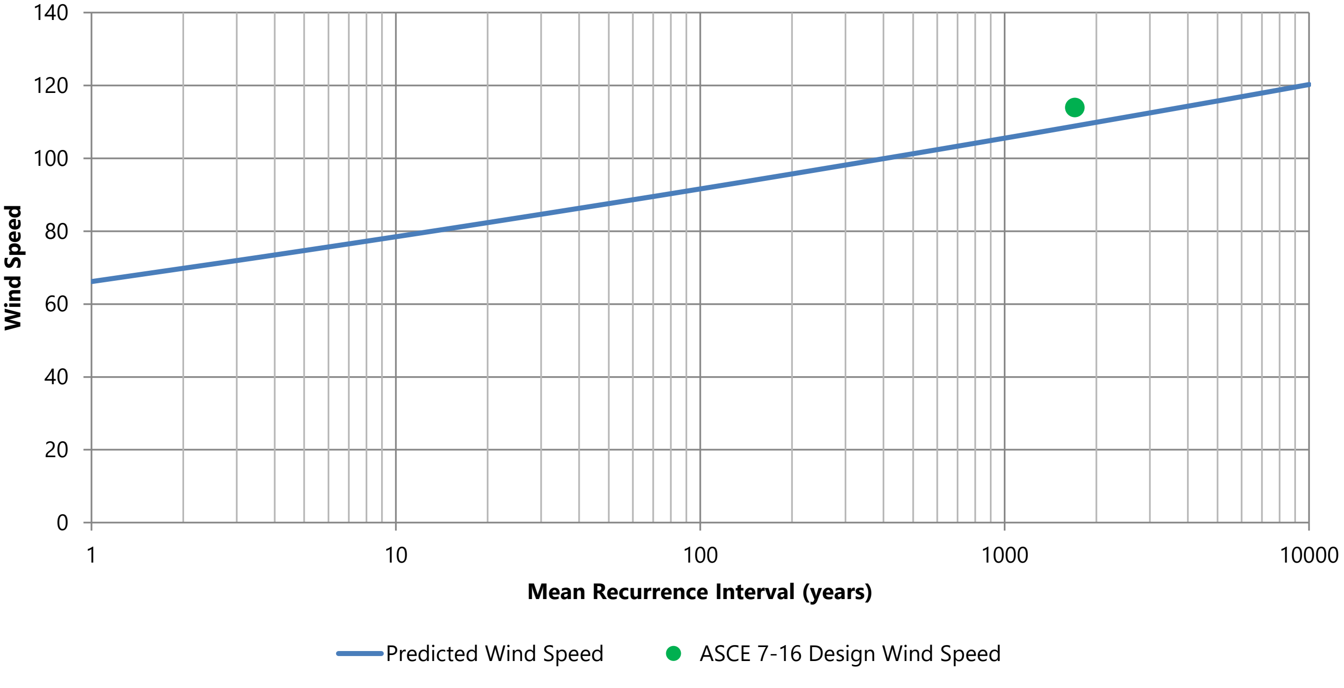
Project #: 2100248



Common Winds



Design Winds



Note: Wind Speeds shown are 3-second Gust Wind Speeds (mph) at 33 ft height in Open Terrain

Directional Distribution of Local Wind Speeds

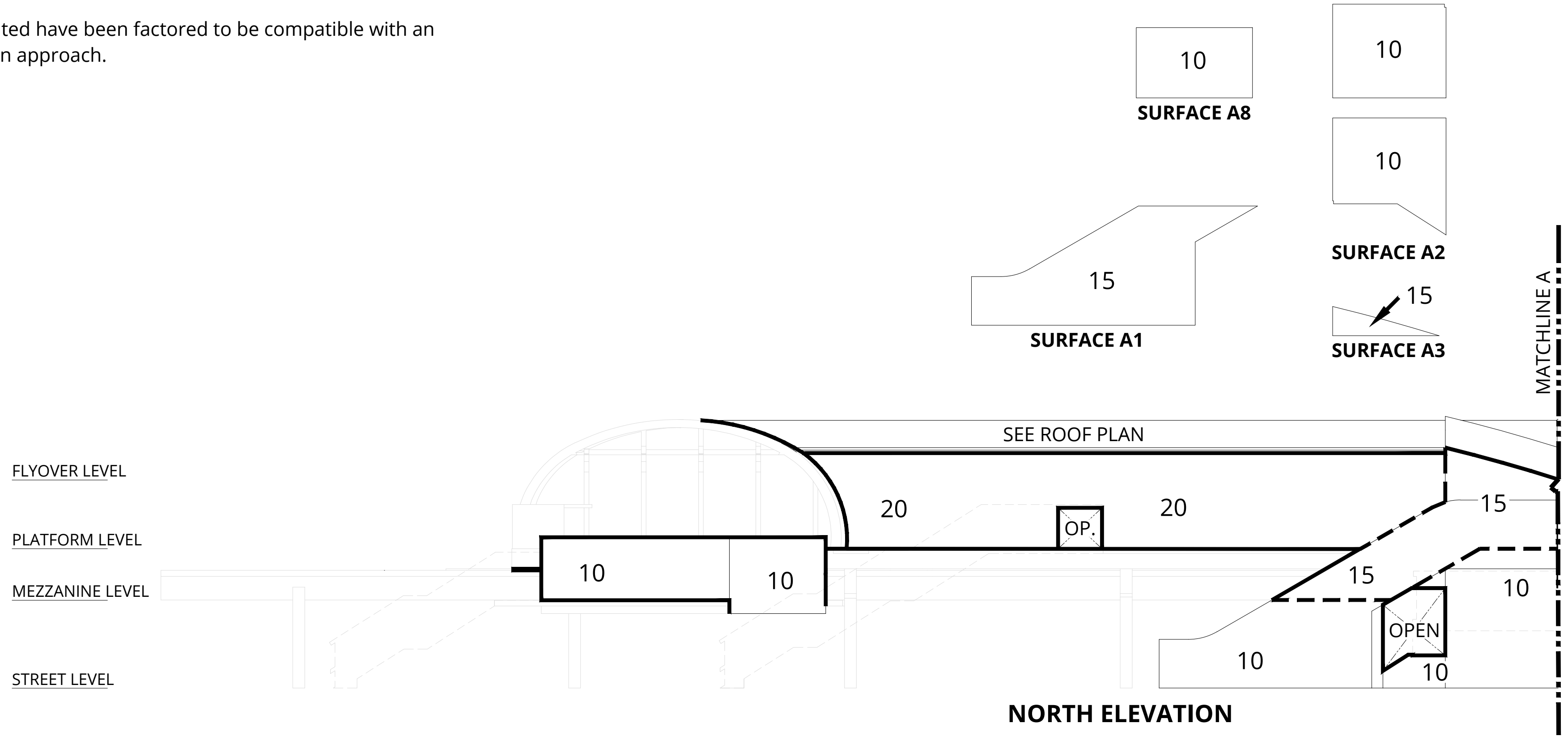
Figure: 3

State & Lake Elevation Station – Chicago, IL

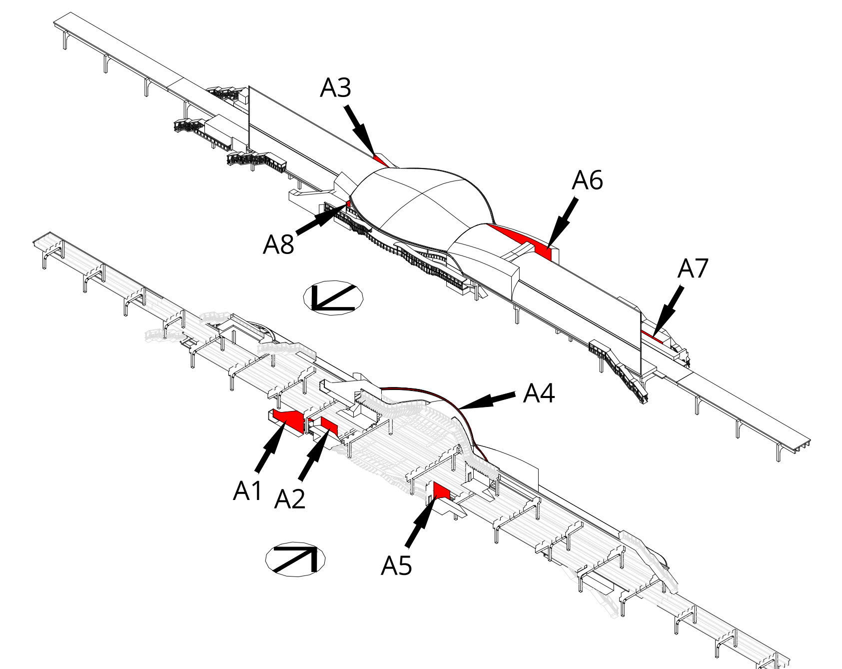
Project #2100248

Date: August 25, 2021

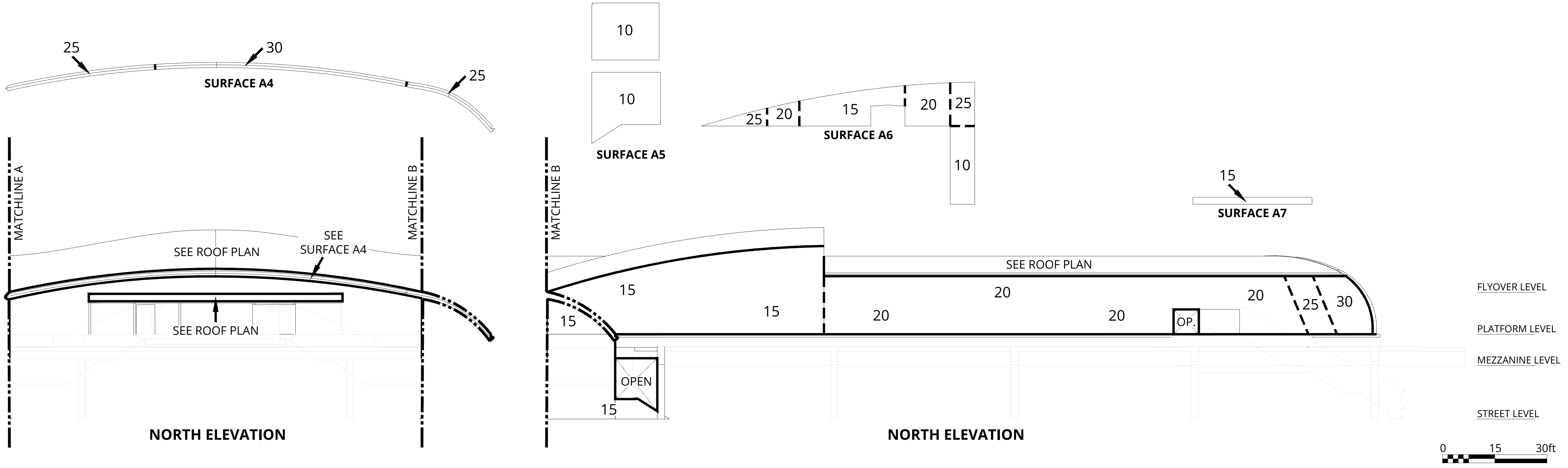
Note:
The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.



NORTH ELEVATION



Isometric View of Wall Surfaces: North (A)



NORTH ELEVATION

NORTH ELEVATION

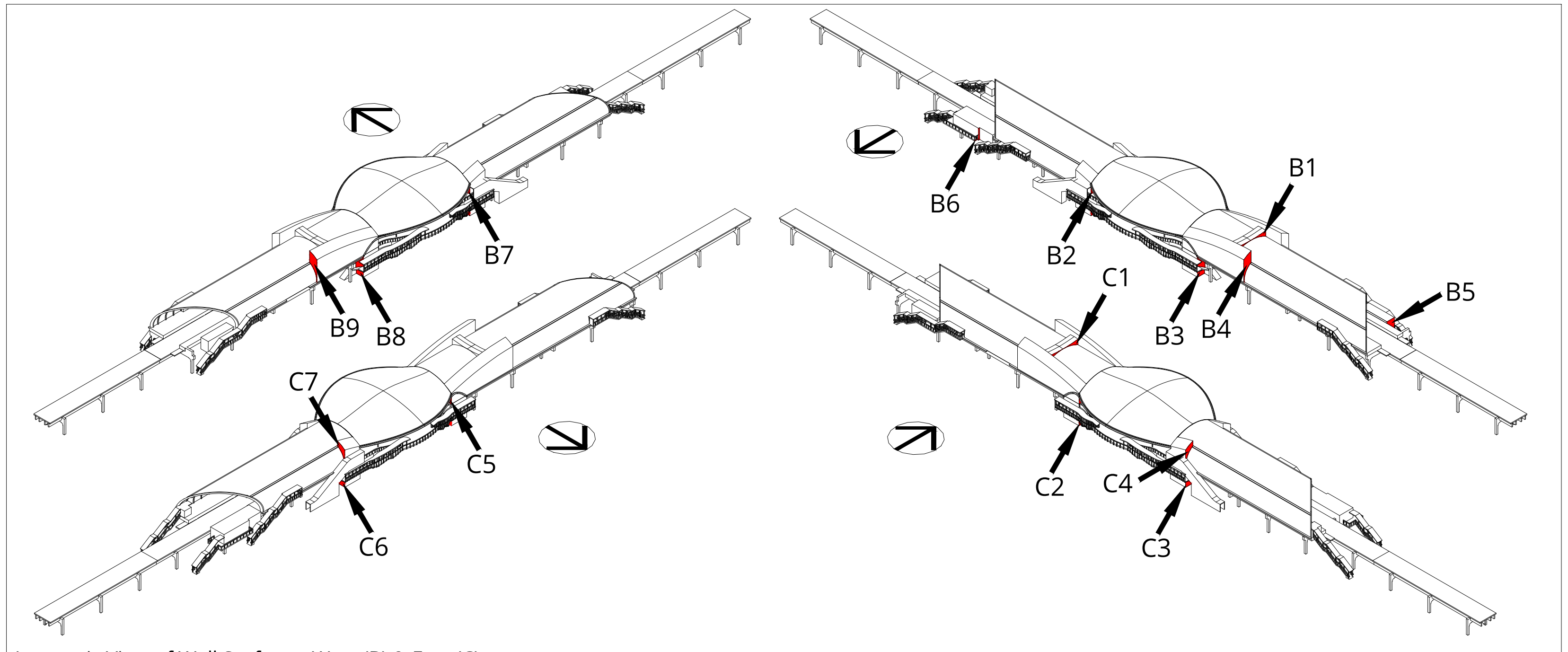
Recommended Wind Loads for Cladding Design (psf)
Peak Differential Negative Pressures
(Negative External Pressure with Positive Internal Pressure Where Applicable)
Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III
State & Lake Elevated Station - Chicago, IL

Project #2100248

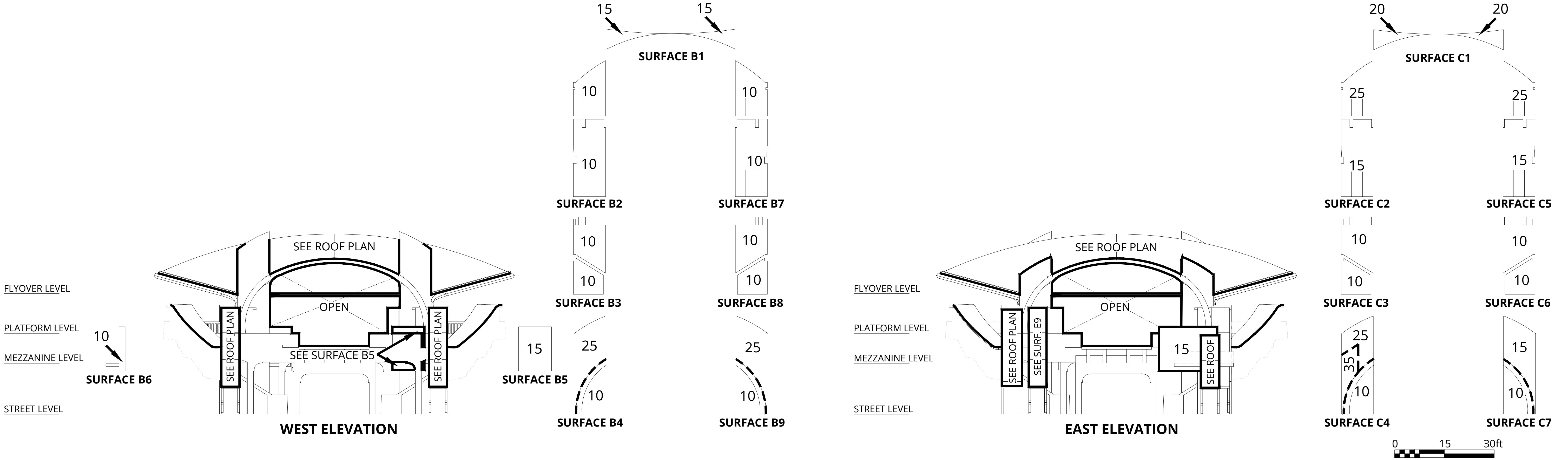
Drawn by: DBB Figure: 4
Approx. Scale: 1"=30'
Date Revised: Aug. 27, 2021

Note:

The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.



Isometric View of Wall Surfaces: West (B) & East (C)



Recommended Wind Loads for Cladding Design (psf)

Peak Differential Negative Pressures

(Negative External Pressure with Positive Internal Pressure Where Applicable)

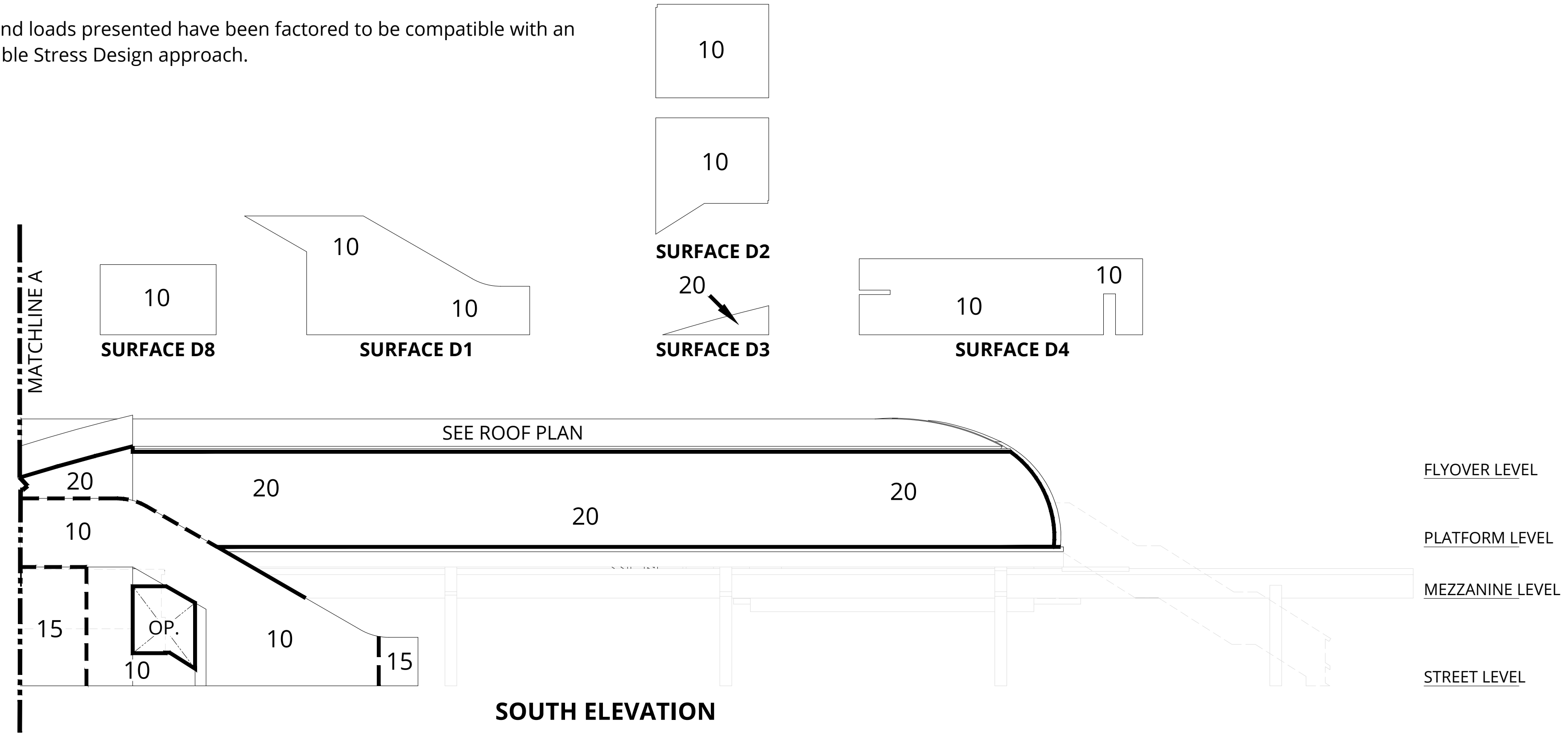
Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III

State & Lake Elevated Station - Chicago, IL

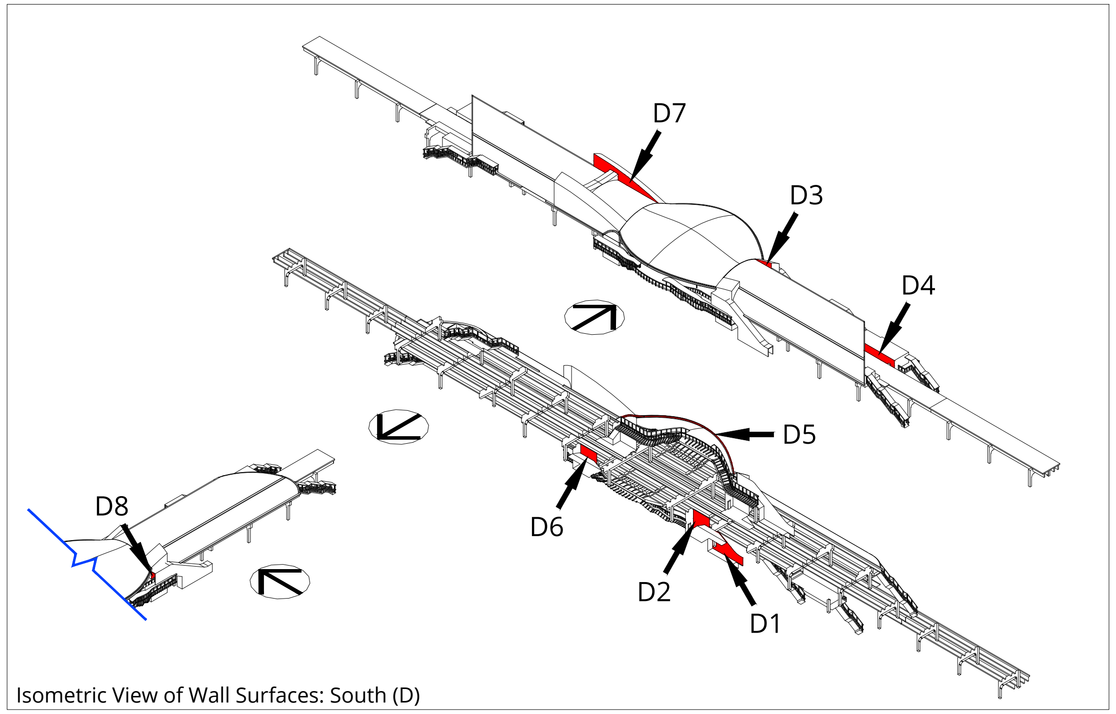
Project #2100248

Drawn by: DBB	Figure: 5
Approx. Scale:	1"=30'
Date Revised:	Aug. 27, 2021

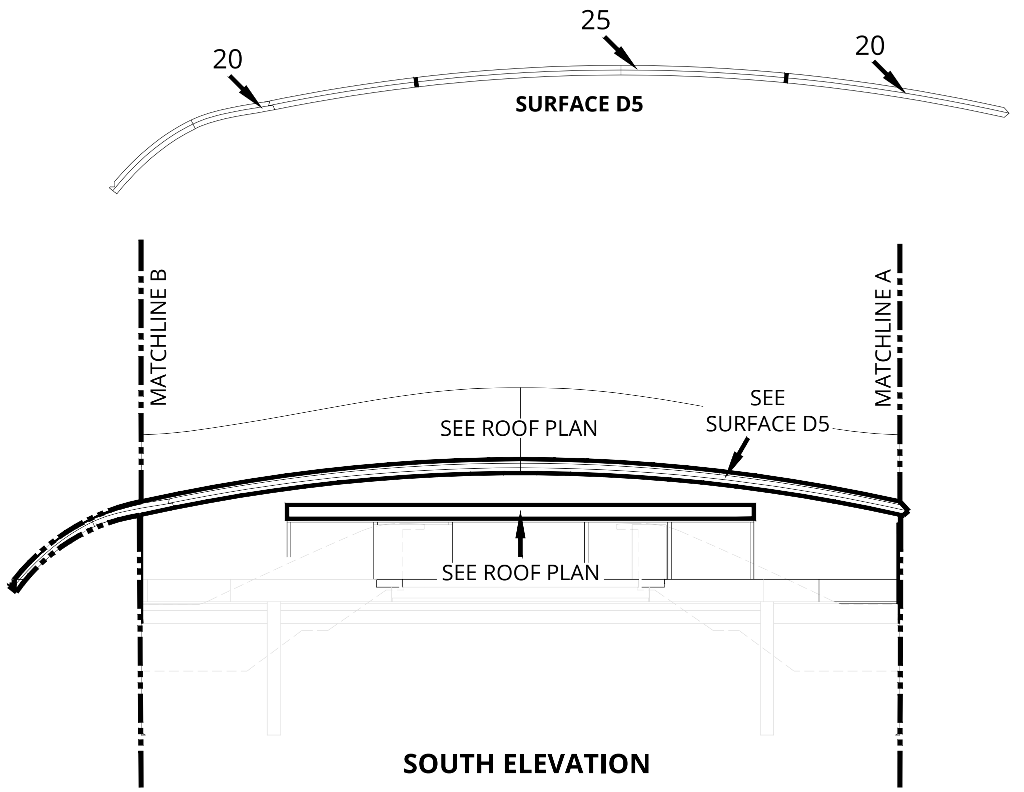
Note:
The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.



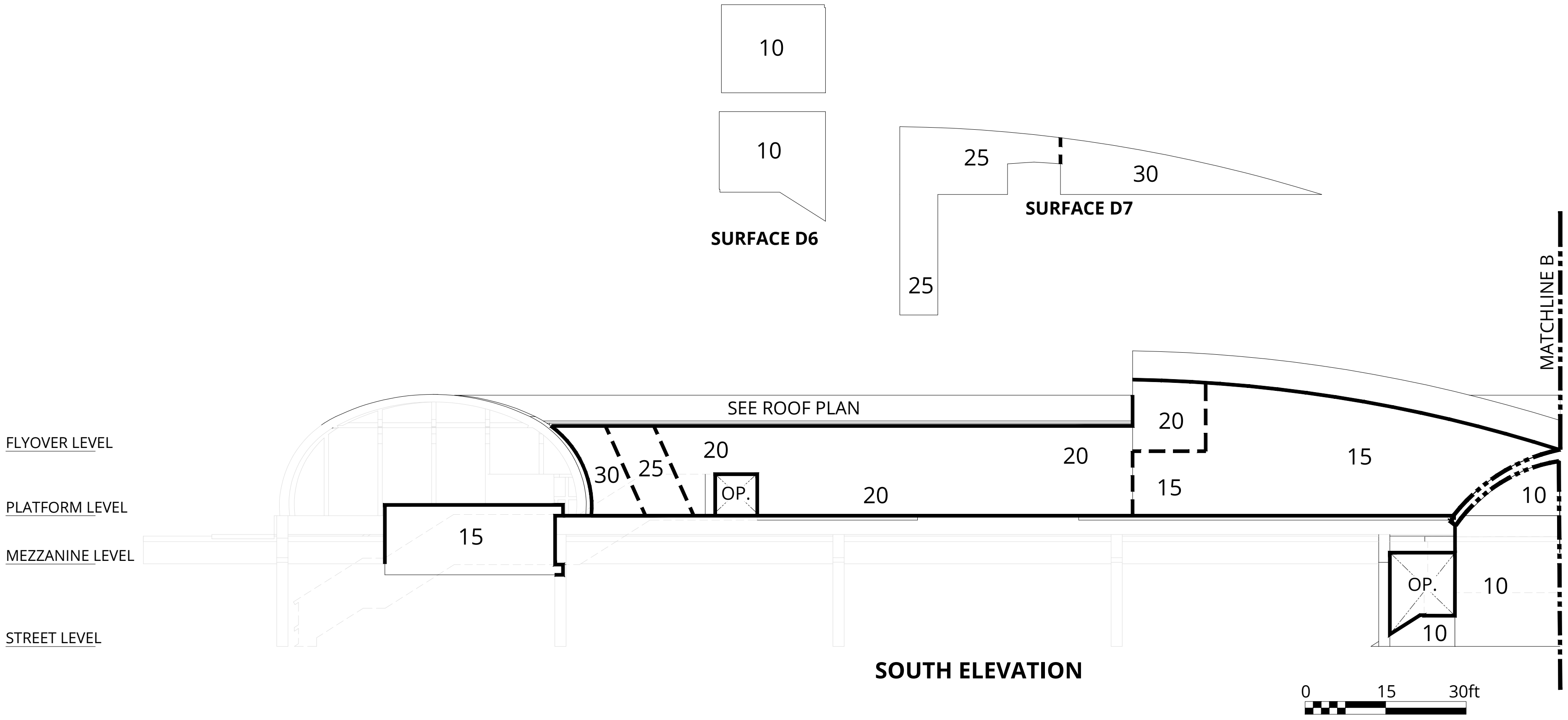
SOUTH ELEVATION



Isometric View of Wall Surfaces: South (D)



SOUTH ELEVATION



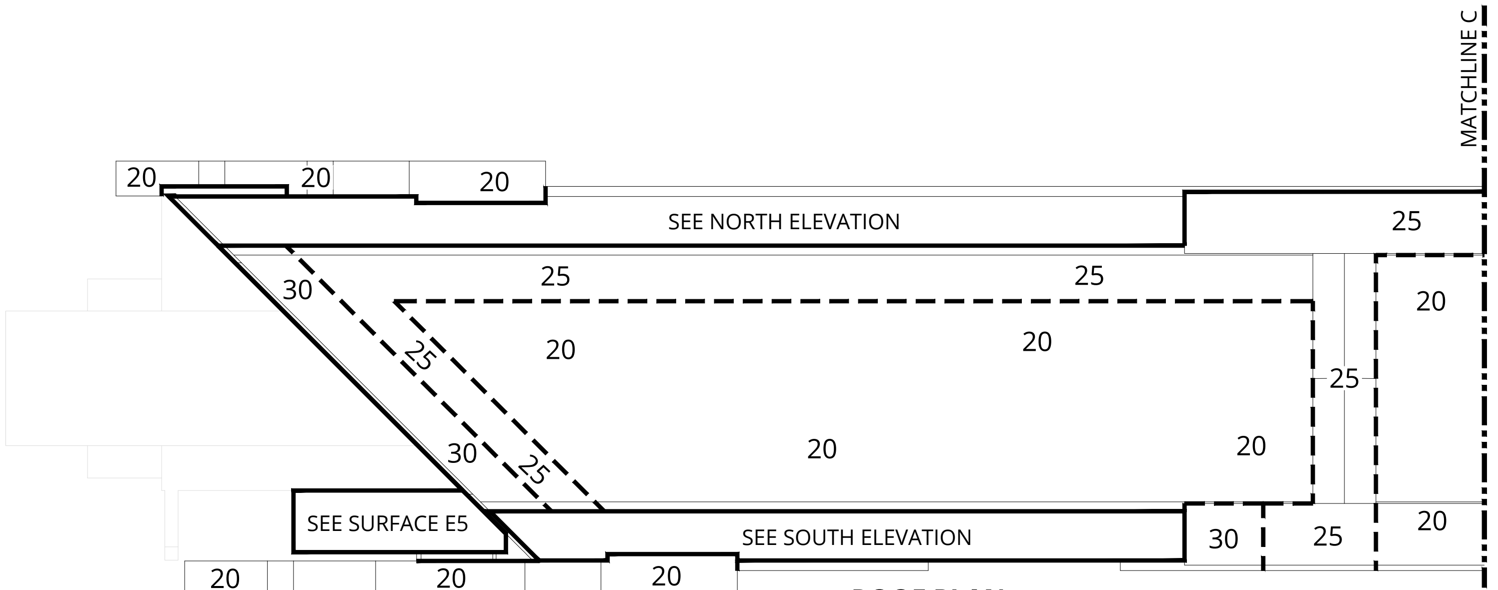
SOUTH ELEVATION

Recommended Wind Loads for Cladding Design (psf)
Peak Differential Negative Pressures
(Negative External Pressure with Positive Internal Pressure Where Applicable)
Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III
State & Lake Elevated Station - Chicago, IL

Project #2100248

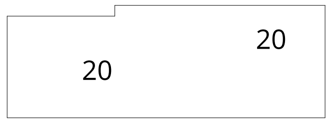
Drawn by: DBB Figure: 6
Approx. Scale: 1"=30'
Date Revised: Aug. 27, 2021

Note:
The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.

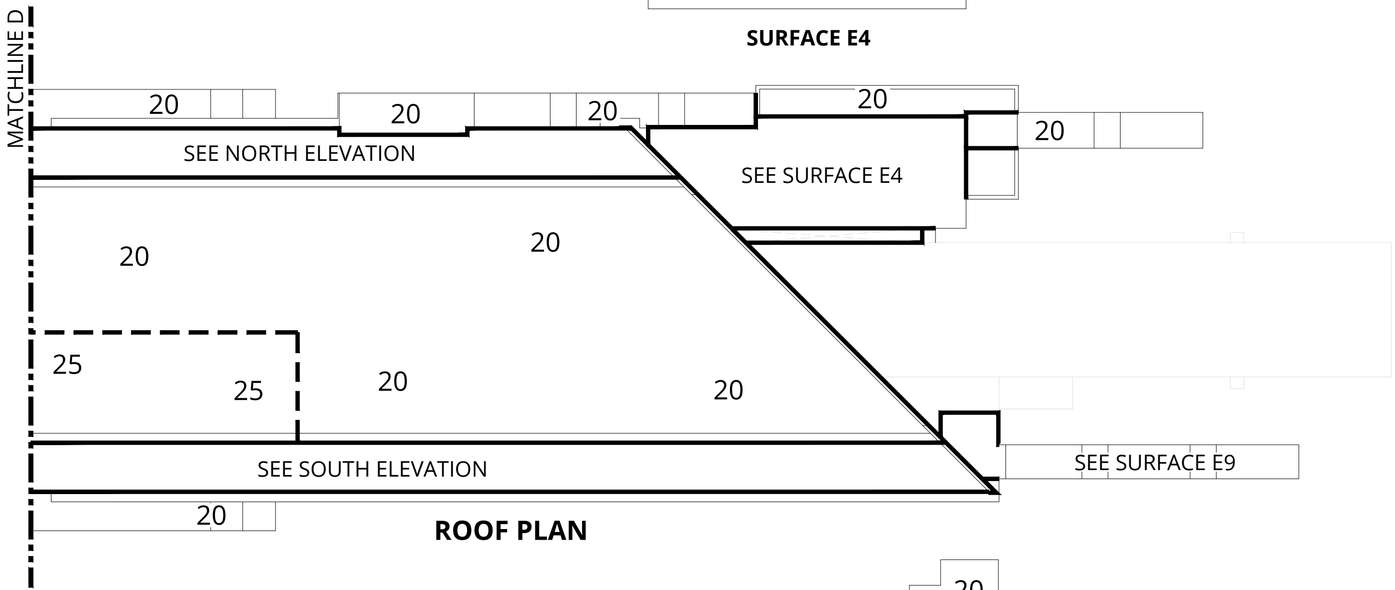


ROOF PLAN

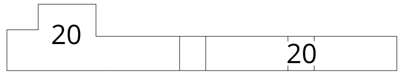
SURFACE E5



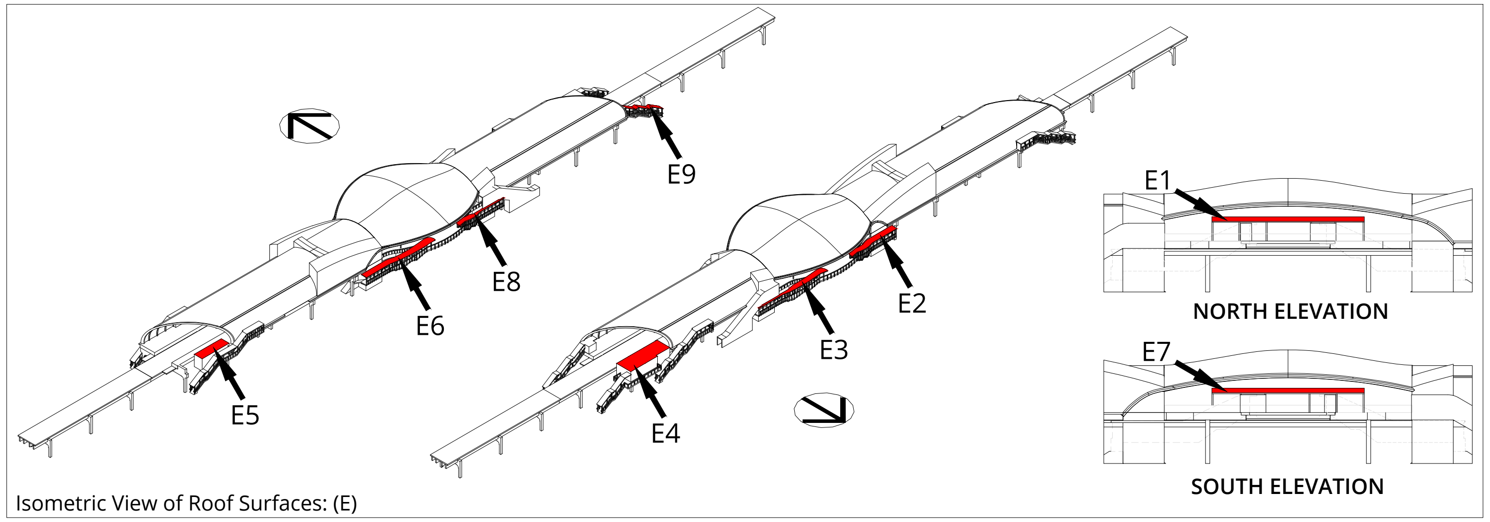
SURFACE E4



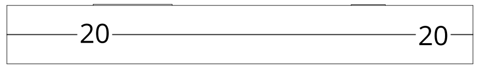
ROOF PLAN



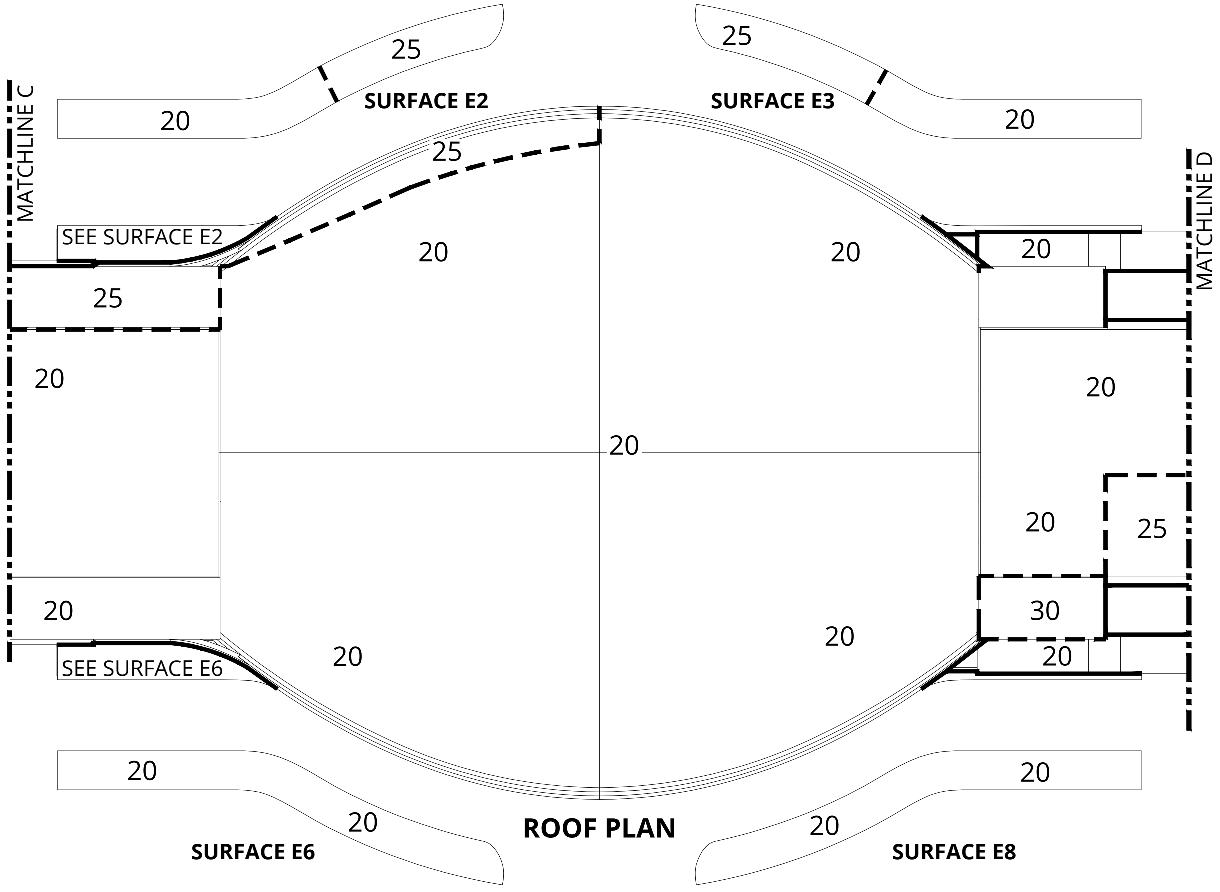
SURFACE E9



Isometric View of Roof Surfaces: (E)



SURFACE E1



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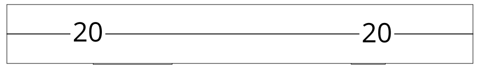


SURFACE E7

0 15 30ft

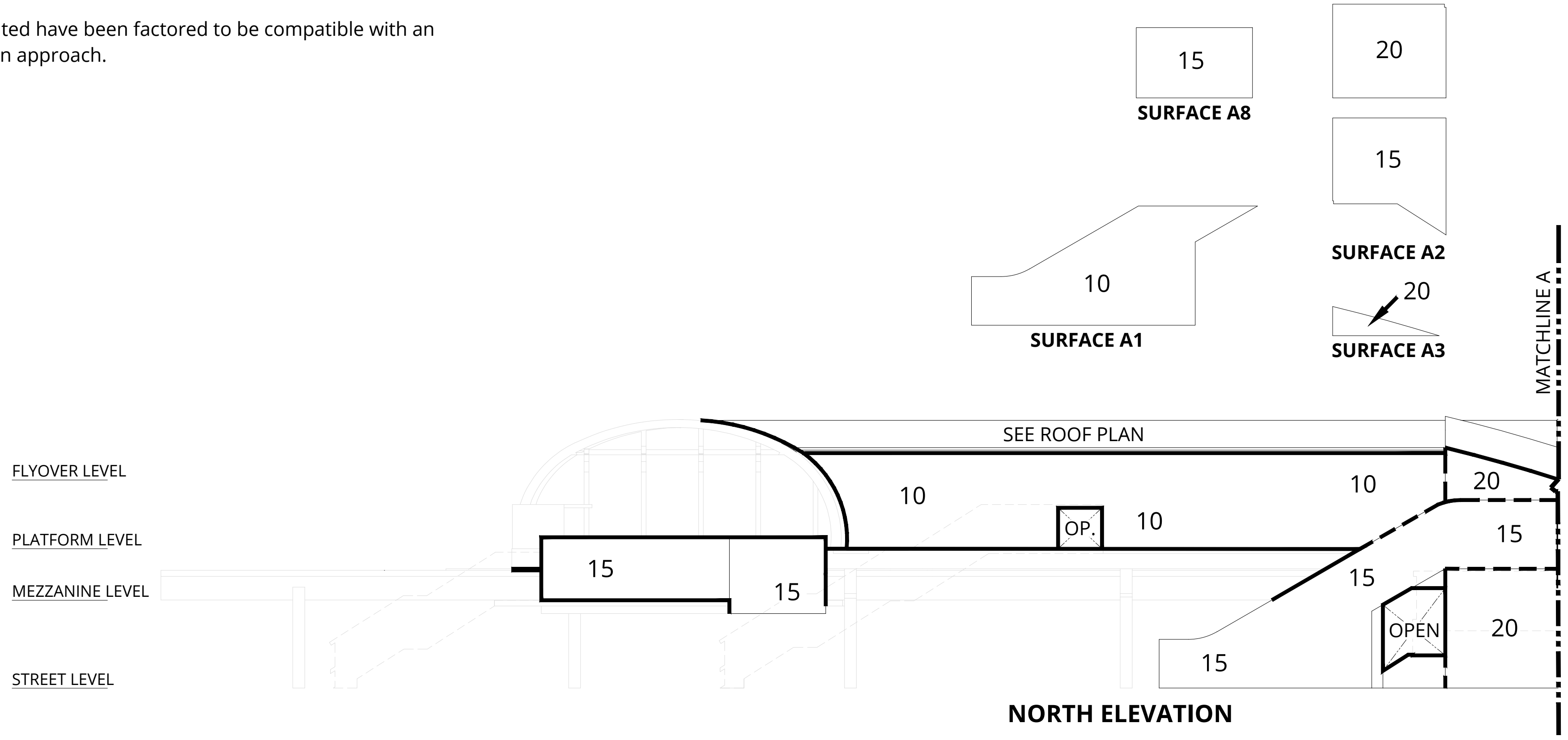
Recommended Wind Loads for Cladding Design (psf)
Peak Differential Negative Pressures
(Negative External Pressure with Positive Internal Pressure Where Applicable)
Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III
State & Lake Elevated Station - Chicago, IL

True North
Project #2100248

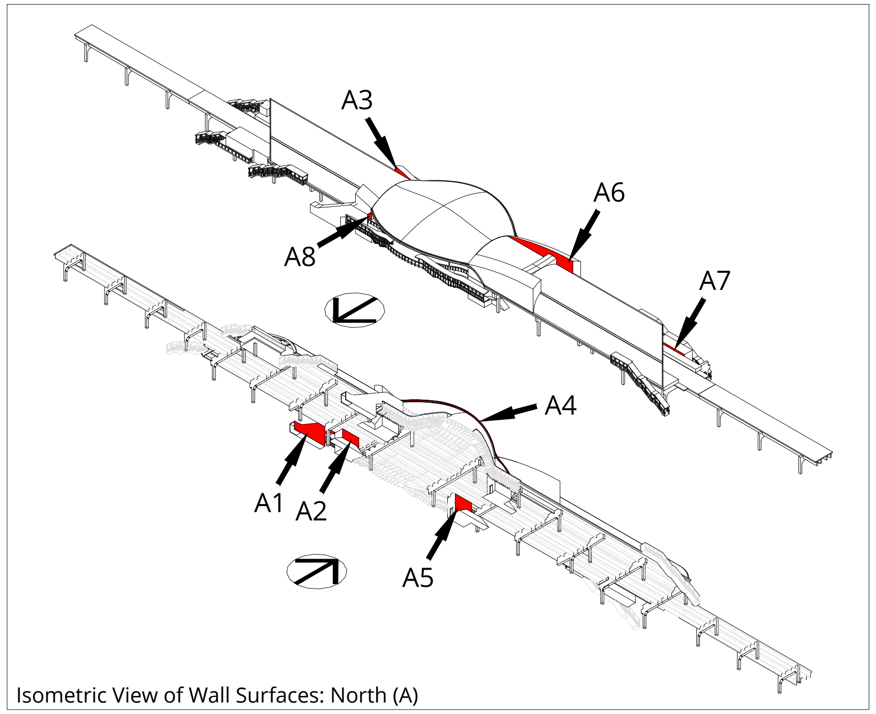
Drawn by:	DBB	Figure:	7
Approx. Scale:	1"=30'		
Date Revised:	Aug. 27, 2021		

Note:

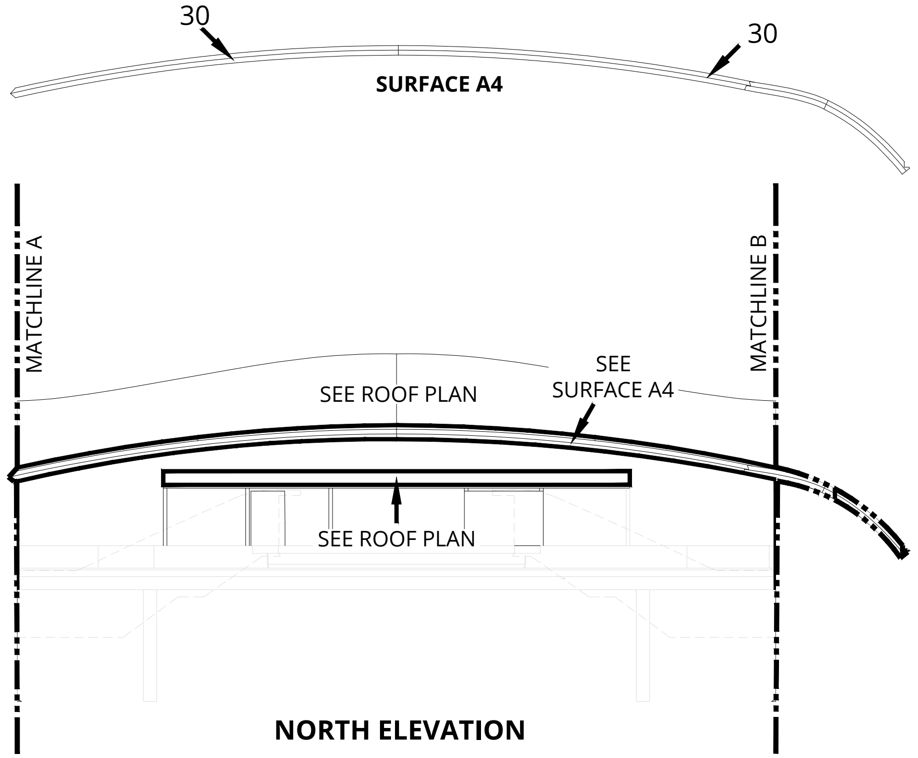
The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.



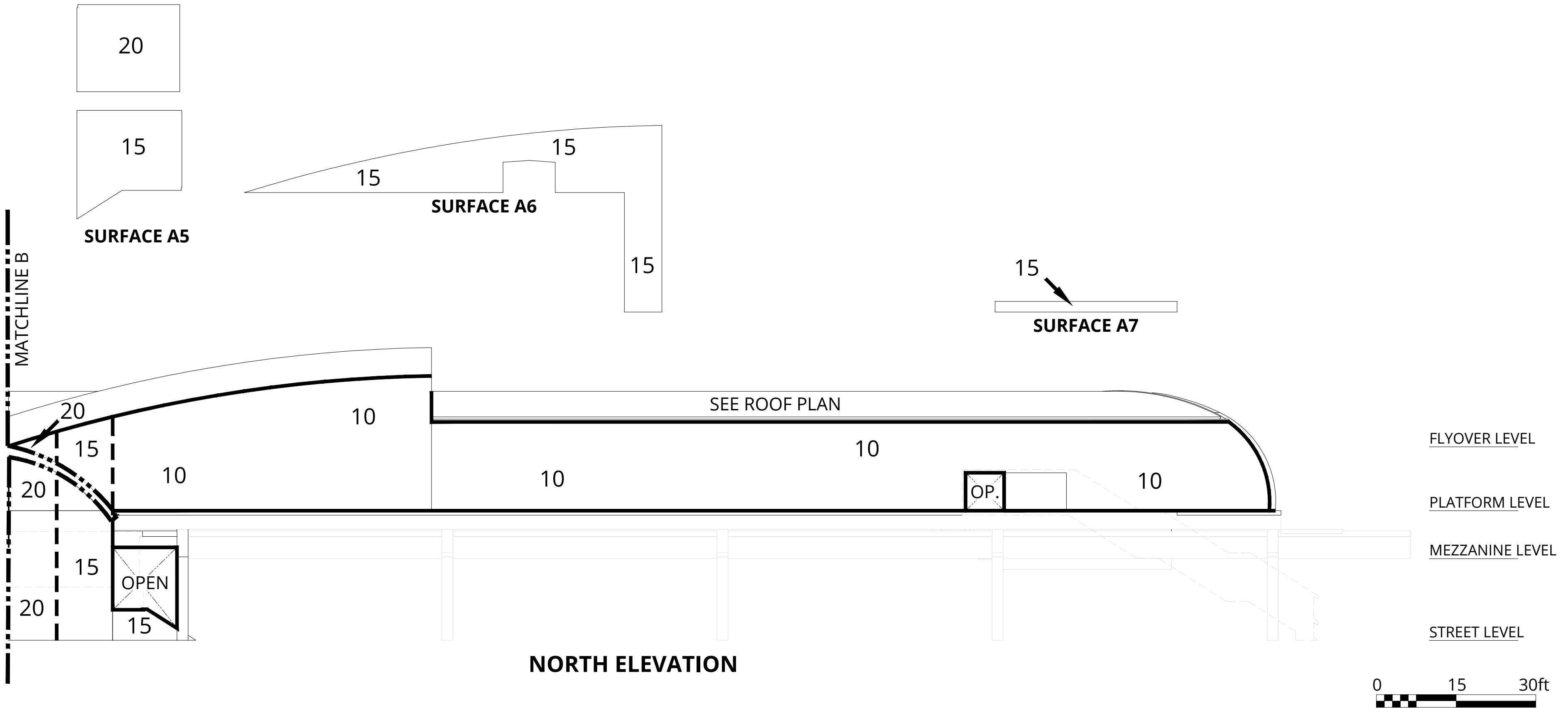
NORTH ELEVATION



Isometric View of Wall Surfaces: North (A)



NORTH ELEVATION



NORTH ELEVATION

Recommended Wind Loads for Cladding Design (psf)

Peak Differential Positive Pressures

(Positive External Pressure with Negative Internal Pressure Where Applicable)

Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III

State & Lake Elevated Station - Chicago, IL

Project #2100248

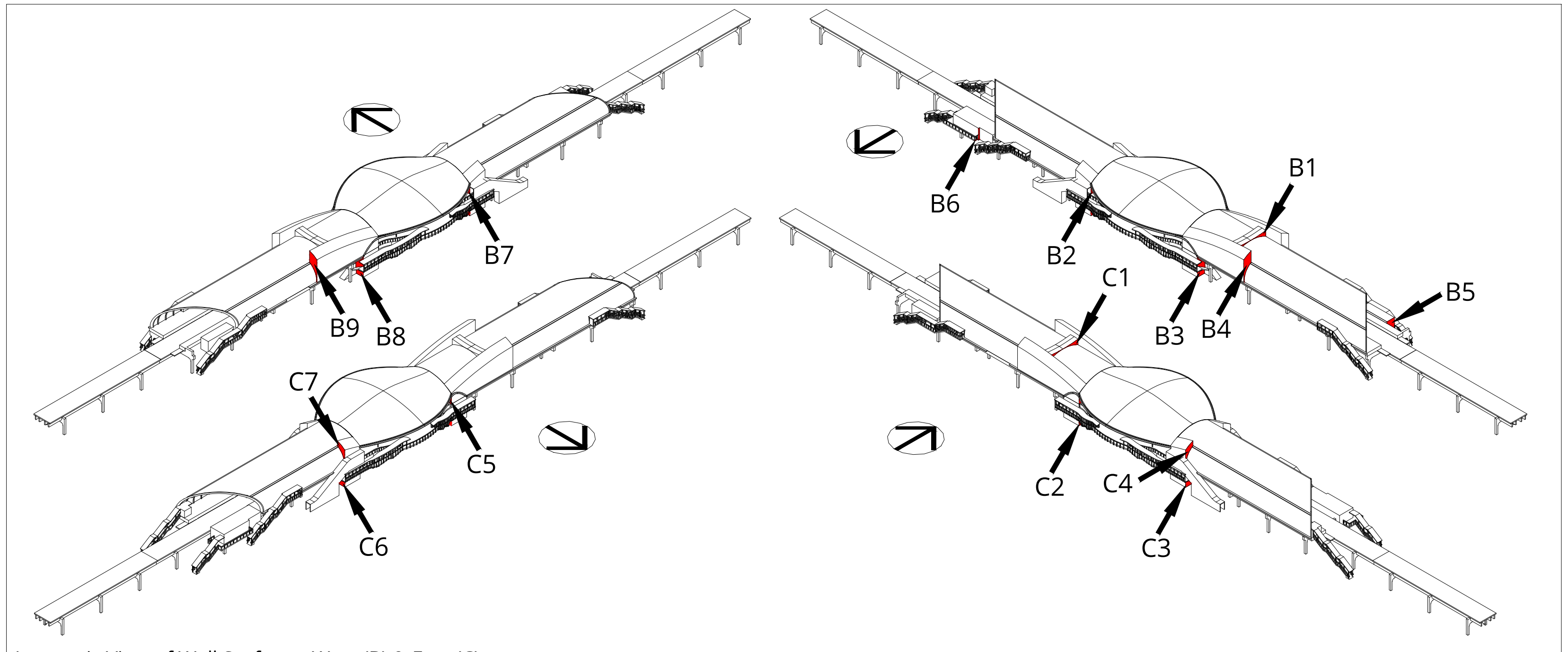
Drawn by: DBB Figure: 8

Approx. Scale: 1"=30'

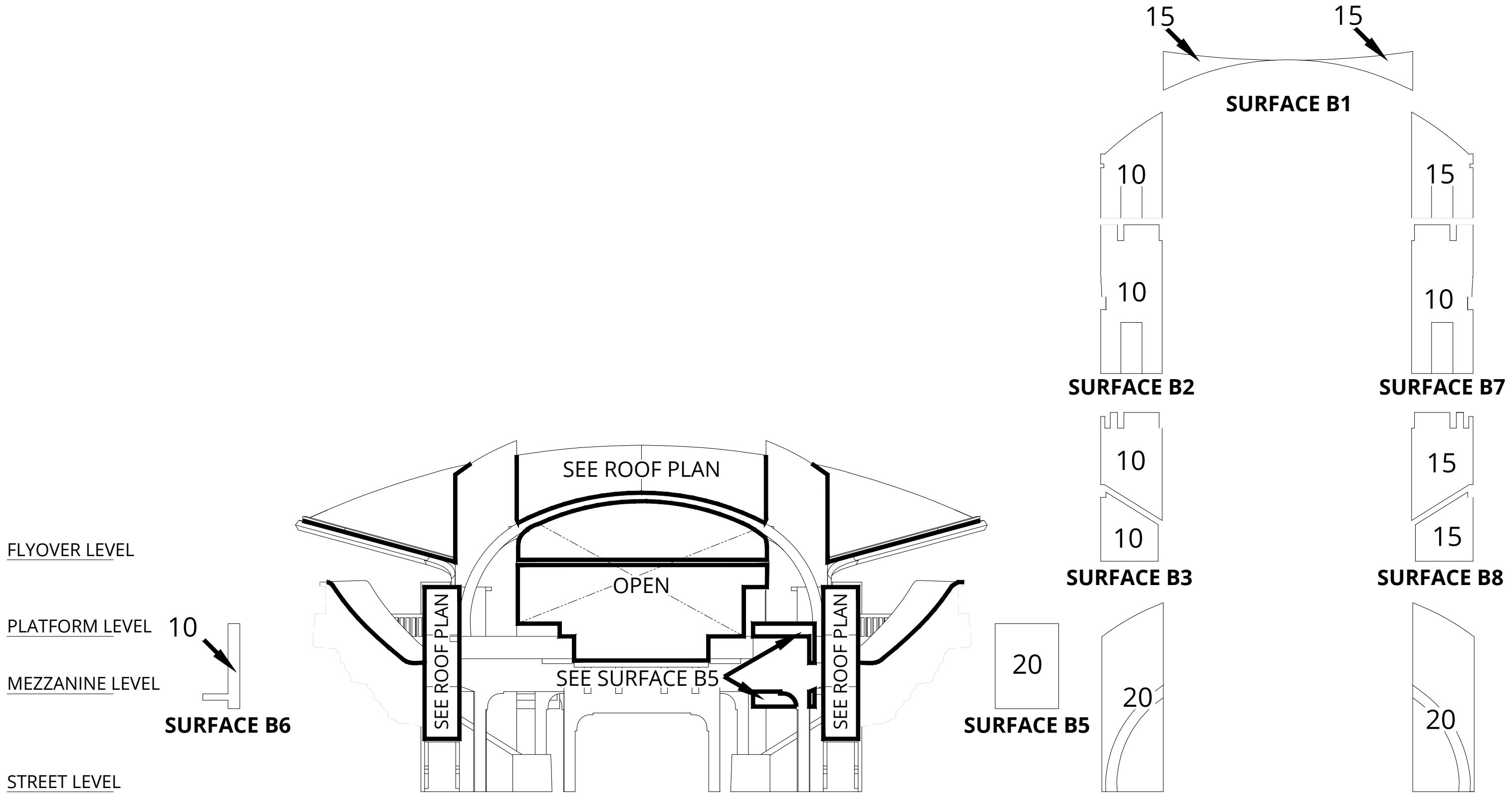
Date Revised: Aug. 27, 2021

Note:

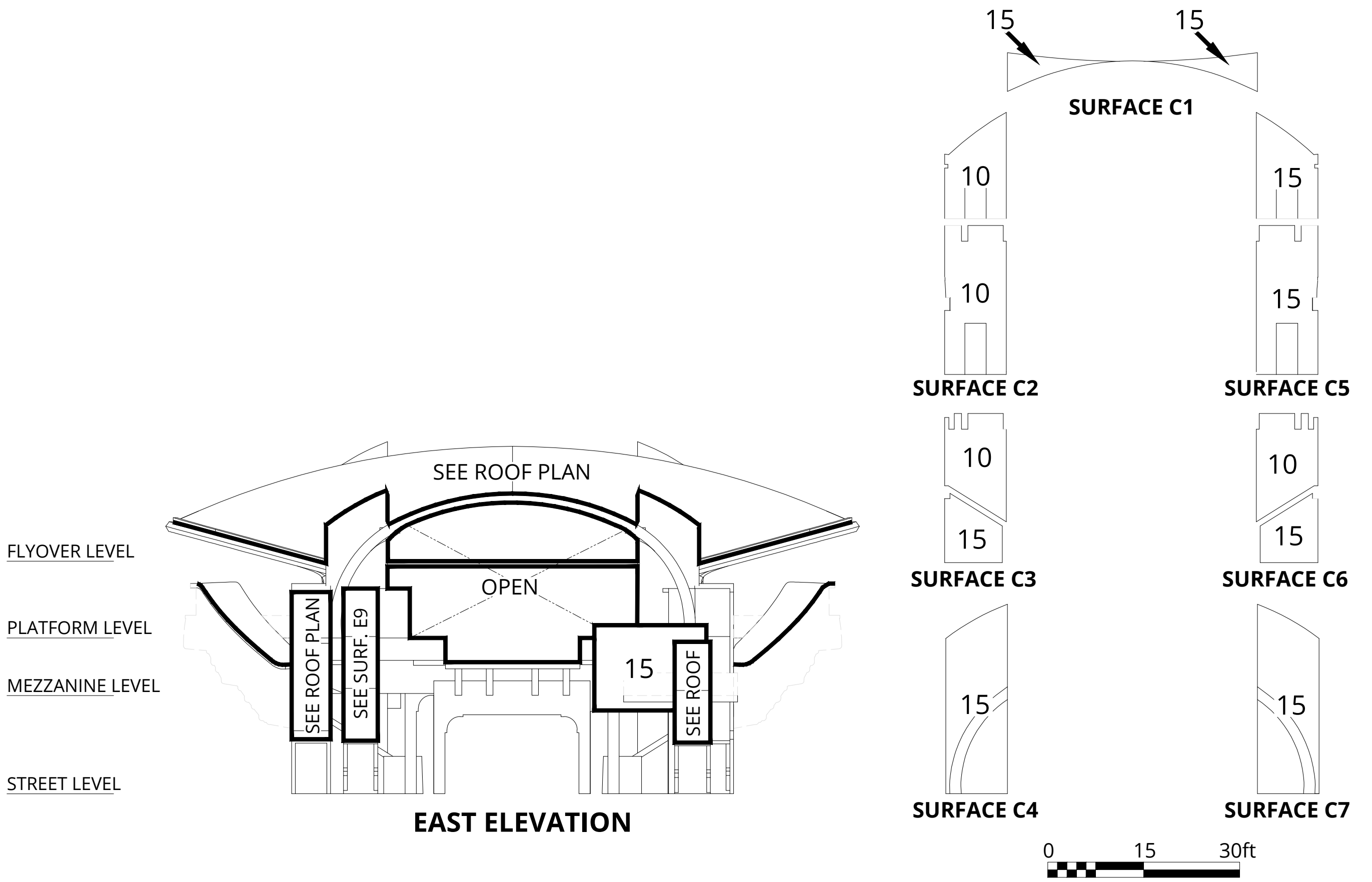
The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.



Isometric View of Wall Surfaces: West (B) & East (C)



WEST ELEVATION



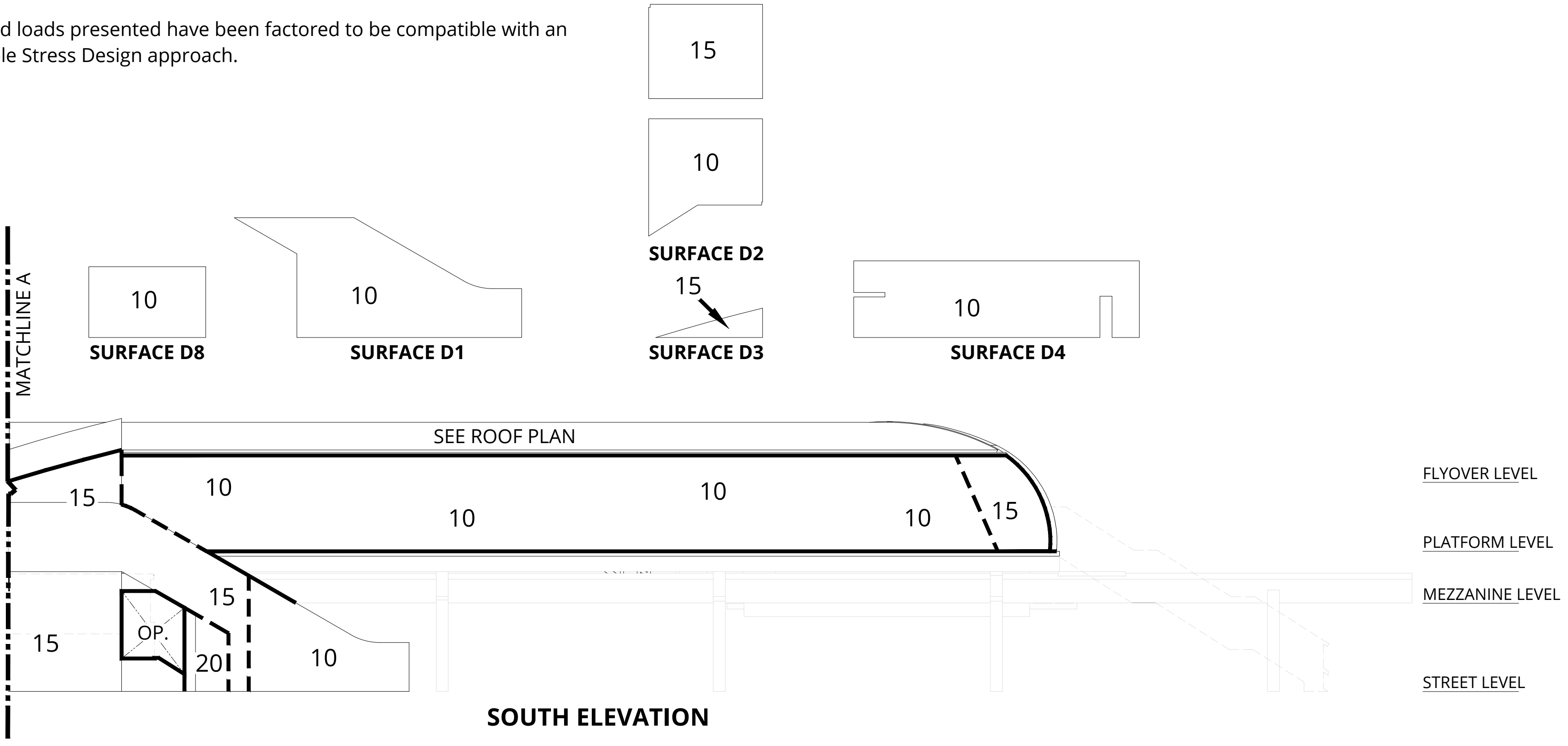
EAST ELEVATION

Recommended Wind Loads for Cladding Design (psf)
Peak Differential Positive Pressures
(Positive External Pressure with Negative Internal Pressure Where Applicable)
Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III
State & Lake Elevated Station - Chicago, IL

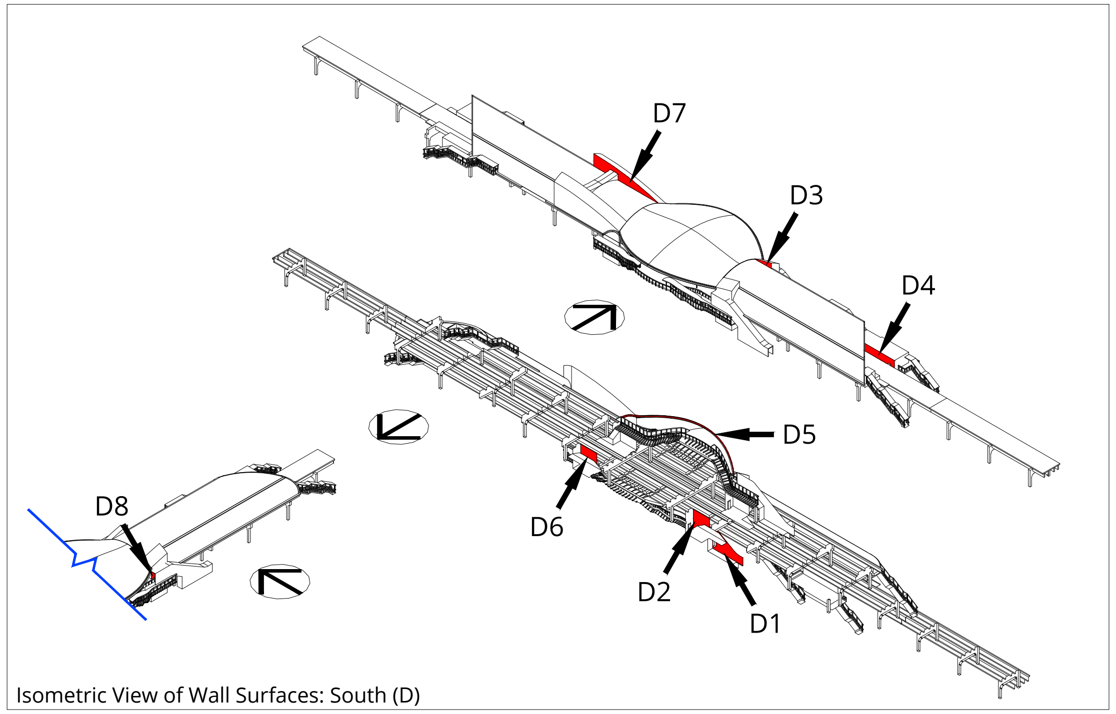
Project #2100248

Drawn by: DBB	Figure: 9
Approx. Scale:	1"=30'
Date Revised:	Aug. 27, 2021

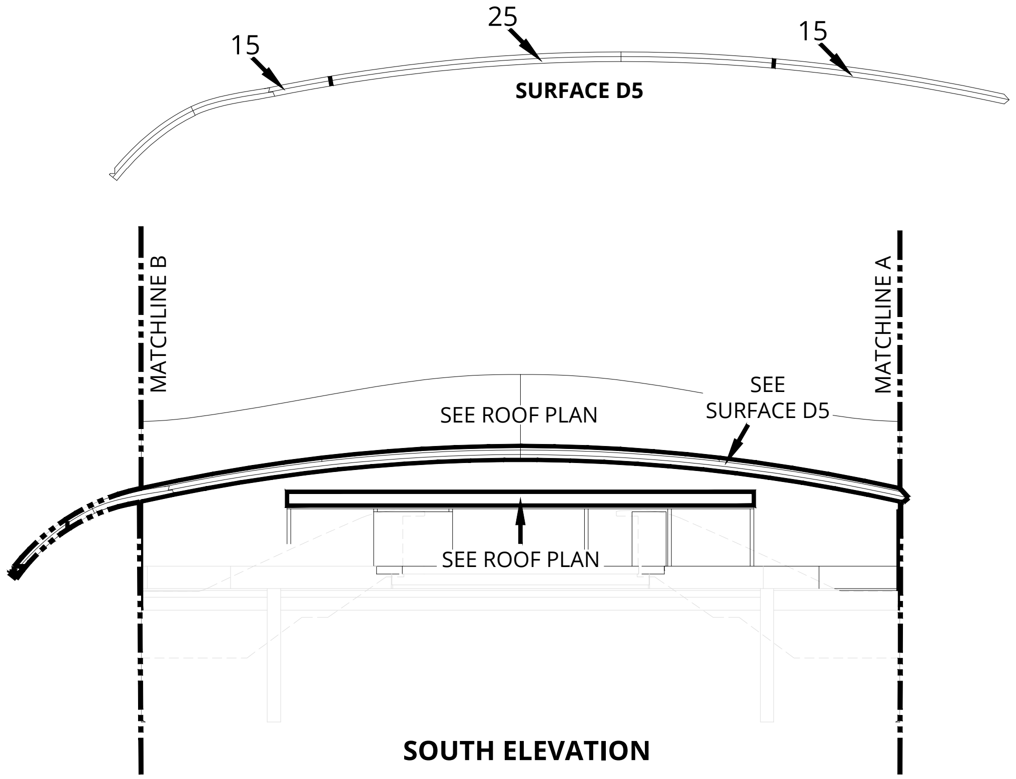
Note:
The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.



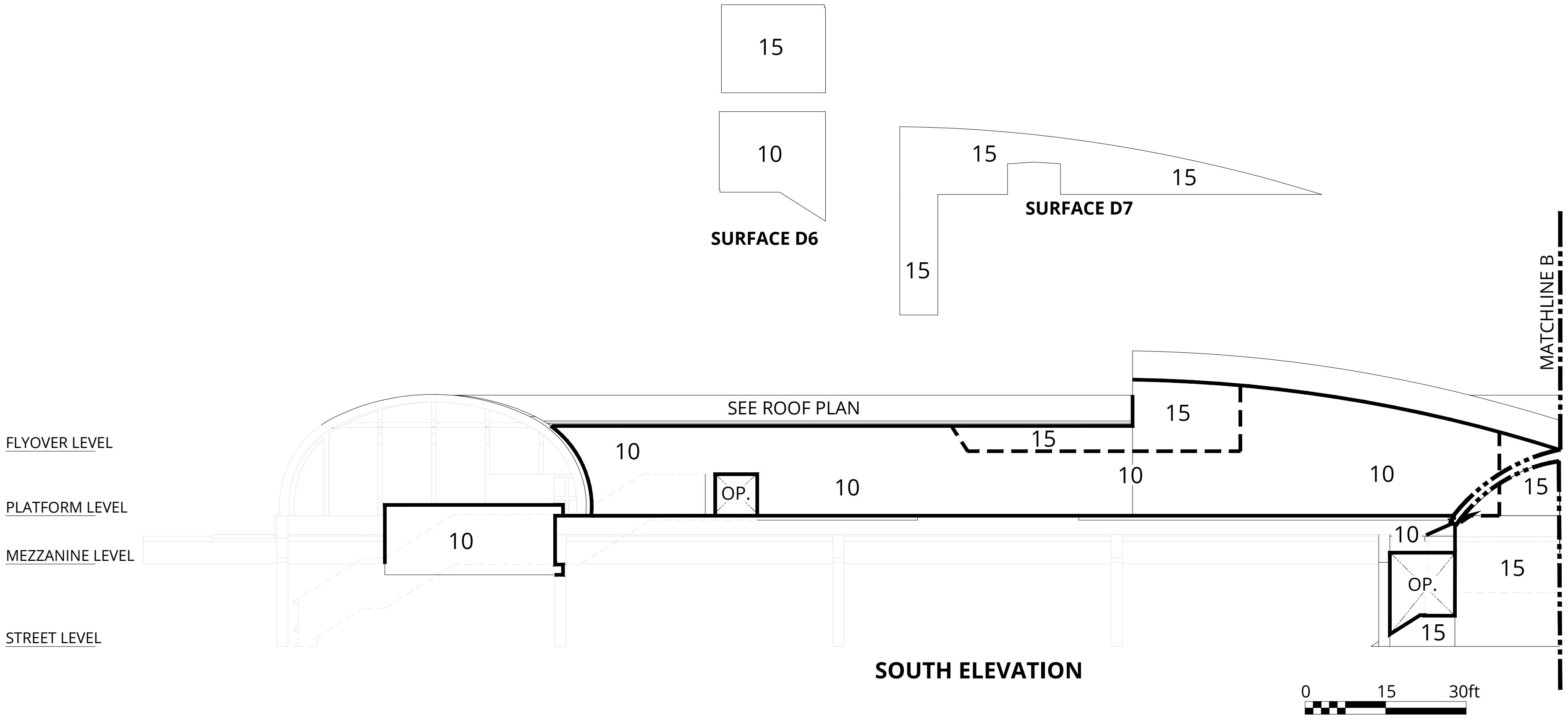
SOUTH ELEVATION



Isometric View of Wall Surfaces: South (D)



SOUTH ELEVATION



SOUTH ELEVATION

Recommended Wind Loads for Cladding Design (psf)
Peak Differential Positive Pressures
(Positive External Pressure with Negative Internal Pressure Where Applicable)
Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III
State & Lake Elevated Station - Chicago, IL

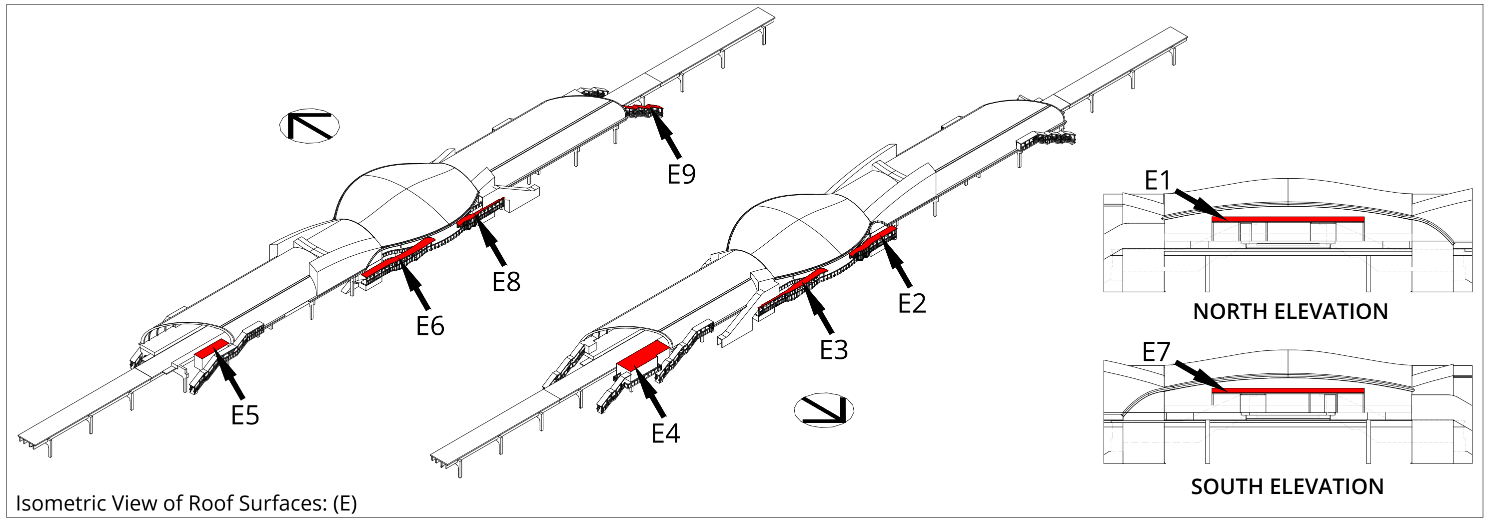
Project #2100248

Drawn by: DBB	Figure: 10
Approx. Scale:	1"=30'
Date Revised:	Aug. 27, 2021

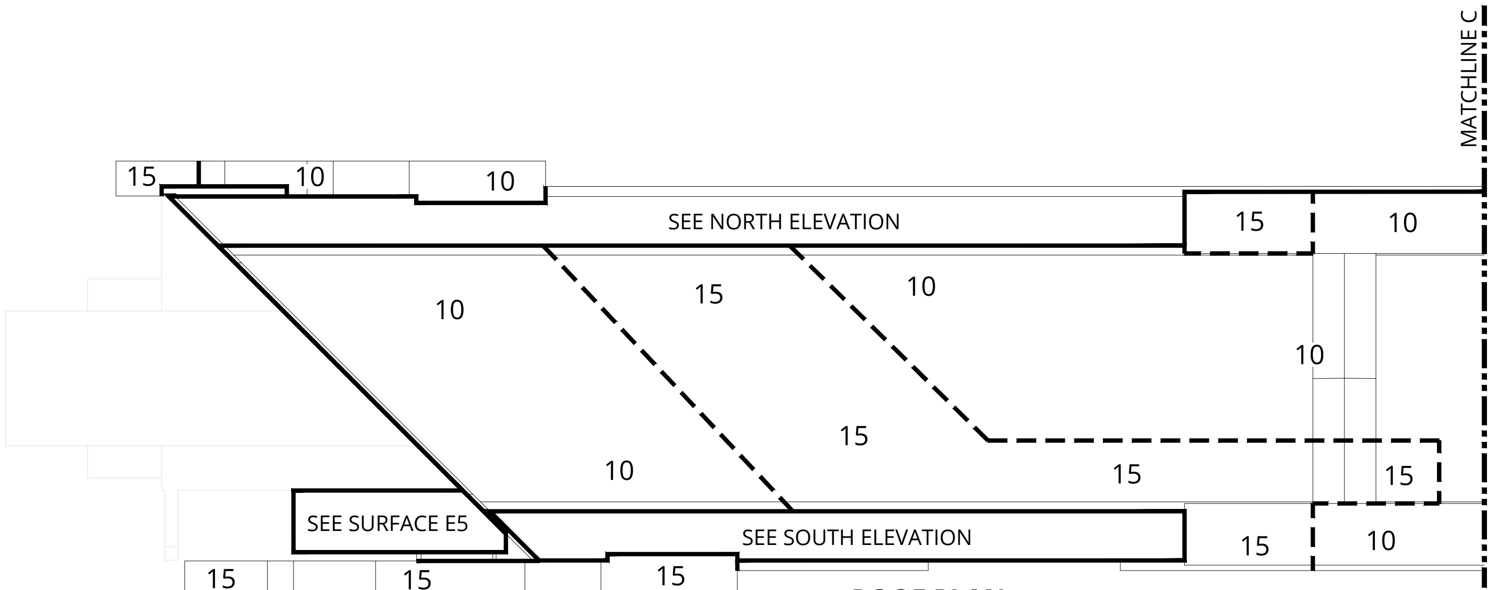
RWDI

Note:

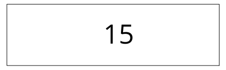
The wind loads presented have been factored to be compatible with an Allowable Stress Design approach.



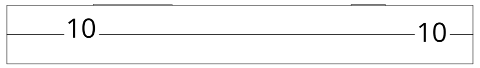
Isometric View of Roof Surfaces: (E)



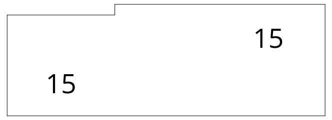
ROOF PLAN



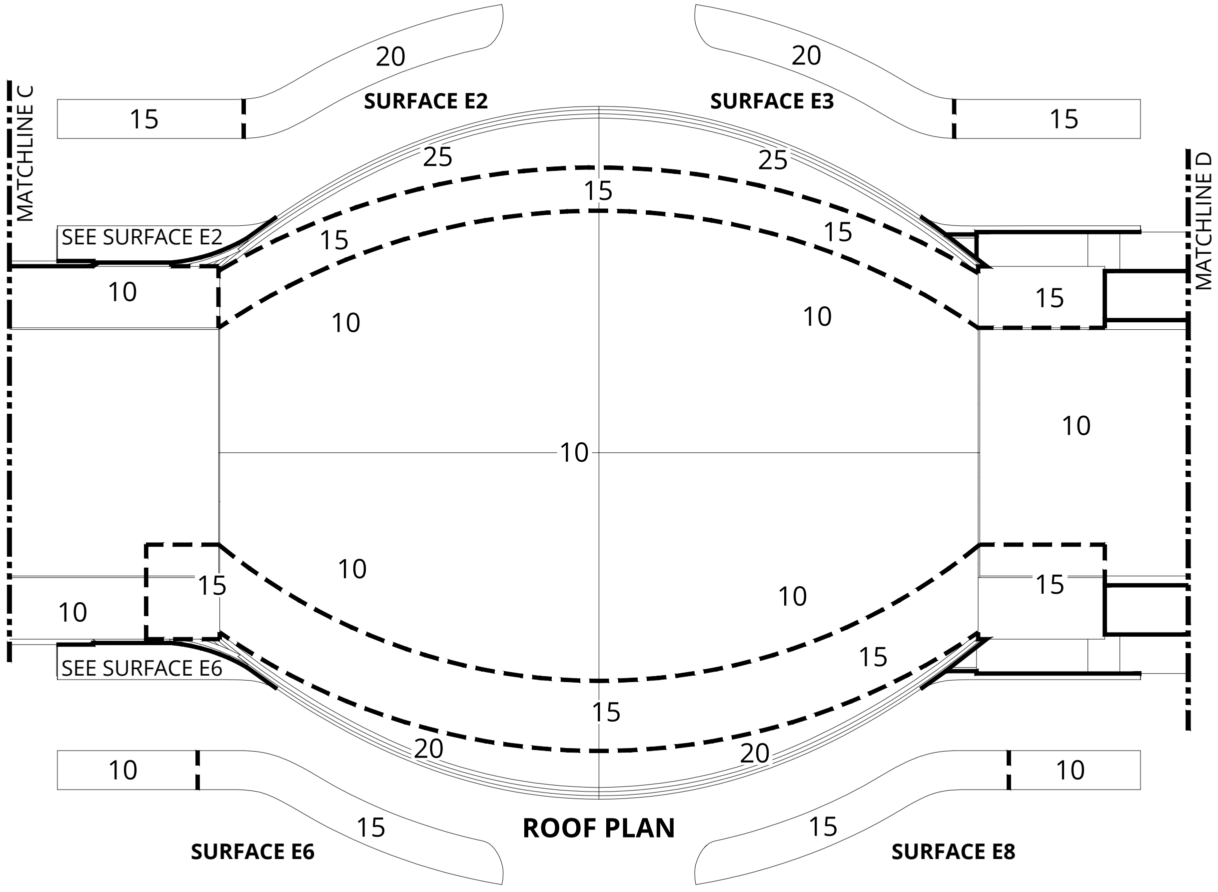
SURFACE E5

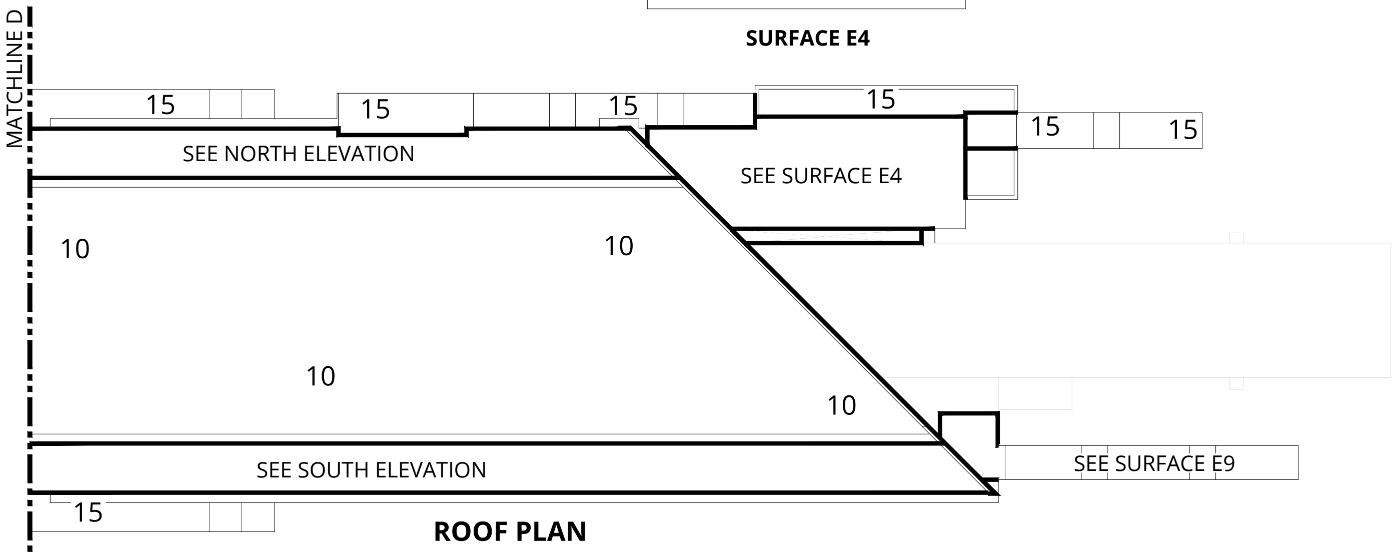


SURFACE E1

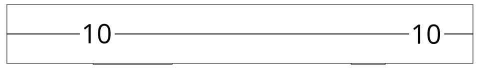


SURFACE E4

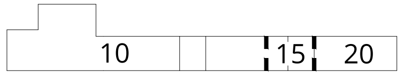




ROOF PLAN



SURFACE E7



SURFACE E9

0 15 30ft

Recommended Wind Loads for Cladding Design (psf)
Peak Differential Positive Pressures
(Positive External Pressure with Negative Internal Pressure Where Applicable)
Basic Wind Speed = 114 mph (3-Second Gust), Risk Category III
State & Lake Elevated Station - Chicago, IL

True North

Project #2100248

Drawn by: DBB	Figure: 11
Approx. Scale: 1"=30'	
Date Revised: Aug. 27, 2021	

APPENDIX A

APPENDIX A: WIND TUNNEL PROCEDURES

OVERVIEW OF WIND TUNNEL PROCEDURES FOR THE PREDICTION OF CLADDING WIND LOADS

A.1 Wind Tunnel Test and Analysis Methods

A.1.1 Wind Tunnel Tests

RWDI's boundary layer wind tunnel facility simulates the mean speed profile and turbulence of the natural wind approaching the modeled area by having a long working section with a roughened floor and specially designed turbulence generators, or spires, at the upwind end. Floor roughness and spires have been selected to simulate four basic terrain conditions, ranging from open terrain, or water, to built-up urban terrain. During the tests, the upwind profile in the wind tunnel is set to represent the most appropriate of these four basic profiles, for directions with similar upwind terrain. Scaling factors are also introduced at the analysis stage to account for remaining minor differences between the expected wind speed and turbulence properties, and the basic upwind flow conditions simulated in the wind tunnel. The full-scale properties are derived using the ESDU methodology[1, 2] for predicting the effect of changes in the earth's surface roughness on the planetary boundary layer. For example, this procedure distinguishes between the flows generated by a uniform open water fetch upwind of the site, versus a short fetch of suburban terrain immediately upwind of the site with open water in the distance.

Wind direction is defined as the direction from which the wind blows in degrees measured clockwise from true north. The test model (study model and surroundings) is mounted on a turntable, allowing any wind direction to be simulated by rotating the model to the appropriate angle in the wind tunnel. The wind tunnel test is typically conducted for 36 wind directions at 10° intervals.

It is prudent to take steps to ensure that the safety of a structure is not entirely dependent on specific surrounding buildings for shelter. Building codes often contain specific provisions to address this. These may include requirements to test with the more significant surrounding buildings removed, and/or lower limits on the reduction that is permitted compared to the code analytical approach.

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[1] Wind speed profiles over terrain with roughness changes for flat or hilly sites. Item No. 84011, ESDU International London, 1984 with amendments to 1993.

[2] Longitudinal turbulence intensities over terrain with roughness changes for flat or hilly sites. Item No. 84030, ESDU International London, 1984 with amendments to 1993.

A.1.2 Measurement Techniques

This study addresses the local wind pressures that act on the exterior envelope of the building. Predictions of these loads are required in order that the cladding system can be designed to safely resist the wind loads. The technique that is used to make these predictions consists of conducting a wind pressure study. The basis of the approach is to instrument a rigid wind tunnel model of the building with pressure taps that adequately cover the exterior areas exposed to wind. The mean pressure, the root-mean-square of pressure fluctuations and the peak negative and peak positive pressures are measured at each tap using a system capable of responding to pressure fluctuations as short as 0.5 to 1 second at full scale. The measured data are converted into pressure coefficients based on the measured upper level mean dynamic pressure in the wind tunnel. Time series of the simultaneous pressures are also recorded for post-test processing if required. A typical example of an instrumented wind tunnel study model is provided in Figure 1.

A.1.3 Consideration of the Local Wind Climate

Carrying out the procedures described in the previous sections determines the peak local external pressure coefficients expected for a given wind direction. However, in order to account for the varying likelihood of different wind directions and the varying strengths of winds that may be expected from different directions, the measured pressure coefficients are integrated with statistical records of the local wind climate to produce predicted peak pressures as a function of return period. In the case of cladding loads, it is appropriate to consider peak loads associated with return periods comparable to the design life of the structure. The choice of return period will be governed by local code requirements that consider the intended use of the building. For Allowable Stress Design, return periods of 50 or 100 years are often used for cladding design, to which appropriate load or safety factors are applied. For Limit States Design, return periods of 700 or 1700 years, without load or safety factors, are used to represent the ultimate state loading.

Wind records taken from one or more locations near to the study site are generally used to derive the wind climate model. In areas affected by hurricanes or typhoons, Monte Carlo simulations are typically used to generate a better database since full scale measurements, if available for a given location, typically provide an inadequate sample for statistical purposes. The data in either case are analysed to determine the probabilities of exceeding various hourly mean wind speeds from within each of 36 wind sectors at an upper level reference height, typically taken to be 600 m (2000 ft) above open terrain. This coincides with the height used to measure the reference dynamic pressure in the wind tunnel.

In order to predict the cladding wind loads for a given return period, the wind tunnel results are integrated with the wind climate model. There are two methods typically used by RWDI to perform this integration. In one method, the historical (or simulated as is the case with hurricanes or typhoons) wind record is used to determine the full-scale cladding wind pressures for each hour, given the recorded wind speed and direction and the wind tunnel predictions for that direction. By stepping through the wind speed and direction data on an hour-by-hour basis, a time history of the resulting peak pressure is generated. Then, through the use of extreme value fitting techniques, statistically valid peak responses for any desired return period are determined.

The second method is the Upcrossing Method as described by Irwin[3] and Irwin and Sifton[4]. In simple terms, this can be thought of as an analytical representation of the first method, in which a fitted mathematical model of the wind statistics is used in place of the detailed wind records themselves. The Upcrossing Method is currently used by RWDI for cladding wind load studies.

A.1.4 Design Wind Speeds in Hurricane/Typhoon Regions

It may be of interest to compare design wind speeds with the Saffir-Simpson hurricane categories, although this should be done with caution. In particular, while associating the building strength or performance with a given category of hurricane may sound appealing, it ignores the likelihood of that category of storm actually occurring at a given site. It also ignores the distinction between a direct hit from a weak hurricane compared with a glancing blow from a strong one. For this reason, when adopting criteria for both strength and serviceability, building codes and standards relate design wind speeds to return period rather than simply to storm categories or other similar systems.

The commentary to the ASCE 7-10 has a discussion in Section C6.26.5.1 regarding the relationship between the Basic Wind Speeds in the standard and the Saffir-Simpson scale. The Basic Wind speeds given currently in the ASCE 7 are 3-second gust speeds at 33 feet over land. The ASCE commentary also provides guidance on conversion to other wind speed durations *in the same terrain conditions*, which may be considered if the design wind speeds are taken from other sources.

Hurricane wind speeds commonly referred to with the Saffir-Simpson scale are 1-minute averages over water. The conversion between these different averaging times and terrain conditions is complicated by the fact that the effective roughness of the sea surface varies with wind speed. The ASCE commentary (Table C26.5-2) provides the following approximate conversions, reflecting research more current than was reflected in the ASCE 7-05:

Saffir/Simpson Hurricane Category	1-minute average speed, 33 ft (10 m) over water, mph (m/s)	3-second gust speed, 33 ft (10 m) over land, mph (m/s)
1	74-95 (33-43)	81-105 (36.2-46.9)
2	96-110 (44-49)	106-121 (47.4-54.1)
3	111-130 (50-58)	122-143 (54.5-63.9)
4	131-155 (59-69)	144-171 (64.4-76.4)
5	>155 (>69)	>171 (>76.4)

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[3] Irwin, P.A., “Pressure Model Techniques for Cladding Loads”, Journal of Wind Engineering and Industrial Aerodynamics 29 (1988), pg. 69-78.

[4] Irwin, P.A. and Sifton, V. L., “Risk Considerations for Internal Pressures”, Journal of Wind Engineering and Industrial Aerodynamics, 77 & 78 (1998), pg. 715-723.

It should be kept in mind that the ASCE 7 uses ultimate wind speeds. While this is the case for some other codes and standards, there are others which work with shorter return period wind speeds with a load factor to produce a design load effect. When commenting on the implications of the various storm categories on a specific structure, it is important to consider the code intent, including any load factors if applicable.

A.1.5 Internal Pressure Allowances Considering Localized Breaches in the Building Facade

In strong winds, air leakage effects dominate the internal pressures. Other factors that influence them, but are usually of less significance, are the operation of mechanical ventilation systems and the stack effect. Important sources of air leakage include uniformly distributed small leakage paths over the building's envelope and larger leakage paths. These larger leakage paths include window breakage due to airborne debris in a windstorm and open doors or windows, in cases where they are operable. The internal pressure allowances can be influenced by many factors including the size and location of potential glass breakage, the internal compartmentalization of the building and the internal volumes. During a major storm event, glass breakage can be different sizes and occur at various locations. There are many types of projectiles that typically cause glass breakage, ranging in size from small rocks to tree branches. Larger projectiles impacting the building would be rare events.

To evaluate the internal pressures resulting from dominant openings in the building envelope, simultaneous measurements are taken during the wind tunnel test between pairs of pressure taps located on building walls that share the same internal volume. Of particular interest are measurements taken in areas where large pressure differences can occur such as those that are generated at the corners of the floor plate. A single opening (worst case) scenario is typically considered since multiple leakage sources tend to reduce the magnitude of the internal pressure. Using an in-house approach, these data are analyzed to determine the range of internal pressures that may occur at selected opening locations and for a range of probabilities of these openings occurring. Lower probabilities are used in lower wind speed areas (i.e., – non-hurricane/non-typhoon areas), and higher probabilities are used in higher wind speed areas (i.e., – hurricane/typhoon areas) or for buildings that have a large number of operable windows or doors. Using these dominant opening probabilities, internal pressures are determined for the same level of risk as that assumed for the external pressures.

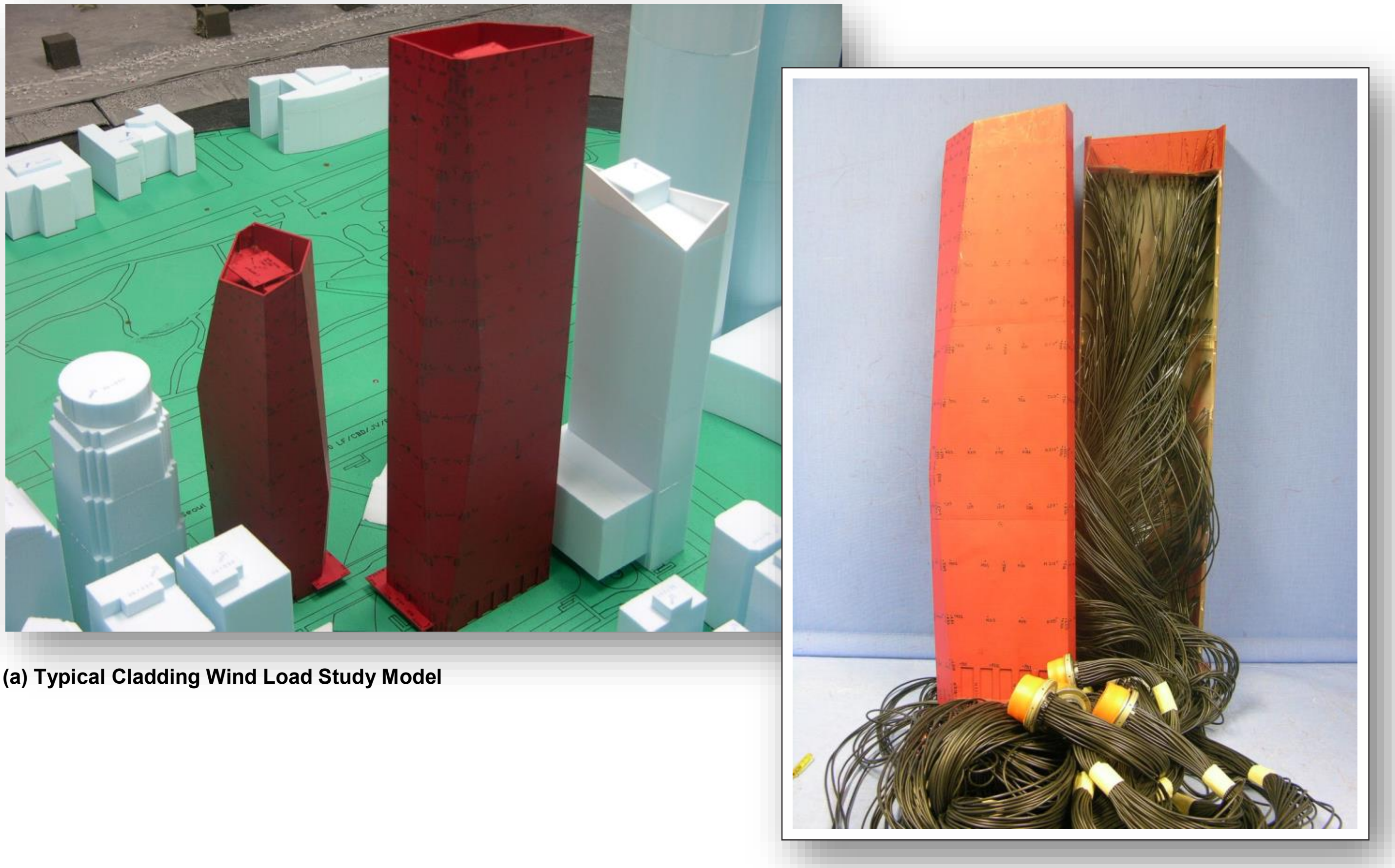
For buildings that use large missile impact resistant glazing everywhere, and do not have operable windows, the potential for breakage due to windborne debris is very low. As a result, the probability of an opening is also very low, and the internal pressures used are at or near the minimum considerations of a nominally sealed building.

The internal pressure allowances are applied to help reduce the possibility of subsequent facade failures due to pressure increases caused by localized breaches in the facade. Design of the cladding to the provided wind loads will not necessarily prevent breakage due to impact by wind borne debris.

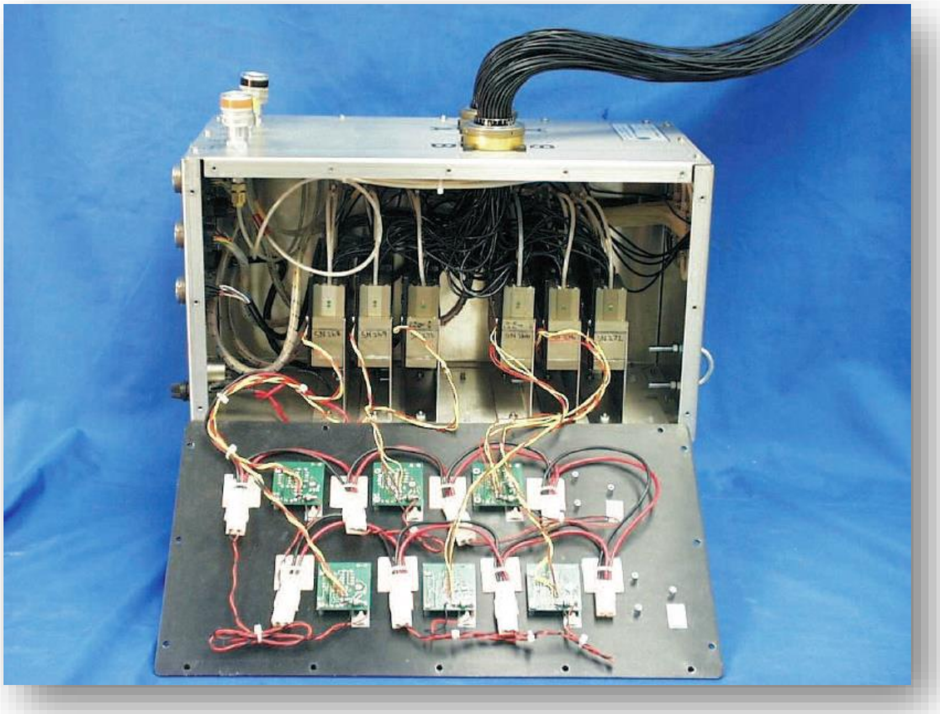
A.1.6 Allowable Stress Design: Comments on the Usage of Recommended Cladding Wind Loads for Glass Design in the United States

Glass is a material for which the strength depends on the duration of the applied load, varying approximately in proportion to $(1/T)^{1/16}$, where T = load duration. The glass strength curves in the ASTM E-1300 standard for various types of glass and sizes of panel are provided for a load of specified duration. The specified load duration is 3 seconds. This is consistent with wind loads calculated using the ASCE 7 analytical method, which have a duration in the 1 to 10 second range.

The wind- tunnel derived loads provided in the recommended cladding pressures report are for a duration consistent with that of the ASCE-7 analytical method (i.e., 1 to 10 seconds) and provide the same level of reliability as the analytical method.



(a) Typical Cladding Wind Load Study Model



(b) Data Acquisition

Measurement Techniques for the Prediction of Cladding Wind Loads

Figure: 1

Appendix A - Wind Tunnel Procedures

Date: December 2, 2016

APPENDIX B

APPENDIX B: DRAWING LIST FOR MODEL CONSTRUCTION

The drawings and information listed below were used to construct the scale model of the proposed State & Lake Elevation Station development. Should there be any design changes that deviate from this list of drawings, the results may change. Therefore, if changes in the design are made, it is recommended that RWDI be contacted and requested to review their potential effects on wind conditions.

File Name	File Type	Date Received (dd/mm/yyyy)
SL CTA STATION_Site_Platform_Stairs	Rhino	14/06/2021
2021.06.10 composite	Rhino	10/06/2021

APPENDIX I

SAFETY CERTIFICATION PROCESS PLANS

State/Lake Elevated Station Project

Safety and Security Certification Plan (SSCP)

Date: October 25, 2023

Revision 3.1

Prior Versions

Rev 1.0 July 1, 2022

Rev 1.1 August 30, 2022

Rev 1.2 January 10, 2023

Rev 1.3 February 1, 2023

Rev 1.4 March 8, 2023

Rev 2.0 April 13, 2023

Rev 3.0 May 5, 2023

Table of Contents

Concurrence and Approvals:

11/2/23

CDOT Project Manager — Date

10/31/23

Chief Engineer — Date

10/31/23

Chief Infrastructure Officer — Date

10/31/23

Vice President, Capital Construction — Date

William G. Poland 10/31/23

General Manager, Construction — Date

11/1/23

Chief Safety and Security Officer — Date

Abbreviations

AAR	After Action Reports
APTA	American Public Transportation Association
CAP	Corrective Action Plan
CCOT	CDOT's Consultant Construction Oversight Team
CCTV	Closed Circuit Television
CDOT	Chicago Department of Transportation
CEL	Certifiable Elements List
CFR	Code of Federal Regulations
CIL	Certifiable Items List
CIO	Chief Infrastructure Officer
CPT	CTA Project Team
CPTED	Crime Prevention Through Environmental Design
CSCC	Construction Specification Conformance Checklist
CSSO	Chief Safety and Security Officer
CTA	Chicago Transit Authority
DC	Design Consultant
DCCC	Design Criteria Conformance Checklist
DHS	Department of Homeland Security
FLSSC	Fire/Life Safety and Security Committee
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IDCM	Infrastructure Design Criteria Manual
IDOT	Illinois Department of Transportation
IL	Illinois
Mil. Std	Military Standard
NCR	Non-Conformance Report
OEMC	Chicago Office of Emergency Management and Communications
OHA	Operating Hazard Analysis
OPSA	Chicago Office of Public Safety Administration
PCO	Potential Change Order
PHA	Preliminary Hazard Analysis
PMOC	Project Management Oversight Consultant
PMP	Project Management Plan
PMT	Project Management Team
PSM	Program Standards Manual
RASP	Rail Agency Safety Plan
SCIL	Safety/Security Critical Items List
SEPP	Security and Emergency Preparedness Plan
SITP	System Integration Test Plan
SSC	Safety and Security Certification
SSCP	Safety and Security Certification Plan
SSI	Sensitive Security Information
SSMP	Safety and Security Management Plan
SSOA	State Safety Oversight Agency
SSPSP	System Safety Program Standard and Procedures
SSRC	Safety and Security Review Committee
T&I	Testing and Inspection
TSAP	Transit Service Activation Plan

TUN	Temporary Use Notice
TVA	Threat and Vulnerability Assessment
VP	Vice President

Referenced Documents

Safety and Security Management Plan	July 1, 2022
Department of Defense Standard Practice Military Standard 882 E	May 11, 2012

1.0 Introduction

Transit projects eligible for FTA Section 5309 funding or other forms of federal assistance require implementation of a Safety and Security Certification Plan (SSCP). This SSCP for the State/Lake Elevated Station Project (Project) was prepared in accordance with FTA guidelines, the Illinois State Safety Oversight (IL-SSOA) Program Standards Manual (PSM), Title 49 CFR Part 674, and Chicago Transit Authority (CTA) Infrastructure Design Criteria Manual (IDCM). This plan meets all requirements by presenting a process to verify the Project is, to the greatest extent possible, operationally safe and secure for passengers, employees, Consultants, Contractors, emergency responders, and the public. FTA has deemed the Project a Major Capital Project, as defined by 49 U.S.C. 5302(a)1, which is receiving federal financial assistance through the programs described at 49 U.S.C. 5307, 5309 or 5311. As such, it must complete Safety and Security Certification.

The Project construction will be managed by the City of Chicago Department of Transportation (CDOT), which also managed the Project design in partnership with the CTA. CTA will operate transit service during construction and will operate the station upon Project completion. As such, CTA will be the entity that completes the formal Safety and Security Certification (SSC) verification process in accordance with Federal and State regulations. CTA will work with CDOT and its contractors to identify the safety and security critical elements of the project, and to further establish the means and evidence by which CTA will seek to assure that hazards have been identified and appropriately eliminated or controlled throughout the Project. CDOT and its contractors will be responsible for gathering and maintaining the documentation necessary to provide these assurances.

1.1 Purpose

The purpose of SSC is to ensure all facilities and equipment, systems, and operational requirements including plans, rules, procedures, and training programs - are systematically reviewed and verified to comply with established system safety and security requirements prior to initiation of revenue service at the station. The CTA will run revenue service through the station during station construction, in accordance with Rail Bulletins, project TUNs, Slow Zone SOP-7038, 7041, and 7045 along with the Transit Service Activation Plan (TSAP). However, trains will not stop at the station during construction. SSC includes ensuring design or operating hazards and threats are identified, monitored, and properly controlled or mitigated, prior to certification. This SSCP therefore addresses all Project systems and equipment which may reasonably be expected to pose hazards and threats to CTA customers, employees, and emergency personnel. The plan identifies the technical and managerial tasks required during the design, and construction, concluding with the release to revenue service of the Project, in order to identify, assess and mitigate associated safety and security risks. The SSCP establishes the processes, responsibilities and documentation required for the Project to achieve the necessary SSC.

1.2 Certification Plan Goals

CTA, as a provider of a vital community service with the potential for accidents and incidents that can result in harm, will certify the Project. It will do so by verifying that CDOT, as manager of the Project has demonstrated that the Project is as safe and secure as possible for use by passengers, employees, consultants, contractors, emergency responders, and the public. CDOT will oversee construction of the station and will recommend safety and security certification of the Project elements and items to CTA for review and approval.

The overall goal of the SSCP is to document how CDOT, in consultation with CTA, will establish and approve safety design elements; how CDOT will monitor construction conformance, testing and documentation; and how CTA will verify completion of all necessary SSC actions. The resulting certification will be the based on the IL-SSOA PSM requirements for concurrence. This SSCP establishes a verification and validation process to ensure the following has been demonstrated:

- Compliance with federal, state, and CTA safety and security requirements;
- Compliance with the Project safety and security design criteria and the specification requirements; and
- Implementation of hazard controls or security countermeasures identified in the hazard analysis, safety assessment process, and the threat and vulnerability assessment process.

Specific SSCP goals include:

- Verify appropriate safety and security codes, standards, and guidelines have been incorporated into the design;
- Confirm a thorough and complete system safety and security process is followed throughout the project;
- Confirm all identified hazards and threats have been eliminated or controlled;
- Confirm normal and emergency hazard resolution methodologies have been implemented; and
- Verify all training required for safe and secure operation of the Project is complete.

1.3 Certification Plan Objectives

Specific certification plan objectives that support the above goals include:

- Ensure system safety and security are integral parts of design, procurement, construction, testing and operations;
- Ensure system safety and security decisions are made by appropriate Project Management Team (PMT) members, and committees;
- Identify specific safety and security requirements to assure the most comprehensive specifications possible to avoid inadvertent hazards and threats;
- Verify all documentation identified as critical to safety or security has been reviewed to ensure compliance with safety criteria;
- Verify that testing associated with elimination or control of hazards has been established, satisfactorily completed, and appropriately documented;
- Confirm user manuals reflect appropriate procedures for the control of hazards and include appropriate warnings and cautions required to promote safe operations;
- Verify maintenance and operational personnel are properly trained where training has been identified as a means to control safety risk;
- Ensure any system safety hazards and security threats or vulnerabilities that become apparent during reviews, audits, inspections or system testing are resolved;
- Verify that any safety or security mitigations are appropriately logged if they are not complete at the time of certification for revenue operations, and that this log is approved and monitored to timely and satisfactory completion;

- Identify and resolve hazards and security threats to CTA passengers, employees, Consultants, Contractors, emergency responders, property, and the public;
- Ensure emergency response agencies, including fire and police departments, are prepared to respond to normal, abnormal, and emergency situations;
- Ensure documentation and certification of the safety and security of the Project;
- Verify analysis of the severity, probability, and risk of the identified hazards and threats; and
- Confirm that appropriate tests and inspections were performed.

1.4 Certification Plan Scope

The SSCP scope includes the activities necessary to verify acceptable levels of safety and security for the Project have been achieved. The SSCP encompasses three (3) overlapping functional areas: System Safety Engineering, Fire and Life Safety, and Occupational Safety.

The SSCP scope includes certification of the Project Safety and Security Certificate and Certificates of Conformance for each element; CTA is authorized to issue Temporary Use Notices (TUN) for planned operable segments with restrictions for multiple construction stages. Project components to be certified may include, but are not limited to, the following:

- Train Control System (Signals)
- Track and Structure
- Traction Power System
- Communications System
- Mechanical/Electrical/Plumbing
- Civil
- Maintenance Plans
- Procedures
- Training

1.5 Certification Methodology

The certification methodology as outlined in FTA's Handbook for Transit Safety and Security Certification is defined as self-certification with internal and external assistance and oversight from CTA Safety Department, CTA Quality Assurance, PMT, IL-SSOA, and Federal Transit Administration's (FTA) Project Management Oversight Consultant (PMOC), as required. The IL-SSOA is the Illinois Department of Transportation (IDOT). CDOT is the entity administering the construction contract, and will monitor the completion of actions necessary to the certification of certifiable elements and collect and document evidence to provide to CTA for its review. CDOT will employ a Consultant Construction Oversight Team (CCOT) to oversee day-to-day project activities. This CCOT will act as CDOT’s agent and will upload the evidence of compliance through CTA’s e-Builder system for CTA review and certification.

The SSCP is structured around, but not exclusive to, the FTA's Handbook for Transit Safety and Security Certification, which consists of a 10-step certification process with related certification tasks and activities. Section 4 explains how each step will be applied to the Project.

1.6 Revisions

This SSCP will be reviewed and, if needed, updated whenever the Project Management Plan (PMP) and Safety and Security Management Plan (SSMP) are updated, or at critical milestones of the Project life cycle. These updates will reflect any changes to the PMP, SSMP, project design criteria, and any other project documentation that will affect the SSCP. This update will be reviewed by the FTA's PMOC, as applicable, to ensure compliance with FTA's guidance, and by the IL-SSOA per the IDOT PSM, or upon request.

2.0 Program Management, Organization and Responsibilities

The SSCP will be implemented by the PMT. The PMT will ensure the execution of the SSCP and certification related activities and tasks. The CTA Project Team will verify the certification related activities and tasks are completed in preparation for self-certification. The PMT consists of several relevant entities CDOT, CCOT, DC, Contractor. The PMT is further defined in section 2.2.7. It should be noted CDOT is responsible for implementing the SSCP and can delegate certain activities to relevant entities, however CDOT cannot delegate its accountability to the SSC process and will ultimately held accountable by CTA for the SSCP process.

CDOT and CCOT will conduct a weekly construction coordination meeting with the contractor and CTA staff which will include CTA Safety Department representatives. CCOT will transmit information for CTA safety's review of certification documents through the e-Builder document management system monthly.

External oversight of the development and implementation of the SSCP is performed by FTA's PMOC and IL-SSOA as illustrated in Appendix A. FTA Safety and Security Readiness Reviews occurring quarterly, will evaluate the effectiveness of the implementation of the SSCP. The CTA Safety Department will provide certification status reports at monthly and quarterly meetings with the FTA PMOC and will be the conduit of Project information and submittals to the IL-SSOA, such as by inviting the IL-SSOA to attend meetings of the SSRC and providing Project documentation in accordance with the IDOT PSM.

IDOT and City of Chicago (other departments besides CDOT and public ROW construction work permitting within CDOT) are also external influences in the project. IDOT is responsible for statewide coordination of multi-modal transportation planning and funding. The City of Chicago is responsible for regulating building construction, streets, underground construction, zoning, utilities and storm water management within the city limits. CDOT will initiate coordination with various City departments in order to secure approval and building permits for the proposed work.

Figures 1-4 show the process flows that will occur for SSC for this project.

Figure 1 – Illustrates the Final Design Phase Roles and Responsibilities

Figure 2 – Illustrates the Construction/Integrated Testing Phase Roles and Responsibilities

Figure 3 – Illustrates the Non-Revenue/Revenue Service Roles and Responsibilities

Figure 4 – Illustrates the SSC Submission Process to IL-State Safety Oversight Agency (SSOA)

2.1 Project Safety Authority

For this project, the CDOT is the project sponsor, and the FTA grantee. CDOT administers the design and construction processes, and this project is a partnership with CTA as described in the PMP. CDOT will construct the project and will be responsible for implementation of the safety certification processes. CTA will perform an oversight role of the safety certification program including final sign-off of the certification. CTA will be the sole maintainer and operator of the facility. While CDOT will retain ownership of the station, it will not manage, maintain, repair, oversee, or operate it or transit service through it.

Additionally, CTA is the current owner and operator of the station, and owns most facilities related to the station, such as the track and track structure, traction power distribution system, train control signals, public address and communication systems, fare collection system, and advertising. Additionally, CTA positions 1 or 2 customer assistants at this station, per a schedule that they maintain. CTA operates the fixed guideway, rapid transit trains that service this station and will continue to do so in the new station. Train service on these lines through this station will continue operations during construction, although the station itself will be closed.

Therefore, while certain safety considerations will be completed by CDOT during design and construction, responsibility for safety reviews and approval will be through CTA.

2.2 Project Phases

Final Design Phase- includes planning and preliminary engineering to encompass project feasibility, research, cost estimates and project impacts. This phase concludes with a formalized concept engineering development, plans, specifications, and bid documents required for awarding the individual construction and equipment fabrication and installation contracts.

Construction/Testing Phase- begins with the development, fabrication, or construction of the engineered design and concludes with the delivery of the completed project. This phase includes the inspection, review, verification, and validation of the delivered project and concludes with the determination that the delivered project meets the engineering specification.

Non-Revenue/Revenue Services Phase- begins with the identification and performance of tests, drills, exercises, and audits designed to verify the functional capability and readiness of the system as a whole and concludes with verified documentation of readiness for revenue operations.

2.3 Organizational Responsibilities

The PMT in collaboration with CTA is responsible for system safety and security certification. System safety and security tasks include review of all designs for safety components and elements, hazard analysis, safety and security certification, TVAs, and special studies related to specific safety and security issues.

Table 1, at the end of Section 2 of this document, outlines the Project safety and security certification responsibilities for the PMT and CTA Project Team. These responsibilities are directly related to accomplishing the safety and security certification process.

2.3.1 CTA Chief Safety and Security Officer

The Chief Safety and Security Officer (CSSO) is accountable for completing the SSC of the Project, ultimately by reviewing and approving the Safety and Security Certification Verification Report and seeking concurrence by the IL-SSOA. In support of its role in verifying the documentation and evidence provided to support certification, the CTA Safety Department is responsible for assisting in the identification of safety critical elements; assisting in safety risk assessments and approving (via its role on the SSRC) plans and actions to reduce or eliminate safety risk; and monitoring Project progress with respect to the completion of SSC requirements. The CSSO has designated the Senior Project Manager, Safety & Security Certification to perform the responsibilities of SSC implementation on the department's behalf, including acting as liaison to the IL-SSOA. The CSSO has designated the General Manager, Construction Safety & Engineering as a safety representative and subject matter expert in reviewing Project design and construction conformance documentation. Other responsibilities include:

- Coordinate, in conjunction with the Certification Manager, all project certification requirements as outlined in this SSCP;
- Review, update, and approve the SSCP;
- Monitor the design and construction change order process for potential safety and security issues;
- Conduct safety reviews on all construction change orders and modifications and track all issues throughout the construction phase through resolution to the satisfaction of the SSRC;
- Support the PMT in identification and approval of Safety Certifiable Items and Certifiable Elements;
- Report to SSRC on the progress of the Hazard Resolution and the Safety and Security Certification (SSC) effort;
- Report management and technical concerns to the SSRC;
- Ensure that all operational Certifiable Items Lists (CILs) requiring safety and security training or policies/procedures are developed and approved for certification purposes;
- Advise on the preparation of the Safety and Security Certification Verification Report;
- Submit required updates to IL-SSOA, as requested; and
- Review the State and Lake Elevated Station PMP and SSMP.

2.3.2 CTA Security

Security critical elements are defined as those elements that must be certified to ensure all identified threats and vulnerabilities related to the project have been eliminated or controlled. CTA Security will work with the PMT to ensure the following:

- Security requirements are incorporated in project designs and specifications;
- Development of the security aspects of compliance checklists;
- Security verification documentation supports compliance with the security requirements; and
- An appropriate security risk index is assigned to an identified vulnerability or threat, based on severity and probability.

2.3.3 CTA Chief Infrastructure Officer

The CTA Chief Infrastructure Officer (CIO) has overall responsibility for implementation of the capital program and ensures ongoing oversight and control of Infrastructure activities. The CIO reports directly to the CTA President and has the Vice President, Capital Construction and Chief Engineer as direct reports. The CIO will approve the SSCP.

2.3.4 CTA Vice President (VP), Capital Construction

The primary responsibilities of the VP are to:

- Verify and account for the project's operations and activities in the infrastructure construction area,
- Report on progress of this Infrastructure construction project.

The VP also monitors and evaluates infrastructure standards to ensure superior quality is maintained in all areas of CTA construction, approves Contract payments and meets regularly with all CTA General Managers to ensure that construction programs and plans are effectively coordinated. The VP reports directly to the CIO and has all General Managers of Construction as direct reports. The VP of Capital Construction will approve the SSCP

2.3.5 CTA Chief Engineer

Primary responsibilities of the Chief Engineer are as follows :

- Reviews design Consultant milestone deliverables to assure the design meets CTA standards regarding functionality, constructability and Engineering criteria;
- Reviews all external firms' submittals;
- Approves use of new technology and materials;
- Participates in the recommendation of engineering solutions for construction deficiencies; and
- Reviews and approves all requests for information.

The Chief Engineer reports to the CIO and has direct reports from the Engineering sections. The Chief Engineer will approve the SSCP

2.3.5.1 CTA Certification Manager

The Project Manager Systems Certifications is designated as the Certification Manager and reports to the Manager, Quality Assurance Design & Construction who intern reports directly to the Chief Infrastructure Officer. The Certification Manager will coordinate with the Senior Management and the appropriate parties within the CDOT and CTA organizations to monitor the implementation of the SSCP and to verify completion of all tasks that address safety and security certifiable elements.

Beginning with the Preliminary Engineering through the Final Design Phase, specific responsibilities include:

- Advisory role on the Development and implementation of the SSCP;
- Advisory role on the Development and implementation the SSMP;
- Work with other departments within CTA and external agencies to identify and define the certifiable elements, items, and safety and security requirements;

- Work with CTA Engineering, CDOT, and DC to develop the Design Criteria Conformance Checklist (DCCC);
- Review PHA;
- Review TVA;
- Assist in the determination of hazard severity, probability, and hazard risk index of identified hazards;
- Assist in the determination of threat/vulnerability severity, likelihood, and threat/vulnerability risk index of identified threats and vulnerabilities;
- Report progress of the safety and security certification effort to the SSRC, CTA, and external stakeholders;
- Review the safety and security certification process, as required;
- Review and update the SSCP, as needed, at significant project phases including construction, testing, and Non-revenue/Revenue operations;
- Review the Construction Specification Conformance Checklist (CSCC);
- Review verification documentation for each certifiable element to ensure conformance with the identified safety and security requirements;
- Verify mitigation measures are closed on PHA and TVA;
- Advise the SSRC of documentation discrepancies or completeness that require resolution; and
- Verify Certificates of Conformance for each certifiable element are completed.

2.3.6 CTA General Manager, Construction

The General Manager (GM), Construction will approve the SSCP and is responsible for project construction oversite. Additional responsibilities include the following:

- Participate as an active member of the SSRC and FLSSC;
- Review and consider all design related recommendations from PHAs and TVAs during the applicable Project design criteria review process. This effort includes consideration of all safety and security design review comments during the preliminary engineering and final design phases;
- Ensure the CCOT utilizes the Project Website to facilitate the certification process and validation. This should include a submittal filing system and submittal tracking log;
- Ensure the PMT develops construction safety and security programs as outlined in the specifications;
- Ensure the PMT meets all specification requirements;
- Ensure the PMT performs detailed activities related to system safety and security including documentation and record keeping; and
- Review and verify successful test program activities identified in the specifications and as outlined in the CILs;

2.3.7 Project Management Team (PMT)

The PMT includes the DC, CDOT, CCOT, and contractor, which will meet weekly or as needed. CDOT will chair the meetings.

The DC is responsible for directly preparing designs and overseeing the preparation of designs by any subcontracted design firms. For the Design Phase, the CCOT and contractor will not be involved. For the Construction Phase, the DC will not be involved. Specific PMT responsibilities related to safety and security certification include the following:

- Assure design incorporates safety and security standards and regulations; including completion of DCCCs. (CDOT)
- Develop and maintain design documents, respond to safety and security design review comments, and incorporate required changes; (CDOT)
- Implement the safety and security certification program; (CDOT)
- Include requirements for hazard analysis and resolution activities in Contract documents; (CDOT—CCOT;)
- identify and report hazards; (CDOT)
- prepare hazard analyses and track process through final resolution; (CDOT)
- maintain hazard analysis records; (CDOT)
- Include requirements for security and threat vulnerability assessment in Contract documents, as appropriate; (CDOT—CCOT)
- Participate in safety and security reviews and presents data to demonstrate compliance, as required, (CDOT)
- Review the draft PHAs and address all design related hazards. Once the PHAs are finalized, identify where in the design specification and drawings the hazards are addressed for verification purposes; (CDOT)
- Populate the DCCCs with whether the items can be found for verification purposes in the construction specifications, drawings, calculations, or another location; (CDOT)
- Define training requirements, and review training programs and manuals submitted by Contractors; (CDOT)
- Perform design services during Construction activities, as required; (CDOT/DC)
- Establish a hazard/threat/vulnerability log to track all identified safety hazards and security threats/vulnerabilities to resolution; (CDOT)
- Review verification documentation for each certifiable element to ensure conformance with the identified safety and security requirements; (CDOT)
- Track the PHA and TVA mitigation measures to closure; (CDOT)
- Prepare Certificates of Conformance for each certifiable element and the completed system; and (CCOT/CDOT)
- Ensure the Project management organization (internal and Consultants) incorporates safety and security requirements into the project specifications. (CDOT)

Thereafter, during construction, specific PMT responsibilities for related to safety and security certification include the following; the DC will not be involved in the construction phase:

- Actively participate as non-voting members of the SSRC;
- Support and implement the safety and security certification process for all identified safety and security CELs; and (Contractor, CCOT, CDOT)
- Complete all safety and security certification documentation including CELs/CILs, and Construction Specification Conformance Checklist (CSCC) from approved DCCC. (CCOT/CDOT)

2.3.8 CTA Project Team (CPT)

The CTA Project Team consists of CTA Project Manager, CTA Senior Manager, Construction Safety, CTA General Manager of Construction Safety & Engineering, CTA Senior Manager, Quality Assurance and Program Certification, Senior Project Manager, Safety & Security Certification, and CTA Certification Manager. Their responsibilities include but not limited to the following:

- Verify the final design conforms to design criteria and standards, (CTA)

- Review and Verify implementation of the safety and security certification program, i.e., SSCVR, TUNs, SSC Certificate, DCCC Certificates of Conformance and CSCC; (CTA)
- Review requirements for hazard analysis and resolution activities in Contract documents; (CTA)
- Review and verify training requirements are clearly defined.
- Review and verify training programs and manuals are implemented, effective, and submitted by Contractors (CTA).
- Review and verify all identified safety hazards and security vulnerabilities are closed. (CTA)

2.3.9 CDOT Consultant Construction Oversight Team (CCOT)

Specific CCOT responsibilities related to safety and security certification include:

- Participate as an active member of the SSRC;
- Develop the CSCC from the final design specifications and submit to CTA for review and approval;
- Assure all Contractor testing requirements are identified, and an Integrated Test Plan is developed and updated as required;
- Utilize the Project Website/e-Builder for submittal tracking to facilitate the SSC process and validation of tests. This should include a tracking system for all construction change orders and modifications;
- Provide construction and modification submittal logs upon request, and have submittal files available for review;
- Perform detailed activities related to system safety and security, including documentation and record keeping;
- Complete (or oversee contractor's completion) and document test program activities identified in the specifications. Specifically, the test programs and reports listed in the construction packages safety and security CELs/CILs;
- Identify, manage, and track hazard resolution activities;
- Ensure timely delivery of system safety and security deliverables;
- Provide monthly updates for the Testing and Start-up Integrated Schedule;
- Perform safety and security inspections and tests required for the completion of the CSCC;
- Request variances or exceptions when items cannot be designed or constructed in accordance with the Design Criteria;
- Review, revise, and/or develop safety analysis and security assessments for CTA review and acceptance;
- Close all identified safety hazards and security vulnerabilities;
- Notifying CTA of any proposed changes to safety and security design criteria and requirements;
- Participate in and provide safety and security inputs for design reviews, emergency drills, test plans, and start-up plans; and
- Validation and verification process implemented by supplying supporting documentation as required for CTA Review and acceptance.

2.3.10 CDOT Contractor

Specific contractor responsibilities related to safety and security certification include:

- Develop Integrated Test Plan and update as required;
- Perform testing and validation of the CELs/CILS for certification purposes;
- Complete and document test program activities identified in the specifications. Specifically, the test programs and reports listed in the construction packages safety and security CELs/CILs;
- Assist in the development of the CSCC from the final design specifications and submit to CTA for review and approval;
- Ensure timely delivery of system safety and security deliverables; and
- Provide monthly updates for the Testing and Start-up Integrated Schedule.

2.3.11 CTA Rail Operations

Specific Rail Operations responsibilities related to safety and security certification include:

- Participate as an active member of the SSRC;
- Provide technical support for all rail operational aspects of the Project;
- Participate in the safety and security design review process;
- Review and provide comments on the operational and service restoration testing CELs/CILs;
- Ensure all required operational training materials, policies, and procedures are developed, updated, executed, and in compliance with approved operational CELs/CILs for certification purposes; and
- Develop Rail Service Activation Plan Charter
- Review and comment on a Rail Service Activation Plan(s) and complete assigned items identified therein.

2.3.12 CTA Quality Assurance

Specific Quality Assurance responsibilities related to safety and security certification include the following:

- Ensure FTA QA/QC program requirements are implemented;
- Participate in SSRC meetings; and
- Verify development and implementation of Quality Programs by CCOT and CDOT.

2.3.13 Project Specific Safety and Security Review Committee (SSRC)

The purpose of the SSRC is to review all safety and security certification documentation to determine if any outstanding items remain, before revenue service begins, and prior to completing its formal certification. The SSRC will develop a charter to detail the conduct of the meeting. The SSRC is accountable to CTA Senior Management for the overall conduct and implementation of the SSCP and approval of the certification documentation, in accordance with the SSCP.

The SSRC meets monthly or as needed. The members of this committee are listed below.

Voting Members include:

- Chair: (Certification Manager)

- Certification Manager
- Safety – Vice President
- Safety - General Manager, Construction Safety & Engineering;
- Safety -Sr. Project Manager
- Security - Vice President;
- Construction - Vice President;
- Construction - General Manager;
- Infrastructure Chief Engineer;
- Rail Operations;
- Infrastructure Maintenance – Vice President;
- Facilities Maintenance – General Manager;
- Power & Way Maintenance (Track and Structural) – General Manager; and
- Power & Way Maintenance (Signal) – General Manager.

Non-voting members from interested parties may include:

- IL-SSOA;
- Vehicle Maintenance;
- CDOT; and
- CCOT.

The SSRC's activities include, but are not limited to, the following:

- Oversee all safety and security efforts;
- Review safety and security certification of system elements including CELs/CILs and hazard analysis;
- Monitor the implementation of Hazard Management activities;
- Review IDOT reportable Incident/Accident Investigation reports;
- Review security breaches;
- Review and approve the hazard resolution documentation process and the TVA process outlined in the SSCP;
- Review and approve the PHA and TVA to include significant subsequent updates;
- Approve safety and security certifiable elements, sub-elements, CILs, and design criteria conformance checklists of the civil, facilities, and systems designs;
- Establish a risk acceptance process;
- Evaluate Contractor deliverables and hazard resolution methodologies;
- Evaluate Contractor deliverables such as systems integration test procedures, operations and maintenance procedures and manuals;
- Recommend the best technical approach regarding resolution of identified system safety and security design issues, PHAs, and OHAs;
- Review and evaluate th hazard severity, probability, and hazard risk index of identified hazards presented to the committee;
- Evaluate proposed hazard and threat resolution methodologies and evidence of compliance to safety and security requirements; and
- Evaluate project compliance with safety and security certification requirements.
- The SSRC is accountable to senior management for the overall conduct and implementation of the SSCP and approval of the certification documentation, in accordance with the SSCP. As such, SSRC voting members must be CTA employees.

2.3.14 Fire/Life Safety and Security Committee (FLSSC)

The FLSSC serves as a liaison among CTA Safety, CTA Security and local police, fire, and emergency response agencies. The FLSSC is comprised of local fire jurisdictions and police jurisdictions, Transportation Security Administration representatives, Chicago Office of Emergency Management and Communications (OEMC), Chicago Office of Public Safety Administration (OPSA), IDOT, and local emergency response agencies, along with key CTA management staff from Transit Operations, Security, Safety, Technology, and Infrastructure, including PMT representatives. This committee is chaired by the Senior Manager of Emergency Preparedness and meets monthly, or as needed. The FLSSC activities include the following:

- Review industry standards, safety-related designs, and tests to verify fire/life safety code and regulation compliance;
- Review and provide comments to the SSRC on all related operational CELs/CILs for verification purposes;
- Address unique emergency response requirements;
- Address preparedness issues and reviews variances;
- Coordinate and schedule emergency response readiness drills for both tabletop and full-scale exercises. This includes the evaluation of all emergency exercises After Action Reports (AARs) and implements corrective action prior to restoring service;
- Coordinate and schedule Responder Orientation; and
- Identify, coordinate, and schedule specific training requirements for the emergency responders that relate to the station configuration, hazards along the rail right-of-way, traction power and rail maintenance facilities.

The organization, additional responsibilities, and overall agency functions of the FLSSC are described in the Public Transportation Agency Safety Plan (PTASP) and the Security and Emergency Preparedness Plan (SEPP).

Table 1. Safety and Security Certification Responsibility Matrix

Key Safety and Security Certification Steps	Design Phase						Construction/Test Phase						Pre-Revenue and Start-up Phase					
	PMT	**DC**	**SAFE**	**CPT**	**SSRC**	**OPS**	**PMT**	**CTR**	**SAFE**	**CPT**	**SSRC**	**OPS**	**PMT**	**CTR**	**SAFE**	**CPT**	**SSRC**	**OPS**
1. Identify Certifiable Elements and Items	P	S	S	RC	RC	S	S	N/A	N/A	RC	RC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2. Develop Safety and Security Design Criteria	P	S	S	RC	RC	RC	P	N/A	N/A	RC	RC	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3. Develop and Complete DCCC	P	S	RC	RC	RC	RC	S	N/A	N/A	RC	RC	RC	N/A	N/A	N/A	N/A	N/A	N/A
4. Develop and Complete CSCC	N/A	N/A	N/A	N/A	N/A	N/A	S	P	RC	RC	RC	(-)	P	S	RC	RC	RC	N/A
5. Identify Additional Safety and Security Test Requirements	P	S	S	S	S	S	P	S	S	S	S	S	P	S	S	S	S	S
6. Perform Testing and Validation	N/A	N/A	N/A	N/A	N/A	N/A	S	P	RC	RC	RC	RC	S	P	RC	RC	RC	RC
7. Manage Integrated Tests	N/A	N/A	N/A	N/A	N/A	N/A	P	S	RC	RC	RC	RC	P	S	RC	RC	RC	RC
8. Manage “Open Items” in the SSCP	P	S	RC	RC	RC	N/A	P	S	RC	RC	RC	RC	P	S	RC	RC	RC	RC
9. Verify Operational Readiness	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	S	S	RC	S	S	P
10. Conduct Final Determination of Project Readiness/ Issue Safety & Security Certification Readiness & Issue Safety and Security Certification	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	P	S	S	RC	RC	S

P = Prime Responsibility
S = Support Responsibility
RC= Review and Comment
N/A = Not Applicable

*= Continues into Revenue Phase

PMT = Project Management Team
CTR = Construction Contractors
SAFE = CTA Safety and Security/Certification Manager
DC = Design Consultant
SSRC = Safety and Security Review Committee
OPS = CTA Rail Operations
CPT= CTA Project Team

Figure 1. Final Design Phase Roles and Responsibilities Cross Functional Flow Chart

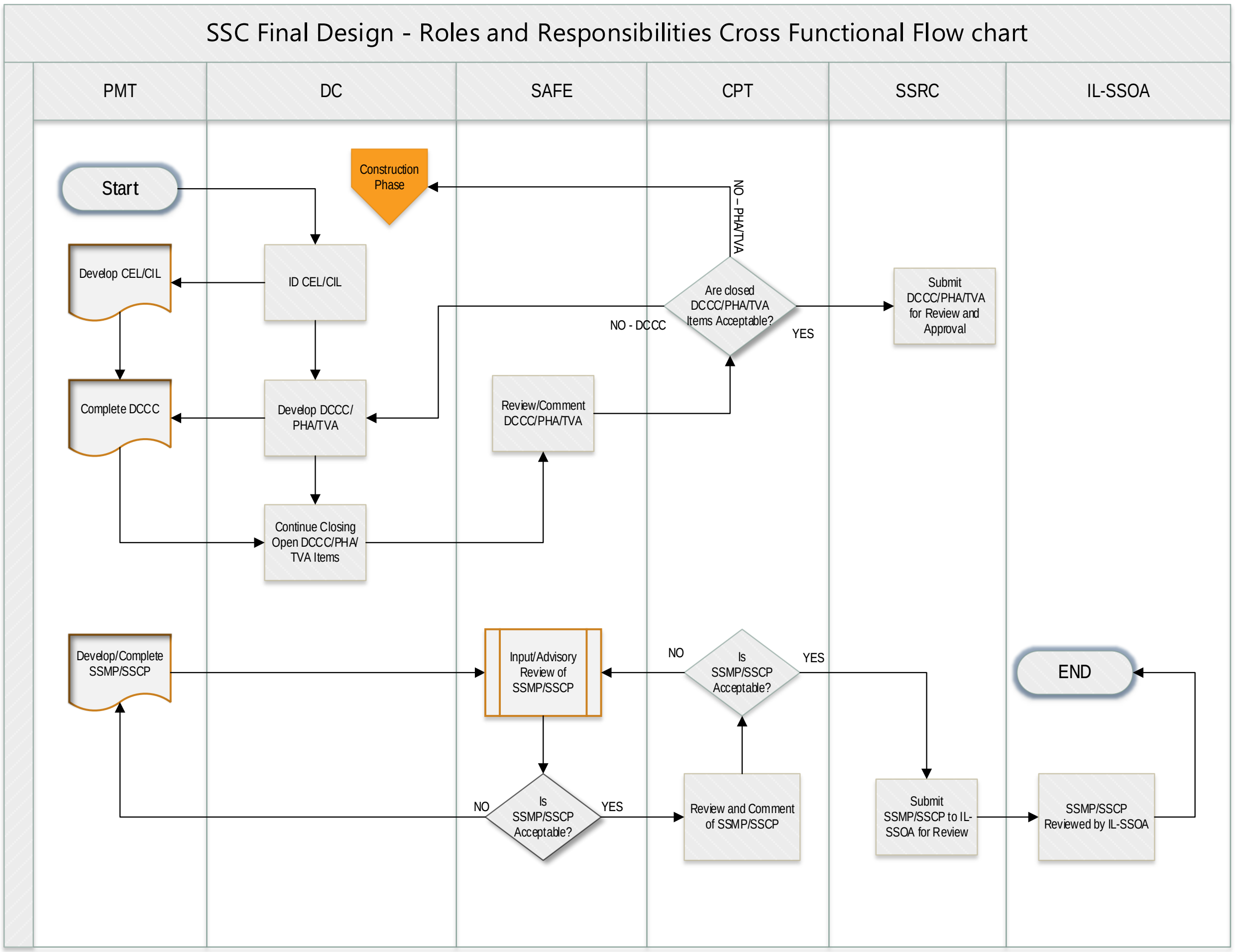


Figure 2. Construction/Integrated Testing Phase Roles and Responsibilities Cross Functional Flow Chart

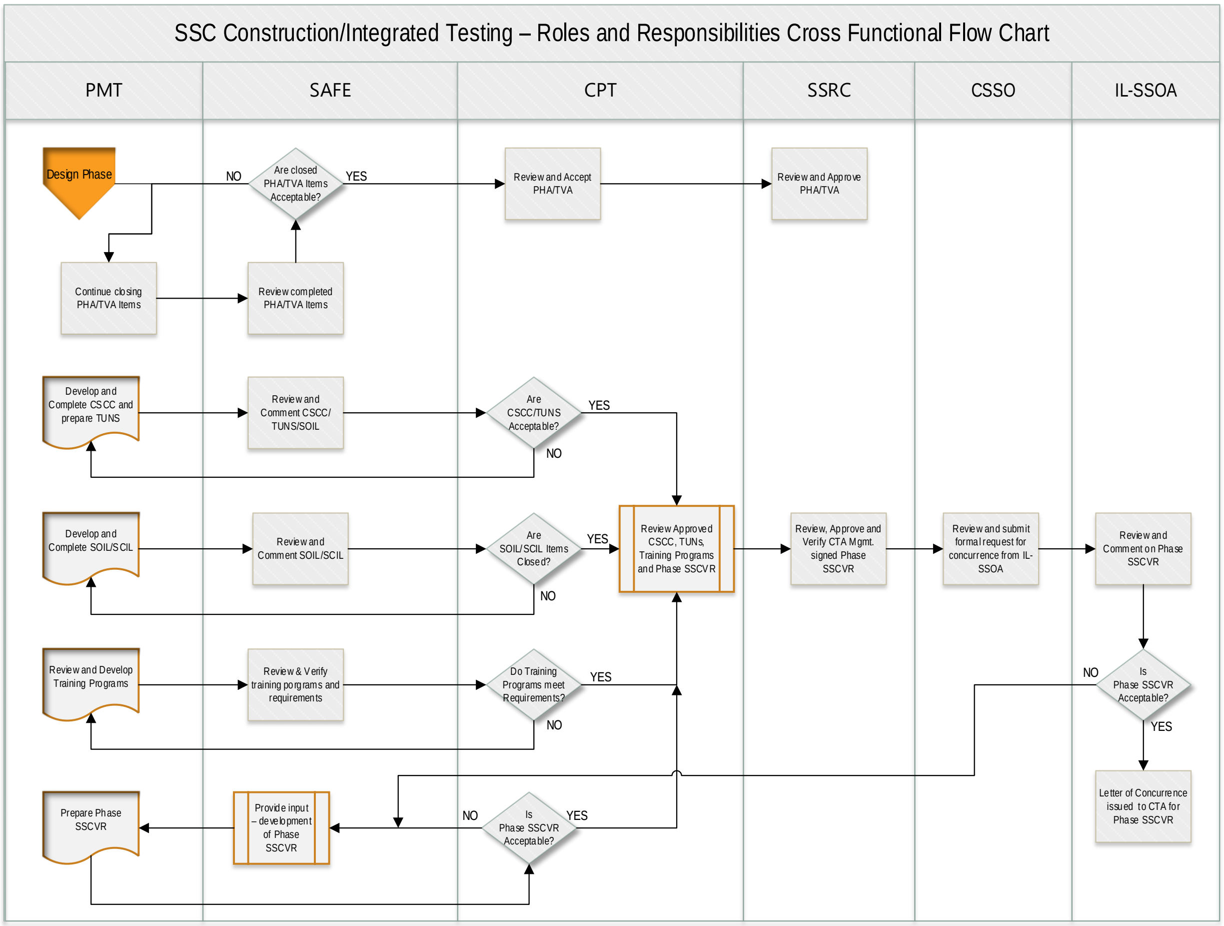


Figure 3. Non-Revenue/Revenue Service Roles and Responsibilities Cross Functional Flow Chart

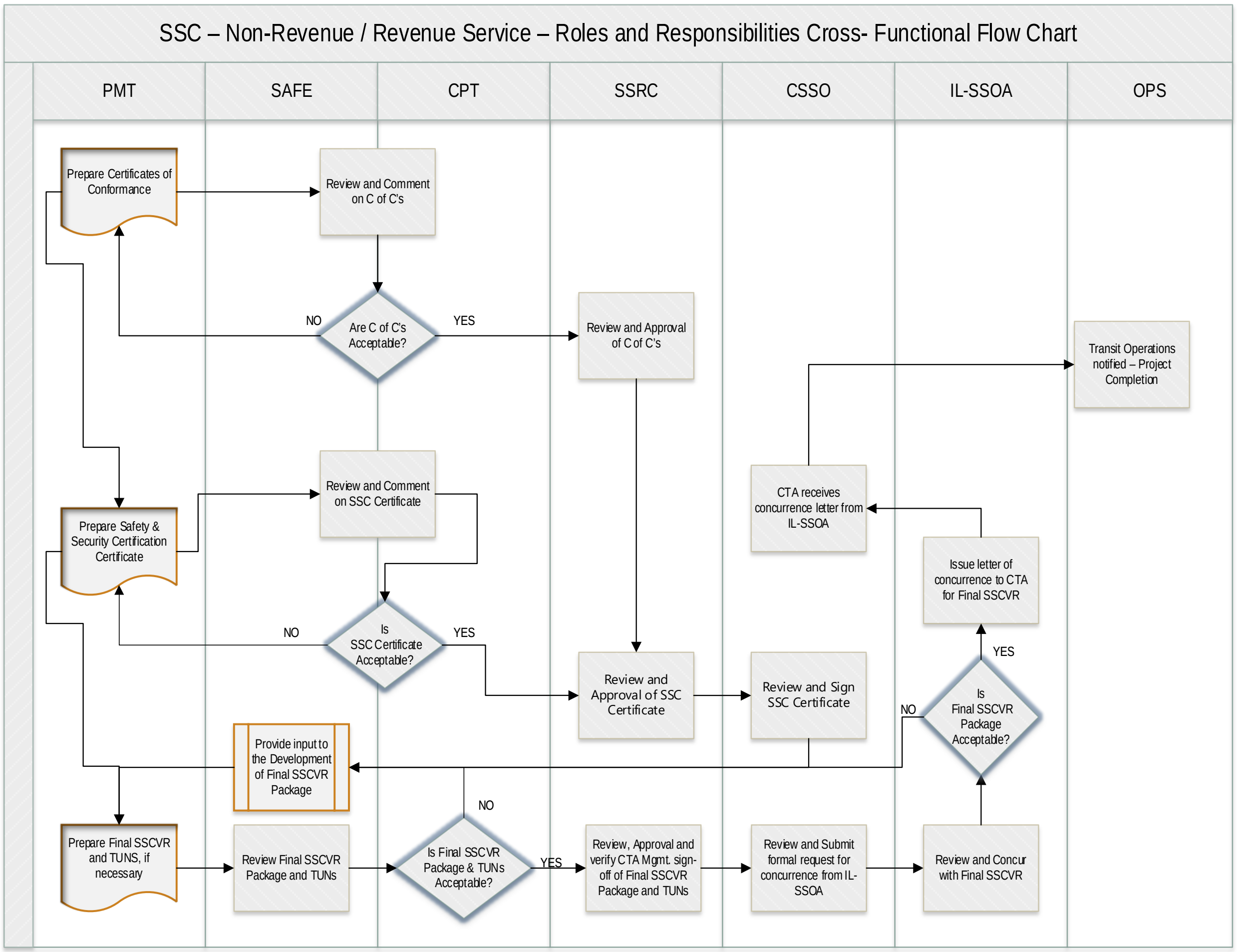
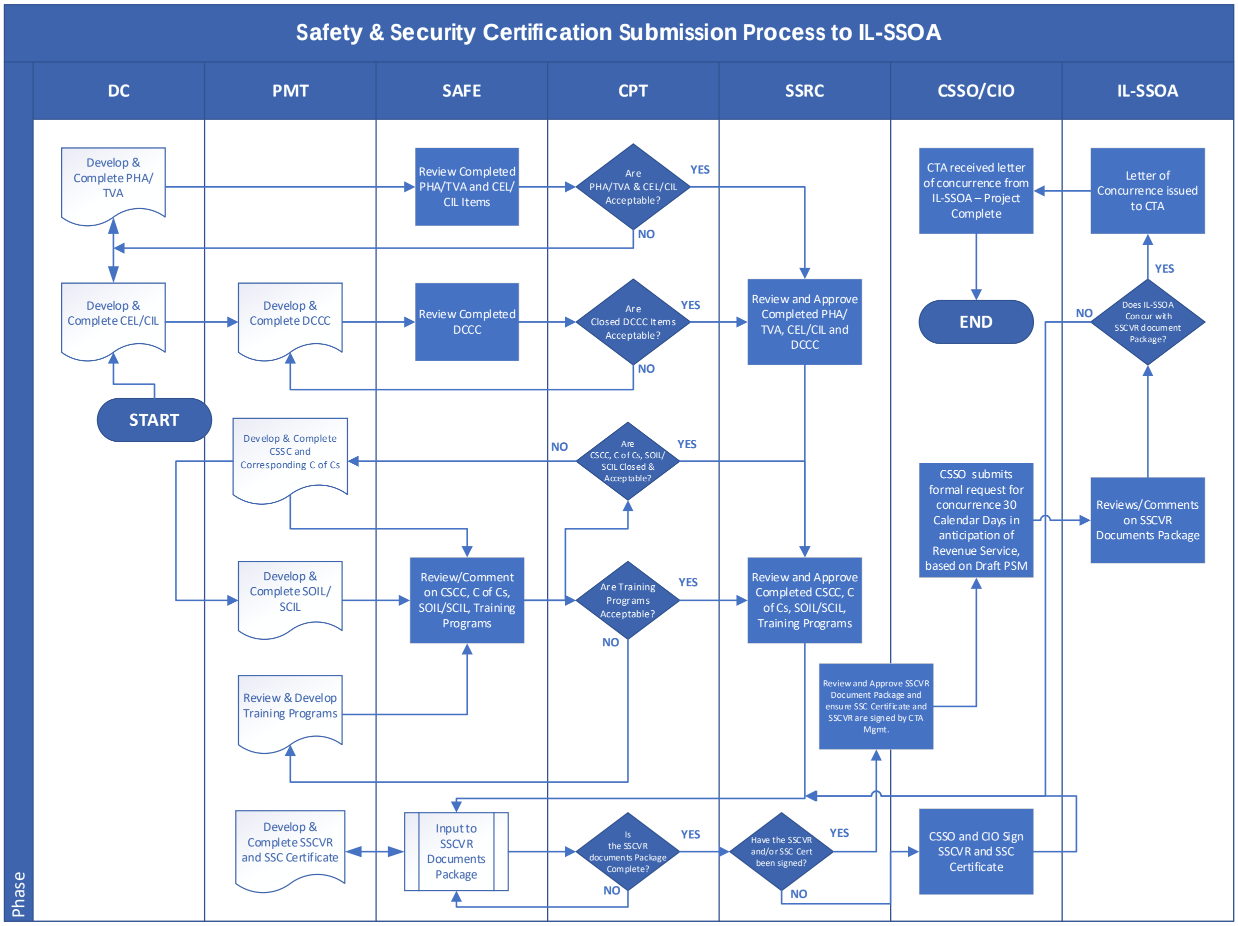


Figure 4. SSC Submission Process to IL-SSOA



3.0 Project Description

The project consists of design and construction of a new architecturally prominent and signature State/Lake Loop Elevated Station. Station capacity – both larger platforms and more fare collection turnstiles – will be increased. Chicago Department of Transportation (CDOT) and Chicago Transit Authority (CTA) staff members observe significant overcrowding during peak periods on the platforms at the State/Lake station, and the planned larger platforms will address the need for additional passenger waiting space. Additionally, the station will be brought into compliance with current code through upgraded security/surveillance systems, backup power systems, and Americans with Disability Act (ADA) accessibility.

The project will also include upgrades of the adjacent Lake/Randolph mezzanine at the Lake Red Line station to bring that entrance into compliance with ADA and to permit accessible transfers between the subway and elevated stations.

Additional information about the project can be found in the Project Management Plan (PMP), Section 1.2 Project Description.

4.0 Safety and Security Certification Process

The safety and security certification process as administered by the FTA consists of the following ten (10) major steps that begin during project development and continue through construction, testing, activation, start-up and revenue service. These steps are in accordance with FTA's Handbook for Transit Safety and Security Certification (Final Report November 2002).

Step 1	Identify safety and security certifiable elements and prepare CILs
Step 2	Develop safety and security design criteria
Step 3	Develop and verify DCCCs
Step 4	Perform construction specification conformance reviews
Step 5	Identify additional safety and security test requirements
Step 6	Monitor and verify systems tests (typically as part of contractual requirements)
Step 7	Monitor and verify systems integration tests
Step 8	Manage "Open Items"
Step 9	Verify operational readiness
Step10	Issue Project Safety and Security Certificate. Issue safety and security verification report; follow-up and final project closeout

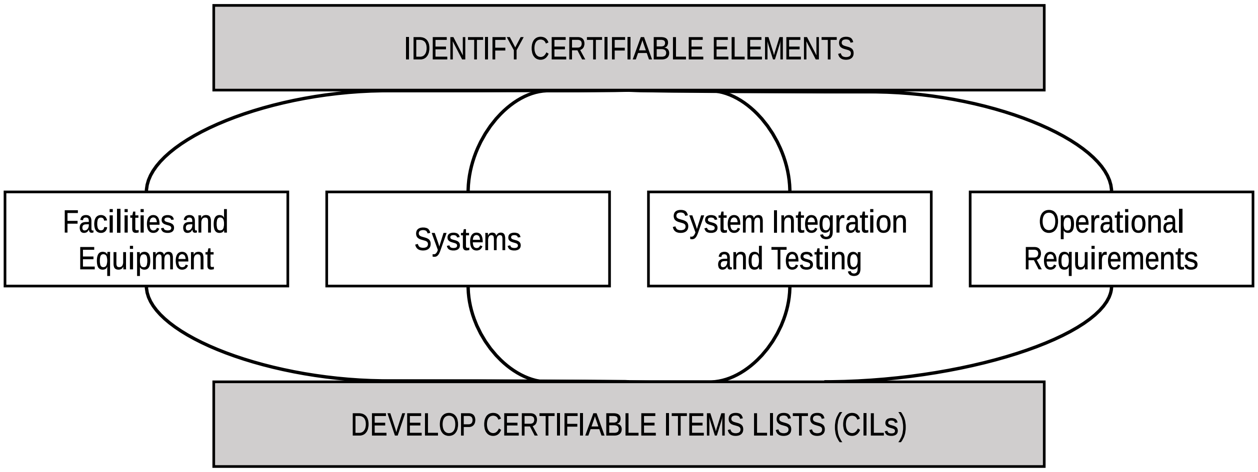
Notwithstanding CDOT's participation in this project and certification process, CTA will be the entity to sign and approve the elements of the safety and security certification process and is the agency to certify the project. The Certification Manager will approve documents and processes following SSRC approval.

4.1 Step 1: Identify Safety and Security Certifiable Elements and Prepare CILs

The certifiable elements for the Project are being defined by reviewing the Infrastructure Design Criteria Manual (IDCM), PMP, and certifiable elements from like projects. This is a primary task of CDOT and the DC which began during the preliminary engineering phase and will include continuous updates as needed throughout all phases of the project (see Table 2.1 of the SSMP). Safety critical elements are defined as system components, requirements, or activities, which could result in death, severe injury, major system damage, adverse environmental impacts, or public property damage and must be certified to assure identified hazards have been eliminated or controlled to acceptable levels. As shown in Figure 5, the elements are broken down into four major categories:

- Facilities and Equipment;
- Systems;
- System Integration and Testing; and
- Operational Requirements.

Figure 5. Development of Certifiable Items List



Each element is broken down into individual items requiring certification; the listing of these individual items is known as the CIL. As design progresses, the PMT will develop a CIL for each element. If the PMT updates the CEL, they will subsequently update the corresponding CIL, as needed, throughout the project.

The primary elements and sub-elements to be certified for the Project may include the following:

Signals:

- Signal Network

Track and Structure:

- Rail Track System

Traction Power

- DC Cable

- Contact Rail

Communications
- Fiber Optics
- OCC Systems
- SCADA
- PA System
- CCTV

Mechanical/Electrical/Plumbing:
- AC Power
- Grounding/Bonding
- Lighting
- Fire Alarm/Suppression
- Elevator System
- Escalator System
- General Mechanical

Civil
- Structural
- Egress Stairs
- Egress
- Station Platforms
- Platform Canopy

Plans, Procedures, and Training
- Systems Integration

4.2 Step 2: Develop Safety and Security Design Criteria

Safety and security design criteria are intended to provide guidance to the design team (CDOT and the DC) to support the definition of systems, sub-systems and components, the development of performance requirements, and the final specification of the engineered system. Safety and security design criteria are generated from the following items:
- Technical specifications from similar projects;
- Existing agency design and performance criteria;
- Transit agency "lessons learned" from previous projects and operating experience;
- PHA results;
- TVA results;
- Transit industry safety and security best practices and reports; and
- Applicable safety and security codes, standards, and regulations defined by federal, state, and local agencies and standards boards and organizations.

The design criteria define how the safety and security aspects of the certifiable items will be addressed in the completed project and how the requirements become manifest in the final design drawings and specifications. For the Project, the safety and security design criteria were taken from the IDCM.

4.3 Step 3: Develop and Complete Design Criteria Conformance Checklist

Safety and security criteria requirements for certifiable elements, sub-elements and items are developed from the IDCM. This process involves the creation of a checklist for each certifiable element to record requirements generated from the IDCM. These checklists, referred to as Design Criteria Conformance Checklists (DCCCs), provide a format to verify compliance with identified safety and security requirements. An example of the DCCC is provided in Appendix B.

The DCCC will be filled out by the DC for each project package and included with each milestone design review submittal through the Contract Deliverables process in e-Builder. The PMT, in conjunction with CTA Engineering and Safety department representatives will review the DC responses and accept it “as is” or request changes. Once the DCCC is complete and acceptable to the PMT, Engineering, and Safety, it will be presented to the SSRC for final acceptance. SSRC approval will be captured via meeting minutes and the certification manager will electronically/wet signature sign the DCCC. In the event the design cannot meet portions of the design criteria, the DC must request an exception via the Design Variance process.

4.4 Step 4: Perform Construction Specification Conformance

Specification conformance establishes a formal process to verify safety and security related specification and Contract document requirements are satisfied by the as-built facilities and systems. The PMT (CCOT and Contractor) will prepare the Construction Specification Conformance Checklist (CSCC) by reviewing the final project specifications and Contract documents to identify safety and security related requirements warranting verification and determining the means of verification. The means of verification for items on the CSCC will draw information from a variety of sources to ensure conformance:

- Submittals are prepared by the Contractor for various items on the Project. Submittals may include shop drawings, engineering calculations, product data, product samples, factory test reports, and construction process plans, which document how the Contractor's proposed means and methods conform to project specifications. The CCOT monitors the contractor to ensure all necessary submittals are received, reviewed, and approved prior to construction commencing.
- Material certifications for various items will be used to ensure conformances for all materials received on the project site. Receipt of the certificates is monitored by CTA Quality Assurance.
- The Testing and Inspection Plan (T&I Plan), a document primarily used by Quality Assurance, includes a listing of all tests required by the construction specifications, including factory acceptance, construction inspection, field inspection and installation verification, acceptance, and integration testing. Any tests from this list required as part of the safety and security certification will be identified.
- Daily Inspection Reports are produced by CCOT to document project progress and events. Observations included in the reports may be used to constitute visual verification of certifiable items.
- Photos are often included with daily inspection reports or may be taken separately to

document project progress. Photos may be used to document visually verified certifiable items.

Once the CSCC is created and means of verification identified for all certifiable items, the CSCC will be submitted to the SSRC to approve the selected items and means of verification. SSRC approval will be captured via meeting minutes and saved on e-Builder. In the event of issues of non-conformance or Potential Change Orders (PCO) occur, CCOT must adhere to the Non-Conformance Report (NCR) and PCO processes established in e-Builder.

4.5 Step 5: Identify Additional Safety and Security Test Requirements

During this step, CTA will work to identify all testing and training to be completed in addition to tests required by construction specification. This will include reviewing current operating and maintenance procedures to ensure adequacy in the context of the new project as well as developing associated training programs for the newly constructed infrastructure. Each of these items will be added to a CIL for tracking.

The need for tests in addition to those identified in the construction specifications and contract documents may arise throughout the project. To request and record the performance of additional tests, the requestor will prepare a formal Test Description Sheet and submit it to the Certification Manager. The Certification Manager will circulate the request to the CPT, CTA Security, and the PMT for review, acceptance, and incorporation into the appropriate part of SSC program.

4.5.1 System Integration Testing

System integration tests are required to verify the ability of all elements of the project, including equipment and facilities, to function properly together.

The PMT (CCOT and Contractor) will be responsible for the development of integrated and pre-revenue demonstration test procedures. Test procedures will identify safety and security specification conformance requirements that must be complete prior to testing. Requirements will depend on the type and nature of the test. A test plan including all identified integrated tests and associated procedures will be assembled by the PMT (CCOT and Contractor) with review and comment from CTA Safety and Security. The test plan will be approved by the SSRC prior to initiation of system integration testing.

4.5.2 Review Adequacy of Plans and Procedures

Existing plans, rulebooks, procedures, and any other documentation governing operations and maintenance activities will be reviewed by the document owners to assure the project elements have not affected their adequacy. The safety and security certification process provides verification:

- Existing plans, rules, and procedures have been reviewed and updated as needed;
- Any additional plans, rules, or procedures have been identified and developed;
- Evaluated under simulated operational conditions for normal, abnormal, and emergency circumstances; and
- Confirmed compliance with code and regulatory requirements.

4.5.3 Training Programs

As part of the safety and security certification process, several training programs will be developed. CDOT in coordination with CTA verifies the following:

- Training for all affected personnel has been developed;
- Training addresses how construction phasing affects personnel;
- Training is adequate and incorporates information regarding safety features of the systems and facilities for normal, abnormal, and emergency conditions; and
- Caution and warning notes have been incorporated into operation and maintenance manuals, as needed.

During this step, necessary training programs will be identified, and development will be assigned to appropriate personnel.

4.5.4 Emergency Drills

CTA routinely conducts or participates in exercises. Drills are held to verify the adequacy of emergency response plans and procedures and to assure outside emergency response personnel are adequately prepared to respond to emergencies at CTA. Emergency drills are developed and conducted for the following purposes:

- Familiarize and train response personnel in emergency procedures;
- Evaluate response procedures;
- Identify needed improvements to response procedures before a real emergency occurs; and
- Maintain an adequate level of preparation for a possible emergency.

During this step, CTA's Safety Department will determine the conduct of simulated emergency drills for the Project and associated development work assigned to appropriate personnel. At minimum, CTA, CDOT, and CCOT will ensure first responders remain familiar with the project area and are aware of access constraints during the various construction phases, via coordination with the FLSSC.

4.5.5 Pre-Revenue Operational Testing

CDOT and CCOT will coordinate with CTA to conduct pre-revenue operational testing simulating revenue service under normal, abnormal, and emergency situations. These tests include verifying the training and capabilities of operating personnel and adequacy of relevant operating procedures. Additionally, these tests verify coordination, response, environmental constraints, and capabilities of CTA and external agencies, such as Chicago Fire and Police Departments. During this step, necessary tests will be identified and assigned to appropriate personnel for development.

4.6 Step 6: Perform Testing and Validation in Support of the SSC Program

Once the Project moves into its construction phase, the certification process moves into testing and verification. This step is focused on verification that the project's safety and security requirements are satisfactorily incorporated into the finished project. The T&I Plan and CSCC will be populated with testing and verification activities that support and validate conformance. The contractor will be responsible for testing and verification and submittal of results to the CCOT. The CCOT will be responsible for verifying the CSCC as records demonstrating conformance are created. As the tracking mechanisms are completed, the CCOT will ensure the needed verification documentation is organized and saved on e-Builder. As certification activities advance, the CCOT also tracks open items lagging in certification documentation or experiencing problems achieving certification. These open items will be forwarded to the SSRC for guidance or resolution on a monthly basis.

4.7 Step 7: Monitor and Verify Systems Integration Tests

During the construction and start-up phases, system integration tests will be conducted to validate proper operation of equipment and systems being furnished and constructed for the Project. CCOT will observe testing and CTA Safety and Security staff may observe testing whenever safety-related activities are an integral part of the testing programs. Observed activities may include installation verification and acceptance, pre-operational demonstration, system integration, and start-up tests. CTA Safety and Security, and CCOT consultant staff may also elect to participate in system integration and pre-revenue testing activities. The results of all safety-related tests will be reviewed by the SSRC to verify satisfactory performance based on preestablished pass/fail criteria via T&I Plan, safety features, and adherence to the approved test procedures.

4.7.1 Inspections

CTA Safety may participate in any Contractor and manufacturer audits, inspections, and tests where the safety and security of passengers, employees, emergency responders, the public, equipment, or facilities could be affected by the improper or incorrect construction or manufacture of system elements. Day-to-day audits will be conducted by CCOT, with CTA staff engaged at its discretion. These audits, inspections, and tests apply to both facilities and system elements and include first article inspections, mock-up reviews, qualification tests, performance tests, and acceptance tests.

4.7.2 System Integration Testing

The PMT (CDOT and CCOT) will be responsible for the development and implementation of the approved system integration test procedures along with documenting and logging all tests performed. The PMT will submit Copies of all test and inspection reports which will be become part of the project files and the safety and security certification documentation package.

4.8 Step 8: Manage Open Items

All certifiable items must be tracked to closure. Open items will be listed on the Safety/Security Open Items List (SOIL) to ease tracking. If an open item is classified as a Category I (Catastrophic) or a Category II (Critical) hazard, it is tracked on the Safety/Security Critical Items List (SCIL), which will be designated items within the SOIL. This SCIL includes those Category I and II open items identified through analyses or field reporting. All open items on the SOIL/SCIL that cannot be resolved to meet the safety requirement for issuance of a safety and security certificate must be submitted to the SSRC.

The SSRC is accountable for approving an acceptable alternative or work around, notify the appropriate authority levels including the President's office, and formally document the resolution as part of the verification for the certifiable element. The SSRC will memorialize the approval via meeting minutes stored on e-builder. CTA Safety and Security will coordinate the decision by either issuing a document verifying closure or proposing an acceptable resolution for these exceptions. This process will ensure that the safety and security elements designed into the system are realized in the delivered, tested, and validated project. Example formats for a SOIL/SCIL are in Appendix B.

4.9 Step 9: Verify Operational Readiness

CTA will verify the Project is ready to initiate revenue operations after completion of each construction stage. CTA's verification will be based on information supplied by the CCOT and CDOT's recommendation of readiness. This verification of readiness includes verifying that items identified during Step 5 have been completed:

- Applicable plans, rulebooks, procedures, and other documentation have been reviewed, developed or updated, and implemented;
- Manuals demonstrating how to operate and maintain systems equipment and facilities have been developed, reviewed, approved, and accepted by the project team;
- Required training for operations and maintenance personnel has been developed, performed, and successfully completed by all appropriate personnel;
- Required emergency training and/or drills have been developed, performed, and successfully completed by all appropriate personnel, including public safety personnel (as appropriate); and
- Pre-revenue operational testing to simulate revenue service under normal, abnormal, and emergency situations has been completed.

At the completion of each construction stage, pre-revenue operational testing will be observed by CTA staff (CPT, Chief Engineer, and VP of Infrastructure Maintenance) to verify the functional capability and operational readiness prior to initiation of revenue service. During this testing, procedures and plans are tested for effectiveness using mock scenarios to simulate operating conditions for normal, abnormal, and emergency situations. Verification of these activities will consist of signatures of the appropriate officials and employees on all procedures, rulebooks, and training necessary to support operation and maintenance of the system. The operating and maintenance procedures and plans will be evaluated to either meet the verification requirements or be recommended for modification.

A final walk-through inspection of completed facilities, track, station extensions, and systems will be performed to determine that fire/life safety and security requirements will be incorporated into the construction and installation of the Project.

All findings not safety or security critical are turned over to the appropriate CTA department (such as Transit Operations or Maintenance) for review and action. All safety and security critical findings will be resolved immediately through the SSRC prior to the initiation of revenue service.

4.10 Step 10: Issue Project Safety and Security Certificates

CCOT will prepare the Project overall Safety and Security Certificate to be issued after all required supporting certification documentation is completed and accepted by the SSRC. These documents include the safety and security CELs/CILs, DCCCs, CSCCs, elements certificates of conformance, and TUNs. These documents, the Project Safety and Security Certificate, and Final Verification Report are required for CTA to confirm Self Certification. If not all documentation is available in time for service initiation, the safety impact of any incomplete documentation will be assessed. Approved equivalencies or operating restrictions will be implemented where unacceptable hazards are identified. The CCOT will be responsible for submitting all documentation to CTA through e-builder. The Certification Manager will convene the SSRC. CTA will also engage IL-SSOA for concurrence with the Safety and Security Certificate issuance.

4.10.1 Temporary Use Notices

Temporary Use Notices are used to memorialize operating restrictions and phased in construction work. TUNs are one component of an SSCVR package and are issued to define any restrictions on any open safety items. The issuance of a TUN ensures that all safety and security certification requirements of Sections 4.3, 4.4, 4.5, 4.6, and 4.7 of this SSCP have been met for that specific element or group of elements. An example format for a TUN is in Appendix B. CCOT will prepare a TUN and prior to issuing, the SSRC will verify that this process has been implemented and that the proper documentation is maintained.

4.10.2 Construction Specification Conformance Checklist (CSCC)

The CCOT will prepare and utilize the CSCC to document safety and security approvals for construction. The CSCC will ensure all relevant submittals have been approved, indicating the submittals are complete, accurate, and in compliance with project specifications. The SSRC may audit submittals with the specifications down to the paragraph level to ensure the submittal information appropriately matches the intent of the specifications. The information on these checklists will be used to generate the necessary records for the elements and their items and will be submitted to the SSRC as supporting documentation for the Certificate of Conformance for the element(s).

4.10.3 Element Certificates of Conformance

The safety and security certifiable elements for various aspects of the project will be certified independently once all sub-element and item checklists are completed, indicating all documentation, inspections, and tests is complete, reviewed by PMT, and verified by the CPT.

Any open items that remain with operational restrictions will be documented and attached to the element certificate. These restrictions must be resolved (or operating restrictions put in place) and approved by the SSRC prior to issuance of the Certificate of Conformance.

4.10.4 Project Safety and Security Certificate

CCOT will prepare the Project safety and security certificate, which will be reviewed by the Certification Manager, and Sr. Project Manager Safety and Security, and submitted to the SSRC for approval after all project elements have certificates of conformance. With approval of the SSRC, the project certificate and cover letter will be presented to the CTA Chief Safety & Security Officer and the Chief Infrastructure Officer for signature. The Chief Safety & Security Officer's and the Chief Infrastructure Officer's signature provides a formal notification that all applicable portions of the project are safe and secure for the Project.

Open items that remain in effect with operational restrictions will be governed by a TUN and attached to the Project safety and security certificate. These restrictions must be resolved (or operating restrictions put in place) and approved by the SSRC.

4.10.5 Safety and Security Certification Final Verification Report

CCOT and The Certification Manager in direct coordination with CTA Safety and Security will prepare a final verification report. This report will include an annotated matrix of all open items associated with each element. Open items will include any required mitigation methods and a time period in which the item will be permanently closed. The report will include the project safety and security certificate. This report will be reviewed by the PMT, as requested by the Certification Manager prior to finalization and presented to the SSRC. CTA will submit this report, along with a formal request for concurrence to IL-SSOA, as defined by the SSOA PSM.

4.10.5.1 Safety and Security Certification Verification Report (Phased)

During construction of the project, there will be a phased approach to final completion. As such certain components will be ready for operational services (i.e. north track, south track, signals, structure, stairwells, etc.) CCOT and the certification manager in direct coordination with CTA Safety and Security will prepare a phased verification report specifically for the component that is ready for operational service. The report will include the Certificate of Conformance or TUN as required. CTA will develop a TSAP for the operational component. CTA will submit this report, along with a formal request for concurrence to IL-SSOA, as defined by the IDOT PSM.

4.10.6 Follow-up and Close-out

Typically, there will be operating restrictions in place when the system/facility is restored to full service. The Certification Manager and the SSRC have the responsibility to track these items to closure to ensure the documentation is complete and accurate. The SOIL will continue to be the primary tracking document.

4.10.7 Configuration Management

All Contract deliverables are captured as part of the Project records on the Project Website as directed by CTA. The Project Website will be the records retention database to store all safety and security certification documents used to verify and complete the certification process.

Upon completion of the Project, the Certification Manager will provide the following documents associated with the Safety and Security Certification Program along with Quality Assurances processes and oversight. At a minimum, the following documents will be provided as a complete package:

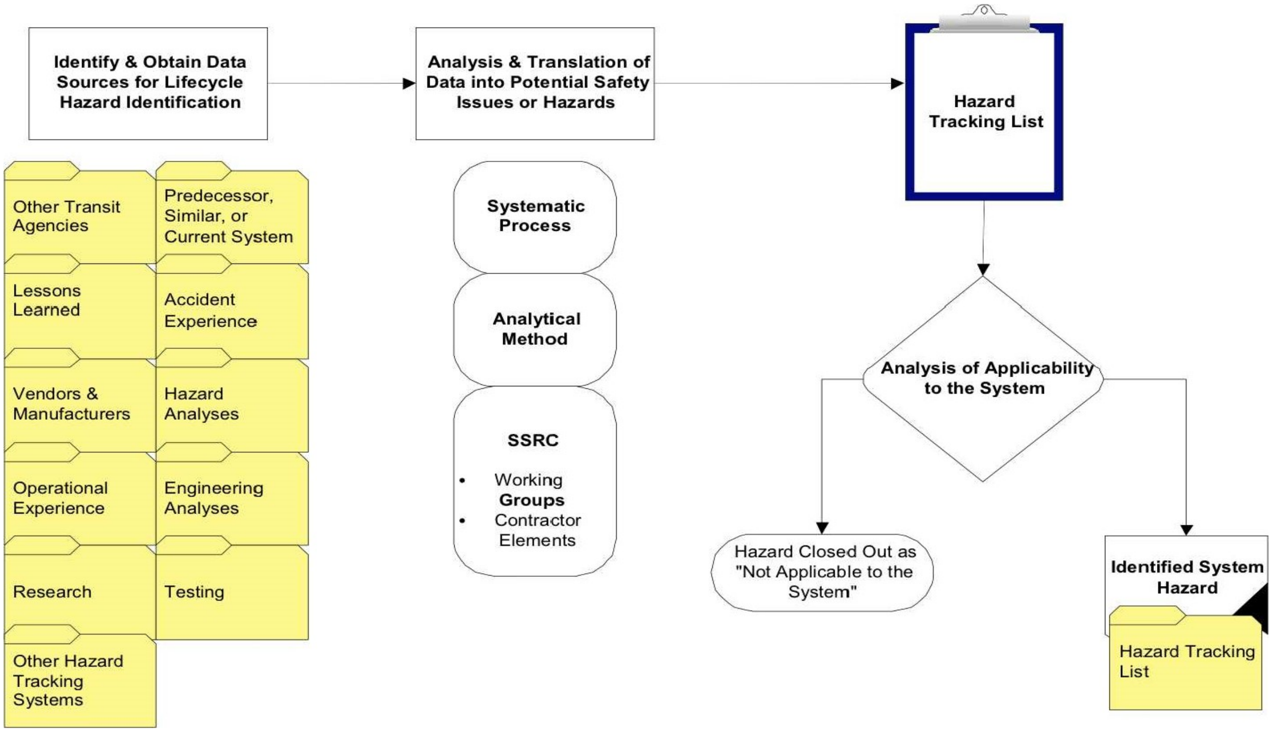
- Project Final Verification Report;
- Project Safety and Security Certificate;
- Certifiable Elements List and Certifiable Items List (CEL/CIL);
- Construction Specification Conformance Checklist (CSCC);
- Preliminary Hazard Analysis (PHA);
- Threat and Vulnerability Assessments (TVA);
- Operational Hazard Analysis (OHA);
- Certifiable Element Certificates of Conformance;
- Temporary Use Notices (TUNs);
- Safety/Security Critical Items Lists; and
- Design Criteria Conformance Checklist (DCCC)

5.0 Hazard Management

As part of the hazard management requirements, Preliminary Hazard Analysis (PHA) reports are developed as the project design criteria are developed, approved, and periodically updated during the Validation and Intermediate design phases. These reports are reviewed by the SSRC, PMT, and FTA's Project Management Oversight Consultant (PMOC) upon request. The IL-SSOA may also request to review the PHA. The recommendations generated from the update of the PHA are reviewed and considered for safety and security design criteria updates and potential design and/or construction change orders.

Hazard management is the formal process to systematically recognize, identify, evaluate, and resolve hazards associated with the design, construction, testing, start-up, and operation of the project for patrons, employees, and the public as shown in Figure 6. Recognized hazards must be categorized as to their potential severity and probability of occurrence and analyzed for potential impact. Those hazards must then be resolved by design, engineering control, procedure, warning device, or other method so that they fall within the level of risk acceptable to transit management.

Figure 6. Hazard Management Process



The system safety approach encourages hazard management throughout the Project's life cycle. Hazard management is most effectively applied starting at Preliminary Engineering so hazards can be controlled through design in an effort to avoid costly changes. Hazard management must also evaluate the safety impacts of the following:

- Deviations from the baseline design;
- Construction change orders and approved equivalencies; and
- Other modifications made during construction, testing, and project activation.

Managing hazards through identification, analysis, resolution, tracking, or acceptance is an essential function. An effective hazard management program also provides a crucial tool for determining the safety impacts of engineering change proposals, construction change orders, operational equivalencies, and the issuance of temporary permits and certificates.

5.1 Identification

The recognition of those conditions which have the potential for causing an accident or which can create an unsafe condition is the objective of the hazard identification function. Two basic strategies for identification are inductive and deductive processes.

The inductive process, sometimes called "bottom up" methodology, involves the analysis of system components and their failure states to identify the effects on the total system. Inductive analyses determine the conditions created if part of a subsystem fails to operate when required, operates when not required, or operates improperly.

Failure Mode and Effect Analysis is the primary example of the inductive process. The item to be analyzed is first listed by its constituent major assemblies and then by its subassemblies and components. Each component is then evaluated to determine how it could malfunction, what would cause it to malfunction, and the effect on the component and on higher-level subassemblies, assemblies, and the entire item. Failure rates may then be determined and listed to establish the overall probability the item will operate without a failure for a specific length of time and that the item will operate a certain length of time between failures.

The deductive process, or "top down" methodology, involves defining an undesired event (hazard) and then deducing the combinations of conditions and acts necessary to produce that hazard. It involves determining what combinations of "and" and "of' conditions of normal and fault events must exist to produce the undesired event. Fault Tree Analysis is representative of the deductive process.

Fault Tree Analysis provides a concise and orderly description of the various combinations of possible occurrences within the system that can result in an undesired event. Fault Tree Analysis can also involve both qualitative and quantitative techniques, the latter providing the most rigorous of the hazard identification analyses and should be reserved for the most complex systems with multiple subsystems and components. As such, the Fault Tree Analysis can also serve as a valuable tool to assess hazard probability described in Section 5.1.4.

The most effective of the inductive or deductive methods should be used as appropriate to identify hazards in each case. Several other inductive methods are:

- PHA - identifies hazards based on previously known or conceivable conditions or causal factors related to subsystems and components, assesses the hazard scenario risk, and identifies mitigation activities to close the hazard;
- System Hazard Analysis - identifies hazards related to a complete system or subsystem;
- Interface Hazard Analysis - identifies hazards related to interface areas between subsystems, systems, and the environment;
- Operating and Support Hazard Analysis - identifies hazards that may be induced by operators and maintainers of the system;
- Software Hazard Analysis; and
- Sneak Circuit Analysis.

5.1.1 Data Source for Hazard Identification

A broad range of internal and external safety data sources will be utilized throughout CTA systems for hazard identification. Each department head, supervisory personnel, CDOT, DC, or Contractor will cooperate with CTA Safety and CTA Security in instituting a systematic plan with departmental procedures for the identification of potential hazards through review of internal and external safety data sources throughout CTA. Internal data sources for hazard identification include:

- Hazard reporting;
- Safety analysis;
- Testing, inspections and audits;
- Quality assurance/quality control non-conformance reports;
- Malfunction reports for rolling stock, vehicles facilities, systems, and equipment;
- Preventive and corrective maintenance reports; and
- Control Center daily logs, load dispatcher reports, yard tower reports, and passenger reports, corroborated by personnel reports.

External data sources, which may be reviewed for hazard identification, include reports from other properties, consultants, American Public Transportation Association (APTA), Federal Transit Administration (FTA), National Transportation Safety Board (NTSB), and the Federal Railroad Administration (FRA).

The safety data collected from internal and external safety data sources are routed to CTA Safety for evaluation of hazards. To perform this collection and routing effectively, local safety committees' function throughout the organization as coordinators for hazard resolution. The committees review all departmental safety data from internal and external sources, evaluate the data for safety impact, and forward the data to the CTA Safety. CDOT, DC, CTA departments and front-line personnel have access and input into the hazard identification and reporting process. Formal channels and procedures for employee access to the hazard identification and reporting process are available through Hazard Reporting and Safety Committees. Other hazard reporting channels are divisional supervisory chains of command.

5.1.2 Hazard Risk Assessment

A hazard risk (level of exposure) assessment procedure is required to establish priorities for corrective action and resolution of identified hazards. Because the priority for system safety is to eliminate hazards by design, a risk assessment procedure considering hazard severity only will generally suffice during the early design phase to minimize hazards. When hazards are not eliminated during the early design phase, a risk assessment procedure, based upon the hazard probability, hazard severity, and the cost of corrective action, is required to establish priorities for remedial action and resolution of identified hazards.

CTA utilizes a risk assessment process based on the principles, descriptions, and definitions of MIL-STD-882E.

The process codifies the hazard severity, hazard probability of occurrence, and the cost of eliminating or controlling the hazard, then ranks each element using established hazard rating tables. The process then determines which hazards are unacceptable or undesirable based on their severity and probability of occurrence. The hazard severity, probability, and cost combination for unacceptable and undesirable risk is then ranked on a Hazard Priority Rating Table, whereby CTA Management can prioritize and allocate the resources available, to eliminate or correct the unacceptable and undesirable hazards.

5.1.3 Severity

Hazard severity categories are defined to provide a qualitative measure of the worst credible mishap resulting from personnel error, environmental conditions, design inadequacies, procedural deficiencies, system, subsystem or component failure or malfunction, as shown in Table 2.

Table 2. Severity Categories		
DESCRIPTION	**SEVERITY CATEGORY**	**MISHAP RESULT CRITERIA**
CATASTROPHIC	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding $10M
CRITICAL	2	Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding $1M but less than $10M
MARGINAL	3	Could result in one or more of the following: injury or occupational illness resulting in one or more lost workday(s), reversible moderate environmental impact, or monetary loss equal to or exceeding $100K but less than $1M
NEGLIGIBLE	4	Could result in one or more of the following: injury or occupational illness not resulting in a lost workday, minimal environmental impact, or monetary loss less than $100K

5.1.4 Probability

The probability that a hazard will occur during the planned life expectancy of the system can be described in potential occurrences per unit of time, events, mileage, population, items, or activity. Assigning a quantitative hazard probability to a potential design or procedural hazard may not be possible in all cases. A qualitative hazard probability may be derived from research, analysis, and evaluation of historical safety data from similar systems. Supporting rationale for assigning a hazard probability will be documented in hazard analysis reports. The qualitative hazard probability ranking utilized at CTA is shown in Table 3.

Table 3. Probability Levels			
Description	**Level**	**Frequency for Specific Item(s)**	**Selected Frequency for Fleet or Inventory**
Frequent	A	Likely to occur often in the life of an item	Continuously experienced
Probable	B	Will occur several times in the life of the item	Will occur frequently
Occasional	C	Likely to occur sometime in the life of an item	Will occur several times
Remote	D	Unlikely but possible to occur in life of an item	Unlikely but can reasonably be expected to occur
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced in the life of an item	Unlikely to occur, but possible
Eliminated	F	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated	Incapable of occurrence. This level is used when potential hazards are identified and later eliminated

5.1.5 Acceptance of Risk

Following classification by severity and probability of occurrence, hazards are given a risk index (criticality) so that the SSRC may further assess the hazards using two distinct yet overlapping criteria:

- Acceptability of the risk to management from a safety standpoint and determination of the appropriate hazard risk index ranking. This hazard priority ranking is called its criticality and is a function of both severity and probability of occurrence.
- Assigning numeric values to each severity category and probability level and combining them mathematically quantifies criticality. Hazard criticality is determined qualitatively.

The hazard criticality ratings, for acceptability of risk by the SSRC, are classified in one of the following categories:

- Unacceptable
- Undesirable, SSRC decision required
- Acceptable with SSRC review
- Acceptable without review

Determination of corrective action rating for unacceptable and undesirable hazards includes considering the cost of corrective action. The hazard rating for corrective action needs to be performed only for identified hazards that have been categorized as unacceptable and undesirable in the initial hazard risk index ranking.

5.2 Categorization

Hazard criticality acceptance criteria: Table 4 depicts the hazard risk assessment matrix to evaluate acceptability-of-risk in identified hazards.

Table 4. Risk Assessment Matrix

SEVERITY/ PROBABILITY	**Catastrophic (1)**	**Critical (2)**	**Marginal (3)**	**Negligible (4)**
Frequent (A)	**High**	**High**	**Serious**	**Medium**
Probable (B)	**High**	**High**	**Serious**	**Medium**
Occasional(C)	**High**	**Serious**	**Medium**	**Low**
Remote (D)	**Serious**	**Medium**	**Medium**	**Low**
Improbable (E)	**Medium**	**Medium**	**Medium**	**Low**
Eliminated (F)	**Eliminated**			

Hazard Risk Index	**Criteria by Index**
IA, 1B, IC, 2A, 2B	Unacceptable
ID, 2C, 3A, 3B,	Undesirable - Decision required
IE, 2D, 2E, 3C, 3D, 3E, 4A, 4B	Acceptable with review
4C, 4D, 4E	Acceptable without review
1F, 2F, 3F, 4F	Eliminated

Hazards with a combination of severity and probability of occurrence IA, 1B, IC, 2A, and 2B are unacceptable, and corrective action must be taken to eliminate or control them, thereby reducing the severity and/or probability of the hazard to an acceptable level. Priority rating for corrective action will be developed, among unacceptable hazards, using the cost of corrective action, as described herein.

Hazards with a combination of severity and probability ID, 2C, 3A, 3B, and 3B are undesirable. These hazards will go before the SSRC for review and approval of the specific method of corrective action. The Corrective Action must define acceptable alternative measures ("approved equivalencies"), on a permanent or temporary basis, to mitigate the attendant risk. Undesirable hazards are generally slated for corrective action and will be prioritized based on the cost of corrective action within that level of criticality in accordance with the method described herein.

Hazards with a combination of severity and probability IE, 2D, 2E, 3C, 3D, 3E, 4A, and 4B are acceptable with review by CTA management. CTA management may accept the risk associated with retaining the identified hazard in an "as-is" condition with no further corrective action. Alternatively, CTA management may prescribe periodic tests and inspections or other preventive measures to ensure, on a continuing basis, the original severity and probability ratings are not invalidated over time by degradation of conditions in the subject item. Proper sign-off on the acceptance of the attendant risk is required. Hazards with a combination of severity and probability 4C, 4D, and 4E are acceptable without CTA Management review.

The Chief Safety and Security Officer will accomplish proper sign-off on acceptance of risk. Review by CTA management will generally be through the SSRC. At a minimum, select members of the SSRC and the affected Operations, Maintenance, Safety, Training, Engineering, Project Management, and Security personnel will be on the review team of hazards for acceptance. The Chair of the SSRC will ensure the resolution action and sign-off on the accepted risk are documented. The Project Website will house all records of the hazard identification, analysis, assessment, and the hazard risk acceptance process.

5.3 Resolution

The best method of resolving potential system hazards is to eliminate them (probability 1F, 2F, 3F, and 4F). However, this may be impossible or impractical at times. Determination of the resolution method will be made by conducting a thorough analysis of the system, considering the possible tradeoffs between various alternatives and the system safety requirements. The philosophy dictating these analyses should result in the resolution of alternatives. Multiple means can be employed to resolve identified hazards, including design changes, installation of controls and warning devices, and implementation of special procedures. The order of precedence for the means to be used in resolving hazards at CTA, and therefore CDOT and DC for this project as CTA’s procedure is being followed, is as follows:

- **Design for Minimum Hazard:** Design, or redesign, refurbish, and retrofit to eliminate (i.e., "design out") the hazards through design selection. This may be accomplished through the use of fail-safe devices and principles in design, the incorporation of high-reliability systems and components, and the use of redundancy in hardware and software design.
- **Safety Devices:** Hazards that cannot be eliminated or controlled through design selection may be controlled to an acceptable level through the use of fixed, automatic, or other protective safety design features or devices. Examples of safety devices include interlock switches, protective enclosures, or safety pins. Care must be taken to ascertain that the operation of the safety device reduces the loss or risk and does not introduce an additional hazard. Safety devices must also permit the system to continue to operate in a limited manner. Provisions must be made for periodic functional checks of safety devices.
- **Warning Devices:** When neither design nor safety devices can effectively eliminate or control an identified hazard, devices may be used to detect the condition and generate an adequate warning signal to correct the hazard or provide for remedial action such as evacuation. Warning signals and their application must be designed to minimize the probability of incorrect personnel reaction to the signals and must be standardized within similar systems.
- **Procedures and Training:** Where it is impossible to eliminate or adequately control a hazard through design selection or use of safety and warning devices, procedures and training will be used to control the hazard. Procedures may include the use of personal

protective equipment. Precautionary notations must be standardized as specified by CTA Safety. Safety critical tasks, duties, and activities throughout the CTA, such as rail vehicle operators' duties require organizational certification of personnel proficiency.

5.4 Investigation Procedures for Unacceptable Hazardous Conditions

The following investigation procedures for unacceptable hazardous conditions will be utilized:

- CTA Safety will institute an initial investigation upon notification of the existence of an unacceptable hazardous condition. This notification may arise from and the initial investigation also be performed by the CCOT or CDOT, however CTA Safety will conduct an additional initial investigation in these cases;
- During the investigation process, CTA Safety will provide investigation status reports to the CTA President;
- Upon completion of the investigation process, CTA Safety will submit a draft final unacceptable hazardous condition investigation report to the President; and
- Upon approval of the draft report, CTA will prepare a final report, and it will serve as the official CTA Report and be submitted to the IL-SSOA for review and approval, in accordance with the IDOT PSM.

5.4.1 Procedure to Correct Deficiencies

Upon receipt of the final unacceptable hazardous condition report, CTA will have 30 calendar days to develop a corrective action plan (CAP) or methodology to correct identified deficiencies. The CAP must include the following information:

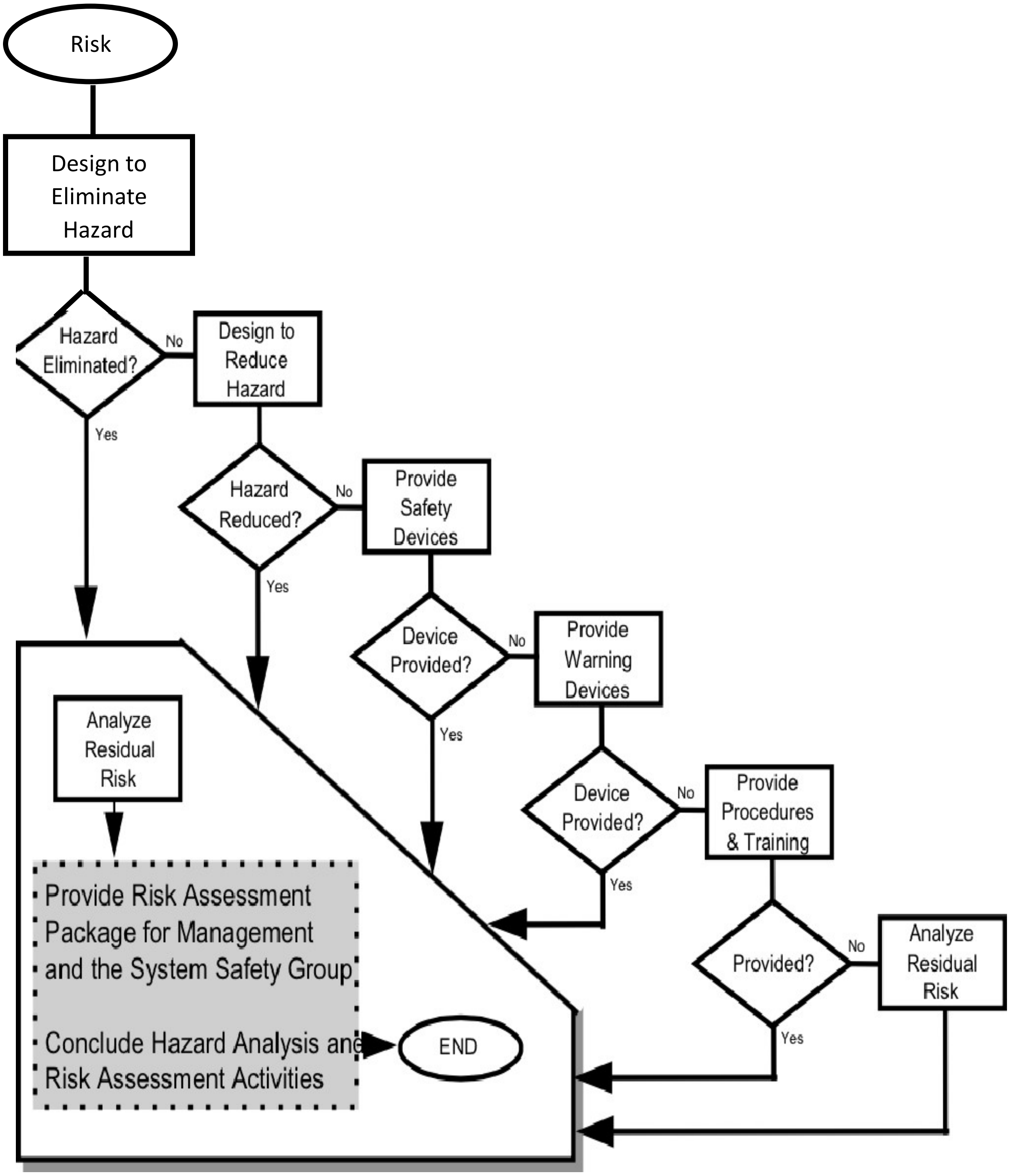
- Identify noted deficiency;
- Process, plan, or implementation to resolve deficiency;
- Time frame for plan implementation;
- Person who will be responsible for implementation; and
- Other critical information.

The CAP will be forwarded to the CTA President and then to the IL-SSOA for review and approval. The approved CAP will be forwarded to CTA for implementation by the responsible organization.

5.5 Safety Design Reviews

Several activities are conducted to assure that designs achieve safety requirements. CTA Safety, Security, Project staff, and the CCOT review all facilities and systems designs to ensure all safety and security requirements have been met. Disposition of comments are resolved through CTA design review process. Industry standards and experience are used to evaluate unique issues related to transit safety. In several cases, special studies or analyses are performed to address specific safety issues. Figure 7 provides the basic hazard reduction order of precedence to eliminate hazards and minimize risk.

Figure 7. Hazard Reduction Order of Precedence



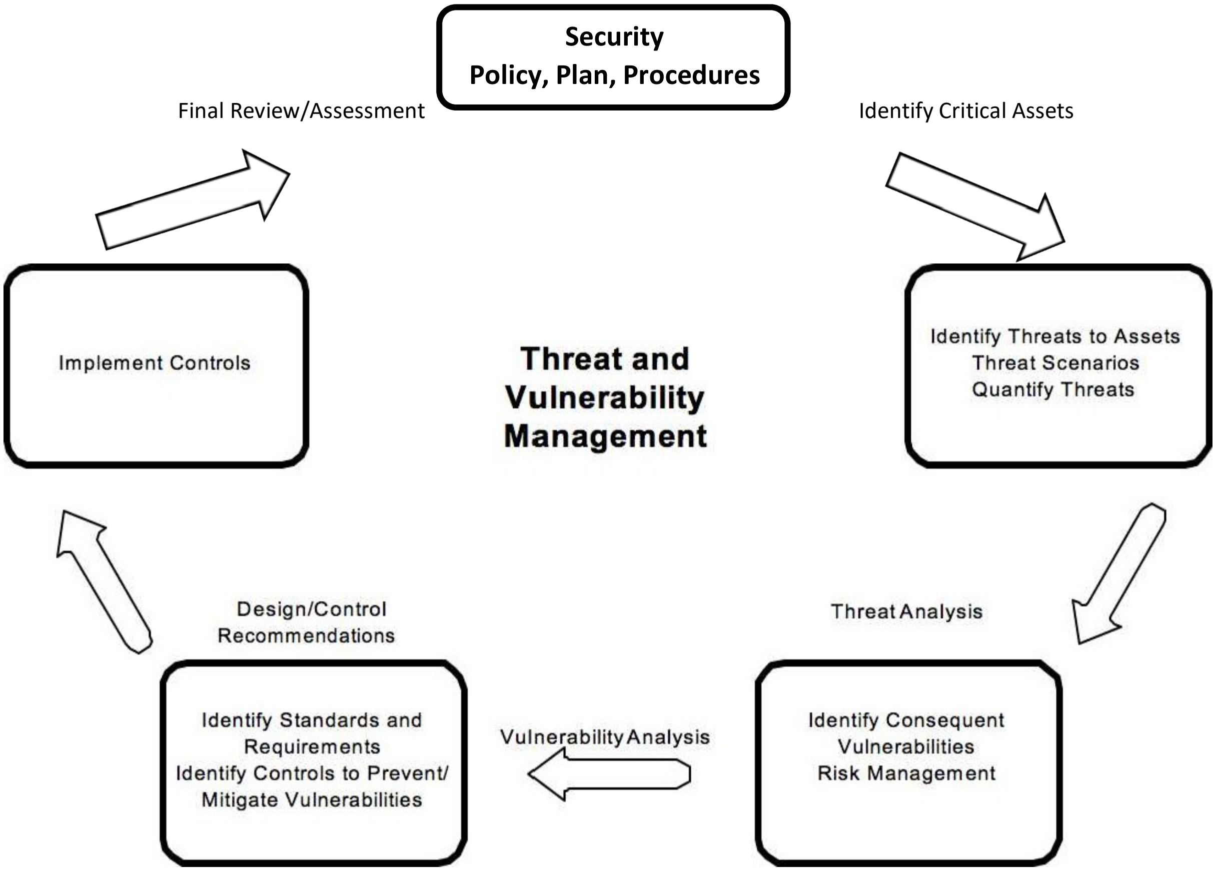
6.0 Threat and Vulnerability Management

6.1 Information

The Threat and Vulnerability Assessment (TVA) process described herein ensures the comprehensiveness of the SSCP. The Project TVA was conducted during the Preliminary Engineering phase and should be reviewed by the SSRC, PMT, and FTA's PMOC. The IL-SSOA may also request to review the TVA, as necessary. The recommendations developed from the design phase process should be reviewed and considered as safety and security design criteria updates and potential design and/or construction change orders. Updates to the TVA are forwarded to CDOT for acceptance and then to CTA for final approval.

Systems security is a form of risk management. It is intended to reduce or control threats and vulnerabilities through the continuous management process shown in Figure 8. Understanding a system's existing security posture is a multi-step process. Typically, a threat assessment is performed followed by other consecutive and progressive assessments to identify risk to systems and recommend controls to be designed into the project during the Final Design phase.

Figure 8. Threat and Vulnerability Management Systems Security Program



6.2 Threat and Vulnerability Assessment Process

A TVA considers the likelihood that a specific threat will endanger the rail system. The TVA identifies activities to reduce the risk of threats and to mitigate the consequences of attacks to the system. They typically use a combination of quantitative and qualitative techniques to identify security requirements, including historical analysis of past events, intelligence assessments, physical surveys, and expert evaluation. When the risk of hostile acts is greater, the analyses may draw more heavily upon information from intelligence and law enforcement agencies about the capabilities and intentions of an adversary. Completion of the TVA uses an eight-step process. Since the TVA will list agency vulnerabilities, it will be designed and marked according to current Federal codified regulation, as Sensitive Security Information (SSI).

Table 1. Threat and Vulnerability Assessment Process

Step	Description
1.	Management Approval, Preparation, and Planning
2.	Asset Identification
3.	Asset Criticality Determination
4.	Threat Assessment
5.	Threat Scenario Development
6.	Vulnerability Assessment
7.	Consequence Assessment
8.	Risk Assessment

6.3 Step 1: Management Approval, Preparation and Planning

Upon notice to proceed with the task, the PMT will begin work on the CTA's State/Lake Elevated Station project, which includes the TVA scope of work. The PMT will hold Project kick-off meetings for the safety and security certification effort where management's approval, preparation, and planning of the task to completion of the task would be discussed.

6.4 Step 2: Asset Identification

Assets are broadly defined as people, information, and property. In public transportation, people include passengers, employees, visitors, contractors, vendors, community members, and others who are exposed to the transit system. Information includes operating and maintenance procedures, vehicle control and power systems, employee information, computer network configurations and passwords, and other proprietary information. The range of transit assets that should be protected are listed in Table 5.

6.5 Step 3: Asset Criticality Determination

Once transit assets are identified, they would be prioritized, granting a higher priority to those assets that would create the most disruption of service or threat to people in the event of an attack. Then, the PMT will categorize the Asset as high, medium, or low to determine mitigations to protect them. Table 6 shows an example.

Table 5. Asset (Example)

People	Property	Information
Employees	*Insert assets here*	O&M Procedures
Contractors		
Vendors		

Table 6. Asset Criticality Determination (Example)

Asset	Category	Asset	Category
People	High[1]	Cranes (OHB and JIB)	
Information	Low[2]	Fire Protection Systems	
Parking Lots	Medium[3]	Traction Power	
Communication Systems		Loading Dock	
Emergency Equipment		Foreman's Tool Crib	

Table 6. Asset Criticality Determination (Example)

Asset	Category	Asset	Category
Water service		Storage Areas/Rooms	
Gas service		Lunchroom/Classroom	
Electrical service		Tracks	
Yard		Guard House	
HVAC			

Conditions that may increase or decrease the category:

[1] Single point of failure
[2] Reliance on functioning of other assets
[3] Time of day and day of week may increase or decrease operations or vehicle and pedestrian circulation

6.6 Step 4: Threat Assessment

Crime or terrorism are intentional actions carried to cause harm, which may result in death, serious injury, destruction, disclosure, interruption of operations, or denial of services. For the threat assessment, the PMT will develop information about crimes against people, crimes against property, and terrorism events, hereafter: threats, to evaluate for the project.

The threat assessment will identify the level of possible threats against assets, including intent and possible tactics, and when available, by adversaries who may carry them out. The process involves gathering and evaluating historical information and data, coupled with evaluating other relevant information about threats to public transportation assets. The PMT will research information and data about possible threats during an assessment, including:

- Factors causing potential hostility to riders, operators, staff or the system;
- Conspicuousness of the transportation facility; and
- Past targeting of similar transportation facilities.

Examples of possible threats against to CTA system assets are listed in **Table 7**.

Table 7. Threats Against Transit (Examples)

Crimes Against Persons	Crimes Against Property	Terrorism
Murder	Burglary	Active Shooter

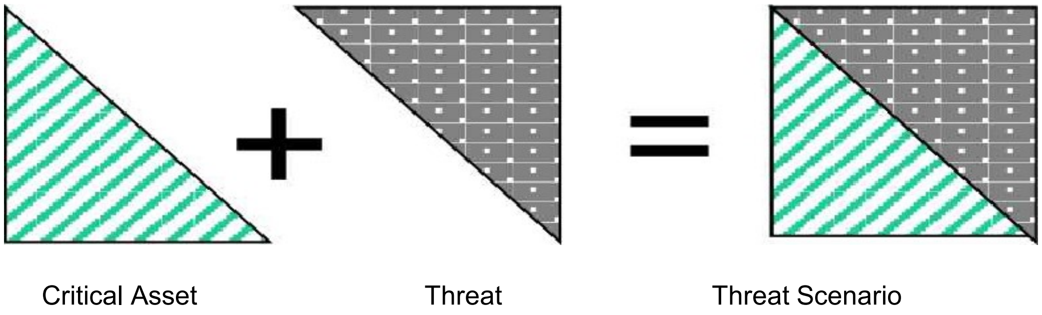
Aggravated Assault	Larceny-Theft	Sabotage
Rape	Motor Vehicle Theft	Chemical- Biological- Radiological
Robbery	Arson	Hostile Vehicle Ramming
		Vehicle-Borne Improvised Explosive Device
		Improvised Explosive Device
		Improvised Incendiary Device

From the assessment, the PMT evaluate, categorize, and rank the possible frequencies of occurrence of potential threats against Assets. Descriptions of frequencies of occurrence, associated levels, and definitions of specific items will be listed from highest to lowest, such as Frequent, Probable, Occasional, Remote, Improbable, or Eliminated. (See Table 3).

6.7 Step 5: Threat Scenarios Development and Assessment

The PMT will develop threat-scenarios for the TVA by matching critical assets (Table 6) with threats (Table 7) and focus on the practical progression of events that would occur. For example, walking through an unlocked door to gain building access would be far more practical than covert activities involving surreptitious entry. Using a practical method of developing threat-scenario provides ranges of threats and details to analyze likely consequences of threats to CTA assets (Figure 9).

Figure 9. Threat-Scenario Development



6.8 Step 6: Vulnerability Assessment

A vulnerability assessment identifies weaknesses that may enhance threat activities to assets. A vulnerability is any organizational, mechanical, or natural activity or activities that can be taken advantage of to carry out a threat. This may include, but not be limited to, site design, construction, and technology systems, and operations (e.g., emergency procedures, security practices or administrative and management controls).

The PMT will perform a Vulnerability Assessment of the proposed building and site to assess vulnerability factors that may develop as risks to assets. The vulnerability factors of access, detection, and response and will be evaluated, considered, and described with recommendations for mitigation measures to reduce risk the assets, as appropriate.

6.9 Step 7: Consequence Assessment

The consequence assessment will apply the interpretive methodology of worst-credible threat scenarios [re: threat-scenario assessment] to develop and assess the maximum credible consequences to effect assets. It will help to answer the question “What happens, if or when...?” and organizes results into one of several categories. For example, the severity of each consequence will be described as catastrophic, critical, marginal, or negligible, and be numerically categorized with a definition (Table 8). From the process, recommended protective measures may be identified and applied to mitigate the severity of consequences to assets.

Table 8. Severity of Consequence (Examples)

Description	Severity Category	Criteria
Catastrophic	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding $10M.
Critical	2	Could result in one or more of the following: permanent partial disability, injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding $1M but less than $10M.
Marginal	3	Could result in one or more of the following: injury or occupational illness resulting in one or more lost workday(s), reversible moderate environmental impact, or monetary loss equal to or exceeding $100K but less than $1M.
Negligible	4	Could result in one or more of the following: injury or occupational illness not resulting in a lost workday, minimal environmental impact, or monetary loss less than $100K.

6.10 Step 8: Risk Assessment

The PMT will perform a risk assessment to identify and prioritize recommended mitigation measures that, if implemented, may reduce the overall risk to the facility and its assets.

It is the final step of the TVA process where the PMT will evaluate the risk ranking for each threat-scenario and apply the findings and values of frequency of occurrence (Table 3) along with severity of consequence (Table 8) to the Risk Matrix (Table 9) to identify the appropriate risk index and accompanying criteria for each threat-scenario

The PMT will use the results to develop and recommend security design criteria and protective measures to mitigate identified vulnerabilities.

The SSRC should evaluate the potential mitigation measures to select and implement practical measures that fit the project's budget, risk tolerance, overall State/Lake Elevated Station's operations, and security posture desired. The measures should be tracked in the Risk Register until appropriately mitigated. Decisions to accept and approve protective measures are critical for the agency and should be recorded and tracked.

As part of the SSCP all approved security countermeasures are integrated into the Project CILs. All security countermeasures not approved are reviewed to identify if any other measures, such as written procedures or new policies, can help to mitigate any potential security threats.

Following classification by severity and probability of occurrence, threat scenarios are given a risk index (criticality) so that the SSRC may further assess the threats using two distinct yet overlapping criteria:

- Acceptability of the risk to management from a security standpoint and determination of the appropriate threat risk index ranking. This threat priority ranking is called its criticality and is a function of both severity and probability of occurrence.
- Assigning numeric values to each severity category and probability level and combining them mathematically quantifies criticality. Threat scenario criticality is determined qualitatively.

The threat criticality ratings, for acceptability of risk by the SSRC, are classified in one of the following categories:

- Unacceptable
- Undesirable, SSRC decision required.
- Acceptable with SSRC review
- Acceptable without review

Implementation of corrective action for unacceptable and undesirable hazards includes considering the cost of corrective action. The corrective action rating is based on the corrective action implemented. The threat rating for corrective action needs to be performed only for identified threats that have been categorized as unacceptable and undesirable in the initial threat risk index ranking.

Table 9. Risk Assessment Matrix

Severity / Probability	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	**High**	**High**	**Serious**	**Medium**
Probable (B)	**High**	**High**	**Serious**	**Medium**
Occasional (C)	**High**	**Serious**	**Medium**	**Low**
Remote (D)	**Serious**	**Medium**	**Medium**	**Low**
Improbable (E)	**Medium**	**Medium**	**Medium**	**Low**
Eliminated (F)	**Eliminated**			

Risk Index	Criteria by Index
IA, 1B, IC, 2A, 2B	Unacceptable
ID, 2C, 3A, 3B,	Undesirable - Decision required
IE, 2D, 2E, 3C, 3D, 3E, 4A, 4B	Acceptable with review
4C, 4D, 4E	Acceptable without review
1F, 2F, 3F, 4F	Eliminated

6.11 Security Design Reviews

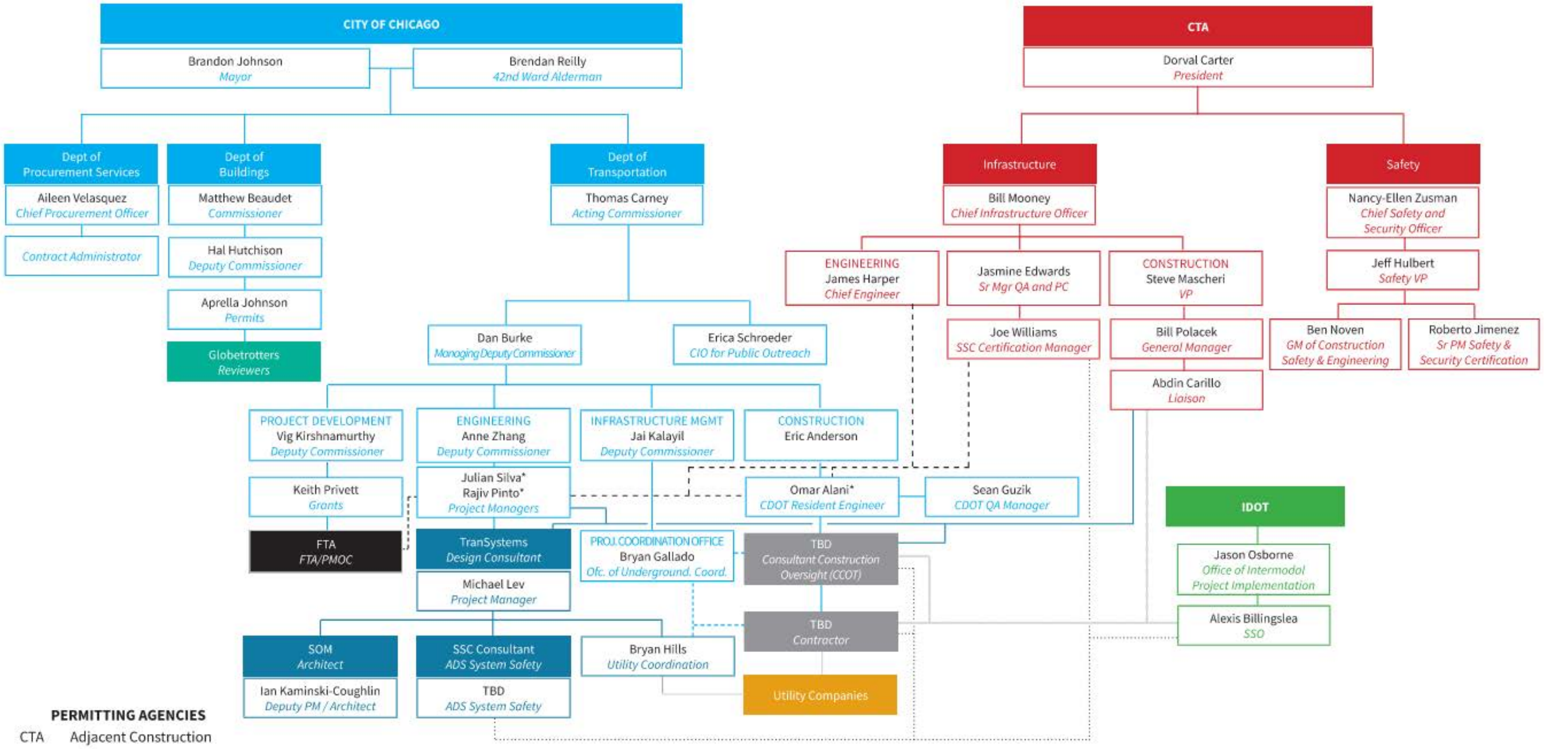
Several activities are conducted to ensure the PMT and CCOT review all facilities and systems designs for security issues. Security design reviews conducted throughout the entire design process from preliminary and final designs final phases are intended resolved issues through CTA's design review process where designs are formally certified and security items are identified through standards and requirements. Industry standards and experience are also used to evaluate unique transit security issues. In several cases, special studies or assessments are performed to address specific security issues. The security design reviews will focus on the following areas:

- Incorporating approved CTA design criteria from IDCM Chapter 17, Safety and Security;
- Incorporating Crime Prevention Through Environmental Design (CPTED) Concepts;
- Identification of new security issues created by design and/or design changes; and
- Incorporating TVA mitigation measure recommendations.

Appendix A

Organizational Charts

Project Organizational Chart

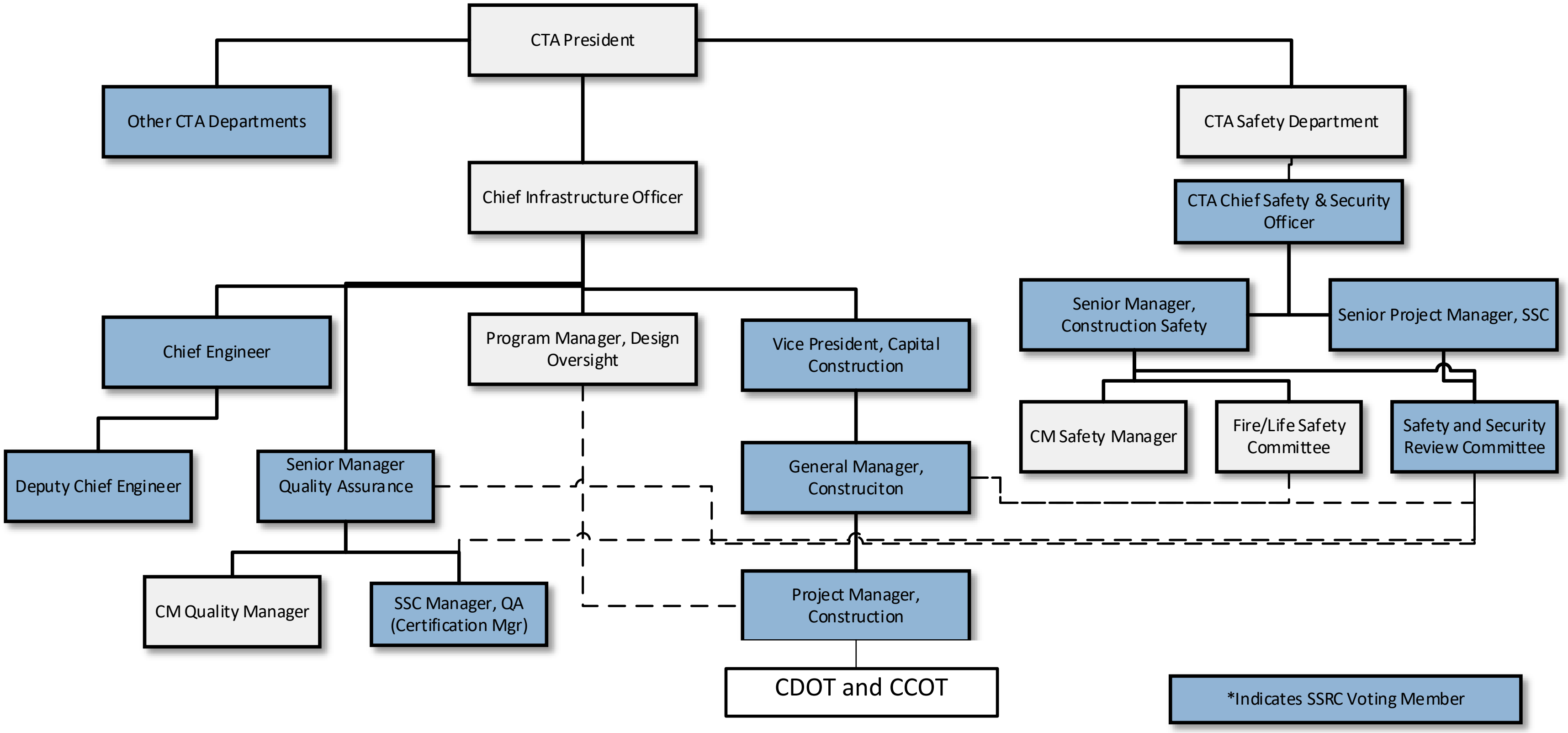


PERMITTING AGENCIES

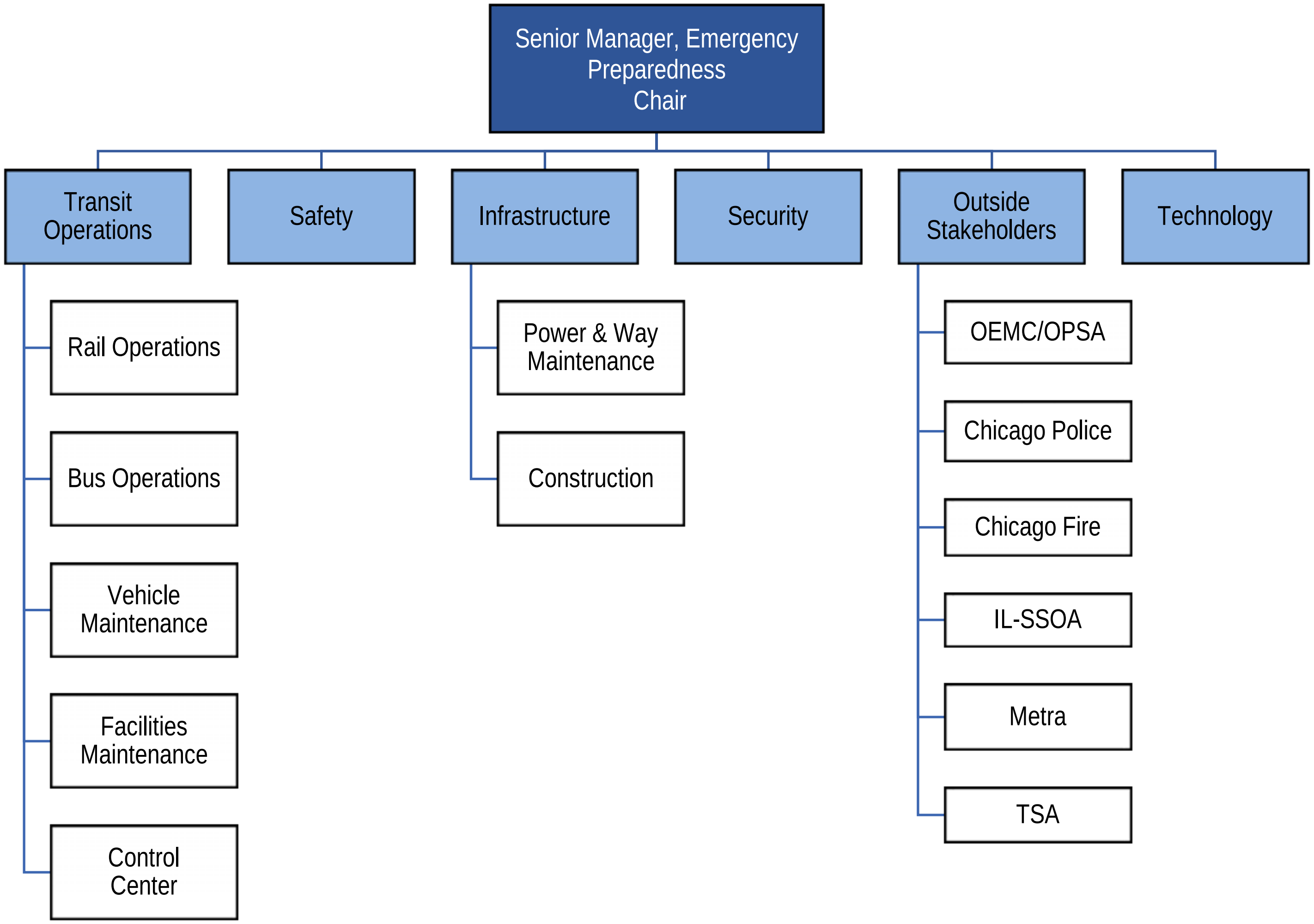
CTA	Adjacent Construction
CDOT	OUC EFP
CDOT	Deep Foundation
DOB	Building Permit
CDOT	Street/Lane Closure

* CDOT Project Management Team (PMT)

CTA Organizational Chart and SSRC Members



Fire/Life Safety and Security Committee



Appendix B

Design Criteria Conformance Checklist (DCCC)

Construction Specification Conformance Checklist (CSCC)

Safety/Security Open Items List (SOIL) – Safety/Security Critical Items List (SCIL)

Certificate of Conformance

Temporary Use Notice (TUN)

Test Description Sheet

Links to CTA Program Wide e-Builder:

Documents \ 02 Reference Documents \ 02 Design References \ Templates and Forms

Documents \ 05 Safety & Security Certification \ 01 Templates

Design Criteria Conformance Checklist

Project Name: **Project ID:**			**Safety & Security Design Criteria Conformance Checklist (DCCC)** **Status: Open; Closed; N/A**					**Revision:** **SSRC Approval Date:**			
Design-Build Preliminary Design Input											
					Designer of Record Verification			**Independent Verification**			
Item No.	Certifiable Element	Sub-element	Safety and Security Requirement	Standard Source	Compliance Specification and/or Drawing Reference	Designer's Remarks	Designer Status	Verifier	Verified Date	Verifier's Remarks	Status

Construction Specification Conformance Checklist

<table>
<tr>
<td colspan="3">Project Name:
Project ID:
Stage:
Certifiable Element:
Certifiable Sub-element</td>
<td colspan="6">Construction Specification Conformance Checklist

Means of Verification:
SUB- Submittal DIR- Daily Inspection Report
CERT- Material Certificate PIC- Photograph
T&I- Test & Inspection Plan Item</td>
<td colspan="2">Page 1 of XX

Revision:
SSRC Approval Date:</td>
</tr>
<tr>
<td>Item No.</td><td>Certifiable Item</td><td>Certifiable Item Description</td><td>Specification</td><td>Spec Paragraph</td><td>Means of Verification</td><td>Verification Document</td><td>Project Website Location</td><td>Verified By</td><td>Date</td><td>Comments</td>
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Safety/Security Open Items List (SOIL) – Safety/Security Critical Items List (SCIL)

Project Name:
Project ID:

No.	Description	SCIL (Y/N)	Potential Cause	Potential Cause	Effect on System/Subsystem and Other Systems/Subsystems	Initial Risk Index	Control Measures/Resolution	Residual Risk Index	Assignment	Dave Closed	Status

Safety and Security Certificate of Conformance

Safety & Security Certification

Project Name:

Project ID:

CERTIFICATE OF CONFORMANCE

COC No:

Certifiable Element/Sub-Elements:

Restrictions Noted:

Chief Engineer	Date	VP, Construction	Date
Chief Infrastructure Officer	Date	Chief Safety & Security Officer	Date

Temporary Use Notice

	Safety & Security Certification Project Name: Project ID:

TEMPORARY USE NOTICE	TUN No:

Certifiable Element/Sub-Elements:

Restrictions Noted:

Chief Engineer Date

VP, Construction Date

Chief Infrastructure Officer Date

Chief Safety & Security Officer Date

TEMPORARY USE NOTICE EXPIRES UPON ISSUANCE OF CERTIFICATE OF CONFORMANCE

Test Description Sheet

Safety & Security Certification

Project Name:

Project ID:

TEST DESCRIPTION SHEET

Date:

Certifiable Element/Sub-Elements:

CSCC Item No(s):

Additional Needed Testing:

Requestor (Name/Title) Date

Certification Manager Date

SSRC Date

State/Lake Loop Elevated Station Project

Safety and Security Management Plan (SSMP)

Date: October 25, 2023

Revision: 1.5

Prior Versions
Rev 1.0 July 1, 2022
Rev 1.1 August 16, 2022
Rev 1.2 September 6, 2022
Rev 1.3 March 9, 2023
Rev 1.4 April 7, 2023

Contents

Approvals

The individuals below, submitting and signing this Safety and Security Management Plan (SSMP), verify it was prepared in accordance with the requirements set forth by FTA Circular 5800.1, 49 CFR Part 633, and 49 CFR Part 674; they are authorized representatives of the Chicago Transit Authority, their signatures attest all items and conditions contained herein are understood, accepted, approved, and they are committed to implementing this SSMP for the Project and achieving its safety and security goals and objectives.

Concurrence and Approved:

Raym Pinto 11/2/23

CDOT Project Manager Date

10/31/23

Chief Engineer Date

10/31/23

Chief Infrastructure Officer Date

S Maschi 10/31/23

Vice President, Construction Date

William D. Pohm 10/31/23

General Manager, Construction Date

Nancy-Ellen Zusman 11/1/23

Chief Safety and Security Officer Date

Abbreviations

APTA	American Public Transportation Association
CCTV	Closed Circuit Television
CFR	Code of Federal Regulations
CEL	Certifiable Elements List
CIL	Certifiable Items List
CIO	CTA Chief Infrastructure Officer
CDOB	Chicago Department of Buildings
CCOT	Consultant Construction Oversight Team
CDOT	Chicago Department of Transportation
CPTD	Crime Prevention Through Environmental Design
CSCC	Construction Specification Conformance Checklist
CSSO	CTA Chief Safety and Security Officer
CTA	Chicago Transit Authority
DC	CDOT's Design Consultant
DCCC	Design Criteria Conformance Checklist
DHS	Department of Homeland Security
EPA	Environmental Protection Agency
FLSSC	Fire/Life Safety and Security Committee
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes and Effects Criticality Analysis
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HHA	Health Hazard Assessment
IDCM	Infrastructure Design Criteria Manual
IDOT	Illinois Department of Transportation
ISTEA	Intermodal Surface Transportation Efficiency Act
NFPA	National Fire Protection Association
OHA	Operating Hazard Analysis
OSHA	Occupational Safety and Health Administration
PE	Preliminary Engineering
PHA	Preliminary Hazard Analysis
PMO	Project Management Oversight
PMOC	FTA's Project Management Oversight Consultant
PMP	Project Management Plan
PMT	CDOT Project Management Team
PSM	IDOT Program Standards Manual
RASP	Rail Agency Safety Plan
RTA	Regional Transportation Authority
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SCADA	Supervisory Control and Data Acquisition
SCIL	Safety/Security Critical Items List
SEPP	Security and Emergency Preparedness Plan
SMS	Safety Management System
SMP	Safety Management Program
SOIL	Safety/Security Open Items List
SOP	Standard Operating Procedure

SSC	Safety and Security Certification
SSCP	Safety and Security Certification Plan
SSHA	Sub-System Hazard Analysis
SSI	Sensitive Security Information
SSMP	Safety and Security Management Plan
SSO	State Safety Oversight
SSOA	State Safety Oversight Agency
SSPP	System Safety Program Plan
SSRC	Safety and Security Review Committee
TSA	Transportation Security Administration
TUN	Temporary Use Notice
TVA	Threat and Vulnerability Assessment

Referenced Documents

49 CFR Part 659 Rail Fixed Guideway Systems; State Safety Oversight	April 2005
49 CFR Part 674 State Safety Oversight	March 2016
Project Management Plan (PMP)	June 29, 2022
Safety and Security Certification Plan (SSCP)	July 1, 2022
Department of Defense Standard Practice System Safety Military Standard	May 11, 2012

1.0 Project Background

The project consists of design and construction of a new architecturally prominent and signature State/Lake Loop Elevated Station. Station capacity – both larger platforms and more fare collection turnstiles – will be increased. Chicago Department of Transportation (CDOT) and Chicago Transit Authority (CTA) staff members observe significant overcrowding during peak periods on the platforms at the State/Lake station, and the planned larger platforms will address the need for additional passenger waiting space. Additionally, the station will be brought into compliance with current code through upgraded security/surveillance systems, backup power systems, and Americans with Disability Act (ADA) accessibility.

The project also includes upgrades of the adjacent Lake/Randolph mezzanine at the Lake Red Line subway station to bring that entrance into compliance with ADA and to permit accessible transfers between the subway and elevated stations.

Additional information about the project can be found in the Project Management Plan (PMP), Section 1.2 Project Description.

2.0 Management Commitment and Philosophy

The Federal Transit Administration (FTA) requires the development and implementation of a Safety and Security Management Plan (SSMP) for the Project throughout the project life cycle, in accordance with FTA Circular 5800.1, August 1, 2007, Safety and Security Management Guidance for Major Capital Projects. FTA developed the circular to implement Section 3026 of the Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) that requires recipients with major capital projects covered by 49 CFR Part 633, Project Management Oversight (PMO), to include "Safety and Security Management" as an element of their Project Management Plan (PMP).

Historically, recipients of FTA funding with projects covered under 49 CFR Part 633 described their Safety and Security Management strategies and controls as sub-elements of other required PMP sections. Some recipients performed specific safety and security activities, such as Safety and Security Certification or service restoration operational readiness assessments, while other recipients did not. There was no consistent approach to safety and security in projects covered by 49 CFR Part 633. With circular 5800.1, FTA addressed these shortcomings and strengthened the role of safety and security oversight and management in all phases of project development.

This document fulfills the Safety and Security Management element of the PMP for the Project. This SSMP formalizes the technical and management strategies for determining safety and security risk acceptance throughout the Project, from the Preliminary Engineering (PE) phase up to final completion. It makes reasonably certain that safety hazards and security vulnerabilities associated with transit operations are identified, evaluated, and resolved prior to the initiation of revenue service. This process helps to assure that the achievement of the highest practical level of operational safety and security is attained prior to the initiation of revenue service.

2.1 Project Safety Authority

For this project, the CDOT is the project sponsor and the FTA grantee. CDOT administers the design and construction processes, and this project is a partnership with CTA as described in the

PMP. CDOT will administer the construction contract and will be the entity responsible, in conjunction with their Consultant Construction Oversight Team (CCOT), for ensuring the contractor's compliance with the contract documents and contractor developed safety plan(s). The CCOT will maintain daily oversight of contractor work. CDOT will delegate certain safety oversight procedures during construction to CTA.

CTA Safety Department staff will attend weekly construction meetings and complex operation planning meetings. CTA staff will visit the site with regularity to monitor work. The delegation of safety oversight duties during construction will be fluid, with CDOT, CCOT, and CTA all possessing the ability to stop contractor work when unsafe conditions arise and to order remediation of these conditions. CDOT and CCOT maintain this authority through the City of Chicago's privity of contract with the contractor, and CTA maintains its authority because the contractor must adhere to CTA Adjacent Construction standards and policies which require the contractor to authorize CTA action in this manner in order to be permitted access to work on CTA facilities.

Once project construction is complete, CTA will be the sole maintainer and operator of the facility, including all safety oversight, audits, and action. While CDOT will retain ownership of the station, it will not manage, maintain, repair, oversee, or operate it or transit service through it. CDOT is responsible for ongoing maintenance of the public streets and sidewalks below the station upon project completion.

CTA is the current owner and operator of the station, and owns most facilities related to the station, such as the track and track structure, traction power distribution system, train control signals, public address and communication systems, fare collection system, and advertising. CTA positions 1 or 2 customer assistants at this station, per a schedule that they maintain, however customer assistants will not be positioned at the station during the period that it is closed. CTA operates the fixed guideway, rapid transit trains that service this station and will continue to do so in the new station. Train service on the lines through this station will continue operations during construction, although the station itself will be closed.

While certain safety considerations will be considered by CDOT during design and certain safety responsibilities held by CDOT and CCOT during construction, many of the processes described herein will be overseen by CTA as CTA employs the staff with responsibility and authority for many of the safety decisions that underly what is constructed and how it is constructed. In particular, variation from these standards, if necessary, will require action by CTA staff or CTA standing committees as described herein, as CDOT does not employ or contract for staff with this expertise or authority.

2.2 Safety Policy Statement

The Chicago Transit Authority (CTA) is committed to providing safe, clean, on-time, courteous, and efficient transit service throughout Chicago and in the Forty (40) surrounding communities. In an effort to meet its goal of providing the highest degree of safety for customers, employees and the public, the CTA makes a constant practice of identifying hazards and eliminating or mitigating them throughout its operations, maintenance, construction, and administrative activities. This Safety Policy flows from the executive level and is a central management priority.

Safety and security are primary concerns that encompass all aspects of the planning, design, construction and subsequent operation of the Project. Safety and Security Management Plan documenting the approach taken to address safety and security requirements and identify the process by which the design, construction, and operational phases of project will be certified as being safe and secure for revenue operations. This SSMP describes the policies, procedures and activities to be followed by management, designers, consultants, and contractors and associated project team members to integrate safety and security activities, to identify, evaluate and resolve safety hazards and security vulnerabilities, and to establish accountability for safety and security during the final design, construction, testing, and start-up phases of the project.

Responsibility for the implementation of this plan is assigned to the appropriate staff and committees as outlined in this document. CTA staff and committees are to continuously review safety and security metrics throughout all Project phases and update the safety and security analyses to improve the system design, construction, maintenance, and operations. All Project employees, staff, consultants, and contractors are directed to comply with the provisions of this SSMP and to fully cooperate in the certification of the Project's safety and security activities and the achieving of the goals set for a safe and secure Project.

2.3 Purpose

This SSMP is being developed to support the design stage of the Project and addresses specifically those safety and security activities. It will be updated to better address the safety and security activities that will occur during construction, testing, start−up, and the transition to operations after the design stage has been completed and upon the selection of a CCOT and contractor.

This SSMP will accomplish:

- Documenting the management philosophy and structures used by the Project to support the implementation of an effective safety and security program;

- Establishing management strategies and activities, in place early in the Project life cycle, to ensure hazards, threats and vulnerabilities are identified; their risks assessed; and mitigating actions are developed, tracked, and resolved prior to operation; and

- Providing guidance for verification that all Project equipment, facilities, plans, procedures, and training programs are systematically reviewed for compliance with established system safety and security requirements prior to implementation of operations.

This SSMP is adopted from and supports the Safety and Security Policy Statement in **SSMP Sub-Section 2.1**.

2.4 Applicability and Scope

This SSMP applies to the Project and all associated project development activities including preliminary engineering, final design, construction, integrated testing, demonstration, initiation of operations, and other applicable transit system improvement capital projects that involve the Project. Specifically, the scope of this SSMP encompasses:

- System-Wide Elements — which include, but are not limited to, the following: traction power; signaling system; voice and data communications; closed-circuit television (CCTV) at the facility; lighting, access control and intrusion detection system; track; SCADA; and fire detection system.
- Fixed Facilities — which includes main and ancillary structures.
- Integrated Testing — which includes testing of all interfacing systems required for proper operational functionality.
- Safety, Security, System Assurance, Operational and Maintenance Plans and Procedures — which includes items such as the Operations and Maintenance Plan, Restoration of Operations, Training Plans, System Integration Test Plan, Standard Operating Procedures, Personnel Qualifications, Drills and Emergency Procedures.

This SSMP is being developed and implemented in coordination with the Project's PMP and other sub−plans including the safety and security certification processes and hazard and vulnerability analyses.

2.5 Goals

The main goal of this SSMP is to assure elements of the Project are safe and secure for passengers, employees, public safety personnel, and the public through a formal program of Safety and Security Certification and hazard and threat/vulnerabilities management. The secondary goals are to provide:

- Clear determinations regarding acceptable safety and security risks, articulated in policy by the project's executive management team.
- Verification an acceptable level of safety and security is designed into the Project.
- Consistent evaluation of safety and security risks is conducted throughout the Project.
- Consistent application of safety and security verification activities to support initiation of the Project and/or individual elements of the Project into operational service.
- Ensure all phases of the Project are evaluated for conformance with the established safety and security requirements.
- Evaluate and resolve any restrictions to complete Safety and Security Certification.
- Ensure a mechanism is provided to follow to completion the resolution of any restrictions to full Safety and Security Certification.

2.6 Objectives

The objectives of this SSMP include:

- Describe the process for the formal identification, consideration, elimination and/or control of hazards and threat/vulnerabilities to passengers, employees, Contractors, emergency responders, and the public,

- Identify the process which verifies the appropriate codes, guidelines, standards, and industry practices have been applied to the Project and form the basis for safety and security considerations in the design,

- Verify the appropriate specifications and drawings are in conformance with the safety and security design criteria, and the design / specification conformance checklists have been appropriately developed, completed, and certified to document design and construction specification conformance,

- Verify a procedure is in place to assure facilities, systems, and equipment are constructed, inspected, and tested in accordance with the design criteria and specifications,

- Verify a procedure is in place to assure safety and security elements of Contract deliverables (facilities, systems, and equipment) are reviewed against the Contract specifications and drawings (including all engineering changes for compliance), and that safety and security elements of the operating system are included in the checklists developed, completed, and certified to document compliance with the design,

- Heighten safety and security awareness among all project participants and enable project personnel to identify, eliminate, minimize, and/or control hazards, threats and vulnerabilities, and their associated risks prior to their resulting in a loss (i.e., injury, illness, death, system loss, property damage, or property loss),

- Thoroughly evaluate the system safety and security implications of all proposed system modifications, prior to implementation, to assure new hazards will not be created,

- Require contractors to thoroughly investigate all accidents/incidents including fires, injuries and near misses to determine root causes, and

- Comply with the safety, security, emergency preparedness and operational readiness requirements.

3.0 Integration of Safety and Security into Project Development

This section provides a description of the safety and security activities performed in each Project phase. As stated throughout this document, as the Project progresses, CDOT and CTA will ensure the DC and CCOT update the PMP and SSMP accordingly. Detailed responsibilities for safety and security activities, and the make-up and role of safety and security committees are further described in SSMP Section 4. The Project team is outlined in **Table 2.0**.

Table 2.0 Project Team

Project Assignment	Organization	Name
General Manager, Construction Safety & Engineering	CTA	Ben Noven
CDOT Project Manager - Design	CDOT	Julian Silva/Rajiv Pinto
CDOT Resident Engineer	CDOT	Omar Alani
CTA Project Manager	CTA	Abdin Carrillo
Design Consultant Manager	TranSystems	Michael Lev
Consultant Construction Oversight Team	TBD	TBD
Contractor	TBD	TBD
Certification Manager	CTA	Joseph Williams

3.1 Integration of Safety and Security into Project Development

The DC prepared this SSMP for the Project which includes activities, assignments, and certification procedures, in later sections of this document, for safety and security. The SSMP is a dynamic document that will require updating and re-release as the Project progresses. The Project Safety and Security Activities Matrix provided in **Table 2.1**, lists the major safety and security tasks and the phase of the project where the task is initiated and performed.

Table 2.1: Project Safety and Security Activities Matrix

MAJOR TASKS	Task Initiator	PE	FD	CON	Test	DEM	OPS
Develop Safety and Security Policy Statement	CTA	✓	▸▸	▸▸	▸▸	▸▸	▸▸
Establish Designated Function for Safety and Security throughout the Project	CTA	✓	▸▸	▸▸	▸▸	▸▸	▸▸
Develop SSMP	DC	✓	▸▸	▸▸	▸▸	▸▸	▸▸
Establish Safety and Security Review Committee	CTA	✓	▸▸	▸▸	▸▸	▸▸	▸▸
Create Safety and Security Certification Responsibilities Matrix	CTA	✓	▸▸	▸▸	▸▸	▸▸	▸▸
Develop SSCP	DC	✓	▸▸	▸▸	▸▸	▸▸	▸▸
Develop and Implement Hazard and Vulnerability Resolution Process and Tracking System	CDOT	✓	▸▸	▸▸	▸▸	▸▸	▸▸
Prepare a Preliminary Hazard and Vulnerability List	DC	✓	▸▸	▸▸	▸▸	▸▸	▸▸

Table 2.1: Project Safety and Security Activities Matrix							
MAJOR TASKS	**Task Initiator**	**PE**	**FD**	**CON**	**Test**	**DEM**	**OPS**
Identify Safety and Security Certifiable Elements	DC	✓	▶▶	▶▶	▶▶	▶▶	▶▶
Establish Safety and Security Certifiable Items List	DC	✓	▶▶	▶▶	▶▶	▶▶	▶▶
Establish Safety and Security Configuration Management Requirements	CTA/CDOT	✓	▶▶	▶▶	▶▶	▶▶	▶▶
Initiate Project Documentation System	CCOT	✓	▶▶	▶▶	▶▶	▶▶	▶▶
Perform a Project Preliminary Hazard Analysis	DC	✓	▶▶	▶▶	▶▶	▶▶	▶▶
Perform a Project Threat and Vulnerability Assessment	DC	✓	▶▶	▶▶	▶▶	▶▶	▶▶
Prepare Safety and Security Design Criteria	CTA	✓	▶▶	▶▶	▶▶	▶▶	▶▶
Perform Safety and Security Review of Preliminary Operations and Maintenance Procedures	CTA		✓	▶▶	▶▶	▶▶	
Perform Safety and Security Design Reviews & Additional Hazard and Vulnerability Analysis	CTA		✓	▶▶	▶▶	▶▶	▶▶
Develop Design Criteria Conformance Checklists	CTA	✓	▶▶				
Complete Design Criteria Conformance Checklists	CTA/CCOT		✓				
Develop Construction Specification Conformance Checklists	CCOT			✓			
Develop Test and Evaluation Requirements	CTA/CDOT/C COT/C			✓	▶▶	▶▶	▶▶
Complete Construction Specification Conformance Checklists (Verification)	C			✓	▶▶	▶▶	
Identify Additional Safety and Security Test Requirements	CDOT/CCOT /CTA			✓	▶▶		
Perform Testing and Validation in Support of SSC Program	CCOT/CTA				✓		
Issue Notices and Occupancy Permits	CDOT/CDOB *			✓	▶▶	▶▶	
Issue Certificates	CTA			✓	▶▶	▶▶	
Complete and Monitor Integrated Testing	C/CCOT/CTA			✓	▶▶	▶▶	
Review of Engineering Change Orders & Waivers	CDOT/CTA			✓	▶▶	▶▶	▶▶
Complete Operational Readiness Review	CTA					✓	
Perform Final Safety and Security Compliance Assessment	CTA					✓	
Issue Final Safety and Security Certification	CTA					✓	
Issue Final Safety and Security Verification Report	CTA					✓	
CCOT=Consultant Construction Oversight Team CDOT=Chicago Department of Transportation CDOB=Chicago Department of Buildings DC=Design Consultant CTA=Chicago Transit Authority C=Contractor	PE=Preliminary Engineering FD=Final Design CON=Construction Test=Integrated Testing DEM=Pre-Revenue Demonstration OPS=Operations						
✓= initiation of activity	▶▶ = on-going						

* CDOB is the City entity responsible for issuing Certificates of Occupancy, through their Building Permit Program. CDOT applied for a building permit and will be the agency requesting that CDOB issue a Certificate of Occupancy.

3.2 Procedures and Resources

The PMP:

- Establishes the framework for managing and administering all activities related to the implementation of the Project in accordance with the requirements of the U.S. Department of Transportation and FTA Project and Construction Management Guidelines;

- Outlines the project management processes and CDOT, CTA, and Project Team organizational structure; and

- Provides guidance for the coordination of design, construction, and start up activities.

The PMP is supplemented by other documents that address specific safety and security activities or requirements of the project, including:

- This **Safety and Security Management Plan (SSMP)**, which establishes the overall safety and security program for the Project. This SSMP contains CTA's safety and security policy, authority, and executive approval for the Project;

- The **Infrastructure Design Criteria Manual (IDCM)**, which includes system safety and security design criteria, will be used for the Project. Relevant safety codes, regulations, standards, and security requirements will be identified by the DC during preliminary engineering and final design;

- The **Safety and Security Certification Plan (SSCP)**, will provide a tailored approach to Safety and Security Certification by:

  -Identifying appropriate safety and security assessment and hazard analysis techniques applied to systems or equipment with safety and security critical functions;

  -Including applicable safety and security requirements in design, specification development, construction, testing, and preliminary operations planning through project completion and revenue service;

  -Assuring consistency in agency response between bus and rail services; and

  -Assuring open communications and coordination with various groups within CTA, consultant, and contractor organizations to facilitate timely verification of system safety and security compliance.

- The **Rail Agency Safety Plan** (**RASP)**, which assures the safe operation of the CTA Rail System for customers, employees, and the public throughout all phases of the rail transit system's life cycle. The RASP includes or references safety policies, procedures and activities that have been designed and implemented to maximize safe operation and assure all required regulatory demands and agency safety requirements are satisfied. The RASP establishes CTA's safety philosophy, Safety Management System (SMS) practices, and provides a means for its implementation and monitoring;

- The **Security and Emergency Preparedness Plan** (**SEPP)**, which assures a planned, documented, organized response to actual and potential security threats to the system, and to address these threats with proactive measures and response techniques that manage and minimize the outcome of security breaches or related events;

- **CTA AP1902 and Control of Sensitive Security Information (SSI)**, which establishes the process for identifying and controlling SSI released to outside entities or uploaded to a Project Website. This document was developed to meet Sensitive Security Information is controlled under the provisions of 49 CFR Parts 15 and 1520. CDOT, CCOT, DC, and the Contractor will use the Project Website (e-Builder) to store and transmit SSI materials; and

- The **Safety Manual for Contract Construction On, Above, or Adjacent to the CTA Rail System** which governs any type of construction, engineering, or maintenance work performed by Contractors and Consultants at any location on, above, or adjacent to the CTA right-of-way.

Periodic audits may be performed, as appropriate, by CDOT, CCOT, and CTA safety and/or security staff to assure these and other safety and security activities are performed effectively and within the requirements of the Project. Ultimate responsibility for Safety and Security Management for the Project, however, remains with CTA management.

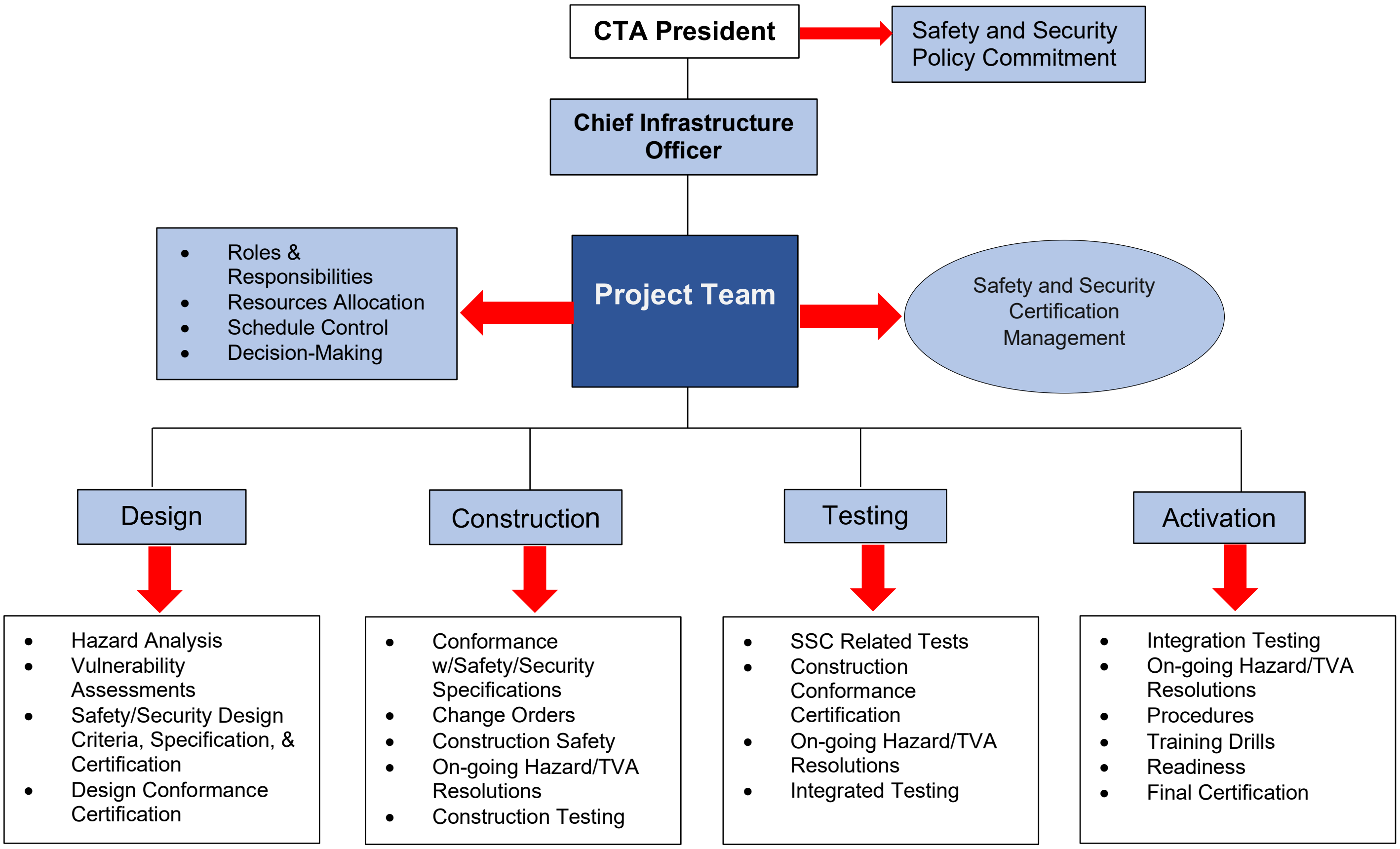
In addition to the results of the Preliminary Hazard Analysis (PHA) and Threat and Vulnerability Analysis (TVA), design reviews and security assessments will be conducted, and the results will be incorporated into the Final Design. An Operating Hazard Analysis (OHA) will be performed during the construction, testing and start-up phases.

3.3 Interface with Management

Each member of the Project Team has a role in Safety and Security Certification (SSC). Figure 2.1 shows the relationship of various project elements and the contributions made by project team members to the SSC process. While Safety and Engineering share primary responsibility for SSC of the system, many functional disciplines included in the project team are required to complete the certification process. As indicated in Figure 2.1, certification management relies on a coordinated effort that brings the capabilities and resources of the design team, the construction team, the acceptance and testing team, and the activation team together to accomplish the Safety and Security Certification activities.

Specific details of the project organization are provided in Section 4.0, “Safety and Security Certification Process” and in Section 2.0 “Program Management, Organization and Responsibilities” of the SSCP. Specifics of organizational interface and coordination between the project management team and the various operational units throughout CTA are provided in these plans.

Figure 2.1 Project Team SSC Interface with Management



CDOT maintains responsibility for overall administration of the PMP. CDOT will collaboratively oversee the administration and update of this SSMP with CTA, including the Chief Safety and Security Officer, or his designee, the Certification Manager, Rail Operations, and Vice President, Security. CDOT will delegate the authority for the day-to-day management of this SSMP to the CCOT, but CTA's Chief Safety and Security Officer will also be engaged in the process.

The Safety and Security Review Committee (SSRC) is the forum for formal discussion of safety and security issues. The SSRC is chaired by the Certification Manager. The SSRC is a multi-disciplinary group comprised of managers and staff having specific expertise in systems engineering, facilities engineering, maintenance engineering, program and construction management, safety and security, emergency preparedness, systems integration, public participation, transit operations, and risk management.

The SSRC voting members include:

- Chair: (Certification Manager)
- Certification Manager;
- Security - Vice President;
- Safety – Vice President;

- Safety - General Manager, Construction Safety & Engineering;
- Safety - Sr. Project Manager;
- Construction - Vice President;
- Construction - General Manager
- Infrastructure Chief Engineer;
- Rail Operations; and
- Infrastructure Maintenance, Vice President
- Facilities Maintenance, General Manager
- Power & Way Maintenance (Track and Structural), General Manager
- Power & Way Maintenance (Signal), General Manager

Non-voting members from interested parties may include:

- IL-SSOA
- Consultant Construction Oversight Team
- Program Manager

SSRC activities include:

- Assuring safety and security requirements are incorporated in the Contract drawings and documents through a process of design exception (versus design review),

- Verifying safety and security requirements and conformance checklists that have been developed for the construction of the Project are formally reviewed and approved,

- Reviewing, monitoring, and overseeing safety and security issues not resolved by the design team and/or construction contractors,

- Assuring coordination of this SSMP between all represented Committee members, including the design to facilities, systems, and equipment,

- Reviewing safety hazards and security vulnerabilities identified through analyses, assessments, design reviews and other mechanisms to assure they are being fully addressed,

- Tracking the status of identified hazards and vulnerabilities,

- Review reports on SSRC activities and outstanding issues,

- Review and approve Conformance Certificates for safety and security related elements in design and other phases of the Project; and

- Reviewing, accepting, and ensuring executive sign-off on a final Safety and Security Certification Verification Report.

Details of the SSRC members' specific duties and responsibilities are more fully described in the CTA Safety and Security Review Committee (SSRC) Charter incorporated by reference into this Plan. The SSRC meets as business dictates or as requested by any of the Committee members.

Detailed organizational charts for the project and project committees are attached as **Appendix A**. An organizational chart showing the interface between the CTA Departments and external stakeholders is also included.

4.0 Assignment of Safety and Security Responsibilities

DC is contracted to develop the Project design and specifications as well as to provide overall advice and guidance with respect to FTA requirements, and Project management.

The Project will be managed, and activities conducted by an integrated team of Project employees and staff, professionals, consultants, and contracted personnel, with this staff coming from CDOT, CCOT, DC, and CTA. The organization and structure of this "PM Team" will be updated as necessary to incorporate the dynamic and shifting roles and responsibilities through the varying stages of Project Development, Construction, and Testing and Start-up. The PM Team is responsible for ensuring safety and security activities are conducted in a timely manner, with the highest degree of quality and completeness throughout all Project phases. The PM Team will interface with others at CDOT and CTA, committees, professionals, consultants, and contracted personnel to assure the work performed meets the requirements of the Project. In addition, the CTA and CDOT delineate specific roles and responsibilities for their personnel, which are outlined in Section 4.1, Table 3.0.

4.1 Responsibilities and Authority

Table 3.0 shows the different authority levels and the responsible parties for ensuring safety and security requirements are integrated into the project and how this SSMP is implemented. The CTA organizational chart is in **Appendix A**.

Table 3.0: Assignment of Safety and Security Authorities

Authority Levels	Responsible Party	Authority Description
Initiating Authority	CTA President CDOT Commissioner	Initiating Authority comes from the project's executive leadership. This authority is typically delegated to other participants for actual execution. However, the initiating authority assures that the safety and security effort will have personnel resources and access to contractor or sub-contractor support. These assurances are critical to the ultimate success of the safety and security activities for the project.

Implementation Authority	CTA Chief Infrastructure Officer (CIO)	Implementation Authority for implementing safety and security requirements ultimately rests with the CTA CIO. The CIO delegates the overall accountability for the project and its various elements, including the ultimate approval authority for safety and security activities, to the VP, Construction and/or the Chief Engineer unless stated otherwise.
Day-to-day Safety and Security Authority	CTA Chief Safety and Security Officer (CSSO) CTA Vice President, Security CDOT Resident Engineer and CCOT	Day-to-Day Safety and Security Authority rests with the designated functions for Safety and Security. Due to the extended period of most major capital projects, this authority may reside with different project personnel throughout design, construction, integrated testing, and demonstration.
Advisory Authority	Safety and Security Review Committee (SSRC) Fire/Life Safety and Security Committee (FLSSC)	Advisory Authority for safety and security rests with committees established to review the overall safety and security program, to provide technical assistance, to coordinate with external agencies, such as the fire department, and law enforcement, and to evaluate specific activities and outcomes. For most major capital projects, advisory authority rests with the SSRC and FLSSC.
Configuration Authority	Project Team via e-Builder Safety and Security Review Committee (SSRC)	Configuration Authority for the safety and security elements of the project rests with the Project Team charged with coordinating and evaluating requests for changes to the projects design baseline to address safety and security concerns. This team works with the projects larger configuration control system (e-Builder) to assure that proposed changes maintain the level of safety and security designed into the system and do not introduce new hazards or vulnerabilities. The Project Team also assures the final safety and security design verification and Construction Specification Conformance Checklists reflect the correct versions of specifications, drawings and bid package materials.

Readiness Assessment Authority	Safety and Security Review Committee (SSRC)	Readiness Assessment Authority for safety and security elements of the project typically rests with a committee established to oversee the development and implementation of rules, procedures, plans, programs, integrated and acceptance tests, service restoration demonstrations, and certification programs for operations and maintenance personnel.
Certification Authority	CTA Chief Infrastructure Officer (CIO) CTA Chief Safety and Security Officer (CSSO)	Certification Authority for the project rests with CTA, as described in the SSCP.

4.2 Committee Structure

Several committees support the implementation of this SSMP. The organizational charts in **Appendix A** and **Figure 3.1** show the organizational relationships among the project committees as they relate to the SSRC.

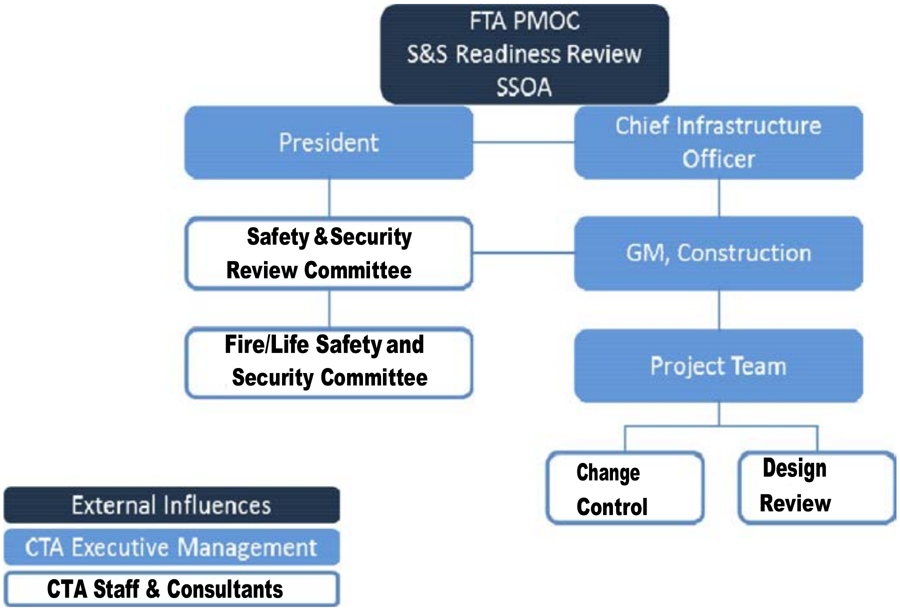
4.2.1 Safety and Security Review Committee (SSRC)

The SSRC reviews and approves elements of the final certification process and is responsible for:

- Assuring that the proper system requirements have been established,
- Assuring that system safety reviews have been performed at each stage of the project,
- Assuring sufficient documentation supports the review and resolution of identified deficiencies;
- Assuring planning and coordination of operational training that simulates revenue service conditions; and
- Reviewing service restoration plans, rules, and procedures for revenue service.

The SSRC reviews procedures, manuals, and other documents that form the basis for certifying compliance with safety and security requirements for systems and fixed facilities. The SSRC may also be responsible for review and concurrence of proposed changes and/or revisions to the project design. The organization, responsibilities, and function of the SSRC will be fully described in the SSCP.

Figure 3.1 Project Committees Org Chart



4.2.2 Fire/Life Safety and Security Committee (FLSSC)

The FLSSC is an established forum for coordination between CTA departments — including Safety, Security, Transit Operations, and Maintenance — and agencies including fire departments, emergency response agencies, TSA, and other local transportation providers (Amtrak, Metra, and Pace). The FLSSC reviews standards, safety-related designs, and tests to verify fire-life safety code and regulation compliance. In addition, the FLSSC addresses preparedness issues and reviews variances. Emergency response readiness drills are coordinated through this committee. The organization, responsibilities, and function of the FLSSC are fully described in the PTASP and SEPP.

4.2.3 Design Review

Design reviews are anticipated to be conducted by members of the Project Team and other subject matter experts from various departments throughout CTA to evaluate and compare the design progress against predetermined project baselines including but not limited to the safety and security design criteria of the CTA Quality Assurance Manual to allow reassessment of these baselines as the design progressed. CDOT also performs design reviews and works collaboratively with DC to make design decisions throughout the design development process.

Formal design reviews were performed at 15%,30%, 60%, 90%, and 100% milestones during design.

4.2.4 Change Control

The Project Team is a panel of key management personnel who meet as required to oversee the Change Control process and review/approve Change Requests for their impact on safety and security. Safety and Security will attend the change control review meetings to review all changes that may affect safety and security critical systems. This review will also investigate the extent of the changes to identify any potential safety hazards and/or security vulnerabilities created by the changes. Any changes that affect safety and security critical systems or create additional safety hazards and/or security vulnerabilities will be addressed with the CTA Project Manager at the project progress meetings and tracked as open items through the SSRC.

4.3 Safety and Security Task Responsibility Matrix

The Safety and Security Task Responsibility Matrix provided in **Table 3.2**, provides an overview of the expected responsibilities and accountabilities for various tasks arising during the Project design and construction.

Table 3.2 Safety and Security Task Responsibility Matrix

Safety and Security Responsibility Legend P—Primary or lead S— Secondary function or assistance A—Approval authority C— Comment only N — Non-applicable	CIO	CSSO	VP, Security	GM, Construction	Chief Engineer	CTA Project Mgr	CDOT	DC	Contractor	CCOT	Rail Operations
Program Management Control											
Establish safety and security policy statement for SSMP.	A	P	S	S	S	N	S	N	C	N	C
Identify who has the Safety & Security designated function.	P	P	P	S	N	N	P	C	C	N	C
Set safety and security task list.	S	C	S	A	N	N	S	C	C	N	C
Develop safety and security task list.	A	C	P	A	A	N	S	N	C	C	C
Decision on Safety & Security Certification Method (self-certify or consultant).	A	P	N	A	S	N	P	N	C	N	C
Decision on Certification Budget (operational or project budget).	P	S	S	S	N	N	P	N	N	N	N
Procurement/contract of safety and security consultants (if applicable).	A	A	C	S	N	N	P	N	N	N	C
Assign roles and responsibilities for safety and security activities.	S	P	S	A	C	C	S	C	C	C	C
Develop and update the Project SSMP.	A	A	S	P	C	C	A	P	C	C	C
Develop and update Project SSCP.	A	A	P	A	C	C	A	P	C	C	C
Develop Safety & Security Certification Milestone Schedule	A	A	S	A	C	C	A	C	N	P	C
Provide Certification Status Reports, Project Team and FTA monthly/quarterly requests.	N	C	S	A	S	S	A	C	C	P	S
Establish the Safety & Security Review Committee.	N	C	S	N	N	C	C	N	N	N	N
Establish the Fire/Life Safety and Security Committee.	N	C	S	N	N	N	C	N	N	N	N
Establish Change Order Committee, Design/Construction.	N	S	S	P	S	S	S	N	N	S	C
FTA Safety Oversight Program Certification Updates.	C	P	S	S	S	S	S	N	N	S	S
Provide assistance on safety and security issues.	S	P	S	P	S	S	P	S	S	S	S
Perform program reviews and audits for safety and security activities.	C	P	S	P	S	S	A	S	S	S	C
Establish system for tracking open items (hazards and vulnerabilities toresolution).	A	P	S	A	S	S	A	S	S	S	C
Conduct hazard and vulnerability analysis to assess impacts of deviations from design criteria/design standards and project technical baseline specifications.	A	P	P	A	S	S	P	P	S	S	S
Design Evaluation											
Establish project concept and component list applicable to safety and security.	N	N	S	A	S	S	A	P	S	C	C
Develop a listing of Safety & Security Certifiable Elements (CEL).	C	C	S	A	S	C	P	P	S	C	C
Identify and review codes, standards, regulations, or existing design criteria or manuals containing safety and security requirements for project.	N	N	S	A	S	S	P	P	P	C	C
Develop Preliminary Hazards and Vulnerabilities List.	N	N	S	A	S	C	A	P	S	C	C

Table 3.2 Safety and Security Task Responsibility Matrix											
Safety and Security Responsibility Legend P—Primary or lead S— Secondary function or assistance A—Approval authority C— Comment only N — Non-applicable	CIO	CSSO	VP, Security	GM, Construction	Chief Engineer	CTA Project Mgr	CDOT	DC	Contractor	CCOT	Rail Operations
Perform PHA.	C	C	A	A	S	C	A	P	S	A	C
Perform TVA.	C	C	P	A	S	C	A	C	S	C	C
Develop Safety & Security Certifiable Items List (CIL) to support preparation of design criteria and construction specification conformance checklists.	C	C	S	A	S	C	A	P	S	C	C
Perform additional safety and security analysis as appropriate.	N	N	P	A	S	C	A	P	S	C	C
Review Preliminary Design (Validation and Intermediate) and update CEL/CILs.	N	N	S	A	S	C	A	N	P	C	C
Review Final Design and update CEL/CIL.	N	N	S	A	S	C	A	C	S	C	C
Develop the Safety and Security Design Criteria Conformance Checklist (DCCC).	N	N	S	A	S	C	A	P	S	C	C
Compliance and Verification											
Audit Safety and Security Certification processes.	A	S	S	A	P	C	C	N	C	C	C
Complete the verification of the DCCC.	N	A	S	A	N	C	A	S	P	P	C
Develop the Safety & Security Construction Specification Conformance Checklist (CSCC).	N	N	S	A	S	C	A	N	S	P	C
Complete the verification of the Safety & Security Construction Specification Conformance Checklists.	N	N	S	A	S	S	A	N	S	P	C
Issue/obtain permits and notices to support testing and service restoration operations.	N	N	S	A	P	S	P	N	C	P	P
Document the findings of integrated testing for safety- and security-related elements.	N	A	S	A	S	P	A	C	P	P	S
Verify contractor training classes have been provided.	N	A	S	A	S	S	S	N	P	S	P
Monitor the identification and resolution of the system hazards and vulnerabilities assessment process to verify that no significant hazard is unresolved at system opening.	N	A	S	P	S	S	P	N	S	P	S
Conduct project demonstration evaluation.	N	S	S	A	C	S	S	N	S	S	P
Identify and resolve restrictions, deviations, and approved equivalencies.	N	C	S	A	A	S	A	N	S	S	P
Issue final Safety and Security Certification certificates for design verification and construction specification conformance.	A	A	S	A	P	S	S	N	S	S	S
Construction Safety and Security											
Establish a construction safety and security plan.	N	N	C	A	C	C	S	N	P	S	C

Table 3.2 Safety and Security Task Responsibility Matrix

Safety and Security Responsibility Legend P — Primary or lead S — Secondary function or assistance A — Approval authority C — Comment only N — Non-applicable	CIO	CSSO	VP, Security	GM, Construction	Chief Engineer	CTA Project Mgr	CDOT	DC	Contractor	CCOT	Rail Operations
Establish an emergency response plan for construction.	A	A	C	A	C	C	A	N	P	S	C
Conduct inspections of construction operations, equipment, storage areas, and facilities.	C	C	C	S	C	P	S	N	P	P	C
Note unsafe acts, unhealthy conditions, or non-secure conditions on the construction site.	C	C	S	S	C	P	P	N	P	P	C
Document serious or repeated construction safety and/or security violations.	A	C	S	A	C	S	P	N	P	P	C
Conduct or monitor construction incident/mishap response and investigations.	A	S	C	A	C	C	S	N	P	S	C
Conduct or monitor construction mishap trend analysis and response planning.	A	S	C	A	C	P	S	N	P	S	C
Provide construction safety, security, and emergency response training.	C	A	A	A	C	C	S	N	P	S	P
Operations Support											
Coordinate with State Safety Oversight Agency regarding requirements for safety and security plans and procedures during operations.	A	P	S	S	C	C	S	N	C	C	C
Coordinate with FRA Office of Safety and Regional Office regarding requirements for safety plans and procedures and shared track waiver submission.	N	N	N	N	N	N	N	N	N	N	N
Update Rail SSPP-PTASP.	A	A	S	S	C	N	N	N	N	N	S
Update SEPP.	C	C	P	S	C	N	N	N	N	N	S
Update Emergency Preparedness and Continuity Plan.	C	A	P	S	C	N	N	N	N	N	S
Update Crisis Communications Plan.	C	S	P	S	C	N	N	N	N	N	P
Perform safety and security review of preliminary operations & maintenance procedures.	N	A	S	C	C	C	C	N	S	C	P
Develop safety and security rules and procedures.	N	A	S	S	C	C	C	N	S	C	P

Table 3.2 Safety and Security Task Responsibility Matrix

Safety and Security Responsibility Legend P — Primary or lead S — Secondary function or assistance A — Approval authority C — Comment only N — Non-applicable	CIO	CSSO	VP, Security	GM, Construction	Chief Engineer	CTA Project Mgr	CDOT	DC	Contractor	CCOT	Rail Operations
Update safety and security staffing and operational safety program.	A	P	S	S	C	C	C	N	C	C	S
Conduct safety incident response and investigations training.	N	C	S	S	C	C	C	N	N	C	P
Conduct security incident/mishap response and investigations training.	N	A	P	S	C	C	C	N	N	C	P
Perform crime pattern trending and response planning.	N	C	P	S	C	C	C	N	N	C	P
Perform safety trend analysis and response planning.	N	A	S	S	C	C	C	N	N	C	P
Develop and disseminate emergency safety and security procedures.	N	C	P	S	C	C	C	N	S	C	P
Provide safety and security related training.	N	A	S	A	C	C	C	N	C	C	P
APTA Peer Reviews	N	S	S	P	S	S	C	N	C	C	S
Conduct internal operational readiness reviews.	A	A	S	A	C	C	A	N	S	S	P
Conduct emergency response drill or exercise	N	P	P	A	C	C	P	N	S	S	S
Identify and resolve restrictions, deviations, and approved equivalencies.	N	A	S	A	C	C	A	N	S	S	P
Public outreach programs, safety, and security information.	C	S	S	P	C	S	P	N	C	S	S
FTA Safety & Security Readiness Reviews.	P	P	S	A	S	S	S	N	C	S	S
Issue final Project Safety and Security Certification Certificates.	P	P	S	S	S	C	C	N	C	S	S
Issue Final Safety & Security Verification Reports.	A	A	S	A	P	S	S	N	S	S	S
Certification configuration management requirements.	A	A	S	A	P	S	S	N	S	S	S

5.0 Safety and Security Analysis

5.1 Approach to Safety and Security Analysis

Identification, categorization, and resolution of safety hazards and security vulnerabilities are addressed in the associated sections of the PTASP, and the SEPP, Section 5, “Threat and Vulnerability Identification, Assessment, and Resolution". The SSCP, Section 5, “Hazard Management" and Section 6, “Threat and Vulnerability Management" focus on the specific details of hazard, threat and vulnerability identification, management, and resolution. These documents will be revised as necessary as the Project progresses.

5.2 Requirements for Safety and Security Analysis

All appropriate safety analyses will be conducted and shared with members of the Project Team using the Project Website. This includes the Project PHAs and OHAs during the design and construction phases respectively. Other analyses that may be conducted throughout the project life cycle include, but are not limited to, Subsystem Hazard Analysis (SSHA), System Hazard Analysis (SHA), Failure Modes and Effects Analysis (FMEA), Failure Modes, Effects, and Criticality Analysis (FMECA), Fault Tree Analysis, Terrorism Risk Assessment, Software Safety and Security Analysis (SSSA), Operations and Support Hazard Analysis (OSHA), and Health Hazard Assessment (HHA).

Both the project TVA and safety analysis were performed during the engineering phase and will be periodically updated. These documents are reviewed by the SSRC, Project design teams, and FTA's Project Management Oversight Consultant (PMOC) upon request. IDOT SSOA may also request to review both documents if IDOT deems it necessary. The recommendations from both document updates are reviewed and considered for safety and security design criteria update and potential design and/or construction change orders.

The primary objectives of the TVA are to:

- Provide the ability to identify critical assets and their vulnerability to threats, to develop and implement countermeasures, and to monitor and improve program effectiveness;
- Reduce potential threats by a committed application of an informed management decision-making process;
- Utilize an analytical approach to consider the likelihood that a specific threat will endanger the system by implementing the eight-step TVA methodology process;
- Identify activities that must be performed to reduce the risk of an attack and mitigate its consequences. This is achieved by using the results of both the TVA and the capabilities assessments associated with the threat scenarios discussed in the TVA;
- Utilize a combination of quantitative and qualitative techniques to identify security requirements, including historical analysis of past events, criminal activity, intelligence assessments, physical surveys, and expert evaluation; and
- Provide security design criteria recommendations.

The primary objectives of the safety analysis are to identify, evaluate, and make recommendations for the elimination, control, or acceptance of hazards that could potentially cause:

- Loss of life and/or serious injury to personnel;
- Serious damage to facilities and/or equipment resulting in large dollar loss;
- Failures with serious adverse impact on system capability, operability, or public opinion;

and/or

- Detrimental harm to the environment and the surrounding community.

6.0 Development of Safety and Security Design Criteria

6.1 Approach to Development of Safety and Security Design Criteria

The CTA Quality Assurance Manual provides the guidelines and controls needed to properly design, construct, test, and prepare for operations of CTA's rail and bus system. The IDCM includes specific safety and security criteria for the control of safety hazards, security threats and vulnerabilities. These design criteria are used to govern project designs.

The IDCM is organized into design discipline chapters that reference codes, standards and practices employed in the design of the system. Safety Criteria Checklists will be developed from these criteria to use as tools to verify design and construction activities have incorporated all safety standards, codes, and regulations into the project, as well as to show the evidence of that incorporation for safety certification.

The purpose of the design criteria is to provide sufficient information, to allow development of final designs to commence to enable development of estimates of capital, operating and maintenance costs and to determine potential impacts of operations and construction on adjacent properties. These design criteria standards also serve to assure consistent application, code compliance and that safety is incorporated into designs. The IDCM stipulates specific codes, standards, and regulations to incorporate in the designs.

The safety and security design criteria were generated from:

- Technical specifications from similar projects;
- Existing agency design and performance criteria;
- Transit agency "lessons learned" from previous projects and operating experience;
- PHA results;
- TVA results;
- Transit industry safety and security best practices and reports; and
- Applicable safety and security codes, standards, and regulations defined by federal, state, and local agencies and standards boards and organizations.

The material contained in the IDCM provides a uniform basis for design. The criteria do not substitute for good engineering judgment and sound engineering practice. Since specific exceptions may apply in special cases, the designers are responsible for identifying any necessary departure from the criteria and bringing it to the attention of the CDOT and CTA Project

Managers. Applications for a change of criteria or other questions are submitted in writing to CTA. Any changes or exceptions to the criteria are reviewed and approved in writing by CTA prior to use in the design.

Equipment for all major subsystems is supplied by established manufacturers. These subsystems shall have a documented operating history of previous and current usage, and shall be available “off the shelf', as far as practicable. A waiver of these requirements is considered only where an alternative subsystem offers substantial technical and cost saving advantages, is in an advanced stage of development and has accumulated substantial test data under near revenue conditions. Specifications evolve from the design criteria. Specifications for the Project are to be prepared in such a way as to encourage competitive bidding by established construction contractors.

Procurement and/or manufacture of the system components and equipment are based on the final designs approved by CDOT and CTA. Only service proven components, equipment, and materials that are standard products of manufacturers regularly engaged in the production of such components, equipment, and materials are to be used. Materials of the highest possible quality will be used for equipment manufacture and fabrication. High-grade workmanship conforming in all respects to the best industry standard manufacturing practices for transit system equipment will be provided. Comprehensive testing of all components and equipment shall be performed during the manufacturing process and upon its completion. Testing will include design and production tests.

6.1.1 Safety and Security Certifiable Safety and Security Elements

The DC will create a preliminary list of hazards, threats, vulnerabilities, and safety and security certifiable elements list during the engineering phase of the project. The list identifies the system safety and security certifiable elements that must be addressed prior to final acceptance of the systems and facilities and defines the scope of the certification effort. The certifiable elements will include the project elements that can affect the system safety and security of passengers, employees, contractors, emergency responders, or the public. The listing of these elements for each major element to be certified is defined as a Certifiable Elements List (CEL).

Identification of the certifiable elements enables the creation of organizational categories that can be further sub-divided to support recognition of individual sub-elements and items with the potential to affect system safety and security. To manage the translation of general system safety and security requirements into the specifications necessary to assure that system safety and security are built into the project, each certifiable element must be broken down into its composite list of “certifiable items.” These items make up the whole of the element and require individual specification and verification before the entire element can be certified as safe for use. The listing of these items for each major element to be certified is defined as a Certifiable Items List (CIL).

Once all sub-elements have been certified, a Certificate of Conformance for the project element will be issued. The ultimate objective of the Safety and Security Certification program is to therefore certify all identified certifiable elements, and to assure all catastrophic and critical hazards have been eliminated by design or reduced to an acceptable level and have been documented appropriately.

6.1.2 Construction/Manufacturing Verification

Following the identification and definition of the requirements for a certifiable item, the contractor's program shall provide a verification process. The certification process involves the verification of system safety and security requirements to assure that the Project elements have been designed, constructed, tested, inspected, and reviewed in accordance with the specified system safety and security requirements. For the construction phase of the Project, the CCOT will oversee the implementation of the construction/manufacturing verification process for the Safety and Security Certification program on behalf of CDOT and CTA. This process shall identify what documentation will be required to verify that fabrication, construction, and installation of each Certifiable Item was fabricated, constructed, delivered, and installed according to the approved design.

A simple signoff that a certifiable item was built to design will not be acceptable. Verification of compliance may take the form of physical inspection, test report, or certification by the appropriate contractor group, and includes the qualification or certification of the person and references to the process used to make the verification. Valid documentation includes inspection reports, certified as-built documentation, certificates of specification conformance, certified test results, or other previously identified and approved documentation.

During construction the contractor will be required to provide signed documentation that certifies fabrication, construction and installation of each Certifiable Item complies with approved design. The contractor shall verify through signature that the construction/manufacturing meets the design requirements.

6.2 Design Reviews

At contractually agreed upon milestones, the DC will prepare and submit design submittal packages to CTA for review and comment. The GM, Construction coordinates design reviews on all design submittals provided by the DC. The reviews will include stakeholders with transit safety, security, maintenance, and operations skills and experience to assure that proposed designs comply with federal, state, and local safety and security requirements. CDOT will conduct design reviews independently of CTA, in part based on milestone reviews and in part based on a weekly design coordination meeting where designs will be actively discussed and reviewed.

For this project, the DC will make design submittals at 15%, 30%, 60%, 90%, and 100%.

6.3 Deviations and Changes

Changes that affect safety and security critical systems or create additional safety hazards and/or security vulnerabilities will be addressed with the CTA Project Manager at the project progress meetings and tracked as open items through the SSRC.

7.0 Process for Ensuring Qualified Operations and Maintenance Personnel

7.1 Operations and Maintenance Personnel Requirements

It has not been determined if the Project will require additional operations and maintenance personnel. Current personnel will be provided the required orientation, instruction, or training regarding operations and maintenance pertaining to this project. CTA Safety and Risk Management Department is staffed to support the project. CDOT staff will not require training on station operation, function, or incident response procedures, as all operations and maintenance will be by CTA once the station opens.

7.2 Plans, Rules, and Procedures

CTA currently has, or will develop as part of this certification process, effective plans, rules, and procedures in place, including:

- RASP
- SEPP
- SOPs
- System Integration Test Plan
- Procedure for Accident/Incident Investigation
- Transit System Activation Plan

7.3 Training Program

Contractors and suppliers providing equipment and facilities for Project are responsible for developing training plans, training manuals, and conducting training courses for applicable CTA operations and maintenance staff. The CTA PM, CDOT, and CCOT will be required to review, comment, and approve Contractor draft and final submittal of operations and maintenance manuals.

The training program for CTA considers both internal and external training requirements. This includes training/orienting new and existing CTA personnel on the new facilities, equipment, and systems. CTA's internal training program is operationally based and focuses on plans, rules, procedures, and emergency management practices to include training of emergency responders on the system and safety and security requirements.

CTA has established and proven Rail Operator, Rail Maintenance, Power & Way Maintenance, and Facilities Maintenance training programs. These programs consist of classroom lecture, fieldwork, and operation of the rail system during the day and night. The training records are maintained in accordance with the records retention schedule. The training programs are revised as necessary.

Required training for each discipline will be addressed by the responsible organization. All safety-related training is reviewed by the Safety Department.

7.4 Emergency Preparedness

Refer to Section 4 of the SEPP for a description of CTA’s approach to drills and exercises. The FLSSC will determine if any emergency exercise will be conducted in association with the Project.

7.5 Public Awareness

The CTA has already established a strong public awareness program with the community. CTA promotes security through the “See Something, Say Something” program and its own campaigns including posters, car cards, and events. CTA staff participated in security awareness training presented by Transportation Safety Institute. CTA will continue to make safety and security public awareness a priority throughout the development of the Project, and the program will be further developed, as required, to support this project.

8.0 Safety and Security Verification Process

This section describes the following processes and requirements:

- Design Criteria Verification, Construction Specification Conformance, and Integration Testing/Inspection Verification processes.
- Hazard and Vulnerability Resolution Verification process used by CDOT, CCOT, and CTA to verify project personnel and contractors have appropriately identified, categorized, and resolved hazards and vulnerabilities to a level acceptable by senior management.
- Operational Readiness Verification process used by CDOT, CTA, and CCOT to verify project personnel and contractors developed plans, rules, procedures, manuals, and training and qualification programs in conformance with the CTA’s safety and security requirements. It also explains the process for ensuring the qualification and readiness of operations and maintenance personnel.
- SSC Requirements used by CDOT, CTA, and CCOT to deliver final certification that the project is safe and secure for passengers, employees, public safety personnel, and the general public, including the individual certificates issued for each of the specific elements to be verified.

The SSCP outlines complete details on the safety and security verification process.

8.1 Design Criteria Verification Process

The process for verifying conformance with the specified safety and security requirements is delineated in the SSCP. The process encompasses design; equipment and materials procurement; and construction, testing, inspection, and start-up phases as well as formal safety certification to enter revenue service. Refer to the SSCP for complete details on the design criteria verification process.

The IDCM will be reviewed and given to the DC. The Project Team will participate in design reviews to assure safety and security codes and standards are incorporated into the project design. The inclusion and evaluation of National Fire Protection Association (i.e., NFPA 130 and NFPA 101) standards and codes, as applicable, are critical elements of the design and the design review process. Elements and sub-elements requiring SSC will be identified, tracked, and verified through the project life cycles. A detailed safety and security design verification process, including preparation of project contract CIL will be completed.

Safety and Security will be responsible for ensuring that safety and security codes and standards are incorporated into the project design and carried through construction and operational readiness. This process is detailed in the SSCP.

8.2 Construction Specification Conformance Process

The construction specification conformance process provides a method to verify that safety and security related specification and contract document requirements are satisfied by the as-built facilities and systems. Many of the safety and security requirements in the specifications take the form of specific deliverables, such as manuals, hazard analyses, reports, approved contract submittals, factory test procedures and results, and inspection reports. Refer to the SSCP for complete details on the construction specification conformance process.

8.3 Testing/Inspection Verification

The SSCP describes the integration testing and inspection verification process used to verify the as-built (or delivered) configuration contains the safety and security related requirements identified in technical specifications, drawings, and Contract documents, including programs for contractual testing, systems integration testing, and service restoration operations testing. Refer to the SSCP and the System Integration Test Plan for complete details on the integration testing and inspection verification process.

8.4 Hazard and Vulnerability Resolution Verification

The PM Team will continue to follow the hazard resolution verification process and the threat and vulnerability resolution process described in the SSCP in Section 5.0, “Hazard Management” and Section 6.0, “Threat and Vulnerability Management'. The system safety and security discipline manages hazards and vulnerabilities throughout the life cycle of a project, program, or activity through a committed approach to risk management, where: a hazard is defined as a condition or circumstance that could lead to an unplanned or undesired event, a vulnerability is a characteristic of the system that increases the probability of occurrence of a security incident, and a risk is an expression of the impact of an undesired event or security incident in terms of severity and likelihood The SSRC's role in the hazard and vulnerability resolution process was described previously in Section 2.3 of this SSMP.

8.5 Operational Readiness Verification

Prior to restoring service, demonstration tests to verify functional capability and operational readiness will be performed by the PM Team. In addition, walk-through inspections of completed facility, support spaces, traction power components, tracks and systems modifications will be performed to verify safety and security requirements have been complied with during the construction associated with the Project.

Prior to the initial activation of an element or system, Operational procedures and plans are tested for effectiveness under simulated operating conditions for normal, abnormal, and emergency situations. Verification for these activities will be established by signatures of the appropriate officials or employees on all affected procedures, processes, plans, rulebooks, and training necessary to support operation and maintenance of the project. The operating and maintenance procedures and plans will be judged as meeting the verification requirements or are recommended for modification. A final ‘talk-through inspection” of completed facilities and systems will be performed in this step.

The SSRC will review the test documentation to assure:

- System safety and security aspects of the design (including operations and maintenance procedures) are adequately demonstrated,
- Results of system evaluations related to system safety and security are included in the test and evaluation reports on hardware and software, and
- The locations of relevant test results are communicated to CTA management, CDOT, CCOT, contractor, and other project participants.

Any test results that are not acceptable or that are accepted with restrictions are placed on a Safety/Security Open Items List (SOIL). In addition, copies of all applicable test and inspection reports will be provided to the Certification Manager to be appropriately referenced in the formal certification files and the Hazard Log. Test reports, prepared to document test results are reviewed to verify the summary of activities, findings and conclusions, identification of open items and resolutions, and recommendations pertaining to approval of the test report.

8.6 Safety and Security Certification Requirements

The project team will follow the Safety and Security Certification process described in the SSCP. The overall Safety and Security Certificate will be issued after all required supporting certification documents are completed and accepted by the SSRC. These documents include the Safety/Security Critical Items List (SCIL) (verified by CTA Safety and Security staff) (for this project, the SCIL will be listed within the SOIL, and specific critical items will be designated as such within the overall SOIL), design criteria conformance checklists, construction specification conformance checklists, elements certificates of conformance, Temporary Use Notices (TUNs), the Project Safety and Security Certificate, and Final Verification Report. Even though not all the documentation may be available in time for releasing the project to revenue service, the safety impact of this documentation will be assessed, and mitigation or operating restrictions will be implemented where unacceptable hazards are identified.

The Safety and Security Certification process reflects CTA's commitment to verify that its operation is free from unacceptable risk. This is a proactive approach to safety and security with clear objectives to identify, anticipate, and control adverse conditions before they occur. Through safety and security certification, a commitment is made to:

- Develop a policy formalizing management risk acceptance practice for activities that affect the safety and security of the operational system;
- Identify and document the safety and security critical elements that comprise the project;
- Specify and apply safety and security requirements, consistent with approved risk management practices, to these elements, using design criteria, design manuals, contract specifications, and safety and security analysis;
- Implement a dedicated program of hazard and vulnerability analysis and tracking, which verifies, for each safety and security critical element, the identification, evaluation, and resolution of all conditions with the potential to result in death, severe injury, multiple injury, system loss, major system damage, or major environmental impact;
- Implement a dedicated program of review to verify that safety and security requirements are included in specifications, test plans, procedures, and operational assessments for the

project and coordinated with transit departments that have responsibilities for the project;

- Implement a dedicated program of testing and evaluation, to verify that safety and security critical elements, delivered to the agency, comply with contract specifications, and that an acceptable level of operational readiness and emergency preparedness exists among the transit departments and personnel responsible for commissioning the project into revenue service;
- Issue written Certificates of Compliance for each safety and security critical element, indicating that it meets established safety and security requirements; and
- Issue a Project Safety and Security Certificate, along with a Final Verification Report, verifying the project's readiness for safe and secure revenue service.

Safety and security certification verifies application of this process for the Project. Through the certification process, hazards and vulnerabilities are translated into risks, which are then analyzed, assessed, prioritized, and resolved, accepted, or tracked.

Safety and security certification may be defined as the series of processes that collectively verify the safety and security readiness of a project for public use. Certification addresses conditions that could result in harm, whether unintentional (safety) or intentional (security). Application of Safety and Security Certification promotes an informed management decision-making process in project design, construction, testing, and pre-revenue operations leading to initiation of revenue service.

Certification for safety and security is not contractual acceptance. Contractual acceptance is defined as an action by an authorized representative of the transit agency by which the transit agency assumes full or partial ownership of the delivered project as complete or partial performance of a contract. Contractual acceptance does not constitute Safety and Security Certification, and safety and security certification does not imply acceptance with respect to contract performance.

9.0 Construction Safety and Security

Construction safety and security is an important aspect of the CTA system safety and security program. CDOT will include specifications which require the contractor to develop and maintain a Safety Management Program (SMP) for the Project. The specification outlines requirements for developing a project-specific SMP for this construction project. The contractor is required to comply with the specifications and the applicable provisions of CTA's Safety Manual for Contract Construction On, Above, or Adjacent to the CTA Rail System, the Illinois State Uniform Fire Prevention and Building Code, Occupational Safety and Health Administration (OSHA), the Environmental Protection Administration (Federal), Department of Environmental Conservation (State), Department of Environmental Protection (City), the National Fire Protection Association (NFPA) including National Electrical Codes, all other applicable rules and regulations, including Drug and Alcohol Laws. CDOT, CCOT, and CTA are responsible for ensuring the construction SMP is in place.

The General Manager, Construction Safety & Engineering has the responsibility for reviewing contractor SMP submittals, monitoring, and assessing the safety of construction activities, and reporting findings to CTA management and the SSRC regarding the compliance of contractor's activities and programs. CDOT and the CCOT will also review the contractor SMP for compliance with the project specifications. The VP, Security is responsible for reviewing the contractor security submittals and overseeing and monitoring the contractor's security elements of the program. No contractor will initiate any work until their SMP for executing safety and security on the construction sites is submitted to, reviewed, and approved by the General Manager, Construction Safety & Engineering (or his designee).

The SMP will be a "living" document issued by construction contractors to provide guidelines for safety and security at construction sites. The guidelines are designed to focus on the contractor's topography, social conditions of the work site, and how the Contractors approach those conditions to maintain a safe and secure work site as possible.

9.1 Construction Safety Management Program Elements

The SMP general requirements will:

- Comply with all safety, fire, security policies, procedures and safe and secure work practices and any other appropriate safety and security procedures specified in the contract;
- Fully describe the contractor's commitments for meeting its obligations to provide and safe, secure, and hazard-free working conditions for its employees, the public, and generally contribute to and enhance safety and security at the project site;
- Reference the standards, codes, rules, and regulations applicable to construction activities;
- Require accident reporting and investigation of serious accidents and incidents (near misses) to prevent reoccurrence;
- Include an organizational chart that illustrates the responsibilities of the personnel responsible for implementing the SMP and of employees at all levels related to the execution of and compliance with the SMP;
- Address the prohibited use of alcohol and drugs including pre-placement, periodic, for cause, suspicion, and post-accident/incident testing; and
- Designate safety representatives.

The SMP safety requirements will:

- Describe field safety meetings and committees, safety orientation, and accident investigation, reporting, and recordkeeping;
- Describe monthly safety walk-thru process;.
- Describe methods for conducting safety inspections for each site and shift worked. Describe procedures for emergency preparedness and response;
- Describe precautions to protect the public from injury or damage to property. Describe emergency procedures and contact information;
- Comply with OSHA requirements for personal protective equipment; housekeeping; guardrails and perimeter protection; concrete and form work; reinforced steel, excavations, trenching, and shoring; fire protection and prevention; flammable and combustible liquids; mobile and tower crane safety; rigging requirements; hazard communication; fall protection;
- Address track safety training;
- Address confined space entry;

- Address Safety Data Sheets;
- Address use of explosives;
- Address fitness for duty;
- Describe handling, storing, and securing tools and materials;
- Address the use of scaffolds;
- Address environmental protection for spills and leakage containment; and
- Describe any special precautions.

Site security and emergency preparedness requirements will be developed to address the following minimum requirements:

- Address perimeter and access control security measures;
- Describe emergency procedures;
- Address securing of the construction site;
- Describe site access management;
- Describe job-site access procedures, including identification;
- Describe guard patrols of site; and
- Include procedures for reporting and investigating security incidents.

The primary responsibility for assuring and monitoring the contractor's adherence with the safety and security requirements rests with the CCOT's Safety Representative. The CCOT Safety Representative will work directly with the contractor to address any issues and assure project completion. CCOT, CDOT, and CTA each have the authority to order work cessation in the event of non-compliance.

9.2 Construction Phase Hazard and Vulnerability Analysis

The SMP must also address specific hazards associated with confined space entry, control of hazardous materials and response to hazardous materials spills, falls from elevation, exposure to toxic materials, electrical shock protection, hand and foot injuries, use of cranes and heavy equipment, and other anticipated hazards.

The program must require and authorize all construction supervisors, when notified of an unsafe or hazardous situation, condition, or practice, to take appropriate action to correct the condition immediately and to take equipment out of service and to re-instate it in accordance with a set standard practice outlined in the plan.

9.3 Safety and Security Incentives and Disincentives

Currently, neither CDOT nor CTA utilize safety and security incentives for construction Contractors.

10. Requirements of 49 CFR Part 674, Rail Fixed Guideway Systems, State Safety Oversight

10.1 Activities

In response to congressional concerns regarding the potential for catastrophic accidents and security incidents on rail systems, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) added Section 28 to the Federal Transit Act (codified at 49 U.S.C. Section 5330). This section required the Federal Transit Administration to issue a rule creating the state managed oversight program for rail transit safety and security. The FTA published Rail Fixed Guideway Systems Oversight on December 27, 1995 (codified at 49 CFR Part 659), subsequently referred to as State Safety Oversight Rule or Part 659. On April 29, 2005, the FTA published the revised rule, 49 CFR Part 659: Rail Fixed Guideway Systems; State Safety Oversight; Final Rule in the Federal Register. In 2012, 49 CFR 659 was reviewed and resulted in 49 CFR 674 being issued on March 16, 2016.

The State of Illinois designated the Regional Transportation Authority (RTA) as the SSOA to implement 49 CFR Part 659 for CTA in 1997. RTA implemented 49 CFR Part 659 under its authority, specified in the amended RTA Act, to assure compliance with federal and state guidelines applicable to CTA. In 2014, the governor of the State of Illinois issued an order designating the Illinois Department of Transportation (IDOT) as the SSOA for all applicable transit systems across Illinois. On July 1, 2016, SSO responsibilities were officially transferred from RTA to IDOT.

IDOT developed and received approval from FTA for its Program Standards Manual (PSM). The PSM is the written document adopted by IDOT that describes the policies, objectives, responsibilities, and procedures used to provide rail transit agency safety and security oversight. IDOT is responsible for establishing standards for rail safety and security practices and procedures to be used by CTA. In addition, the SSOA must oversee the execution of these practices and procedures to assure compliance with 49 CFR Part 674.

Refer to the IDOT PSM for additional requirements.

10.2 Implementation Schedule

IDOT's SSO Program and associated PSM are in place and CTA participates in internal reviews. The implementation schedule for any necessary modifications to the CTA' s RASP, Rail SSPP, SEPP, and required reports and documents are captured in corrective action plans that are tracked and monitored by IDOT.

10.3 Coordination Process

The CSRMO is the primary point of contact for IDOT SSOA. The PSM describes IDOT's communication process with CTA. IDOT formally communicates with CTA through reports and checklists as identified in the PSM. CTA and IDOT, as the SSO Agency, comply with the requirements as established in the FTA's State Safety Oversight Standard 49 CFR Part 674, and perform the necessary investigations, internal safety and security reviews, reports, and audits as specified. CDOT does not have legislatively required interaction with the SSOA and is not subject to direct SSOA oversight. Therefore, CTA will lead all project interaction with the IDOT SSOA, as CTA is subject to the regulations associated with the SSOA's oversight and authority.

11.0 Federal Railroad Administration (FRA) Coordination

The FTA requires a response to SSMP Section 10, FRA Coordination, if the following conditions are met:

- Project will share a track with one or more FRA regulated railroads; or
- Project will operate on, connect to, or share a corridor with, the general railroad system.

No railroad coordination will be required for the Project as neither of these qualifying conditions apply.

12.0 Department of Homeland Security (DHS) Coordination

12.1 Activities

CTA has already established a working relationship with the Department of Homeland Security (DHS), Transportation Security Administration (TSA), and the Office of Grants and Training. CTA is currently in compliance with all Presidential Directives affecting transit security. CTA has identified a Security Coordinator and Alternate Security Coordinator, completed a System Security Plan, and completed an Emergency Preparedness Plan. Training is provided to designated staff.

12.2 Coordination Process

The VP, Security serves as the primary point of contact with DHS and TSA. TSA and CTA routinely communicate via telephone and email and participate in joint exercises and training activities. TSA and CTA expect this relationship will continue throughout the Project and beyond its completion. The project team will support the CTA and DHS interface throughout the Project. CDOT and CCOT will support CTA in this effort, when required.

Glossary

Acceptance Tests: Procedures designed to evaluate correct performance of that subsystem's components in a static environment. These tests are usually performed prior to integrated testing.

Corrective Action: A documented design, process, procedure, or materials change implemented and validated to correct the cause of failure, design or construction deficiency or procedural deficiency.

Implementation Authority: This authority for implementing safety and security requirements ultimately rests with the CTA's Chief Safety and Risk Management Officer and Chief Infrastructure Officer (CIO). The CIO has overall accountability for the project and its various elements, including safety and security.

Initiating Authority: This authority comes from the CTA President and CDOT Commissioner. This authority is typically delegated to other participants for actual execution. However, the initiating authority assures that the safety and security effort will have personnel, resources and access to contractor or sub-contractor support. These assurances are critical to the ultimate success of the safety and security activities for the project.

Integration Test: A test performed to demonstrate that a system or systems function satisfactorily when connected to interfacing systems.

Preliminary Hazard Analysis (PHA): An inductive analysis performed to obtain an initial risk assessment of a concept or system.

Risk: An expression of possible loss over a specific period of time or number of operational cycles. It may be indicated in terms of hazard severity and probability.

Safety and Security Certification (SSC): The process of verifying that safety- and security - related requirements are incorporated into a transit system, thereby demonstrating that it is operationally ready for revenue service and safe and secure for passengers, employees, emergency responders, and the general public.

Safety and Security Design Criteria: An organized listing of safety codes, regulations, rules, design procedures, standards, recommended practices, handbooks, and manuals prepared to provide guidance to project designers in the development of technical specifications that meet minimum safety parameters.

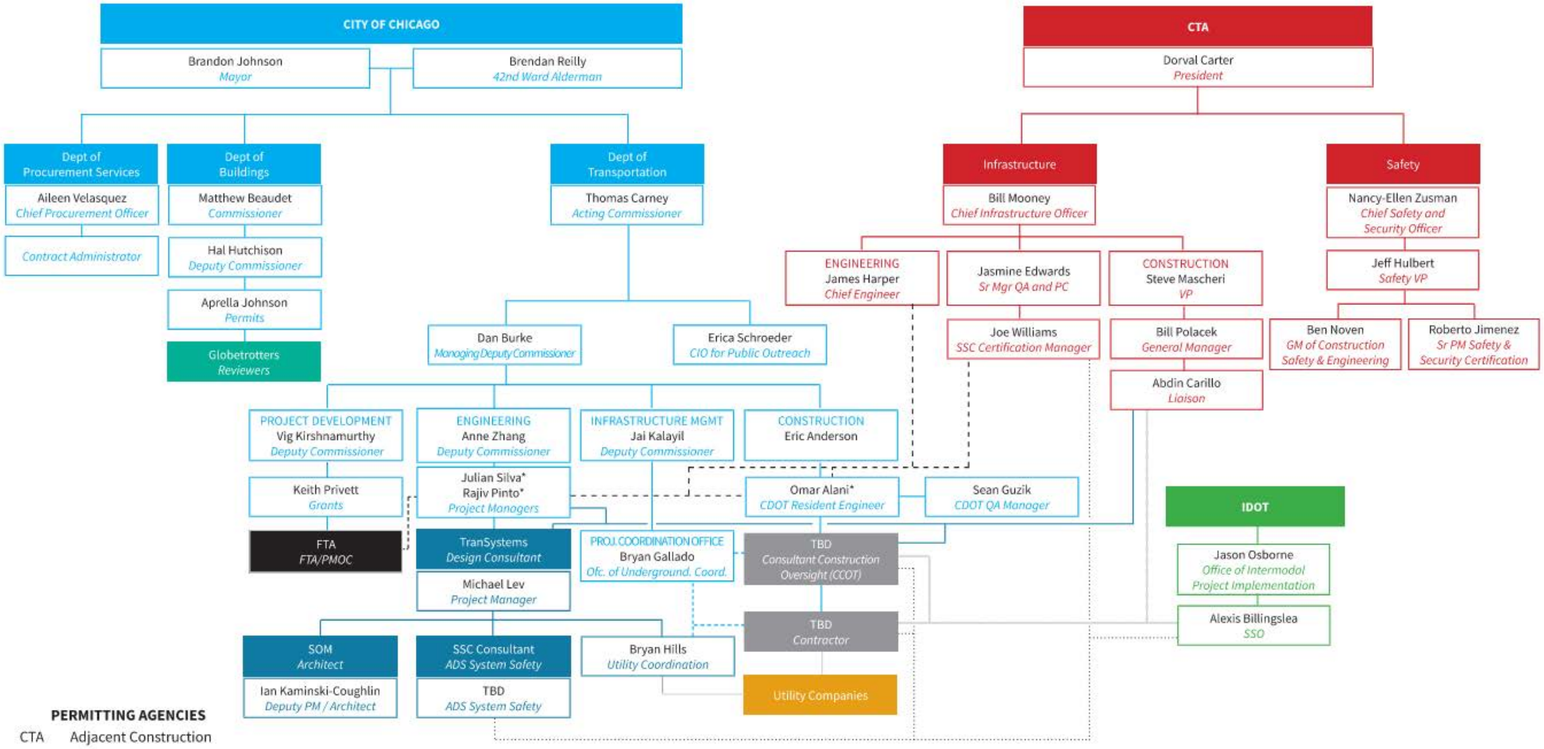
System Safety Program: The combined tasks and activities of system safety management and system safety engineering that enhance operational effectiveness by satisfying the system safety requirements in a timely, cost- effective manner throughout all phases of the system life cycle.

System Safety Program Plan: A description of the planned methods to be used by the agency to implement the tailored requirements for describing its safety policies, objectives, responsibilities, and procedures, including organizational responsibilities, resources, methods of accomplishment, milestones depth of effort, and integration with other program engineering and management activities and related systems.

System Security Program: The combined tasks and activities of system security management and system security analysis that enhance operational effectiveness by satisfying the security requirements in a timely and cost-effective manner through all phases of a system life cycle.

Appendix A

Project Organizational Chart

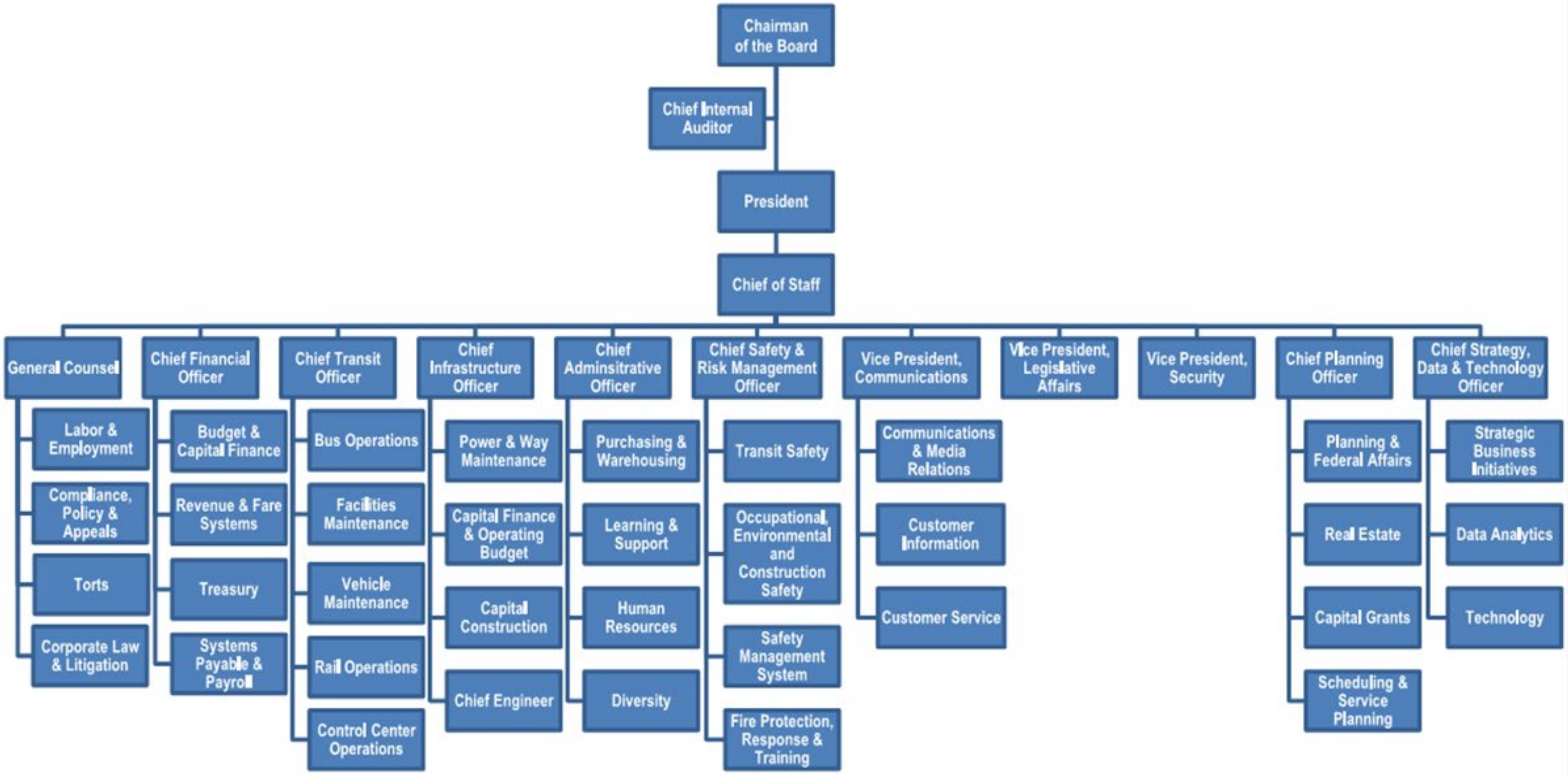


PERMITTING AGENCIES

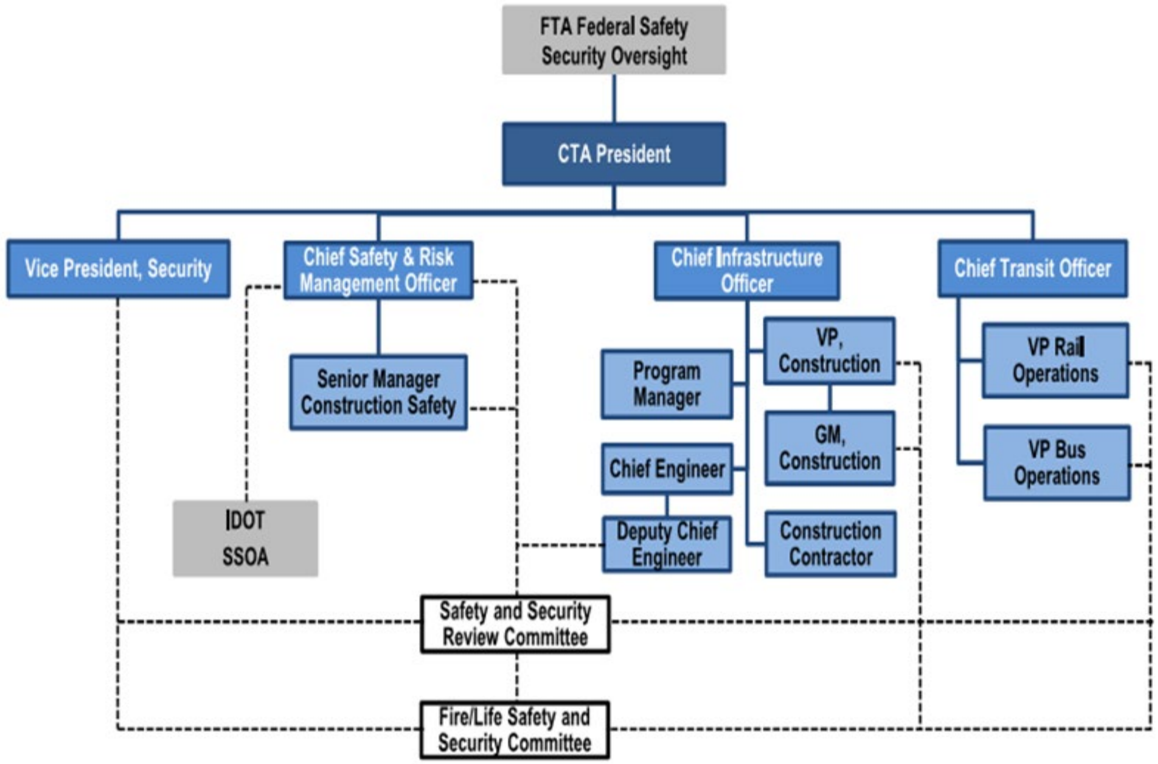
CTA	Adjacent Construction
CDOT	OUC EFP
CDOT	Deep Foundation
DOB	Building Permit
CDOT	Street/Lane Closure

* CDOT Project Management Team (PMT)

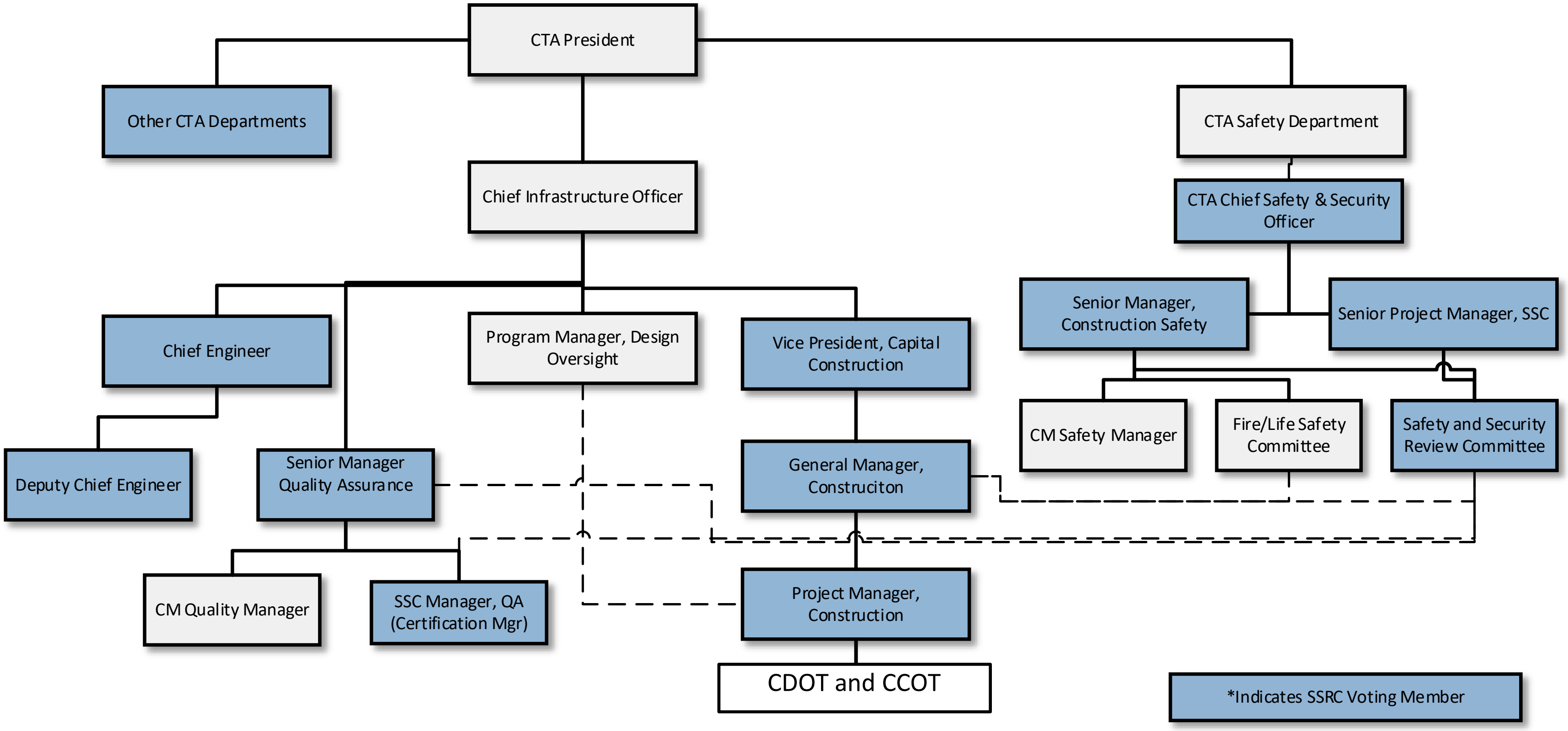
Organizational and Committee Charts



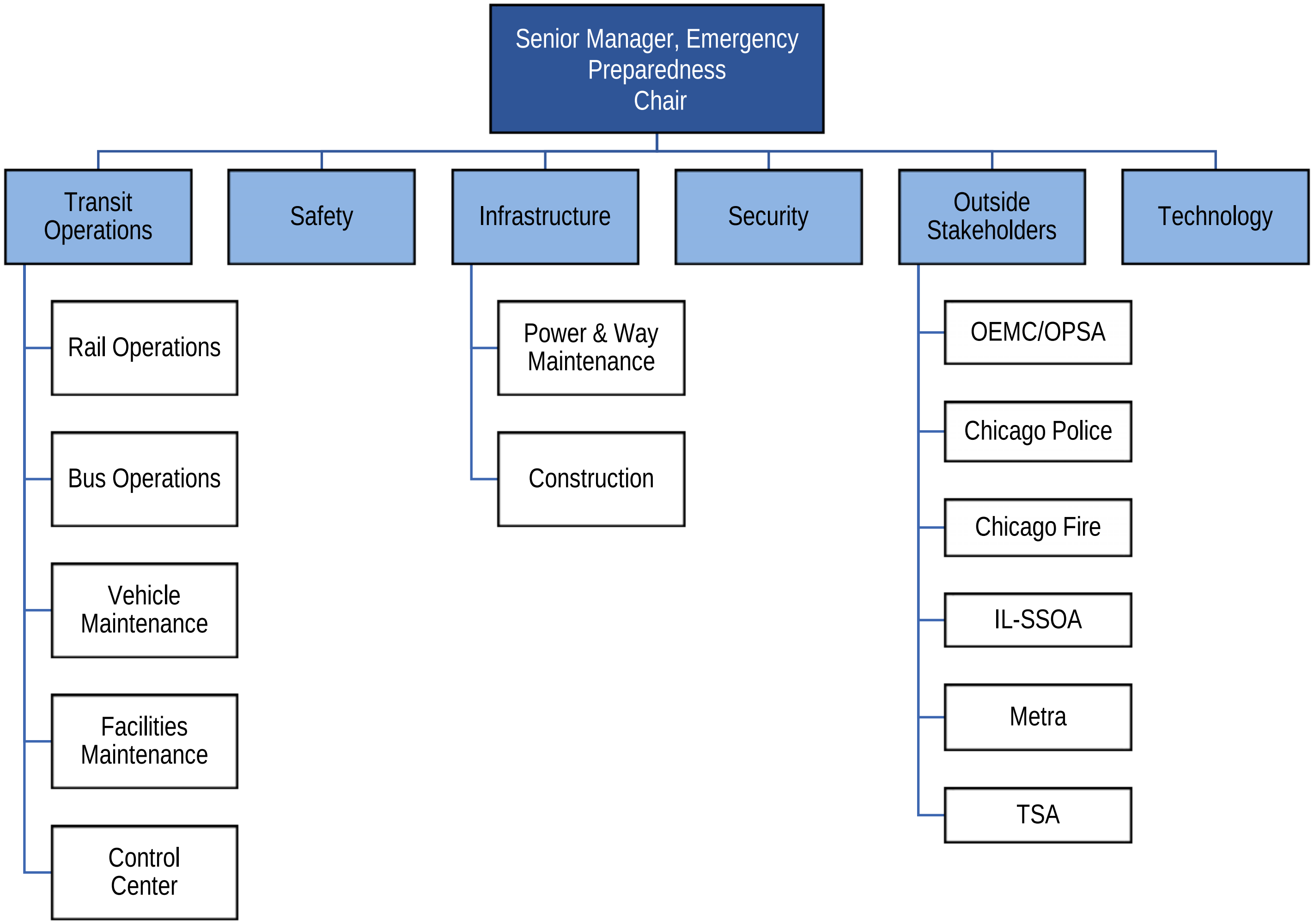
Safety and Security Oversight Structure



Safety and Security Review Committee



Fire/Life Safety and Security Committee



State/Lake Loop Elevated Station

Chicago Department of Transportation

PRELIMINARY HAZARD ANALYSIS (PHA) REPORT

January 20, 2023

Revision 1.3

Prepared by: Michael Lev

Table of Contents

Document Revision Policy

This Project PHA is a controlled document and will be stored on the Project Website. Anyone referring to a copy of this document should verify they are using the latest revision.

Revision History

Revision Number	Revision Description	Date
0.0	Initial draft for review	8-23-2021
1.0	Internal draft (not issued)	6-29-2022
1.1	Revisions and updates for 100% submittal	10-11-2022
1.2	Update CEL/CIL table to new format and list	1-9-2023
1.3	Update CEL/CIL table	1-20-2023

Abbreviations

AAR	After Action Reports
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
CAP	Corrective Action Plan
CCTV	Closed Circuit Television
CDOT	Chicago Department of Transportation
CEL	Certifiable Elements List
CFR	Code of Federal Regulations
CIL	Certifiable Items List
CIO	Chief Infrastructure Officer
CM	Construction Manager
CPTED	Crime Prevention Through Environmental Design
CSCC	Construction Specification Conformance Checklist
CTA	Chicago Transit Authority
DCCC	Design Criteria Conformance Checklist
DHS	Department of Homeland Security
DOR	Designer of Record
FLSSC	Fire/Life Safety and Security Committee
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IDCM	Infrastructure Design Criteria Manual
IDOT	Illinois Department of Transportation
Mil. Std	Military Standard
OHA	Operating Hazard Analysis
PHA	Preliminary Hazard Analysis
PMOC	Project Management Oversight Consultant
PMP	Project Management Plan
PMT	Project Management Team
PTASP	Public Transportation Agency Safety Plan
SCIL	Safety/Security Critical Items List
SEPP	Security and Emergency Preparedness Plan
SITP	System Integration Test Plan
SSC	Safety and Security Certification
SSCP	Safety and Security Certification Plan
SSI	Sensitive Security Information
SSMP	Safety and Security Management Plan
SSO	State Safety Oversight
SSOA	State Safety Oversight Agency
SSPSP	System Safety Program Standard and Procedures
SSRC	Safety and Security Review Committee
TUN	Temporary Use Notice
TVA	Threat and Vulnerability Assessment

Referenced Documents

Safety and Security Certification Plan	September 6, 2022
Safety and Security Management Plan	August 16, 2022
Department of Defense Standard Practice Military Standard 882 E	May 11, 2012

1.0 Introduction

This document outlines the process undertaken, and the results of the Preliminary Hazard Analysis (PHA) conducted for the Chicago Department of Transportation (CDOT) State/Lake Loop Elevated Station project. This PHA revision supports the design progress from 30% to 100% design and continues the analytical process by which safety hazards and hazardous conditions are evaluated for their probability of occurrence, and the resultant consequence(s) of that occurrence. The PHA enables identified hazards and hazardous conditions to be eliminated through design alternatives; the use of hazard control measures (i.e. training, operations and maintenance (O&M); or allow the determination by CDOT and Chicago Transit Authority (CTA) that the risk(s) associated with the identified hazard is acceptable without any further mitigation. The PHA uses analysis methods defined in the Federal Transit Administration (FTA) **Hazard Analysis Guidelines for Transit Projects**, DOT-FTA-MA-26-5005-00-01 and is responsive to CTA Public Transportation Agency Safety Plan (PTASP) Revision 2, April 3, 2020, Safety Risk Management requirements, including Safety Hazard Identification, Safety Risk Assessment, and Safety Risk Mitigation.

1.1 Safety Objectives

The objectives of the PHA are to:

- Identify hazardous conditions which could exist, evaluate the effects of the hazards to personnel, equipment, facilities, the public, and the environment, and to define the designs and criteria to eliminate, or control the identified hazards.
- Identify hazardous activities that could affect the safe operation of the station
- Identify potential incidents/accidents and the consequences (i.e. fatalities, injuries, property damage, etc.) associated with each hazardous condition.
- Provide timely notification of hazards to personnel who are to resolve them.
- Identify measures that will prevent incidents/accidents by eliminating or controlling the underlying hazards.
- Document the safety concepts incorporated into the design of Project elements and provide the basis for the development of procedures to compliment the design or resolve a hazardous condition.
- Document the hazard analysis results in a clear and concise manner, facilitating resolution of all identified hazards.
- Provide a basis for additional safety analyses and assessments for specific Project elements and sub- elements, if required to further mitigate the identified hazard(s).

1.2 Scope

The scope of this report is to provide CTA with the results of the PHA performed for the State/Lake Loop Elevated Station (“the Project”). The PHA relates to the construction and permanent use of these Project elements and documents the results of the safety analysis conducted at the 100% Design phase. This report includes the methodology and technical approach in conducting the PHA, and the results of the hazard analysis is provided to assist CDOT and CTA to identify potential safety issues associated with the project, and the hazard mitigation strategies being proposed.

The PHA is not intended to present an analysis of all hazards and safety issues that can potentially occur on the Project. The PHA focuses on analyzing the Project’s 100% design to identify the potential for credible hazards, and hazardous conditions based on the design, subsequent operations and maintenance of each Project certifiable element, and recommending hazard controls/mitigations. The initial step in the PHA process is to define the physical and functional characteristics of the Project to be analyzed. These characteristics are presented in terms of the major elements that comprise the Project and are evaluated for their effect on the safety of the station facilities, systems/subsystems, equipment, service, O&M, and their interface with employees, contractors, emergency responders, riders/customers, and the public. Such elements include Mechanical/Electrical/Plumbing (MEP), Communications, Signage and Graphics, emergency notification/response systems/equipment, and pavements.

The identification of these Project elements is important to the scope of this PHA, as it assures that analyses and assessments are targeted and conducted on those elements which are safety critical in nature and are verified to be safe for use prior to the initiation of revenue service. Preliminary O&M aspects associated with the Project that are necessary to assure safety are also analyzed in the PHA based on information known or made available by CDOT and CTA.

1.3 Safety Goals Approach

The goal of this PHA is to achieve the highest practical level of safety on the Project by applying a formalized process to identify and assess conditions that could potentially affect the safe operation, maintenance, and response to abnormal or emergency incidents occurring on the Project. The PHA is prepared to assist in the design of a safe Project in the Engineering Phases and establishes further safety controls and measures which carry through to the O&M phases of the Project. Primary goals of the PHA process are to also assure that safety hazards and hazardous conditions that are identified are translated into risks, which are then analyzed, assessed, prioritized, and resolved, accepted and tracked to closure. Should hazard mitigation measures be temporary, follow-up actions become part of the PHA process.

The Hazard Identification and Resolution Process (HIRP) is shown in Figure 1.

Figure 1 – Hazard Identification and Resolution Process

1	**Define the System**	• Define the physical and functional characteristics, employee/public interface, facilities, equipment, procedures and the environment.
2	**Identify the Hazard**	• Identify hazards and undesired events. • Determine the causes of the hazards.
3	**Assess the Hazard**	• Determine severity. • Determine probability. • Decide to accept risk or eliminate/control.
4	**Resolve the Hazard**	• Assume risk or implement corrective action. • Eliminate/Control Eliminate/control.

5	**Follow Up**	- Monitor for effectiveness. - Monitor for unexpected hazards

2.0 Define the System

2.1 Project Description

The project consists of design and construction of a new architecturally prominent and signature State/Lake Loop Elevated Station. The construction plans will include new station house facilities and will incorporate new and innovative sustainable design features and construction features whenever possible. Station capacity – both larger platforms and more fare collection turnstiles – will be increased. CDOT and CTA staff members observe significant overcrowding during peak periods on the platforms at the State/Lake station, and the planned larger platforms will address the need for additional passenger waiting space. Additionally, the station will be brought into compliance with current code through upgraded security/surveillance systems, backup power systems, and Americans with Disability Act (ADA) accessibility.

2.2 CTA Safety

Certifiable Elements & Certifiable Items (CE&CI) are safety and security related elements/items of a project deemed necessary to require certification using CTA's safety and security certification process developed in accordance with Federal Transit Administration (FTA) Circular 5800.1, Safety and Security Management Guidance for Major Capital Projects. The identification of these project elements is Step 1 in the Safety and Security Certification (SSC) 10-Step process. The identification of CE&CI drives the development and preparation of the Project's Design Criteria Conformance Checklists (DCCC), Construction Specification Conformance Checklists (CSCC), and Operational Readiness Conformance Checklists (ORCC), which are used to verify that safety and security criteria and requirements are satisfied during the applicable Project phase.

The following CE&CI List identifies the project elements/items to be certified for the Project, based on the 100% Design phase. It should be noted that the CE&CI List is preliminary, and may change as the design evolves, or by changes brought about due to the safety and security analyses being performed. The Project Design Team will review the CE&CI List for accuracy, and as additional safety and/or security items are identified, the list will be updated.

Table 1 presents the State/Lake Elevated Station CEL/CIL List

Table 1: Certifiable Elements & Items List

Project Elements - Certifiable Elements / Certifiable Items List

Contract Name:	State/Lake Loop Elevated Station
Contractor:	
Location:	
Contract No:	
Req No:	

Revision History	
Version	**Date**
0.1	10/11/2022
1.0	1/9/2023

		1.1	1/20/2023

Group	Element	Element No.	Sub-Element	Sub-Element No.	Item	Item No.
Systems	Signal	01	Signal Network	01	Signal Cable	001
Systems	Signal	01	Signal Network	01	Impedance Bonds	002
Systems	Signal	01	Signal Network	01	Junction Boxes	003
Systems	Track and Structure	02	Rail Track System	01	Insulated Joint	001
Systems	Track and Structure	02	Rail Track System	01	Jointed Rail	002
Systems	Track and Structure	02	Rail Track System	01	Guardrails	003
Systems	Track and Structure	02	Rail Track System	01	Footwalks	004
Systems	Track and Structure	02	Rail Track System	01	Track Alignment	005
Systems	Track and Structure	02	Rail Track System	01	Softwood Ties	006
Systems	Traction Power	03	DC Cable	01	Cables and Terminations	001
Systems	Traction Power	03	DC Cable	01	Foundation Electric Isolation	002
Systems	Traction Power	03	Contact Rail	02	Contact Rail	001
Systems	Traction Power	03	Contact Rail	02	Insulator Chair - Porcelain	002
Systems	Traction Power	03	Contact Rail	02	Anchors	003
Systems	Communications	04	Fiber Optics	01	Fiber Optic Backbone System	001
Systems	Communications	04	Cable	02	Communication Cable System	001
Systems	Communications	04	OCC Systems	03	Control Center Integration	001
Systems	Communications	04	OCC Systems	03	Telephones	002
Systems	Communications	04	OCC Systems	03	Intrusion and Fire Alarms	003
Systems	Communications	04	SCADA	04	Remote Terminal Units (RTU)	001
Systems	Communications	04	PA System	05	Dynamic Messaging Systems	001
Systems	Communications	04	PA System	05	PA Control Console	002
Systems	Communications	04	PA System	05	Integration Testing	003
Systems	Communications	04	CCTV	06	Software	001
Systems	Communications	04	CCTV	06	Video Terminal	002
Systems	Communications	04	CCTV	06	Network Video Recorder (NVR)	003
Systems	Communications	04	CCTV	06	Fixed Cameras	004
Systems	Communications	04	CCTV	06	PTZ (Pan-Tilt-Zoom) Cameras	005
Civil Installations	Mech/Elec/Plumb	05	AC Power	01	Normal and Reliable AC Power Feeds	001
Civil Installations	Mech/Elec/Plumb	05	Grounding/Bonding	02	Ground Grids	001
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Fire / Life Safety Lighting	001
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Lighting Fixtures and Accessories	002
Civil Installations	Mech/Elec/Plumb	06	Lighting	03	Controls	003
Civil Installations	Mech/Elec/Plumb	06	Lighting	03	Conduits and Raceways	004
Civil Installations	Mech/Elec/Plumb	06	Lighting	03	Terminations	004
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Emergency (backup battery units)	005
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Illuminated Signage/Exit Signage	006
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Roadway Lighting	007
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Traffic Signals	008
Civil Installations	Mech/Elec/Plumb	05	Fire Alarm/Suppression	04	Fire Alarm System	001
Civil Installations	Mech/Elec/Plumb	05	Fire Alarm/Suppression	04	Fire Extinguishers	002
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Motors	001

Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Hoists and Hoistway	002
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Machine Room	003
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Cab	004
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Emergency Systems	005
Civil Installations	Mech/Elec/Plumb	05	Escalator System	06	Motors	001
Civil Installations	Mech/Elec/Plumb	05	Escalator System	06	Machine Room	002
Civil Installations	Mech/Elec/Plumb	05	Escalator System	06	Emergency Systems	003
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Sump Well and Deep Pumps	001
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Louvers and Mechanical Ventilation	002
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Water Heaters	003
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Electric Heaters	004
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Air Conditioning	005
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Water Supply and Distribution	006
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Wastewater Collection and Conveyance/Plumbing	007
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Infrared Heaters	008
Civil Installations	Civil	06	Structural	01	Foundations	001
Civil Installations	Civil	06	Structural	01	Platform	002
Civil Installations	Civil	06	Structural	01	Railings	003
Civil Installations	Civil	06	Structural	01	Metal Stair Systems	004
Civil Installations	Civil	06	Structural	01	Floor	005
Civil Installations	Civil	06	Structural	01	Framing Elements	006
Civil Installations	Civil	06	Egress Stairs	02	Railings	001
Civil Installations	Civil	06	Egress	03	Pedestrian Paths	001
Civil Installations	Civil	06	Station Platforms	04	Platform Surface Treatments	001
Civil Installations	Civil	06	Station Platforms	04	Tactile Edge	002
Civil Installations	Civil	06	Platform Canopy	05	Signage	001
Civil Installations	Civil	06	Platform Canopy	05	Emergency Egress Doors	002
Civil Installations	Civil	06	Platform Canopy	05	Snow Guards	003
Civil Installations	Civil	06	Platform Canopy	05	Fall Protection	004
Civil Installations	Civil	06	Platform Canopy	05	Turnstiles	005
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Test Plans	001
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Training	002
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Revised SOPs	003
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Revised CTA Manuals and Rule Books	004
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Operations and Maintenance Manuals (Updates/Revisions)	005
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	System Integration Testing (SIT)	006
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Pre-Revenue Operation / Operator Training / Familiarization for Revenue Service	007

3.0 Hazard Management Process

3.1 Methodology

Hazard analyses are performed during the design and developmental phases of a Project. Focus is given to the identification of hazards and hazardous conditions associated with the design, functionality, and subsequent operations of the Station. Focus is also given to providing for employee, public, rider/customer, and emergency response personnel safety. Where identified hazards result in unacceptable or undesirable conditions, they are to be eliminated, whereas hazards which are serious or marginal can be controlled in a systematic manner to reduce the overall system risk to the lowest practical level through the most efficient use of resources. System Safety is the application of technical, engineering, and managerial skills to the systematic, forward-looking identification and control of hazards and hazardous conditions. The following sections identify the steps and processes included in this PHA as applied to the Certifiable Elements and Certifiable Items of the Project.

3.2 Hazard Identification and Categorization

Hazards associated with the station, including systems and equipment used with these facilities, can be identified through;

1) Data from previous like safety analyses (case studies)
2) Design experience
3) Operating experience
4) Hazard scenario development
5) Safety engineering judgment of qualified safety professionals
6) Generic hazard checklists
7) Formal hazard analysis techniques
8) Design data and drawings/plans

Once identified, hazards are categorized in order of significance and priority. This PHA uses the CTA Safety Risk Management Process which uses MIL-STD-882E as a reference. Guidelines established by **MIL-STD-882E, DOD Standard Practice – System Safety** requires identified hazards to be ranked by severity and probability. Severity is defined as the magnitude of potential consequences of a mishap to include death, injury, occupational illness, damage to or loss of equipment or property, damage to the environment, or monetary loss. Probability is defined as an expression of the likelihood of occurrence of a mishap, such as likely, frequently, sometimes, or unlikely. The product of these two parameters established the Risk associated with the identified hazard. Risk is defined as a combination of the severity of the mishap and the probability that the mishap will occur; and Risk Levels are defined as High/Unacceptable; Serious/Undesirable; Medium/Acceptable with CTA Safety Review; or Low/Acceptable.

The hazard severity categories listed in Table 2: Levels of Severity and used by CTA provide a qualitative indication of the relative severity of the possible consequences of the hazard or hazardous conditions. The severity categories that will be applied to provide a qualitative measure of the potential outcomes of an accident/incident include: **Catastrophic, Critical, Marginal, and Negligible.**

The hazard probability levels listed in Table 3: Levels of Likelihood and used by CTA represent a qualitative judgment of the relative likelihood of occurrence of a hazard or hazardous conditions. Probability is generally rated through six standard categories: **Frequent, Probable, Occasional, Remote, Improbable, and Eliminated.**

Table 2: Levels of Severity

Criteria	Severity Category
• Death • Permanent total disability to employees, customers, contractors, or public at large • Irreversible severe environmental damage that violates law or regulation • Permanent loss of equipment or infrastructure	Catastrophic (1)
• Permanent partial disability • Injuries or illness that may result in hospitalization of at least 3 people • Reversible environmental damage causing a violation of law or regulation • Partial loss of equipment or infrastructure	Critical (2)
• Injury or illness resulting in one or more lost work/normal activity day • Mitigation of environmental damage without violation of law or regulation whenrestoration activities can be accomplished • Marginal loss of equipment • Major to severe damage to system environment	Marginal (3)
• Injury or illness not resulting in a lost work/normal activity day • Minimal environmental damage that does not violate law or regulation	Negligible (4)

Table 3: Levels of Likelihood

Severity Category	Criteria
• Likely to occur frequently • Continuously experienced	Frequent (Daily)
• Will occur several times in the life of an item • Will occur frequently	Probable (Weekly)
• Likely to occur sometime in the life of an item • Unlikely but can be reasonable be expected to occur	Occasional (Monthly)
• Unlikely but possible to occur in the life of an item • Unlikely but can be reasonable be expected to occur	Remote
• So unlikely it can be assumed occurrence may not be experienced • Unlikely to be exposed, but possible	Improbable
• The hazard has been removed from the system	Eliminated

3.3 Risk Assessment Value Matrix

The Risk Assessment Value Matrix, Table 4, and Hazard Risk Assessment Code, Table 5, assists the decision-making process in determining the approach to the disposition of identified hazards. CTA and the Project Team will evaluate hazard resolutions using these criteria to bring risks down to an acceptable level.

Table 4: Risk Assessment Value Matrix

Frequency of Occurrence	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent - A	1A	2A	3A	4A
Probable - B	1B	2B	3B	4B
Occasional - C	1C	2C	3C	4C
Remote - D	1D	2D	3D	4D
Improbable - E	1E	2E	3E	4E
Eliminated - F	Eliminated			

Table 5: Hazard Risk Assessment Code

Risk Assessment Code	Risk Color	Action
1A, 1B, 1C, 2A, 2B	🟥	High/Unacceptable
1D, 2C, 3A, 3B,	🟧	Serious/Undesirable
1E, 2D, 2E, 3C, 3D, 3E, 4A, 4B	🟨	Medium/Acceptable with Review
4C, 4D, 4E	🟩	Low/Acceptable

3.4 Hazard Resolution Order of Precedence

When possible, the following order of precedence shall be used in attempts to eliminate or control hazards associated with the Project. As hazards are identified, a combination of several or all the following means may be used depending on the nature and the extent of the hazard to reduce the risk to an acceptable level, including:

(Per MIL-STD-882E)

- ***Eliminate hazard through design selection***. Ideally, the hazard should be eliminated by selecting a design or material alternative that removes the hazard altogether.
- ***Reduce risk through design alteration.*** If adopting an alternative design change or material to eliminate the hazard is not feasible, consider design changes that reduce the severity and/or probability of the mishap potential caused by the hazard(s).
- ***Incorporate engineered features and devices.*** If mitigation of the risk through design alteration is not feasible, reduce the severity or the probability of the mishap potential caused by the hazard(s) using engineered features or devices. In general, engineered features actively interrupt the mishap consequence and devices reduce the risk of a mishap.
- ***Provide warning devices.*** If engineered features and devices are not feasible or do not adequately lower the severity or probability of the mishap potential caused by the hazard, include detection and warning systems to alert personnel to the presence of a hazardous condition or occurrence of a hazardous event.
- ***Incorporate signage, procedures, training, and Personal Protective Equipment (PPE).*** Where design alternatives, design changes, and engineered features and devices are not feasible and warning devices cannot adequately mitigate the severity or probability of the mishap potential caused by the hazard, incorporate signage, procedures, training,

and PPE.

Key areas for Design Safety considerations and prioritization for safety hazard analysis for this station include, but are not limited to the following:

- Signals and Facilities
- Track
- Communication
- Civil (including structural members)
- Mechanical/Electrical/Plumbing
- Traction Power
- Architecture
- Commissioning
-

Key areas for **Construction Safety** considerations and prioritization for safety hazard analysis associated with the station include, but are not limited to the following:

- Compliance with CTA Safety Manual for Contract Construction On, Above or Adjacent to the CTA Rail System
- Compliance with 49 CFR Part 1910, Occupational Safety & Health Standards
- Job Safety Analysis (JSA)
- Staging Plans and Procedures
- Site Safety including Equipment Staging Areas
- Heavy Lifts – Elevated Structures
- Personnel working at heights
- Utility protection and utility relocations
- Ventilation
- Passenger Rerouting Plans – Stationhouse Entrances/Exits
- Emergency Plans and Procedures – Work Site
- Emergency Plans and Procedures – State/Lake Elevated Station
- Emergency Plans and Procedures – Lake Red Line Station
- Accident/Incident Reporting – Work Site

The responsibility for construction safety during the construction of the Project elements will be that of the CTA Prime Contractor. It will be the Prime Contractor’s responsibility to prepare a **Safety Management Plan (SMP)**, and a **Site-Specific Safety Plan (SSSP)** responsive to CTA’s **Safety Manual for Contract Construction On, Above or Adjacent to the CTA Rail System**, and ensure adherence to these plans by all workers during the periods of Work.

The Prime Contractor is required to submit their SMP to the CTA (via submittal to CDOT who will forward the documents to CTA) for review and comment within 30 days of the date of the Notice to Proceed (NTP). The SMP must comply with the requirements of Chapter 2: Contractor Training and Other Pre-Requisites, Section 2-1 Contractor Safety Management Plan of CTA Safety Manual, OSHA, City of Chicago and other regulatory agencies. Work on the project will not be permitted to start until the full written plan, covering all required items is submitted, and approved. The SSSP governs all contractor and subcontractor personnel activity and addresses the Project’s health and safety issues including:

1. Prime Contractor’s management commitment to safety

2. Assignment of responsibilities
3. Training and education
4. Communications
5. Safe Work Plan (SWP)
6. Identification and control of hazards
7. Hazard analysis
8. Accident Reporting and Investigation
9. Recordkeeping
10. First aid and medical assistance

The Contractor's SSSP specifies the name of the Contractor Safety Representatives (CSR) (safety engineer, safety supervisor and competent person) assigned to that project and who are responsible for the safe and healthful performance of all work, including that performed by Subcontractors. The CSR will ensure that all Subcontractors are familiar and comply with the Prime Contractor’s SSSP.

4.0 Safety Recommendations and Design Considerations

As part of the hazard management requirements, Preliminary Hazard Analysis (PHA) reports are developed as the project design criteria are developed, approved, and periodically updated during the Validation and Intermediate design phases. These reports are reviewed by the SSRC, Project Management Team, and FTA's Project Management Oversight Consultant (PMOC) upon request. The IDOT SSOA may also request to review the PHA. The recommendations generated from the update of the PHA are reviewed and considered for safety and security design criteria updates and potential design and/or construction change orders.

Hazard management is the formal process to systematically recognize, identify, evaluate, and resolve hazards associated with the design, construction, testing, start-up, and operation of the project for patrons, employees, and the public as shown in Figure 3. Recognized hazards must be categorized as to their potential severity and probability of occurrence and analyzed for potential impact. Those hazards must then be resolved by design, engineering control, procedure, warning device, or other method so that they fall within the level of risk acceptable to transit management.

4.1 Safety Recommendations

The results of the PHA provide several mitigations/resolutions to potential hazards and risk conditions. It is recommended that mitigations/resolutions be evaluated against current design, construction, installation, operating, and maintenance practices and methods to enable fully comprehensive safety recommendations to be made regarding management of hazards and risks. This additional assessment will provide assurance to CDOT and CTA that the selected safety recommendations made in response to hazards and risks maximizes the safety benefit to the Project.

4.2 Design Review Process

The design review process conducted during the 100% Design Phase is crucial to uncovering design flaws, omissions, errors, and technical requirements and criteria which may not apply to the end use design. The process also provides a forum to raise design safety issues or considerations and allows all departments to evaluate what impact(s) such issues have on their operations. The development and conduct of this PHA can be used in supporting the 100% design review process and assuring that recommendations resulting from safety analyses are identified, incorporated into the design, or if they are not, that sound technical judgment and rationale has been exercised and the associated risk(s) are acceptable to CDOT and CTA.

4.3 PHA Results

This PHA is provided to CDOT and CTA for review and approval. Based on the design phase of the project, the PHA also serves as an independent safety verification tool to provide assurance that hazards were indeed identified, evaluated and are being mitigated in the Project design. The PHA can also trigger further analysis of conditions which are found to be unsafe, or unsatisfactory based on the hazard control measures employed. Where hazards are to be controlled by Vendor/Contractor-provided safety analysis documentation, or by CTA Operations and Maintenance Departments, the PHA will require verification, or affirm reference to those documents at the relevant Project phase. Furthermore, the PHA may also include actions for other CTA Departments supporting the Project, Emergency Response Agencies, or other Third Parties.

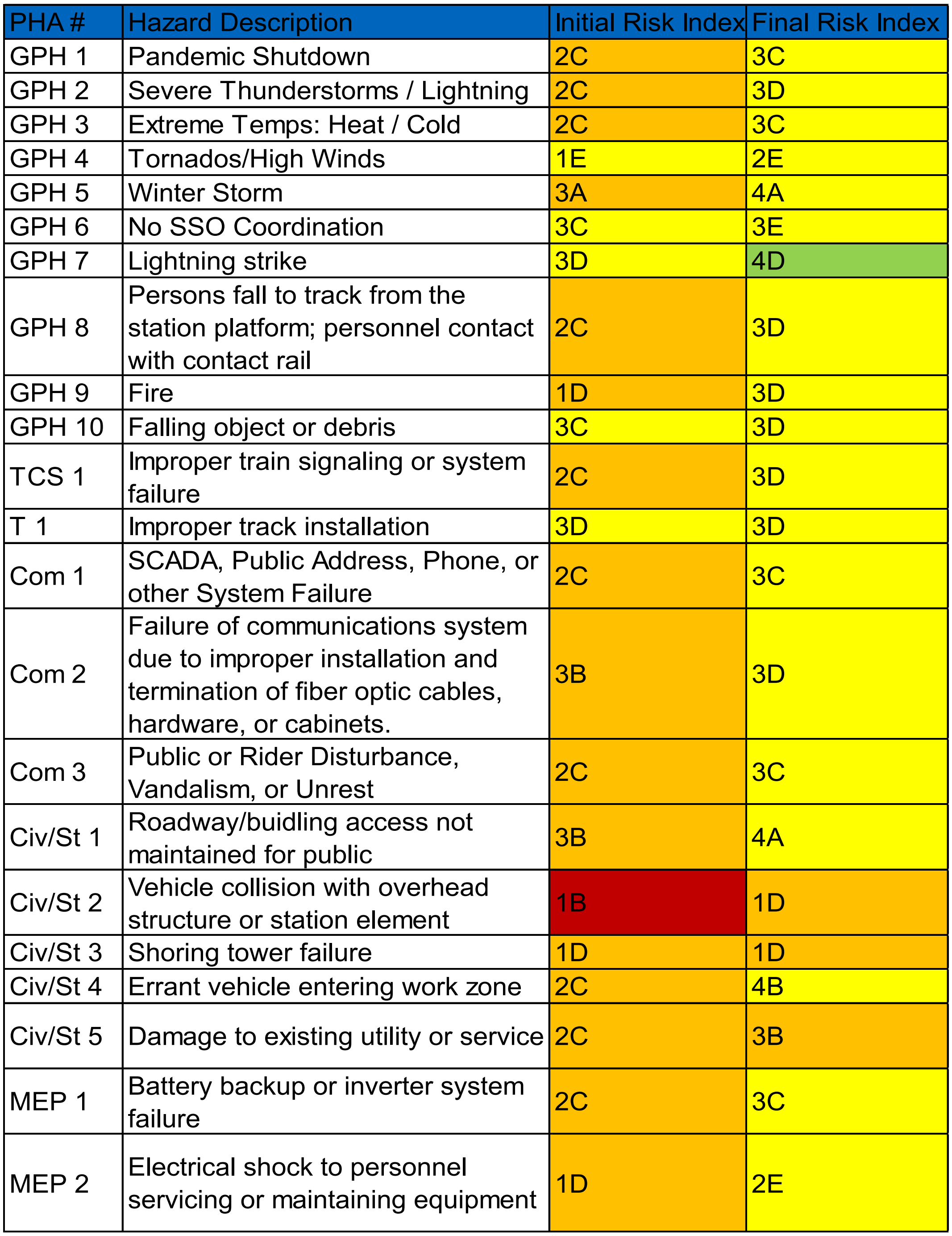
5.0 Preliminary Hazard Analysis (PHA) Summary Findings

The results of this PHA provide several mitigations/resolutions to real and potential hazards and risk conditions associated with the Project. It is recommended that CDOT and CTA use this analysis to maximize the safety benefit to the Project by reviewing and selecting recommendations to be integrated into the subsequent phases of the design of the Project. This PHA conducted for the station identified and analyzed potential hazards associated with the following project elements:

1. State/Lake Elevated Station
2. Lake Red Line Station

Table 6 provides a Summary of the hazard descriptions and the Initial Risk Index (IRI) and Final Risk Index (FRI) assigned to each hazard.

Table 6: Preliminary Hazard Analysis Worksheets Summary



PHA #	Hazard Description	Initial Risk Index	Final Risk Index
GPH 1	Pandemic Shutdown	2C	3C
GPH 2	Severe Thunderstorms / Lightning	2C	3D
GPH 3	Extreme Temps: Heat / Cold	2C	3C
GPH 4	Tornados/High Winds	1E	2E
GPH 5	Winter Storm	3A	4A
GPH 6	No SSO Coordination	3C	3E
GPH 7	Lightning strike	3D	4D
GPH 8	Persons fall to track from the station platform; personnel contact with contact rail	2C	3D
GPH 9	Fire	1D	3D
GPH 10	Falling object or debris	3C	3D
TCS 1	Improper train signaling or system failure	2C	3D
T 1	Improper track installation	3D	3D
Com 1	SCADA, Public Address, Phone, or other System Failure	2C	3C
Com 2	Failure of communications system due to improper installation and termination of fiber optic cables, hardware, or cabinets.	3B	3D
Com 3	Public or Rider Disturbance, Vandalism, or Unrest	2C	3C
Civ/St 1	Roadway/buidling access not maintained for public	3B	4A
Civ/St 2	Vehicle collision with overhead structure or station element	1B	1D
Civ/St 3	Shoring tower failure	1D	1D
Civ/St 4	Errant vehicle entering work zone	2C	4B
Civ/St 5	Damage to existing utility or service	2C	3B
MEP 1	Battery backup or inverter system failure	2C	3C
MEP 2	Electrical shock to personnel servicing or maintaining equipment	1D	2E

PHA #	Hazard Description	Initial Risk Index	Final Risk Index
MEP 2	Electrical shock to personnel servicing or maintaining equipment	1D	2E
MEP 3	ComEd service failure/overcurrent/undercurrent, transformer failure, or loss of power	3B	2D
MEP 4	Loss of circuit breaker functionality.	2D	3D
MEP 5	HVAC Systems Failure	2D	3D
MEP 6	Flooding in pits or basements	3C	3C
TP 1	Stray current corrosion (DC current straying to ground and other utilities)	2C	3D
TP 2	Power cabling/wiring short-circuits	2C	3D
Arch 1	Inadequate egress clearances or capacity	1C	3D
Arch 2	Blind corners	1C	3E
Arch 3	Escalator/elevator failure	2C	3D
C/M 1	Failure to develop/update SSMP	3C	4C
C/M 2	Failure to develop/update SSCP	3C	4C
C/M 3	Failure to develop/update PHA	3C	4C
C/M 4	Failuire to develop/update TVA	3C	4C
C/M 5	No PRO / Operator Training / Familiarization with project	3C	4C
C/M 6	Corrosion of structure or station elements	3C	4C

Resolutions

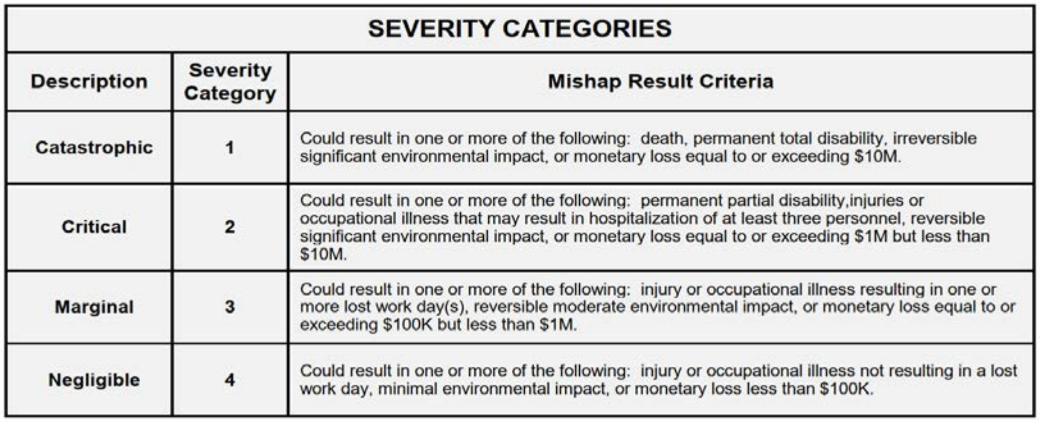
Hazard Risk Index Resolutions			
Pre-Resolution		Post Resolution	
Total # of Hazards with Pre-Resolution HRI =1	7	Total # of Hazards with Post-Resolution HRI =1	2
Total # of Hazards with Pre-Resolution HRI =2	15	Total # of Hazards with Post-Resolution HRI =2	3
Total # of Hazards with Pre-Resolution HRI =3	15	Total # of Hazards with Post-Resolution HRI =3	22
Total # of Hazards with Pre-Resolution HRI =4	0	Total # of Hazards with Post-Resolution HRI =4	10

Appendix A

Preliminary Hazard Analysis Worksheets

Risk Index: Ref. MIL-STD 882E

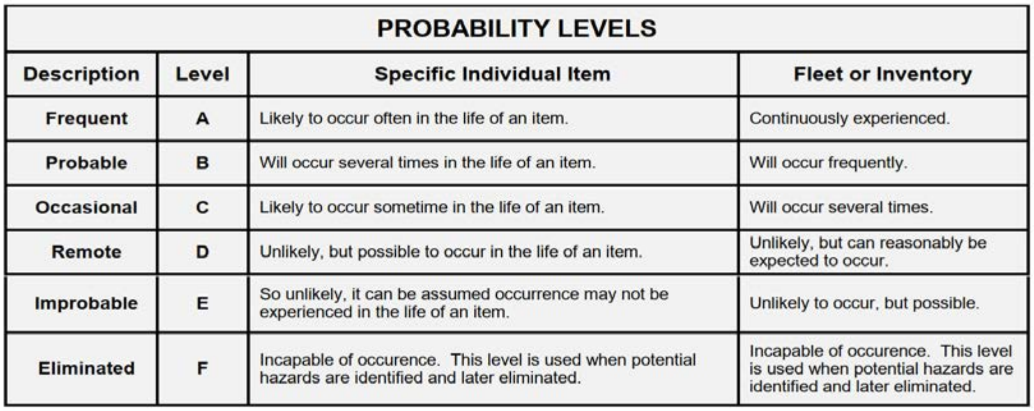
Severity Categories



SEVERITY CATEGORIES

Description	Severity Category	Mishap Result Criteria
Catastrophic	1	Could result in one or more of the following: death, permanent total disability, irreversible significant environmental impact, or monetary loss equal to or exceeding $10M.
Critical	2	Could result in one or more of the following: permanent partial disability,injuries or occupational illness that may result in hospitalization of at least three personnel, reversible significant environmental impact, or monetary loss equal to or exceeding $1M but less than $10M.
Marginal	3	Could result in one or more of the following: injury or occupational illness resulting in one or more lost work day(s), reversible moderate environmental impact, or monetary loss equal to or exceeding $100K but less than $1M.
Negligible	4	Could result in one or more of the following: injury or occupational illness not resulting in a lost work day, minimal environmental impact, or monetary loss less than $100K.

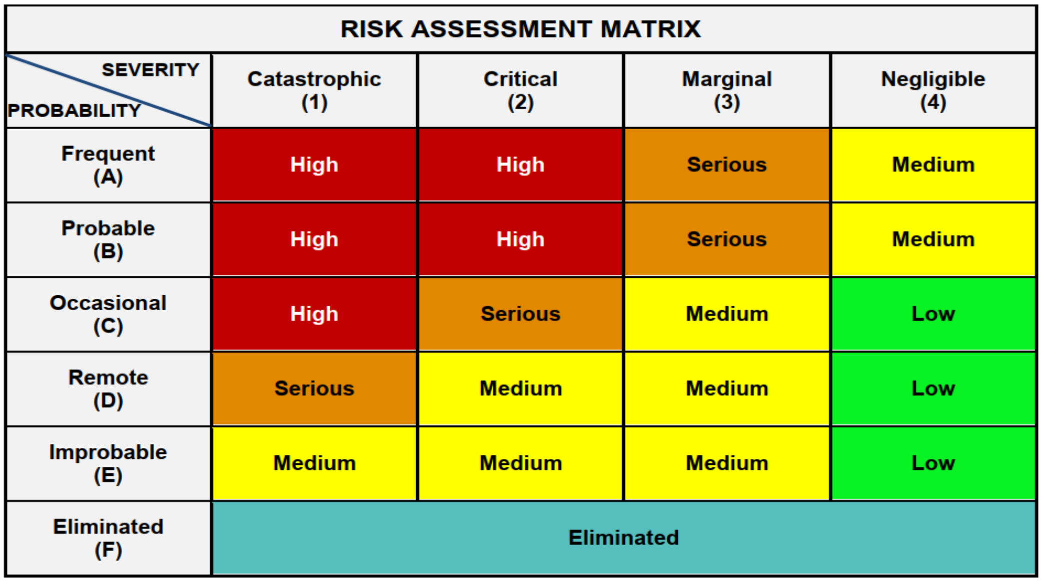
Probability Levels



PROBABILITY LEVELS

Description	Level	Specific Individual Item	Fleet or Inventory
Frequent	A	Likely to occur often in the life of an item.	Continuously experienced.
Probable	B	Will occur several times in the life of an item.	Will occur frequently.
Occasional	C	Likely to occur sometime in the life of an item.	Will occur several times.
Remote	D	Unlikely, but possible to occur in the life of an item.	Unlikely, but can reasonably be expected to occur.
Improbable	E	So unlikely, it can be assumed occurrence may not be experienced in the life of an item.	Unlikely to occur, but possible.
Eliminated	F	Incapable of occurence. This level is used when potential hazards are identified and later eliminated.	Incapable of occurence. This level is used when potential hazards are identified and later eliminated.

Risk Assessment Matrix



RISK ASSESSMENT MATRIX

SEVERITY PROBABILITY	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

Hazard Categories

Frequency of Occurrence	1 Catastrophic	2 Critical	3 Marginal	4 Negligible
(A) Frequent	1A-UA	2A-UA	3A-UA	4A-AC/WR
(B) Probable	1B-UA	2B-UA	3B-UD	4B-AC/WR
(C) Occasional	1C-UA	2C-UD	3C-UD	4C-AC
(D) Remote	1D-UD	2D-UD	3D-AC/WR	4D-AC
(E) Improbable	1E-AC/WR	2E-AC/WR	3E-AC/WR	4E-AC
(F) Eliminated	1F-AC/WR	2F-AC/WR	3F-AC/WR	4F-AC

Hazard Risk Index	Acceptance Criteria
1A, 1B, 1C, 2A, 2B	**UA-Unacceptable**
1D, 2C, 3A, 3B	**UD-Undesirable (decision required)**
1E, 2D, 2E , 3C, 3D, 3E, 4A, 4B	**AC-Acceptable with review**
4C, 4D, 4E	**AC-Acceptable without review**
1F, 2F, 3F, 4F	**Elminated**

	Acceptance Criteria	Probability	Risk Severity
1A	Unacceptable	Frequent	Catastrophic
1B	Unacceptable	Probable	Catastrophic
1C	Unacceptable	Occasional	Catastrophic
2A	Unacceptable	Frequent	Critical
2B	Unacceptable	Probable	Critical
1D	Decision Required	Remote	Catastrophic
2C	Decision Required	Occasional	Critical
3A	Decision Required	Frequent	Marginal
3B	Decision Required	Probable	Marginal
1E	Review Required	Improbable	Catastrophic
2D	Review Required	Remote	Critical
2E	Review Required	Improbable	Critical
3C	Review Required	Occasional	Marginal
3D	Review Required	Remote	Marginal
3E	Review Required	Improbable	Marginal
4A	Review Required	Frequent	Negligible
4B	Review Required	Probable	Negligible
4C	No Review Required	Occasional	Negligible
4D	No Review Required	Remote	Negligible
4E	No Review Required	Improbable	Negligible
1F	Elminated	Eliminated	Catastrophic
2F	Elminated	Eliminated	Critical
3F	Elminated	Eliminated	Marginal
4F	Elminated	Eliminated	Negligible

PRELIMINARY HAZARD ANALYSIS (PHA)

State/Lake Loop Elevated Station			1A, 1B, 1C, 2A, 2B	**High - Unacceptable -RISK MUST BE MITIGATED**
Prepared By: Michael Lev, TranSystems	**DATE:**	1/20/2023	**1D, 2C, 3A, 3B**	**Serious - Unacceptable/Undesireable (Management Decision required)-RISK SHOULD BE MITIGATED/REDUCED TO LOWEST ACCEPTABLE LEVEL**
Reviewed By:	**DATE:**		**1E, 2D, 2E, 3C, 3D, 3E, 4A, 4B**	**Medium - Unacceptable/Undesireable (Management Review required) -THREAT SHOULD BE MITIGATED IF POSSIBLE WITHIN FISCAL CONSTRAINTS**
Approved By:	**DATE:**		**4C, 4D, 4E**	**Low - THREAT IS ACCEPTABLE WITHOUT REVIEW/APPROVAL BY MANAGEMENT**
			1F, 2F, 3F, 4F	**Eliminated - THREAT HAS BEEN ELIMINATED/MITIGATED**

Rev No: 1.3

Hazard Description					**Hazard Risk Index Assessment**				**Corrective Action**							
#	CEL ID#	Hazard Scenario/ Description	Potential Cause	Effect on Subsystem/System	Initial Risk Category	Acceptance Criteria	Probability	Risk Severity	Possible Controlling Measures and Remarks	Final Mitigation	Desing Package/Drawing/Specification Reference	Residual Risk Category	Acceptance Criteria	Probability	Risk Severity	Resolution Status (Date Closed)
Category: General Project Hazards (GPH)																
GPH 1	N/A	Pandemic Shutdown	Pandemic / Epidemic (e.g., COVID-19 / SARS CoV-2)	General shutdown; additional vehicles on system to handle social distancing; health risks; personal injury; death; service disruptions; service slowdowns	**2C**	**Decision Required**	Occasional	Critical	Follow established CDC / Federal / State guidelines; follow established SOPs and emergency / pandemic guidelines; verification during construction required	Apply CTA/CDOT SOP regrading COVID-19 Mitigation	N/A	**3C**	**Review Required**	Occasional	Marginal	TBD by CTA/CDOT policy in place at time of incident; monitor during Consturction phase
GPH 2	N/A	Severe Thunderstorms / Lightning	Natural occurrence	Flooded trackways, high winds, downed trees or utilities, other debris blocking roadways; injuries to patrons and employees; lightning overvoltage could cause equipment damage and operational disruptions	**2C**	**Decision Required**	Occasional	Critical	Monitor weather as necessary and implement inclement weather contingencies; utilize reroute measures or suspend services as necessary. Coordinate with contractor and CDWM to ensure sewers and catch basins are cleared in floodprone areas ahead of storm/flash flood conditions. Protect vulnerable assets from lightning, wind, hail. Consider during phasing plan; lightning - in case of outage, move to manual blocking, etc.	Adhere to CTA SOP and CDOT/CTA leadership decisions.	N/A	**3D**	**Review Required**	Remote	Marginal	Considered during design phase; monitor during Consturction phase
GPH 3	N/A	Extreme Temps: Heat / Cold	Natural occurrence	Damage to vehicles, infrastructure/track system; patron and employee illness; AC system effects; approach & departure of trains on curves	**2C**	**Decision Required**	Occasional	Critical	Monitor weather as necessary and implement inclement weather contingencies; protect key vulnerable assets as practically capable; protect patrons and employees as practically capable; suspend services as necessary. Protect vulnerable assets. Consider track ambient temp and ballast needs; use accepted value for rail temp; rail shoulder capable of withstanding thermal stresses; AR fixation system doesn't restrain 3rd rail/design/placement of elements/sub-elements; slip-joints on down-spouts, etc.; depth of subsurface elements	Adhere to CTA SOP and CDOT/CTA leadership decisions.	N/A	**3C**	**Review Required**	Occasional	Marginal	Considered during design phase; monitor during Consturction phase
GPH 4	N/A	Tornados/High Winds	Natural occurrence	Damage to vehicles and structures; injuries to or loss of life of patrons and employees; flying debris;	**1E**	**Review Required**	Improbable	Catastrophic	Monitor weather as necessary and implement inclement weather contingencies; protect key vulnerable assets as practically capable; protect patrons and employees as practically capable; suspend services as necessary. Ensure elements properly secured; material choices	Adhere to CTA SOP and CDOT/CTA leadership decisions.	N/A	**2E**	**Review Required**	Improbable	Critical	Considered during design phase; monitor during Consturction phase
GPH 5	N/A	Winter Storm	Natural occurrence	Damage to vehicles, construction equipment and structures; injuries to or loss of life of patrons and employees; operational disruption/degradation	**3A**	**Decision Required**	Frequent	Marginal	Monitor weather as necessary and implement inclement weather contingencies; protect key vulnerable assets as practically capable; protect patrons and employees as practically capable; suspend services as necessary. Enforce through design there is positive drainage around special track use devices to prevent freeze; be aware of IDOT pushing snow over barrier walls - monitor track conditions; corrosive environment caused by salt; design for melt off drainage;	Adhere to CTA SOP and CDOT/CTA leadership decisions.	N/A	**4A**	**Review Required**	Frequent	Negligible	Designed for positive drainage CTA to monitor conditions and implement contingencies
GPH 6	N/A	No SSO Coordination	Failure to follow PTASP guidelines; general FTA and state oversight requirements	Compliance deficiency finding during Triennial Review of SSO Audit;	**3C**	**Review Required**	Occasional	Marginal	Regularly coordinate with SSO and other applicable oversight agencies regarding new projects and rehabilitation projects to meet compliance	Coordinate with ILSSO regularly and invite to	N/A	**3E**	**Review Required**	Improbable	Marginal	CDOT/CTA to coordinate with SSO
GPH 7	N/A	Lightning strike	Direct strike or over-voltage from lightning strike	Serious injury / death; equipment / infra. / property damage; service disruption	**3D**	**Review Required**	Remote	Marginal	Follow applicable design criteria; specify lightning arrestors on power lines; specify surge protection to power and other circuits potentially subject to lightning induced surge; or consider intercept junction box outside house;	Adhere to CTA SOP and CDOT/CTA leadership decisions.	N/A	**4D**	**No Review Required**	Remote	Negligible	Considered during design phase
GPH 8	N/A	Persons fall to track from the station platform; personnel contact with contact rail	Trip-and-fall; crime; illness /injury; unaccompanied child;	Electrical shock; serious injury or death;	**2C**	**Decision Required**	Occasional	Critical	Contact rail installed on the opposite side of the station platform within the station limits; station signage; tactile warning edge	Adhere to CTA SOP and leadership decisions.	CT sheets	**3D**	**Review Required**	Remote	Marginal	Verify during construction/installation

PRELIMINARY HAZARD ANALYSIS (PHA)

State/Lake Loop Elevated Station			1A, 1B, 1C, 2A, 2B	High - Unacceptable -RISK MUST BE MITIGATED
Prepared By: Michael Lev, TranSystems	DATE:	1/20/2023	1D, 2C, 3A, 3B	Serious - Unacceptable/Undesireable (Management Decision required)-RISK SHOULD BE MITIGATED/REDUCED TO LOWEST ACCEPTABLE LEVEL
Reviewed By:	DATE:		1E, 2D, 2E, 3C, 3D, 3E, 4A, 4B	Medium - Unacceptable/Undesireable (Management Review required) -THREAT SHOULD BE MITIGATED IF POSSIBLE WITHIN FISCAL CONSTRAINTS
Approved By:	DATE:		4C, 4D, 4E	Low - THREAT IS ACCEPTABLE WITHOUT REVIEW/APPROVAL BY MANAGEMENT
			1F, 2F, 3F, 4F	Eliminated - THREAT HAS BEEN ELIMINATED/MITIGATED

Rev No: 1.3

Hazard Description					Hazard Risk Index Assessment				Corrective Action							
#	CEL ID#	Hazard Scenario/ Description	Potential Cause	Effect on Subsystem/System	Initial Risk Category	Acceptance Criteria	Probability	Risk Severity	Possible Controlling Measures and Remarks	Final Mitigation	Desing Package/Drawing/Specification Reference	Residual Risk Category	Acceptance Criteria	Probability	Risk Severity	Resolution Status (Date Closed)
GPH 9	N/A	Fire	Construction operations, flammable materials storage	Electrical shock; serious injury or death;	1D	**Decision Required**	Remote	Catastrophic	Install fire detection system and fire extinguishers; follow NFPA 130 code for emerency egress	Adhere to CTA SOP and CDOT/CTA leadership decisions. Do not store flammable materials near flame sources.	N/A	3D	**Review Required**	Remote	Marginal	Monitor during construction
GPH 10	N/A	Falling object or debris	Construction operations, improper element installation	Serious injury or death	3C	**Review Required**	Occasional	Marginal	Contractor to use bracing or nets.	Follow OSHA standards and specifications for required bracing of incomplete work.	N/A	3D	**Review Required**	Remote	Marginal	Monitor during construction
Category: Train Control Signals (TCS)																
TCS 1	01	Improper train signaling or system failure	Equipment/power failure, OCC comms failure, loss of circuit, incorrect software, incorrect hardware	Loss of vehicle tracking and schedule aherence, loss of PIS on platform	2C	**Decision Required**	Occasional	Critical	Test system before operation.	Service outages include scheduled time for CTA test and verification of system operation.	TC series sheets and Div 34 specifications	3D	**Review Required**	Remote	Marginal	Monitor during construction. CTA to test system after modifications.
Category: Track (T)																
T 1	02	Improper track installation	Incorrect layout or installation structure deflection during installation	Derailment	3D	**Review Required**	Remote	Marginal	Use templates for layout. Run test train before revenue service restart.	Use templates for layout. Run test train before revenue service restart.	CT series sheets	3D	**Review Required**	Remote	Marginal	Monitor during construction. CTA to provide test train after track construction
Category: Communications (Com)																
Com 1	04	SCADA, Public Address, Phone, or other System Failure	Equipment/power failure, OCC comms failure, loss of circuit, incorrect software, incorrect hardware	Loss of vehicle tracking and schedule aherence, loss of PIS on platform	2C	**Decision Required**	Occasional	Critical	Implement operating rules, prceedures for loss of AVL, Maintenance checks and inspections, training; (Communication Dept)	All work done in compliance with CTA Safety Manual for Contract Construction On, Above or Adjacent to the CTA Rail System. Update maintenance SOPs and provide training.	Div 27 specifications	3C	**Review Required**	Occasional	Marginal	Verify during construction/installation
Com 2	04	Failure of communications system due to improper installation and termination of fiber optic cables, hardware, or cabinets.	Improper Installation	System Loss, Service Disruption	3B	**Decision Required**	Probable	Marginal	1.) Design in accordance with applicable Fiber Optic Installation Standards and/or manufacturer instruction. 2.) Verify installation is compliant with the design with QA/QC program.	All work done in compliance with CTA Safety Manual for Contract Construction On, Above or Adjacent to the CTA Rail System. Update maintenance SOPs and provide training.	Div 27 specifications	3D	**Review Required**	Remote	Marginal	Verify during construction/installation
Com 3	04	Public or Rider Disturbance, Vandalism, or Unrest	Non-visible areas of station for cameras, fare evading riders	Vandalism, Revenue Loss	2C	**Decision Required**	Occasional	Critical	1.) Locate cameras with full station visibility. 2.) Install protections to thwart fare evaders.	1.) Locate cameras with full station visibility. 2.) Install protections to thwart fare evaders.	A , AS, T, and TS series sheets	3C	**Review Required**	Occasional	Marginal	Verify during construction/installation. Upon system turn-on, review camera views to ensure adequacy.
Category: Civil/Structural (Civ/St)																
Civ/St 1	06	Roadway/buidling access not maintained for public	Failure to coordinate with outside agencies; project team communication failure	Project delay; cost overruns; rework;	3B	**Decision Required**	Probable	Marginal	Continued/ongoing coordination with outside agencies - specifically with approving agencies; maintain ongoing project coordination meetings	Discussed access needs with adjacent businessess. Contract plans contain requirements to maintain access.	CX sheets	4A	**Review Required**	Frequent	Negligible	Monitor during construction
Civ/St 2	06	Vehicle collision with overhead structure or station element	Improper vehicular channelization or signage	Structure damage or collapse	1B	**Unacceptable**	Probable	Catastrophic	Install concrete barrer wall to protect low clearance areas. Use bollards in key areas.	Install concrete barrer wall to protect low clearance areas. Use bollards in key areas. Design structure for collision forces.	CX, C, and S sheets	1D	**Decision Required**	Remote	Catastrophic	Considered during design phase. Monitor during construction phase.

PRELIMINARY HAZARD ANALYSIS (PHA)

State/Lake Loop Elevated Station			1A, 1B, 1C, 2A, 2B	High - Unacceptable - RISK MUST BE MITIGATED
Prepared By: Michael Lev, TranSystems	DATE:	1/20/2023	1D, 2C, 3A, 3B	Serious - Unacceptable/Undesireable (Management Decision required)-RISK SHOULD BE MITIGATED/REDUCED TO LOWEST ACCEPTABLE LEVEL
Reviewed By:	DATE:		1E, 2D, 2E, 3C, 3D, 3E, 4A, 4B	Medium - Unacceptable/Undesireable (Management Review required) -THREAT SHOULD BE MITIGATED IF POSSIBLE WITHIN FISCAL CONSTRAINTS
Approved By:	DATE:		4C, 4D, 4E	Low - THREAT IS ACCEPTABLE WITHOUT REVIEW/APPROVAL BY MANAGEMENT
			1F, 2F, 3F, 4F	Eliminated - THREAT HAS BEEN ELIMINATED/MITIGATED

Rev No: 1.3

Hazard Description					Hazard Risk Index Assessment				Corrective Action							
#	CEL ID#	Hazard Scenario/ Description	Potential Cause	Effect on Subsystem/System	Initial Risk Category	Acceptance Criteria	Probability	Risk Severity	Possible Controlling Measures and Remarks	Final Mitigation	Desing Package/Drawing/Specification Reference	Residual Risk Category	Acceptance Criteria	Probability	Risk Severity	Resolution Status (Date Closed)
Civ/St 3	06	Shoring tower failure	Improper installation or vehicle collision	Structure damage or collapse	1D	**Decision Required**	Remote	Catastrophic	Install concrete barrier wall around shoring towers.	Install concrete barrer wall around shoring towers. Locate shoring towers in lesser-traveled portions of the roadway.	CX and S sheets	1D	**Decision Required**	Remote	Catastrophic	Considered during design phase. Monitor during construction phase.
Civ/St 4	06	Errant vehicle entering work zone	Breaks in barrier wall allowing for contractor and construction vehicle access	Service interruptions (CTA and CDOT); project delay; unforseen expense;	2C	**Decision Required**	Occasional	Critical	Coordinate with CDOT and ensure CDOT permit reviews. CDOT's consultant construction engineer to regularly review work zone and signage.	Install concrete barrier around work zone. Monitor work zone traffic control.	CX sheets	4B	**Review Required**	Probable	Negligible	Considered during design phase. Monitor during construction phase.
Civ/St 5	06	Damage to existing utility or service	Contractor excavation operations	Utility service interruption to surrounding buildings; damage to utility infrastructure	2C	**Decision Required**	Occasional	Critical	Coordinate utility impacts through CDOT-OUC	Submitted plans through OUC-EFP proces. Call DIGGER during construction phase for locates.	C sheets. Meeting minutes.	3B	**Decision Required**	Probable	Marginal	Considered during design phase. Monitor during construction phase.
Category: Mechanical, Electrical, Plumbing (MEP)																
MEP 1	05	Battery backup or inverter system failure	Electrical connection or short, physical damage	SCADA notiification of CTA Control Center	2C	**Decision Required**	Occasional	Critical	Lockout tagout procedure for maintenance; verify procedures for testing; follow existing maint. / inspection guidelines for ground testing	1.COC Electrical Code, and CTA IDCM Chapter 10 design requirements applied to design. 2.CTA Maintenance Plans and Procedures for TPS to be revised as necessary.	E sheets and Div 28 specifications	3C	**Review Required**	Occasional	Marginal	Considered during design phase. Monitor during construction phase.
MEP 2	05	Electrical shock to personnel servicing or maintaining equipment	Differences in electrical potential due to inadequate grounding. TPS equipment not electrically isolated. Power cable/wiring damaged.	Death. Permanent total disability to employees, customers, contractors, or public at large.	1D	**Decision Required**	Remote	Catastrophic	1.Design in accordance with City of Chicago Electrical Code, and CTA IDCM Chapter 10, Electrical. 2.CTA inspection, service, and maintenance of facility and equipment conducted under safety plans and procedures.	1.COC Electrical Code, and CTA IDCM Chapter 10 design requirements applied to design. 2.Grounding systems employed internally and externally. 3.CTA Maintenance Plans and Procedures followed.	E and ES sheets and Div 27 specifications	2E	**Review Required**	Improbable	Critical	Considered during design phase. Monitor/verify during construction phase.
MEP 3	05	ComEd service failure/overcurrent/undercurrent, transformer failure, or loss of power	Outage or equipment damage	Loss of service	3B	**Decision Required**	Probable	Marginal	Battery backup system for key station functions, 2nd ComEd feed to facility, generator tap/connection box at street level, surge protection device	1.COC Electrical Code, and CTA IDCM Chapter 10 design requirements applied to design. 2.Automatic circuit breakers protect against over voltage conditions.	E sheets and Div 27 specifications	2D	**Review Required**	Remote	Critical	Considered during design phase. Monitor/verify during construction phase.
MEP 4	05	Loss of circuit breaker functionality.	Defective circuit breaker. Circuit breaker rating incorrect. Control circuit failure.	Partial loss of equipment or infrastructure.	2D	**Review Required**	Remote	Critical	1.Design in accordance with City of Chicago Electrical Code, and CTA IDCM Chapter 10, Electrical. 2.Conduct factory test and site end-to-end test of protective devices upon installation. 3.Supervisory Control and Data Acquisition (SCADA) monitoring provides system status and health check of system. 4.Ensure correct installation of equipment/components following maintenance actions. 5.Training provided to CTA personnel to ensure correct operations and maintenance. 6.CTA inspection, service, and maintenance of facility and equipment conducted under safety plans and procedures.	1.COC Electrical Code, and CTA IDCM Chapter 10 design requirements applied to design. 2.Grounding system testing to be conducted. 3.SCADA health checks. 4.CTA Operations and Maintenance personnel will be trained on station operations.	E and ES sheets and Div 27 specifications	3D	**Review Required**	Remote	Marginal	Considered during design phase. Monitor/verify during construction phase.
MEP 5	05	HVAC Systems Failure	Malfunction or breaker trip	Freezing pipes, undesirable interior space temperatures, damaged equipment	2D	**Review Required**	Remote	Critical	Tie systems to SCADA. Ensure sizing adequacy	1.CTA IDCM Chapter 9 design requirements applied to design. 2.Calculated loads and system needs. 3.CTA Maintenance Plans and Procedures for TPS to be revised as necessary.	M, MS, P, PS, T, and TS sheets	3D	**Review Required**	Remote	Marginal	Considered during design phase. Monitor/verify during construction phase.
MEP 6	05	Flooding in pits or basements	Heavy rain, inadequate seals	Damage to equipment; loss of service	3C	**Review Required**	Occasional	Marginal	Install pumps tied to SCADA. Seal all openings which are exposed to rain or runoff. Slope sidewalks away from elevators and escalators.	Install pumps tied to SCADA. Seal all openings which are exposed to rain or runoff. Slope sidewalks away from elevators and escalators.	C, P, PS, T, and TS sheets	3C	**Review Required**	Occasional	Marginal	N/A - not in design contract
Category: Traction Power (TP)																

PRELIMINARY HAZARD ANALYSIS (PHA)

State/Lake Loop Elevated Station			1A, 1B, 1C, 2A, 2B	High - Unacceptable -RISK MUST BE MITIGATED
Prepared By: Michael Lev, TranSystems	DATE:	1/20/2023	1D, 2C, 3A, 3B	Serious - Unnacceptable/Undesireable (Management Decision required)-RISK SHOULD BE MITIGATED/REDUCED TO LOWEST ACCEPTABLE LEVEL
Reviewed By:	DATE:		1E, 2D, 2E, 3C, 3D, 3E, 4A, 4B	Medium - Unnacceptable/Undesireable (Management Review required) -THREAT SHOULD BE MITIGATED IF POSSIBLE WITHIN FISCAL CONSTRAINTS
Approved By:	DATE:		4C, 4D, 4E	Low - THREAT IS ACCEPTABLE WITHOUT REVIEW/APPROVAL BY MANAGEMENT
			1F, 2F, 3F, 4F	Eliminated - THREAT HAS BEEN ELIMINATED/MITIGATED

Rev No: 1.3

Hazard Description					Hazard Risk Index Assessment				Corrective Action									
#	CEL ID#	Hazard Scenario/ Description	Potential Cause	Effect on Subsystem/System	Initial Risk Category	Acceptance Criteria	Probability	Risk Severity	Possible Controlling Measures and Remarks	Final Mitigation	Desing Package/Drawing/Specification Reference	Residual Risk Category	Acceptance Criteria	Probability	Risk Severity	Resolution Status (Date Closed)
TP 1	03	Stray current corrosion (DC current straying to ground and other utilities)	Electrical connection between negative and ground due to improper isolation	Equipment and property damage; service inturruption	2C	**Decision Required**	Occasional	Critical	Isolate negative rails and returns from grounded structures. Use insulated rail fasteners. Isolate structural members from foundations.	CTA IDCM Chapters 4 and 7 design requirements for foundation electrical isolation.	CT and S sheets	3D	**Review Required**	Remote	Marginal	Considered during design phase. Monitor/verify during construction phase.
TP 2	03	Power cabling/wiring short-circuits	Improper installation of traction power cables	Equipment and property damage; service inturruptions	2C	**Decision Required**	Occasional	Critical	All traction power cables shall be installed in based on currect design criteria; Cables shall be meggered after installation and prior to revenue service	1.COC Electrical Code, and CTA IDCM Chapter 10 design requirements. Exceptions as noted. 2.Grounding systems employed internally and externally to electric room and equipment.	ET sheets and Div 34 specifications	3D	**Review Required**	Remote	Marginal	Verify during construction/installation
Category: Architecture (Arch)																
Arch 1	06	Inadequate egress clearances or capacity	Narrow passages, inadequate stair quantity	Death or serious injury	1C	**Unacceptable**	Occasional	Catastrophic	Follow NFPA 130, review requirements wit h Chicago DOB	NFPA exiting requirements met in elevated station; exiting capacity maintained in subway sation.	G sheets	3D	**Review Required**	Remote	Marginal	Considered during design phase
Arch 2	06	Blind corners	Collision between passengers walking	Injury to employees or customers	1C	**Unacceptable**	Occasional	Catastrophic	Light to City and CTA standard, Layout station such that common travel paths do not coincide with blind corners.	Light to City and CTA standard, Layout station such that common travel paths do not coincide with blind corners.	A and AS sheets	3E	**Review Required**	Improbable	Marginal	Verify during construction/installation
Arch 3	06	Escalator/elevator failure	Improper installation or maintenance	Service disruption	2C	**Decision Required**	Occasional	Critical	Properly vent machine rooms, sump pumps in pits, independent elevator battery backup to return to 1st floor in event of power outage or malfunction.	Properly vent machine rooms, sump pumps in pits, independent elevator battery backup to return to 1st floor in event of power outage or malfunction.	A and AS sheets and Div 14 specifications	3D	**Review Required**	Remote	Marginal	Verify during construction/installation
Category: Commissioning/Maintenance (C/M)																
C/M 1	07	Failure to develop/update SSMP	Lack of oversight; unfamiliarity with FTA SSC requirements;	Project delays; deficiency findings by oversight agencies; NCRs, Rework	3C	**Review Required**	Occasional	Marginal	Proper oversight; personnel training; ongoing coordination with oversight agencies	All work done in compliance with project-specific SSMP	SSMP	4C	**No Review Required**	Occasional	Negligible	Completed, closed
C/M 2	07	Failure to develop/update SSCP	Lack of oversight; unfamiliarity with FTA SSC requirements;	Project delays; deficiency findings by oversight agencies; NCRs, Rework	3C	**Review Required**	Occasional	Marginal	Proper oversight; personnel training; ongoing coordination with oversight agencies	All work done in compliance with project-specific SSCP	SSCP	4C	**No Review Required**	Occasional	Negligible	Completed, closed
C/M 3	07	Failure to develop/update PHA	Lack of oversight; unfamiliarity with FTA SSC requirements;	Project delays; deficiency findings by oversight agencies; NCRs, Rework	3C	**Review Required**	Occasional	Marginal	Proper oversight; personnel training; ongoing coordination with oversight agencies	Conduct PHA	PHA	4C	**No Review Required**	Occasional	Negligible	PHA ongoing
C/M 4	07	Failure to develop/update TVA	Lack of oversight; unfamiliarity with FTA SSC requirements;	Project delays; deficiency findings by oversight agencies; NCRs, Rework	3C	**Review Required**	Occasional	Marginal	Proper oversight; personnel training; ongoing coordination with oversight agencies	Conduct TVA	TVA	4C	**No Review Required**	Occasional	Negligible	TVA ongoing
C/M 5	07	No PRO / Operator Training / Familiarization with project	Lack of oversight; unfamiliarity with FTA SSC requirements;	Project delays; deficiency findings by oversight agencies; potential incident	3C	**Review Required**	Occasional	Marginal	Proper oversight; personnel training; ongoing coordination with oversight agencies	All work done in compliance with CTA Safety Manual for Contract Construction On, Above or Adjacent to the CTA Rail System. Update maintenance SOPs and provide training.	Div 01 specifications	4C	**No Review Required**	Occasional	Negligible	To be addressed in future project phase by contractor and CDOT/CTA.
C/M 6	07	Corrosion of structure or station elements	Weather damage, improper painting or sealing, long-term weather exposure	Damage to station elements and staining of finishes	3C	**Review Required**	Occasional	Marginal	Use stainless steel, specify high quality coatings/finishes, design to permit natural water runoff/avoid pooling.	Use stainless steel, specify high quality coatings/finishes, design to permit natural water runoff/avoid pooling, CTA maintenance of painted areas and sealants.	A and AS sheets	4C	**No Review Required**	Occasional	Negligible	Considered during design. Future maintenance is by CTA.

PHA Summary

PHA #	Hazard Description	Initial Risk Index	Final Risk Index
GPH 1	Pandemic Shutdown	2C	3C
GPH 2	Severe Thunderstorms / Lightning	2C	3D
GPH 3	Extreme Temps: Heat / Cold	2C	3C
GPH 4	Tornados/High Winds	1E	2E
GPH 5	Winter Storm	3A	4A
GPH 6	No SSO Coordination	3C	3E
GPH 7	Lightning strike	3D	4D
GPH 8	Persons fall to track from the station platform; personnel contact with contact rail	2C	3D
GPH 9	Fire	1D	3D
GPH 10	Falling object or debris	3C	3D
TCS 1	Improper train signaling or system failure	2C	3D
T 1	Improper track installation	3D	3D
Com 1	SCADA, Public Address, Phone, or other System Failure	2C	3C
Com 2	Failure of communications system due to improper installation and termination of fiber optic cables, hardware, or cabinets.	3B	3D
Com 3	Public or Rider Disturbance, Vandalism, or Unrest	2C	3C
Civ/St 1	Roadway/buidling access not maintained for public	3B	4A
Civ/St 2	Vehicle collision with overhead structure or station element	1B	1D
Civ/St 3	Shoring tower failure	1D	1D
Civ/St 4	Errant vehicle entering work zone	2C	4B
Civ/St 5	Damage to existing utility or service	2C	3B
MEP 1	Battery backup or inverter system failure	2C	3C
MEP 2	Electrical shock to personnel servicing or maintaining equipment	1D	2E
MEP 3	ComEd service failure/overcurrent/undercurrent, transformer failure, or loss of power	3B	2D
MEP 4	Loss of circuit breaker functionality.	2D	3D
MEP 5	HVAC Systems Failure	2D	3D
MEP 6	Flooding in pits or basements	3C	3C
TP 1	Stray current corrosion (DC current straying to ground and other utilities)	2C	3D
TP 2	Power cabling/wiring short-circuits	2C	3D
Arch 1	Inadequate egress clearances or capacity	1C	3D
Arch 2	Blind corners	1C	3E
Arch 3	Escalator/elevator failure	2C	3D
C/M 1	Failure to develop/update SSMP	3C	4C
C/M 2	Failure to develop/update SSCP	3C	4C
C/M 3	Failure to develop/update PHA	3C	4C
C/M 4	Failuire to develop/update TVA	3C	4C
C/M 5	No PRO / Operator Training / Familiarization with project	3C	4C
C/M 6	Corrosion of structure or station elements	3C	4C

Hazard Risk Index	Acceptance
1A, 1B, 1C, 2A, 2B	High
1D, 2C, 3A, 3B	Serious
1E, 2D, 2E , 3C, 3D, 3E, 4A, 4B	Medium
4C, 4D, 4E	Low
1F, 2F, 3F, 4F	Eliminated

Hazard Risk Index Resolutions			
Pre-Resolution		Post Resolution	
Total # of Hazards with Pre-Resolution HRI =1	7	Total # of Hazards with Post-Resolution HRI =1	2
Total # of Hazards with Pre-Resolution HRI =2	15	Total # of Hazards with Post-Resolution HRI =2	3
Total # of Hazards with Pre-Resolution HRI =3	15	Total # of Hazards with Post-Resolution HRI =3	22
Total # of Hazards with Pre-Resolution HRI =4	0	Total # of Hazards with Post-Resolution HRI =4	10
Total for all categories	37	Total for all categories	37

Project Elements - Certifiable Elements / Certifiable Items List

Contract	State/Lake Loop Elevated
Contractor:	
Contract No:	
Req No:	

Revision History	
Version	**Date**
0.1	10/11/2022
1	1/9/2023
1.1	1/20/2023

Group	Element	Element	Sub-Element	Sub-Element	Item	Item
Systems	Signal	01	Signal Network	01	Signal Cable	001
Systems	Signal	01	Signal Network	01	Impedance Bonds	002
Systems	Signal	01	Signal Network	01	Junction Boxes	003
Systems	Track and Structure	02	Rail Track System	01	Insulated Joint	001
Systems	Track and Structure	02	Rail Track System	01	Jointed Rail	002
Systems	Track and Structure	02	Rail Track System	01	Guardrails	003
Systems	Track and Structure	02	Rail Track System	01	Footwalks	004
Systems	Track and Structure	02	Rail Track System	01	Track Alignment	005
Systems	Track and Structure	02	Rail Track System	01	Softwood Ties	006
Systems	Traction Power	03	DC Cable	01	Cables and Terminations	001
Systems	Traction Power	03	DC Cable	01	Foundation Electric Isolation	002
Systems	Traction Power	03	Contact Rail	02	Contact Rail	001
Systems	Traction Power	03	Contact Rail	02	Insulator Chair - Porcelain	002
Systems	Traction Power	03	Contact Rail	02	Anchors	003
Systems	Communications	04	Fiber Optics	01	Fiber Optic Backbone System	001
Systems	Communications	04	Cable	02	Communication Cable System	001
Systems	Communications	04	OCC Systems	03	Control Center Integration	001
Systems	Communications	04	OCC Systems	03	Telephones	002
Systems	Communications	04	OCC Systems	03	Intrusion and Fire Alarms	003
Systems	Communications	04	SCADA	04	Remote Terminal Units (RTU)	001
Systems	Communications	04	PA System	05	Dynamic Messaging Systems	001
Systems	Communications	04	PA System	05	PA Control Console	002
Systems	Communications	04	PA System	05	Integration Testing	003
Systems	Communications	04	CCTV	06	Software	001
Systems	Communications	04	CCTV	06	Video Terminal	002
Systems	Communications	04	CCTV	06	Network Video Recorder (NVR)	003
Systems	Communications	04	CCTV	06	Fixed Cameras	004
Systems	Communications	04	CCTV	06	PTZ (Pan-Tilt-Zoom) Cameras	005
Civil Installations	Mech/Elec/Plumb	05	AC Power	01	Normal and Reliable AC Power Feeds	001
Civil Installations	Mech/Elec/Plumb	05	Grounding/Bonding	02	Ground Grids	001
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Fire / Life Safety Lighting	001
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Lighting Fixtures and Accessories	002
Civil Installations	Mech/Elec/Plumb	06	Lighting	03	Controls	003
Civil Installations	Mech/Elec/Plumb	06	Lighting	03	Conduits and Raceways	004
Civil Installations	Mech/Elec/Plumb	06	Lighting	03	Terminations	004
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Emergency (backup battery units)	005
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Illuminated Signage/Exit Signage	006
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Roadway Lighting	007
Civil Installations	Mech/Elec/Plumb	05	Lighting	03	Traffic Signals	008
Civil Installations	Mech/Elec/Plumb	05	Fire	04	Fire Alarm System	001
Civil Installations	Mech/Elec/Plumb	05	Fire	04	Fire Extinguishers	002
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Motors	001
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Hoists and Hoistway	002
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Machine Room	003
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Cab	004
Civil Installations	Mech/Elec/Plumb	06	Elevator System	05	Emergency Systems	005
Civil Installations	Mech/Elec/Plumb	05	Escalator System	06	Motors	001
Civil Installations	Mech/Elec/Plumb	05	Escalator System	06	Machine Room	002
Civil Installations	Mech/Elec/Plumb	05	Escalator System	06	Emergency Systems	003

Project Elements - Certifiable Elements / Certifiable Items List

Contract	State/Lake Loop Elevated
Contractor:	
Contract No:	
Req No:	

Revision History

Version	**Date**
0.1	10/11/2022
1	1/9/2023
1.1	1/20/2023

Group	Element	Element	Sub-Element	Sub-Element	Item	Item
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Sump Well and Deep Pumps	001
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Louvers and Mechanical Ventilation	002
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Water Heaters	003
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Electric Heaters	004
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Air Conditioning	005
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Water Supply and Distribution	006
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Wastewater Collection and	007
Civil Installations	Mech/Elec/Plumb	05	General Mechanical	07	Infrared Heaters	008
Civil Installations	Civil	06	Structural	01	Foundations	001
Civil Installations	Civil	06	Structural	01	Platform	002
Civil Installations	Civil	06	Structural	01	Railings	003
Civil Installations	Civil	06	Structural	01	Metal Stair Systems	004
Civil Installations	Civil	06	Structural	01	Floor	005
Civil Installations	Civil	06	Structural	01	Framing Elements	006
Civil Installations	Civil	06	Egress Stairs	02	Railings	001
Civil Installations	Civil	06	Egress	03	Pedestrian Paths	001
Civil Installations	Civil	06	Station Platforms	04	Platform Surface Treatments	001
Civil Installations	Civil	06	Station Platforms	04	Tactile Edge	002
Civil Installations	Civil	06	Platform Canopy	05	Signage	001
Civil Installations	Civil	06	Platform Canopy	05	Emergency Egress Doors	002
Civil Installations	Civil	06	Platform Canopy	05	Snow Guards	003
Civil Installations	Civil	06	Platform Canopy	05	Fall Protection	004
Civil Installations	Civil	06	Platform Canopy	05	Turnstiles	005
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Test Plans	001
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Training	002
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Revised SOPs	003
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Revised CTA Manuals and Rule Books	004
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Operations and Maintenance Manuals (Updates/Revisions)	005
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	System Integration Testing (SIT)	006
Commissioning	Plans, Procedures, and Training	07	Systems Integration	01	Pre-Revenue Operation / Operator Training / Familiarization for Revenue Service	007

SAFETY AND SECURITY CERTIFICATION
DESIGN CRITERIA CONFORMANCE CHECKLIST (DCCC)

Contract Name: State/Lake Elevated Loop Station

Contractor:

Contract No:

Req. No.

Revision: 1.1

Date: January 20, 2023

Compliance Status

C = Compliant

NC = Non-Compliant

PC = Partially Compliant

NA = Not Applicable

Variance Request Reference

Design Conformance Verification

Method of Verification

DS = Design Submittal

CO = Change Order

CA = Calculations

O = Other

NA = Not Applicable

Item No.	Certifiable Element	Certifiable Sub-Element	Certifiable Item	SSC Reference PHA - P, TVA - T, ITP - I	Design Criteria Reference/Source/Standard/Specification #	Description	Compliance Status	DVI Process #	Design Verification						CTA Review			
									Responsible Organization	Reviewed By (Initials)	Date of Verification	Means of Verification	Comments	Ready for CTA Review	Reviewed By	Comments	Date Accepted	Status (Open, Closed, SOIL, DVI, CSCC)
1				PHA-P	IDCM 4.6.1	The clearance requirements, as indicated by the CTA standard Rail Clearance Diagrams defining areas within which no fixed objects may be located, are based on the following:	C - Compliant		TranSystems	MJL	10/11/2022	DS - Plans		Yes				
2	03 Traction Power	03 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 4.6.1.1	Center of contact rail shall be located 1 ft 8 1/8 in, ±1/8 in. outside the gauge line of nearest running rail with the plane of such contact rail 6 1/2 in, ± 1/8 in. perpendicular above the top of the running rails.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
3	03 Traction Power	03 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 4.6.1.1	In platform areas, the contact rail shall be located on the side of the track away from the platform.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
4	02 Track and Structure	01 Rail Track System	005 Track Alignment	PHA-P	IDCM 4.6.3.1.2	The horizontal alignment shall consist of tangents joined to circular curves with or without spiral transitions. Mainline curves shall be of the maximum radius practical considering the economic restraints of the right-of-way and the track configurations. Curvature and superelevation shall be related to a design speed based on the maximum operable speed for each individual curve location considering the acceleration and deceleration characteristics of the design vehicle. Whenever possible, the geometry shall accommodate the maximum design speed of 70 mph, considering the location of curves, station stop spacings, and the performance characteristics of the design vehicle. The minimum permissible radii for all curves are defined below under Curvature.	NA - Not Applicable		TranSystems	MJL	10/12/2022	NA	Alignment follows existing, and new track is entirely tangent.	Yes				
5	02 Track and Structure	01 Rail Track System	002 Jointed Rail	PHA-P	IDCM 4.6.3.2.2	Jointed rail shall be used on all open deck structures. Rails shall be furnished with drilled ends for bolted connections.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
6	02 Track and Structure	01 Rail Track System	006 Softwood Ties	PHA-P	IDCM 4.6.3.2.2	A 6-hole joint bar shall be used at all bolted connections unless the installation is limited by the adjacent trackwork.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
7	02 Track and Structure	01 Rail Track System	001 Insulated Joint	PHA-P	IDCM 4.6.3.2.2	A tie shall be provided under all Joint Bar locations.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
8	02 Track and Structure	01 Rail Track System	006 Softwood Ties	PHA-P	IDCM 4.6.3.2.3	Wood ties are preferred for both ballasted track and open-deck elevated track construction. Southern yellow pine is to be used for open-deck elevated track and oak is to be used for ballasted track. Ties shall be creosote treated following current standards.	C - Compliant		TranSystems	MJL	1/9/2023	DS - Specifications	Per direction from CTA civil engineers, CU Nap ties are possible, in addition to creosote.	Yes				
9	02 Track and Structure	01 Rail Track System	003 Guardrails	PHA-P	IDCM 4.6.3.2.7.2	Emergency (inner steel) guard rails shall be provided at locations where it is important to prevent a derailed train from traveling more than a few inches from the running rails. These locations shall include but are not limited to: Bridge or aerials structure.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
10	02 Track and Structure	01 Rail Track System	003 Guardrails	PHA-P	IDCM 4.6.3.2.7.2	The addition of guard rails shall be based on the assumption that each track shall be capable of carrying normal running and reverse running traffic. At approaches to obstructions, guard rails shall be installed between points 50 ft before and 10 ft beyond the point of potential contact. See Figure 4.15 for emergency guard rail locations. Refer to Directive Drawings for beginning and ending treatments.	NA - Not Applicable		TranSystems	MJL	10/12/2022	DS - Plans	Guard rails are present for full length of project.	Yes				
11	02 Track and Structure	01 Rail Track System	003 Guardrails	PHA-P	IDCM 4.6.3.2.7.2	On non ballasted track, emergency guard rail shall be parallel to and on the gauge side of running rail, with 7 1/2 in clearance between the heads of running and guard rails.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
12	02 Track and Structure	01 Rail Track System	004 Footwalks	PHA-P	IDCM 4.6.3.2.10	Walkways and footwalk shall be provided along all tracks to allow for access to the train by personnel and the evacuation of passengers from a disabled train. Walkways and footwalk shall also provide a path for personnel to access the length of the right of way without walking in the gauge of the track. When only one walkway is provided for a track, it is desirable for the walkway to run along the contract rail side of the track to allow for personnel to access both the stationary and train-mounted parts of the contact rail system. In the event that a walkway must change sides of the track, it is desirable to overlap the ends of the walkway so that personnel have as short of path as possible from one walkway to the other. Where a walkway terminates into a wayside platform or track access stair, the transition shall be designed so that personnel are not required to enter the path of a train while moving between the platform/stair and walkway.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
13	06 Civil	03 Egress	001 Pedestrian Paths	NA - Not Applicable	IDCM 4.7.4	Construction and restoration of Roadways, Pavement, Driveways, Curb & Gutters, Wheelchair Curb Cuts, Sidewalks and Alleys shall meet the requirements of Illinois Department of Transportation (IDOT), Chicago Department of Transportation (CDOT) or the appropriate local authority having jurisdiction over the project.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
14				PHA-P	IDCM 4.9.2.3	4.9.2.3 Provisions for maintenance of street traffic shall meet the	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
15				PHA-P	IDCM 4.9.2.4	Other streets may be under the authority of multiple jurisdictions. In these cases, the Consultant shall determine the jurisdiction under which the street is governed.	NA - Not Applicable		TranSystems	MJL	10/12/2022	NA	No other jurisdictions besides CDOT.	Yes				
16				PHA-P	IDCM 4.9.2.4	Maintenance of traffic on these streets shall meet the	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
17	06 Civil	03 Egress	002 Pedestrian Paths	PHA-P	IDCM 4.9.2.5	Pedestrian traffic shall be maintained where possible to safely do so. Access to buildings shall be provided at all times unless otherwise approved by the CTA.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
18				PHA-P	IDCM 6.1.3	The Consultant will investigate the conditions of the utilities in the area of the project and determine a scope of work of each utility required to complete the construction of the project.	C - Compliant		TranSystems	MJL	10/12/2022	O	Coordination of relocations through OUC and numerous meetings.	Yes				
19				PHA-P	IDCM 6.1.3	In collaboration with the CTA, the Consultant will meet with the	C - Compliant		TranSystems	MJL	10/12/2022	O	Coordination of relocations	Yes				
20	05 Mech/Elec/Plumb	05 Lighting	007 Roadway Lighting	NA - Not Applicable	IDCM 6.3.3.2	Temporary street lighting used during construction, if required, shall conform to the requirements of the City Bureau of Electricity, Department of Streets and Sanitation of the City of Chicago	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
21	05 Mech/Elec/Plumb	05 Lighting	007 Roadway Lighting	NA - Not Applicable	IDCM 6.3.3.3	If required, permanent street lighting shall be replaced with the latest design of street lighting and traffic signs as approved by the City Bureau of Electricity. Furnishing and installing permanent below ground equipment will be indicated on the contract plans by the Consultant as work performed by the Contractor. Furnishing and installing permanent light poles, luminaries and wiring will be done by the City of Chicago. Power for street lighting will not be supplied by the Authority.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				

Item No.	Certifiable Element	Certifiable Sub-Element	Certifiable Item	SSC Reference PHA - P, TVA - T, ITP - I	Design Criteria Reference/Source/Standard/Specification #	Description	Compliance Status	DVI Process #	Design Verification						CTA Review			
									Responsible Organization	Reviewed By (Initials)	Date of Verification	Means of Verification	Comments	Ready for CTA Review	Reviewed By	Comments	Date Accepted	Status (Open, Closed, SOIL, DVI, CSCC)
22	06 Civil	05 Lighting	008 Traffic Signals	NA - Not Applicable	IDCM 6.3.3.4	If required, traffic signals will be removed and replaced by the City of Chicago. Changes in signal location or phasing, both temporary and permanent, will be done by the City of Chicago. Temporary location for these facilities will be developed during the design phase as required by the construction staging and approved by the City Bureau of Electricity.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
23	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	PHA-P	IDCM 6.3.3.6	Commonwealth Edison Co. (COMED) will remove and relocate all electrical equipment, wire and cable as required, furnish and install all new electrical equipment, wire and cable and construct new manholes and ducts as required. The Utility will furnish equipment and suppliers for use in vaults and manholes. The contractor shall remove deactivated manholes and ducts in the project area. The Utility will inspect any work on its facilities done by the contractor including temporary support arrangements for existing facilities. The Consultant shall include an allowance in the construction contract for any cost from the Utility. The CTA and COMED have an electric service agreement of August 1, 1958 as amended, which governs the responsibilities of each party upon the activation of service, pursuant to CTA operation.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
24				PHA-P	IDCM 6.4.7	Utility facilities within or affected by the construction activities shall	C - Compliant		TranSystems	MJL	10/12/2022	DS -		Yes				
25	06 Civil	05 Platform Canopy	004 Fall Protection	PHA-P	IDCM 7.2.3	Design of Fall Protection Fall Protection Code (ANSI) Z359.6	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
26	06 Civil	01 Structural	005 Floor	NA - Not Applicable	IDCM 7.3.3.8	Pedestrian Areas at Stations (a) 100 psf - Applicable to Platforms, Stairways, Mezzanines, Pedestrian Ramps, Pedestrian Bridges, and Stairs. Live load reductions are not permitted. (b) 3 kips point load - For future scaffolding or mobile crane loads (coupled with a 30 psf construction load)	C - Compliant		GKE	JL	10/13/2022	DS - Plans		Yes				
27	06 Civil	05 Platform Canopy	004 Fall Protection	PHA-P	IDCM 7.3.3.9(a)	Guardrails At Platforms and Mezzanines - Framing elements and their connections must be designed for a horizontal force of 75 pound per linear foot plf concurrent with a vertical force of 50 pound per linear foot plf applied to the top rail. A concentrated force of 200 lbs. applied vertically and 300lbs. applied horizontally, not concurrently, must be considered. The concentrated force may be distributed over a 1 square foot when applied to the infill areas. The concentrated forces need not be applied concurrently with the uniform load forces.	C - Compliant		GKE	JL	10/12/2022	DS - Plans		Yes				
28	06 Civil	05 Platform Canopy	004 Fall Protection	PHA-P	IDCM 7.3.3.9(b)	All Other Guardrails and Handrails - Framing elements and their connections must be designed for a horizontal force of 50 pound per linear foot (plf) concurrent with a vertical force of 50 pound per linear foot (plf) applied to the top rail. A concentrated force of 200 lbs. applied in any direction at any point must be consider. The concentrated forces need not be applied concurrently with the uniform load forces.	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans		Yes				
29	06 Civil	05 Platform Canopy	004 Fall Protection	NA - Not Applicable	IDCM 7.3.3.17	Fall Protection - Platform canopy structures and other related roof structures, including their connections at the platform level, must be capable of supporting the required loading from the fall protection system per ANSI Z359.6 "Fall Protection Code."	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
30	06 Civil	01 Structural	006 Framing Elements	NA - Not Applicable	IDCM 7.4.4.1	The type of structural steel to be used must be ASTM A36, or ASTM A709, having a minimum yield point of Fy = 36,000 psi. For uses requiring higher strength or other desirable properties, or where economically justifiable, other grades or types of steel may be considered, subject to the approval of the CTA. All steel designed with an Fy > 36,000 psi must be stamped with the design Fy value. The mark must be easily identifiable on the steel member.	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans	Steel with yield stength of 50,000 psi will be used	Yes				
31	06 Civil	01 Structural	006 Framing Elements	NA - Not Applicable	IDCM 7.4.4.2	A plan in compliance with the AREMA Manual or AASHTO Code, as applicable, must be included in the construction documents. Fracture critical members must be identified with "FCM" next to its size call-out in the framing plans.	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans		Yes				
32	06 Civil	01 Structural	001 Foundations	NA - Not Applicable	IDCM 7.4.10	All steel elements of an aerial transit structure (track structure, station, stairs, elevators, etc.) must be electrically isolated at their interface with supporting concrete substructure. Repairs and renovations to existing structures must be in accordance with this criteria to the extent feasible. For other general recommendations regarding protection against corrosion, see Chapter 14 Corrosion Control.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
33	06 Civil	01 Structural	006 Framing Elements	NA - Not Applicable	IDCM 7.5.1.1	Connections for Track Structure (a) All field connections must be bolted, unless otherwise approved by the CTA. (b) Turn-of-nut installation method must be specified and AREMA Table 15-1-11a must be used to determine the allowable stress for slip-critical connections. (c) If two or more fillers between the connected parts are used, and where bolts are not added to distribute the load in the filler, the allowable stress must be reduced by a factor of 0.85. (d) Assume that bolts in a slip-critical connection will slip into bearing. Design base metal at the net section of bolted joints for fatigue category D per AREMA Table 15-1-9 note 2.3.	PC - Partially Compliant	1	TranSystems	WJC	10/21/2022	CA	Sections a, b, and c are in compliance. Section d is non-compliant. Since the connections are for Fracture Critical Members, we followed the provisions for AREMA Article 15.1.3.13(i) which discourages the use of Category D type connections.	Yes				
34	06 Civil	01 Structural	002 Platform	NA - Not Applicable	IDCM 7.5.3.1	Elastomeric Bearing Pads - All elastomeric bearing pads must be fabric reinforced.	C - Compliant		TranSystems	WJC	10/28/2022	DS - Plans		Yes				
35	06 Civil	01 Structural	002 Platform	NA - Not Applicable	IDCM 7.5.4.1	Precast Connections (a) All embedded plates and anchorage to be galvanized. (b) Allow for erection tolerances. (c) Allow for temperature fluctuations during the construction process and throughout the life of the structure.	C - Compliant		GKE	JL	10/13/2022	DS - Plans		Yes				
36	06 Civil	01 Structural	002 Platform	NA - Not Applicable	IDCM 7.5.5(a)	All structural steel must be accessible for the purposes of routine maintenance and inspection.	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans		Yes				
37	06 Civil	01 Structural	001 Foundations	NA - Not Applicable	IDCM 7.5.7.2	Foundations (a) Estimated future settlement must be determined per the Geotechnical Report. Design soil bearings stresses must be minimized to minimize settlements, short and long-term. (b) At pedestrian levels, designer should consider details that can accommodate anticipated settlements that will create elevation differences greater than 1/4". (c) It is permissible to oversize foundations to maintain the same settlement as the adjacent platform/station settlements. (d) Electrical isolation is required.	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans		Yes				
38	06 Civil	01 Structural	001 Foundations	NA - Not Applicable	IDCM 7.5.7.3	Lateral Deflection - Must be limited per Section 3.17(d)	C - Compliant		TranSystems	WJC	10/21/2022	CA		Yes				
39	06 Civil	01 Structural	001 Foundations	NA - Not Applicable	IDCM 7.5.7.4	Vertical Deflection - Must be limited to L/1666 for machine support beams per ASME A17.1, "Safety Code for elevators and Escalators"	C - Compliant		TranSystems	WJC	10/21/2022	CA		Yes				
40	06 Civil	01 Structural	001 Foundations	NA - Not Applicable	IDCM 7.5.7.5	Column Splices - Bolted splices must be designed as slip-critical.	NA - Not Applicable		TranSystems	WJC	10/21/2022	NA	No column splices on this project	Yes				

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41	06 Civil	01 Structural	006 Framing Elements	NA - Not Applicable	IDCM 7.5.9.2	"Rolled-in" or Prefabricated Bridges (a) Allowances and considerations must be made for temperature variations. (b) Allowances and considerations must be taken into account for the higher variability in erection tolerances when connecting different prefabricated materials in the field. When adjoining different materials, the greater of the material specified tolerances must be used for both materials.	NA - Not Applicable		TranSystems	WJC	10/20/2022	NA	No prefabricated bridges are used.	Yes				
42	06 Civil	01 Structural	002 Platform	NA - Not Applicable	IDCM 7.5.10	Requirements for Train Passenger Platforms (a) Floor: solid, 6ksi pre-cast slabs. Rebar only, no strands. Slope to edges to allow water to run off edges. Cast in recess for tactile edge strip. (b) Floor Support structure: hot dip galvanized structural steel, no tubes. Steel supporting only floor should not to be part of the fracture critical plan. (c) Canopy structure: hot dip galvanized structural steel, and except where used as purlins, no tube sections. Base of columns must be bolted to floor support structure.	C - Compliant		GKE	JL	10/12/2022	DS - Plans and DS - Specifications		Yes				
43	06 Civil	01 Structural	006 Framing Elements	PHA-P	IDCM 7.6.1(e)	The Contract Documents must require the construction contractor to prepare detailed shop and erection drawings, and a monitoring program.	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans and DS - Specifications		Yes				
44	06 Civil	01 Structural	006 Framing Elements	PHA-P	IDCM 7.6.1(g)	CDOT and OUC applicable requirements for temporary structures must be incorporated.	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans		Yes				
45	06 Civil	01 Structural	006 Framing Elements	PHA-P	IDCM 7.6.3	Structure Shoring (a) See Section 6.1 (b) Comply with CTA specifications 31 15 00 and 31 09 13	C - Compliant		TranSystems	WJC	10/20/2022	DS - Plans		Yes				
46				TVA-T	IDCM 8.4.2.5	8.4.2.5. Glass: All glass shall be clear, low-e panels,	C - Compliant		SOM	SD	10/20/2022	DS -		Yes				
47	06 Civil	01 Structural	002 Platform	NA - Not Applicable	IDCM 8.4.1.9	Platforms, both side and island type, shall be sloped to drain to the track area(s) at a minimum rate of 1%. For track area drainage requirements see Chapter 4, Civil.	C - Compliant		GKE	JL	10/13/2022	DS - Plans		Yes				
48	06 Civil	04 Station Patforms	001 Platform Surface Treatments	NA - Not Applicable	IDCM 8.4.1.9	Floors: Flooring material shall have a non-slip surface and slope toward floor drains at a minimum rate of 1%. Terrazzo with a coefficient of friction exceeding code requirements is recommended.	C - Compliant		SOM	SD	10/20/2022	DS - Plans and DS - Specifications		Yes				
49				TVA-T	IDCM 8.4.1.9	Lighting fixtures shall be located such that they are easily reached for lamp replacement or maintenance. See Chapter 10, Electrical for Lighting.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
50	05 Mech/Elec/Plum	03 Lighting	002 Lighting Fixtures and Accessories	TVA-T	IDCM 8.4.2.11	Lighting: Public spaces shall be lighted to maximize visual surveillance and to eliminate dark spaces. Lighting levels shall enhance the openness and spaciousness of the facility and promote a greater sense of security. Particular attention shall be directed towards lighting areas under stairs and escalators and other low, concealed spaces.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
51	05 Mech/Elec/Plum	03 Lighting	002 Lighting Fixtures and Accessories	TVA-T	IDCM 8.4.2.11	The consultant shall establish artificial illumination standards for stations/facilities by using the Illuminating Engineering Society of North America's "IESNA Lighting Hand Book-Reference & Application" (current edition). The Consultant shall determine the specific number and placement of fixtures. See Chapter 10, Electrical.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
52				PHA-P	IDCM 8.6	Exiting flow requirements described in NFPA 130.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
53				TVA-T	IDCM 8.6.2.2.4	Light fixtures in the customer assistant kiosk shall be positioned and shielded to avoid specular reflections from glass areas and other highly reflective surfaces.	C - Compliant		SOM	SD	10/21/2022	DS - Plans		Yes				
54	06 Civil	05 Platform Canopy	002 Emergency Egress Doors	NA - Not Applicable	IDCM 8.6.2.2.4	All exiting passenger traffic shall be assumed to pass out of the station through the automatic entrance turnstiles. Roto-gates are NOT to be used in the calculations for exiting purposes.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
55	06 Civil	05 Platform Canopy	002 Emergency Egress Doors	NA - Not Applicable	IDCM 8.6.2.2.6	Push plates shall be of a contrasting color. Hardware provided for doors into hazardous areas shall be provided with a change in texture. (Knurled hardware as per City of Chicago Accessibility Code)	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
56	06 Civil	05 Platform Canopy	002 Emergency Egress Doors	NA - Not Applicable	IDCM 8.6.2.2.6	Two means of exiting shall be provided from the Electrical Room. One exit door is to be a minimum of a 4'—0" in width and leads directly to the exterior of the station for easy access to the CTA Service Parking Area.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
57	05 Mech/Elec/Plum	03 Lighting	002 Lighting Fixtures and Accessories	NA - Not Applicable	IDCM 8.6.2.2.6	Toilet Room electrical requirements as follows: - Recessed ceiling lighting fixtures installed to provide general illumination levels as specified in Chapter 10, - Lighting fixtures shall be on an interlocked motion/sound sensor (with variable time settings.) Locate the sensor on the ceiling in the room and adjacent to the entry door.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
58	05 Mech/Elec/Plum	04 Fire Alarm/Suppression	002 Fire Extinguishers	NA - Not Applicable	IDCM 8.6.2.2.6	Portable fire extinguisher, wall-hung.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
59	05 Mech/Elec/Plum	03 Lighting	002 Lighting Fixtures and Accessories	NA - Not Applicable	IDCM 8.6.2.2.6	Storage Rooms - Industrial-type, surface-mounted lighting fixtures shall be installed. as necessary. The lighting control switch shall be located inside the room at the door.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
60	06 Civil	01 Structural	003 Railings	NA - Not Applicable	IDCM 8.6.2.5.2	Cane Rails: Provide where applicable per code.	C - Compliant		SOM	SD	10/27/2022	DS - Plans		Yes				
61	06 Civil	01 Structural	004 Metal Stair Systems	NA - Not Applicable	IDCM 8.6.2.5.2	Stairs shall be noncombustible, constructed of either steel or granite on reinforced concrete. Pan construction is NOT allowed.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
62	06 Civil	01 Structural	004 Metal Stair Systems	NA - Not Applicable	IDCM 8.6.2.5.2	Steel Stairs: Guide and Standard drawings of the Steel Stairs will be provided.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
63	06 Civil	01 Structural	004 Metal Stair Systems	NA - Not Applicable	IDCM 8.6.2.5.2	All landings are self-draining. The top of stair and landings longer than 7'-0" shall have a detectable warning surface as wide as the stair.	C - Compliant		SOM	SD	10/21/2022	DS - Plans		Yes				
64	05 Mech/Elec/Plum	06 Escalator System	004 Emergency Systems	NA - Not Applicable	IDCM 8.6.2.5.3	Escalators - Smoke detectors shall be installed which will activate an alarm and 15 seconds later disable the escalator by interrupting power to the driving machine motor and brake as per ASMI A 17.1 rule 805.8.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
65	05 Mech/Elec/Plum	06 Escalator System	004 Emergency Systems	NA - Not Applicable	IDCM 8.6.2.5.3	Safety Markings and Lights: The combplates shall be backlighted to identify the limits of the moving treads. Each movable tread shall have safety edge and demarcation markings.	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
66	05 Mech/Elec/Plum	05 Elevator System and 006 Escalator System	001 Motors, 002 Hoists and Hoistway, 003 Machine Room, and 004 Cab and 001 Motors, 002 Machine Room, and 003 Emergency Systems	NA - Not Applicable	IDCM 8.6.2.5.3	Circulation elements shall conform to the requirements of the applicable building code and the American National Standards Institute Code for Elevators, Dumbwaiters and Escalators, (ANSI/ASME A17.1), as well as the requirements as set forth in the latest version of ADA Accessibility Guidelines.	C - Compliant		TranSystems	MJL	1/9/2023	DS - Specifications		Yes				
67	06 Civil	06 Station Platforms	002 Tactile Edge	NA - Not Applicable	IDCM 8.6.2.5.4	Platform boarding edges shall have a Detectable Warning Surface (Tactile Tile). The floor surface shall differ in color, texture, and material from the platform flooring and complies with the latest edition of the City of Chicago Code 13-200-400 and the ADA Accessibility Guidelines.	C - Compliant		SOM	SD	10/20/2022	DS - Plans and DS - Specifications		Yes				
68	06 Civil	02 Egress Stairs	001 Railings	TVA-T	IDCM 8.6.2.5.4	A gate shall be provided at platform ends in alignment with the Track Access Stair. The gate is to swing away from the platform side. A Guide Drawing of the Track Access Stair will be provided by the CTA.	C - Compliant		TranSystems	WJC	10/21/2022	DS - Plans		Yes				

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69	05 Mech/Elec/Plum	03 Lighting	002 Lighting Fixtures and Accessories	TVA-T	IDCM 8.6.2.5.4	Light fixtures, in general, shall be located so as to be readily accessible for maintenance and lamp replacement from a stepladder. No fixtures shall occur over the track level. No fixtures shall occur directly over stairs or escalators.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
70	05 Mech/Elec/Plum	03 Lighting	002 Lighting Fixtures and Accessories	TVA-T	IDCM 8.6.2.5.4	General illumination fixtures shall be constructed entirely of stainless steel and shall be Underwriters Laboratory listed for use in damp locations. Fixtures shall be vandal resistant.	C - Compliant		SOM	SD	10/20/2022	DS - Plans and DS - Specifications	Aluminum and steel enclosures used	Yes				
71	05 Mech/Elec/Plum	03 Lighting	002 Lighting Fixtures and Accessories	TVA-T	IDCM 8.6.2.5.4	Lenses used in general illumination fixtures shall be tightly gasketed to prevent insect, water, and dust infiltration.	C - Compliant		SOM	SD	10/20/2022	DS - Plans and DS - Specifications		Yes				
72	05 Mech/Elec/Plum	05 General Mechanical	004 Electric Heaters	NA - Not Applicable	IDCM 8.6.2.6.5	Heaters shall maintain a minimum clearance of 9 ft. above the platform, and shall be positioned to provide maximum passenger comfort. Heaters shall NOT be mounted directly over benches. Heaters shall be passenger-activated and have a timer. See Chapter 10, Electrical, for heater criteria.	C - Compliant		SOM	SD	10/20/2022	DS - Plans and DS - Specifications		Yes				
73				TVA-T	IDCM 8.6.2.6.5	Trash Receptacles CTA will provide a Standard Specification for the Trash Receptacle.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
74				TVA-T	IDCM 8.6.2.6.5	The volume capacity of a receptacle liner shall not exceed 3 cu. ft. Receptacle mouth shall be a minimum size of 10 in and shall have a self—extinguishing type lid.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
75				TVA-T	IDCM 8.6.2.6.5	The trash receptacle unit shall be designed to be as maintenance-free and vandalproof as possible. Unnecessary seams, joints, hard to clean corners and horizontal dust collecting surfaces shall be avoided. Liner and tops shall be locked in place. All material fasteners shall be concealed or tamperproof.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
76				TVA-T	IDCM 8.6.2.6.5	Trash receptacle materials shall be noncombustible and resistant to defacement caused by fire. Finish materials must be compatible with related station room materials.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Specifications		Yes				
77				TVA-T	IDCM 8.6.2.6.5	One trash receptacle shall be located approximately every 100 feet of platform length and shall be free standing and floor mounted.	C - Compliant		SOM	SD	10/21/2022	DS - Plans		Yes				
78				TVA-T	IDCM 8.6.2.6.5	Recycling Containers Provide one recycling container per platform.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
79	04 Communications	05 PA System	002 Telephones/002 PA Control Console/003 Integration Testing	NA - Not Applicable	IDCM 8.6.2.6.7	In CAK equipment includes: CTA telephone, train communication equipment, train starting light controls, public address controls, electric clock, and lighting fixtures and controls.	C - Compliant		SOM, Facet	SD, JCM	10/27/2022	DS - Plans and DS - Specifications		Yes				
80	05 Mech/Elec/Plumb and 06 Civil	05 Elevator System and 01 Structural	002 Hoists and Hoistway and 004 Metal Stair Systems	TVA-T	IDCM 8.6.4.1	8.6.4.1. STATION ENTRANCES In most cases, the station entrance consists of an independent structure that is designed to shelter the vertical access (stairways, escalators and/or elevators.) The entrance enclosure shall have a single opening providing direct access to the circulation element and includes gates or an overhead rolling grille with grille enclosure to secure the station when not in operation.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
81	05 Mech/Elec/Plum	03 Lighting	001 Fire / Life Safety Lighting	PHA-P	IDCM 8.6.4.4	a Platform Lighting Provide platform edge lighting with emergency lighting and Light Fixtures as described in Chapter 10, Electrical.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
82	06 Civil	05 Platform Canopy	003 Snow Guards	NA - Not Applicable	Best Practice	Snow Guards - Install snow guards on roof surfaces where large snow and ice sheets may fall onto streets or sidewalks below.	C - Compliant		SOM	SD	10/20/2022	DS - Plans and DS - Specifications		Yes				
83				PHA-P	Best Practice	Blind Corners - Design corridors, platforms, and hallways such that blind corners are not included. Provide mirrors if needed.	C - Compliant		SOM	SD	10/20/2022	DS - Plans	Security Cameras cover these areas	Yes				
84	05 Mech/Elec/Plum	05 General Mechanical	005 Air Conditioning	NA - Not Applicable	IDCM 9.1.4.2.1	9.1.4.2.1 Air conditioning design loads for the purpose of sizing systems shall be determined in accordance with the procedure described in the 2009 ASHRAE Handbook – Fundamentals, Chapter 18, or an equivalent computation procedure.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
85	05 Mech/Elec/Plum	05 General Mechanical	004 Electric Heaters	NA - Not Applicable	IDCM 9.1.4.2.4	9.1.4.2.4 The Consultant shall make an adequate allowance in HVAC heating system design to accommodate severe cold weather (100 yr. occurrence) heating requirements for small, enclosed spaces, e.g., station attendant's kiosks. For Indoor Design Conditions, see Table 9-1.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
86	05 Mech/Elec/Plum	05 General Mechanical	004 Electric Heaters	NA - Not Applicable	IDCM 9.1.5.3	9.1.5.3 For HVAC subsystems, where the malfunction of the heating system could cause significant collateral damage to CTA facilities from freezing and bursting water pipes, e.g., mechanical rooms, concession spaces and janitor's closets, these HVAC subsystems shall be provided with a low-temperature alarm that will annunciate both locally and at a manned location.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
87	05 Mech/Elec/Plum	05 General Mechanical	002 Louvers and Mechanical Ventilation	NA - Not Applicable	IDCM 9.1.6.1	9.1.6.1 Indoor air ventilation rates shall meet the requirements of ASHRAE. 62.1– 2010, Ventilation for Acceptable Indoor Air Quality. Indoor air ventilation rates shall be prepared by the Consultant for review by the CTA.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
88	05 Mech/Elec/Plum	04 Fire Alarm/Suppression	001 Fire Alarm System	NA - Not Applicable	IDCM 9.1.6.3	9.1.6.4 Provide for fan interlocks with fire detection system to shut down applicable fan systems in case of fire detection. Dry-relay contacts shall be provided for this purpose.	NA - Not Applicable		Facet	JCM	10/27/2022	NA		Yes				
89	05 Mech/Elec/Plum	05 General Mechanical	005 Air Conditioning	NA - Not Applicable	IDCM 9.1.6.4	9.1.6.4 Specific provisions for preventing excessive heat buildup shall be addressed by the Consultant. Mechanical ventilation systems shall be designed to prevent abnormal conditions in subject spaces, including temperature abnormalities, air circulation abnormalities, stratification, and odor buildup.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
90	05 Mech/Elec/Plum	05 General Mechanical	005 Air Conditioning	NA - Not Applicable	IDCM 9.1.6.4	9.1.6.4 Areas requiring mechanical ventilation include those listed in Table 9-1 and the following: Covered depressed areas, enclosed bridges and tunnels	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
91	05 Mech/Elec/Plum	05 General Mechanical	005 Air Conditioning	NA - Not Applicable	IDCM 9.1.7.1	9.1.7.1 Air conditioning systems and/or units shall be designed to use up to and including 100 percent of the fan system capacity for cooling with outdoor air automatically where practical. Activation of the economizer cycle shall be controlled by sensing outdoor air temperature.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
92	05 Mech/Elec/Plum	05 General Mechanical	005 Air Conditioning	NA - Not Applicable	IDCM 9.1.7.1	9.1.7.1 Condensing coils and/or condensing units shall be situated such that the coils are not restricted, blocked or improperly installed with respect to the building(s).	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
93	05 Mech/Elec/Plum	05 General Mechanical	005 Air Conditioning	NA - Not Applicable	IDCM 9.1.7.1	9.1.7.1 Areas designated for air conditioning are as listed in Table 9-1.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
94	05 Mech/Elec/Plum	05 General Mechanical	005 Air Conditioning	NA - Not Applicable	IDCM 9.1.8.1	9.1.8.1 Unit Heaters with blowers shall be provided for all ancillary areas and shall include the following areas: (see list)	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
95	05 Mech/Elec/Plum	05 General Mechanical	003 Water Heaters	NA - Not Applicable	IDCM 9.1.16.1	9.1.16.1 Hot water shall be supplied to all toilet and janitor's rooms. A hot water recirculation system shall be employed if the water heater is located further than 100 ft. from the connected fixture(s).	C - Compliant		Milhouse	MAC	10/27/2022	CA		Yes				
96	05 Mech/Elec/Plum	05 General Mechanical	001 Sump and Deep Well Pumps	NA - Not Applicable	IDCM 9.1.16.3	9.1.16.3 Electric-driven duplex sump pumps with electronic alternators and floats shall be provided for storm (non-sanitary) water only, for all facilities where gravity flow to a sewer main is not possible.	C - Compliant		Milhouse	MAC	10/27/2022	DS - Plans and DS - Specifications		Yes				
97	05 Mech/Elec/Plum	05 General Mechanical	001 Sump and Deep Well Pumps	NA - Not Applicable	IDCM 9.1.16.3	9.1.16.3 Sump pump sizing shall be based on data obtained from the Chicago Building Code, and applied in conjunction with sound engineering judgment. Power available, motor overload, high-level and low-level water indications shall be provided with local audible alarm and remote indicating alarm.	C - Compliant		Milhouse	MAC	10/27/2022	CA		Yes				

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98	07 Plans, Procedures, and Training	01 Systems Integration	006 System Integration Testing (SIT)	NA - Not Applicable	IDCM 9.1.17.2	Coordinate the commissioning activities with the Construction Manager in a logical, sequential and efficient manner utilizing consistent protocols and forms, clear and regular communications and consultations with all necessary parties and with technical expertise.	PC - Partially Compliant		TranSystems	MJL	10/30/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
99	07 Plans, Procedures, and Training	01 Systems Integration	006 System Integration Testing (SIT)	NA - Not Applicable	IDCM 9.1.17.2	Coordinate the commissioning work with the Construction Manager to ensure that commissioning activities are incorporated into the General Contractor's construction schedule.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
100	07 Plans, Procedures, and Training	01 Systems Integration	001 Test Plans	NA - Not Applicable	IDCM 9.1.17.2	With necessary assistance and review from installing contractors, write the functional performance test procedures for equipment and systems. This will include manual functional testing, energy management control systems trending and may include standalone datalogger monitoring.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
101	07 Plans, Procedures, and Training	01 Systems Integration	005 Operation and Maintenance Manuals (Updates/Revisions)	NA - Not Applicable	IDCM 9.1.17.2	9.1.17.2 Review equipment warranties to ensure that CTA responsibilities are clearly defined.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
102	07 Plans, Procedures, and Training	01 Systems Integration	002 Training and 007 Pre-Revenue Operation/Operator Training/Familiarization for Revenue Service	NA - Not Applicable	IDCM 9.1.17.2	9.1.17.2 Oversee and review the training of CTA operating personnel in coordination with the Construction Manager.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
103	07 Plans, Procedures, and Training	01 Systems Integration	002 Training and 007 Pre-Revenue Operation/Operator Training/Familiarization for Revenue Service	NA - Not Applicable	IDCM 9.1.17.2	9.1.17.2 Oversee the videotaping of training	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
104	07 Plans, Procedures, and Training	01 Systems Integration	003 Revised SOPs / 004 Revised CTA Manuals and Rule Books / 005 Operation and Maintenance Manuals (Updates/Revisions)	NA - Not Applicable	IDCM 9.1.17.2	9.1.17.2 Review the preparation of O&M manuals for commissioned equipment.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
105	07 Plans, Procedures, and Training	01 Systems Integration	003 Revised SOPs / 004 Revised CTA Manuals and Rule Books / 005 Operation and Maintenance Manuals (Updates/Revisions)	NA - Not Applicable	IDCM 9.1.17.3	9.1.17.3 Return to the site at 10 months into the 12 month warranty period and at the next heating season cycle and review with CTA staff the current building operation and the condition of unresolved issues related to the original commissioning. Interview facility staff and identify problems or concerns they have with operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist CTA facility in developing reports, documents and requests for services to remedy unresolved problems.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
106	07 Plans, Procedures, and Training	01 Systems Integration	005 Operation and Maintenance Manuals (Updates/Revisions)	NA - Not Applicable	IDCM 9.1.17.3.1	9.1.17.3.1 Deliverables include a Commissioning Report and a Systems Manual	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
107	05 Mech/Elec/Plumb	02 Grounding/Bonding	001 Ground Grids	PHA-P	IDCM 10.1.2	10.1.2 Grounding and lightning protection of substations, elevated tracks and station facilities shall be provided for the protection of persons and equipment, and for reliability of operation, as required in accordance with the IEEE requirements.	NA - Not Applicable		Facet	JCM	10/27/2022	NA		Yes				
108	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.2.1.2	10.2.1.2 Reliability values shall be established for major items of these systems. These values shall be based on empirical data or similar equipment and systems operations, and/or reliability estimates for comparable systems, and shall be submitted to the CTA for review and approval. The Design Goal shall be culminated with the Consultant specifying Maintenance Personnel to the extent of man-hours per person per system component session per designated location.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
109	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.2.1.2	10.2.1.2 The design shall be prepared in accordance with the approved reliability values, incorporating into the contract documents any requirements which are appropriate to assure that the reliability goals can be achieved.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
110	07 Plans, Procedures, and Training	01 Systems Integration	001 Test Plans	NA - Not Applicable	IDCM 10.2.1.2	10.2.1.2 Material selection, manufacturing quality control processes, and pre-operational testing requirements necessary to achieve the reliability and availability goals shall be specified, in detail, in the design documents.	C - Compliant		Facet	JCM	10/27/2022	DS - Specifications		Yes				
111	07 Plans, Procedures, and Training	01 Systems Integration	002 Training	NA - Not Applicable	IDCM 10.2.1.2	10.2.1.2 Equipment operation and maintenance considerations shall be examined by the Consultant. Requirements for training CTA personnel in the operation and maintenance of the equipment shall be identified. All special tools, handling equipment and maintenance manuals shall be identified in the detail specifications. These items shall be furnished by the Contractor during the construction phase. Individual equipment manufacturers shall provide on site training to a specific number of CTA employees.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
112	07 Plans, Procedures, and Training	01 Systems Integration	001 Test Plans	NA - Not Applicable	IDCM 10.2.1.3	10.2.1.3 A human factors analysis, appropriate to the man-machine interfaces required by the A.C. and D.C. electrical systems shall be accomplished. Test requirements shall be prepared which are appropriate and adequate to prove the safe operability and maintainability of the electrical equipment and systems by qualified CTA employees.	PC - Partially Compliant		TranSystems	MJL	10/12/2022	NA	To be addressed during construction phase, after Construction Manager is hired.	No				
113	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.1	10.5.1 The main line contact rail shall consist of a base steel rail and two aluminum extrusion sideplates. The base steel rail shall be rolled from alloy steel and shall weigh approximately 85 pounds per yard. The sideplates shall be an aluminum extrusion which shall be Huckbolt compression fastened every 18 in along the rail. The aluminum extrusion sideplates shall be forced to permanent contact by applied pressure Huckbolt compression type fastener method. Interfacing surfaces of the aluminum and base steel rail shall be well cleaned of all mill scale and contaminants to minimize electrical resistance between the metals. Aluminum/steel contact surfaces shall be sealed with an oxide inhibitor to prevent penetration by polluting or corroding matter. All excess oxide inhibitor shall be removed from contract rail, see standard drawings for cross section view of the contact rail.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				

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114	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.1	10.5.1 Base Steel Rail as described (without Aluminum Extension) above shall be used for kick, lap and yard contact rail.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
115	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.1	10.5.1 The D.C. resistance of the composite rail shall be 0.002 ohm per 1,000 ft., a copper equivalent of approximately 4,600,000 circular mils, and shall be supported at approximately 8ft intervals on tangent track and approximately 6 ft. intervals on curves with radius of curve (R) equal to 2500ft or less with either post-type porcelain or fiberglass support insulators.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
116	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.1	10.5.1 The D.C. resistance of the base steel rail shall be 0.01125 ohm per 1000 ft. The squareness of the end of the rail shall be such that the top of the rail shall always be butt tight and square at a 180 - degree angle, so that a clean sheet of #20 bond writing paper cannot be passed through any part of the head at the very least.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
117	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.1	10.5.1 The splice joint assembly shall consist of two aluminum splice plates, which seat over the aluminum booster plates and bridge the contact rail joint, and four Huckbolts which are used for compression fasteners.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
118	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.1	10.5.1 Maximum length of each contact rail shall be no longer than 39 ft. 0 in in length.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
119	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.2	10.5.2 The contact rail and continuation cables shall provide electrical continuity from substation to substation except at section gaps. Section separation of the contact rail system shall be accomplished by using non-bridgeable gaps in the contact rail in the vicinity of all traction power substations, tie breaker, crossover, turnout and pocket track locations. This method will allow power to be removed from a section of track for maintenance and/or emergency purposes. A non-bridgeable gap shall consist of a gap in the contact rail dimensioned so that the gap will not be bridged by the front and rear collector shoes of the transit vehicle.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
120	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.2	10.5.2 Where contact rail separations are required--for example, as at crossovers, turnouts, and expansion gaps -- when sectionalization is not required, continuation cables shall be used to maintain continuity. The contact rail sections shall be connected into continuous lengths except for gaps mentioned above. Inclines shall be used at the gaps to provide for smooth pickup of contact shoe.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
121				PHA-P	IDCM 10.5.3.3.1	10.5.3.3.1 Substation Getaway, isolating switches shall be housed in rigid, weather proof fiberglass reinforced polyester resins for use outdoors. Design shall conform in general to NEMA 3 construction and identified as shown on the drawings.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
122	03 Traction Power	02 Contact Rail	001 Contact Rail	PHA-P	IDCM 10.5.4	10.5.4 Contact rail through stations shall be located at track side opposite the platform. Contact rail on aerial structures and at-grade shall be located at track side inboard of the running tracks, except at crossover locations. Contact rail in subways and tunnels shall be located opposite of catwalks.	C - Compliant		TranSystems	MJL	10/12/2022	DS - Plans		Yes				
123	03 Traction Power	02 Contact Rail	002 Insulator Chair - Porcelain	NA - Not Applicable	IDCM 10.5.4	10.5.4 The relative position of the contact rail to the running rails and the type of support insulator shall be as shown on the standard drawings.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
124	03 Traction Power	02 Contact Rail	001 Contact Rail	NA - Not Applicable	IDCM 10.5.4	10.5.4 For the contact rail, when it is feasible to locate a section gap at a Passenger Station, it should be located on the non-accelerating section of track approaching the Station.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
125	03 Traction Power	02 Contact Rail	002 Insulator Chair - Porcelain	NA - Not Applicable	IDCM 10.5.4.2	10.5.4.2 The Contact Rail shall be supported by post-type porcelain insulators or fiberglass support insulators. Porcelain insulators are to be used in subways and expressways, at areas of ballasted track and on elevated open deck structures fiberglass support insulators to be used. Contact Rail is to be supported on field side of track at distances shown on the standard drawings.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
126	03 Traction Power	02 Contact Rail	003 Anchors	NA - Not Applicable	IDCM 10.5.5.2	10.5.5.2 Anchors shall be installed at the midpoint of each continuous length of contact rail. Anchors are required to prevent movement of the contact rail due to thermal expansion and/or contraction, or due to the impact of the vehicle current collectors. Use two (or double) anchors at rail midpoint for continuous contact rail lengths in excess of 1200 feet. Anchors shall be installed as shown on the standard drawings.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
127	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.1	All traction power cables shall be stranded, non-shielded copper conductors conforming to specifications listed in IPCEA/NEMA Standards Publication. The cables shall be rated for 2,000 volt D.C. distribution and shall be temperature rated for not less than 194o F dry or in moisture.	C - Compliant		Facet	SM	10/21/2022	DS - Specifications		Yes				
128	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.1	Traction power cable insulation shall be ethylene propylene rubber with low smoke non-halogen cross linked polyolefin jacket, taking into account such desirable properties as: stable electrical characteristics, high mechanical strength, flexibility, self-extinguishing or non-burning, non-smoking and non-toxic products of combustion.	C - Compliant		Facet	SM	10/21/2022	DS - Specifications		Yes				
129	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.2	10.5.7.2 The positive cable feeder connecting the D.C. feeder breaker to the contact rail and the negative cable feeder connecting the running rails to the substation negative bus shall consist of a multiple conductors and shall be sized to carry the maximum overload continuous currents with a temperature rise not to exceed safe insulation design limits of the cable based on a minimum insulation life of 40 years. The conductivity of positive and negative cable feeders shall be sufficient to maintain voltage levels within limits defined in Section 10.4.4 confining the major voltage drop to the contact rail and running rails.	C - Compliant		Facet	SM	10/21/2022	DS - Plans		Yes				
130	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.2	10.5.7.2 The negative cable shall have a minimum of 75% of the amount of copper of the positive cable.	C - Compliant		Facet	SM	10/21/2022	DS - Plans		Yes				
131	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.3	10.5.7.3 For the routing of cables in the traction power substation, non-metallic or aluminum cable trays shall be used for control cables. Nonconductive racks with wood insulator blocks shall be used for traction power cables. The Consultant shall investigate the effects of power surges on cable movement and tray loads. Cable tray supports shall be designed to accommodate these loads. Cables of different voltage levels shall be routed in separate trays. All metallic cable racks and trays shall be tied to the station ground bus using a separate 4/0 ground cable.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				
132	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.3	10.5.7.3 The cross-sectional area of trays shall be adequate to permit neat alignment of the cables, avoiding crossing or twisting. The supporting arms or racks shall be spaced to avoid excessive weight upon the cable insulation.	NA - Not Applicable		Facet	SM	10/21/2022	NA		Yes				

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133	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.3	10.5.7.3 The positive and negative power cables shall be extended from the substation to trackside. The power cables shall be adequately protected by non-metallic conduits only, such as reinforced thermosetting resin (fiberglass) conduit (RTRC) encased in concrete. The CTA prefers the use of RTRC, as the ducts are usually reclaimable after a catastrophic event, such as a traction power cable fire. If alternate materials are specified, the Consultant shall submit data on the material's recoverability from a catastrophic event. The duct lines shall be properly drained away from the substation. Ductbank profiles shall be designed to drain towards the manholes. Positive and negative cables shall not be run in the same conduit. Preferred design is one (1) cable per minimum slope 1.0 inch per 100 feet conduit with the installed negative cables occupying the lowest ducts in the ductline. Provide 25% spare ducts for each conduit run.	C - Compliant		Facet	SM	10/21/2022	DS - Plans		Yes				
134	03 Traction Power	01 DC Cable	001 Cables and Terminations	NA - Not Applicable	IDCM 10.5.7.3	10.5.7.3 Provide cable bushing for sealing ducts at both ends of each duct with cable or spare. The selection of cable bushings will require CTA concurrences.	C - Compliant		Facet	SM	10/21/2022	DS - Specifications		Yes				
135				PHA-P	IDCM 10.6.2	10.6.2 A permanent fire suppression system shall be provided for the main electrical equipment rooms, particularly at elevated stations and subway stations.	NC - Non-Compliant	2	Milhouse	MAC	10/28/2022	NA	Established early in project that this is a non-sprinklered facility	Yes				
136	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	PHA-P	IDCM 10.6.6	10.6.6 All passenger stations shall have two A.C. Services: One normal service (full capacity) to supply all station loads and one reliable service (reduced capacity) to supply only essential loads. In certain critical operations such as Rapid Transit Terminals and subway stations, two full capacity services may be required.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
137	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.6.6	10.6.6 Each service to a facility, normal or reliable, shall be supplied from a different and completely separate source of supply to minimize the probability for simultaneous interruption (See NFPA 78).	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
138	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.6.6	10.6.6 Concerning service to facilities, for certain essential loads, the Consultant shall consider the need for a back- up to the reliable service. This back-up may be supplied either from: (see list)	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
139	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.6.6	10.6.6 If the cost of the reliable service from a second utility source exceeds the cost of a D.C./A.C. converter, including present worth of future maintenance, then either of those may be considered. All proposals for other than utility source alternates shall be submitted to the CTA for approval before proceeding with working drawings.	NA - Not Applicable		TranSystems	MJL	10/12/2022	NA	Station will have a second/reliable service.	Yes				
140	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.6.6	10.6.6 Normal and reliable services shall be 3-phase. Loads Connected to Normal Service (see list)	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
141				PHA-P	IDCM 10.6.6	10.6.6 A generator connection box shall be furnished at each passenger station. Locate the generator connection box where it is easily accessible for the portable generator. The generator connection box shall include a Kirk-keyed interlocked generator disconnect and shall be sized for the full platform and station load. The box shall be NEMA4, stainless steel.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
142	05 Mech/Elec/Plumb	03 Lighting	005 Emergency (backup battery units)	NA - Not Applicable	IDCM 10.6.7	10.6.7 All Rapid Transit Subway Stations shall receive power from the Normal, Essential Transportation, and Emergency (Evacuation) Systems per Figure. 10-3.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
143	05 Mech/Elec/Plumb	03 Lighting	005 Emergency (backup battery units)	TVA-T	IDCM 10.6.7.2	10.6.7.2 The Essential Transportation Systems Loads shall be considered as follows: Twenty percent (20%) of all platform, station mezzanine, service & utility room, Electrical-Communication-Fare Control-Train Control room, track area lighting, and forty percent (40%) of all stairway-escalator lighting; Continued expansion of ETS will include tunnel lighting before and after of a station; Power for the Public Address System, Phones, and Security Systems via the Communications Room panel; Power for the Fare Control Equipment via the Fare Control Equipment Room panel; Power for the Station Room Intrusion, Customer Assistant Kiosk, Elevator Failure, Pipe Freeze, Smoke, High Water Alarms via the electrical Room panel; Fifty percent (50%) of Customer Assistant Kiosk receptacles; Passenger control illuminated signs; and Power for proximate Signal Systems fed from the Station.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
144	05 Mech/Elec/Plumb	03 Lighting	005 Emergency (backup battery units)	NA - Not Applicable	IDCM 10.6.7.3	10.6.7.3 The Emergency (Evacuation) System source shall be from one feeder taken from the Essential Transportation System that serves the station. A second feeder shall be taken from a D.C. to A.C. converter (UPS). The converter shall be supplied by power from a stationary battery. The battery shall have a capacity to operate the load for a minimum of two (2) hours. The Emergency (Evacuation) System loads are as follows: (see list)	NA - Not Applicable		Facet	JCM	10/27/2022	NA		Yes				
145	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.6.9	10.6.9 All passenger stations shall have two A.C. Services: One normal service (full capacity) to supply all station loads and one reliable service (reduced capacity) to supply only essential loads. In certain critical operations such as Rapid Transit Terminals, two full capacity services may be required.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
146	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.6.9	10.6.9 Each service, normal or reliable, shall be supplied from a different and completely separate source of supply to minimize the probability for simultaneous interruption (See NGPS 78).	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
147	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.6.9	10.6.9 For certain essential loads, the Consultant shall consider the need for a back- up to the reliable service. This back-up may be supplied either from: (see list)	NA - Not Applicable		Facet	JCM	10/27/2022	NA		Yes				
148	05 Mech/Elec/Plumb	01 AC Power	001 Normal and Reliable AC Power Feeds	NA - Not Applicable	IDCM 10.7.2.1	10.7.2.1 The "reliable" electrical service shall be protected by a molded case circuit breaker equipped with shunt trip and thermal magnetic non-interchangeable trip elements; and having interrupting capacity sufficient to safely interrupt maximum available short circuit current at its load terminals.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
149				PHA-P	IDCM 10.7.2.1	10.7.2.1 Branch breakers shall be the molded-case, bolt-on type, with a removable front, with interrupt maximum available short circuit current at 208 volts. Rating to be as follows: (see list)	C - Compliant		Facet	JCM	10/27/2022	DS - Specifications		Yes				
150	05 Mech/Elec/Plumb	03 Lighting	003 Controls and 004 Terminations	NA - Not Applicable	IDCM 10.7.2.8	10.7.2.8 General platform lighting controls including photo-cell control relay, test-automatic selector switch, terminal strips and all interconnecting wiring shall be installed in a control panel. Provide electrically-held contactors.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
151	05 Mech/Elec/Plumb	05 Elevator System	003 Machine Room	PHA-P	IDCM 10.8.5.1	10.8.5.1 The elevator equipment room shall provide a common trouble light in the Entrance Enclosure for each elevator.	C - Compliant		TranSystems	MJL	10/27/2022	DS - Specifications	"Elevator not in Service" displays are required at call button locations.	Yes				
152	05 Mech/Elec/Plumb	06 Escalator System	001 Motors and 003 Emergency Systems	PHA-P	IDCM 10.8.6.2	10.8.6.2 Escalator controls shall provide both manual and automatic operation, and emergency stop. Manual operation shall permit escalators to be run continuously in either direction as selected, and stopped. Manual operation shall be activated by key-operated controls located at both the top and bottom of each escalator.	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
153	05 Mech/Elec/Plumb	06 Escalator System	003 Emergency Systems	PHA-P	IDCM 10.8.6.2	10.8.6.2 Emergency stop shall be activated by switches located at both the top and bottom of all escalators. Escalators shall be key started at the escalator after the emergency stop button is pushed back in.	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				

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154	05 Mech/Elec/Plumb	05 Elevator System	005 Emergency Systems	PHA-P	IDCM 10.8.8	10.8.8 The alarm and control panel shall be provided in the electrical room, from which these facilities shall be checked and controlled. Alarms shall report to the station SCADA RTU.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
155	05 Mech/Elec/Plumb	07 General Mechanical	008 Infrared Heaters	NA - Not Applicable	IDCM 10.9.3	10.9.3 Infrared heaters shall be mounted 9 ft above the floor and 3'-6" from the back wall with installation per manufacturer's recommendations.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
156	05 Mech/Elec/Plumb	07 General Mechanical	008 Infrared Heaters	NA - Not Applicable	IDCM 10.9.3	10.9.3 Heaters shall generate an initial intensity of 125 watts/sq ft, at 5 ft above the platform. Energy densities shall not exceed 150 watts/square foot anywhere on a plane 5 ft above the platform.	C - Compliant		Milhouse	GB	10/31/2022	DS - Plans		Yes				
157	05 Mech/Elec/Plumb	03 Lighting	004 Conduits and Raceways	NA - Not Applicable	IDCM 10.10.1	10.10.1 The lighting system shall be functional and shall utilize fixtures which are readily accessible for maintenance and are designed to provide for easy fixture, lamp and lens replacement. Fixtures will be non-corroding, vandal resistant and Underwriters' Laboratories listed for use in wet locations. Conduit layout and fixture mountings shall be designed to minimize trapping condensate water in the fixture.	C - Compliant		TranSystems	MJL	1/9/2023	DS - Specifications		Yes				
158	05 Mech/Elec/Plumb	03 Lighting	002 Lighting Fixtures and Accessories	NA - Not Applicable	IDCM 10.10.4	10.10.4 All platform lighting fixtures shall be designed to minimize glare in the direction of approaching train motorman eyes.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
159	05 Mech/Elec/Plumb	03 Lighting	001 Fire / Life Safety Lighting	NA - Not Applicable	IDCM 10.10.4	10.10.4 Approximately 25% of all platform and station lighting fixtures shall be connected to the Reliable source of power. Platform Reliable service lights shall be controlled by the photocell.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
160	05 Mech/Elec/Plumb	07 General Mechanical	001 Sump and Deep Well Pumps	PHA-P	IDCM 10.12.1	10.12.1 The loss of A.C. electrical supply, trip out of motor overload devices and high and low water level shall be alarmed visually and audibly, both at the Control Center area and at local locations. The data transmission system described in Chapter 12, Communication Systems shall be used as the communication link to the Control Center area.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
161	05 Mech/Elec/Plumb	07 General Mechanical	001 Sump and Deep Well Pumps	NA - Not Applicable	IDCM 10.12.4	10.12.4 Subway Drainage Pumps shall be as per Contract Drawings and Specifications	C - Compliant		Milhouse	MAC	10/27/2022	DS - Plans		Yes				
162	05 Mech/Elec/Plumb	04 Fire Alarm/Suppression	001 Fire Alarm System	NA - Not Applicable	IDCM 10.14.4	10.14.4 Fire alarm system wiring shall be silicon rubber insulated, glass braid jacketed.	C - Compliant		Facet	JCM	10/27/2022	DS - Specifications		Yes				
163	04 Communications	04 SCADA	001 Remote Terminal Units (RTU)	NA - Not Applicable	IDCM 10.15.2.1	10.15.2.1 The supervisory control system equipment shall consist of a self-supporting cabinet (RTU) containing control hardware to handle initial requirements plus 25 percent spare additions to the control and indicating functions. The supervisory control system shall be solid state system based on and operationally compatible with current CTA design.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
164	04 Communications	04 SCADA	001 Remote Terminal Units (RTU)	NA - Not Applicable	IDCM 10.15.4	10.15.4 Supervisory Control Functions shall be according to Table 10-2.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
165	01 Signal	01 Signal Network	001 Signal Cable	PHA-P	IDCM 11.29.1	Vital copper cable shall be used for all fail-safe type line circuits between facilities. Fail-safe line circuits between facilities shall utilize double-break contact methodology. The common and battery shall both break through the feeding relay.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Specifications		Yes				
166	01 Signal	01 Signal Network	001 Signal Cable	PHA-P	IDCM 11.29.2	All external copper interfaces shall be through vital relays. At no time shall a microprocessor directly feed a circuit leaving or an external input feed directly into a microprocessor.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. No existing fiber optic cable is being disturbed, and no new fibre optic is being added.	Yes				
167	01 Signal	01 Signal Network	001 Signal Cable	NA - Not Applicable	IDCM 11.29.3	Dedicated fiber optic cable shall be used for all non-vital train control communication.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. No existing fiber optic cable is being disturbed, and no new fibre optic is being added.	Yes				
168	01 Signal	01 Signal Network	001 Signal Cable	PHA-P	IDCM 11.29.6	Aerial cables shall be rated for outdoor exposed sunlight applications. Aerial cables shall be supported on an external messenger or shall be a self-supporting integral messenger type.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Specifications		Yes				
169	01 Signal	01 Signal Network	001 Signal Cable	NA - Not Applicable	IDCM 11.29.8	All cables shall be installed utilizing cable messenger systems. Cable support systems and messenger brackets shall be designed by a licensed Structural Engineer.	C - Compliant		Gannett Fleming	MAS	1/13/2023	DS - Specifications	Specification amended to include requirement for SE evaluation of cable support structure loads.	Yes				
170	01 Signal	01 Signal Network	003 Junction Boxes	PHA-P	IDCM 11.29.9	Junction boxes, relay cases, or signal equipment housings shall be provided for all Signal Cable terminations.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Plans		Yes				
171	01 Signal	01 Signal Network	001 Signal Cable	PHA-P	IDCM 11.29.10	Maximum length of cable between terminations shall be 1500 feet for runs between housings and equipment.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Plans		Yes				
172	01 Signal	01 Signal Network	002 Impedance Bonds	PHA-P	IDCM 11.29.11	Maximum length of cable between terminations and impedance bond connections shall be 250 feet. Preferred length shall be within 15 feet of impedance bond.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Plans		Yes				
173	01 Signal	01 Signal Network	003 Junction Boxes	NA - Not Applicable	IDCM 11.29.13	Design shall include junction boxes installed within 50 feet of each side of a station to terminate all cables passing across the station area.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Plans		Yes				
174	01 Signal	01 Signal Network	002 Impedance Bonds	PHA-P	IDCM 11.31.2	Train detection monitoring system shall distinguish between a track circuit becoming unoccupied when caused by normal train movements and shall detect the loss of shunt of a train or absence of a train that has not followed a proper sequence of movements through adjacent track circuits.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. Addition of sequential occupancy monitoring is beyond the scope of this work and does not apply.	Yes				
175	01 Signal	01 Signal Network	002 Impedance Bonds	PHA-P	IDCM 11.31.3	Detection of a movement anomaly shall generate an alarm in the Control Center and Maintenance Support Network.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. Addition of sequential occupancy monitoring is beyond the scope of this work and does not apply.	Yes				
176	01 Signal	01 Signal Network	002 Impedance Bonds	PHA-P	IDCM 11.11.3	The audio frequency track circuit sensitivity shall be adjusted to ensure a train is detected with a 0.25 ohm (0.25 Ω) shunt across the rails at any location within the boundaries of the track circuit.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Specifications	This adjustment is specified. Acutal adjustment to be completed by the Contractor.	Yes				
177	01 Signal	01 Signal Network	002 Impedance Bonds	PHA-P	IDCM 11.11.4	Audio Frequency track circuits shall meet OEM requirements for proper shunting including pre and post shunting, and should typically be adjusted to allow for at least a 15 foot pre-shunt distance but no more than a 50 foot pre-shunt distance. Audio Frequency track circuits should be adjusted to have no more than a 45 foot post-shunt distance.	C - Compliant		Gannett Fleming	MAS	10/19/2022	DS - Specifications	This adjustment is specified. Acutal adjustment to be completed by the Contractor	Yes				
178	01 Signal	01 Signal Network	002 Impedance Bonds	PHA-P	IDCM 11.11.5	Train detection track circuits shall have proper frequency separation to avoid interference from other track circuits and signals that may be present.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. Addition of sequential occupancy monitoring is beyond the scope of this work and does not apply.	Yes				

Item No.	Certifiable Element	Certifiable Sub-Element	Certifiable Item	SSC Reference PHA - P, TVA - T, ITP - I	Design Criteria Reference/Source/Standard/Specification #	Description	Compliance Status	DVI Process #	Design Verification						CTA Review			
									Responsible Organization	Reviewed By (Initials)	Date of Verification	Means of Verification	Comments	Ready for CTA Review	Reviewed By	Comments	Date Accepted	Status (Open, Closed, SOIL, DVI, CSCC)
179	04 Communications	01 Fiber Optics / 02 Cable	001 Fiber Optic Backbone System/002 Communications Cable System	TVA-T	IDCM 12.4.1	All structured cabling design shall support IP communications, unless noted otherwise. Backbone optical cable along rail right-of-way shall be single mode, 8.3 micron core, loose tube construction with a nominal strand quantity of 192 strands. Backbone copper cable along rail right-of-way shall be #22 AWG twisted pair, gel filled construction, with a nominal pair quantity of 50 pairs.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. Addition of sequential occupancy monitoring is beyond the scope of this work and does not apply.	Yes				
180	04 Communications	01 Fiber Optics / 02 Cable	001 Fiber Optic Backbone System/002 Communications Cable System	NA - Not Applicable	IDCM 12.4.1	The CTA has fiber optic and copper backbone cables along each rail route which terminate within each rail station communication node.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. Addition of sequential occupancy monitoring is beyond the scope of this work and does not apply.	Yes				
181	04 Communications	01 Fiber Optics / 02 Cable	001 Fiber Optic Backbone System/002 Communications Cable System	NA - Not Applicable	IDCM 12.4.1	Horizontal copper cables shall be Category-6 4 pair unshielded twisted pair (UTP) construction. Horizontal optical cables shall be 1 pair multimode, 50 micron core, tight buffered construction.	NA - Not Applicable		Gannett Fleming	MAS	10/19/2022	NA	There are no modifications to the vital or non-vital train control logic as part of this work. Addition of sequential occupancy monitoring is beyond the scope of this work and does not apply.	Yes				
182	04 Communications	05 PA System	001 Dynamic Messaging Systems	PHA-P	Spec 27 40 00	Dynamic Message Signs (DMS)	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
183				TVA-T	Spec 27 50 00	Public Address System	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
184	04 Communications	06 CCTV	001 Software/002 Video Terminal/003 Network Video Recorder (NVR)/004 Fixed Cameras/005 PTZ (Pan-Tilt-Zoom) Cameras	TVA-T	Spec 28 20 00	Electronic Surveillance	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
185	04 Communications	06 CCTV	001 Software/002 Video Terminal/003 Network Video Recorder (NVR)/004 Fixed Cameras/005 PTZ (Pan-Tilt-Zoom) Cameras	TVA-T	Spec 28 20 00	CCTV	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
186	06 Civil	01 Structural	001 Foundations	NA - Not Applicable	IDCM 13.4.1.3	For aerial structure columns or girders, the transit structures should be separately founded from buildings and resilient bearing pads or elastomer separation elements provided between the transit structures and the building. There shall be no rigid connection between the building elements and the transit structure elements	C - Compliant		TranSystems	WJC	10/21/2022	DS - Plans		Yes				
187				PHA-P	IDCM 14.2	The design and specifications for the corrosion-control program shall comply with the latest editions of all applicable sections, requirements, codes, laws, standards and ordinances of Federal, State and Local bodies having jurisdiction.	C - Compliant		TranSystems	WJC	10/21/2022	DS - Plans		Yes				
188	03 Traction Power	01 DC Cable	002 Foundation Electric Isolation	PHA-P	IDCM 14.4.1.3	Where the track is elevated and supported by bridge structures, all metallic elements of the bridge shall be insulated from ground or the negative return. Where concrete foundations and piers are used to support the steel columns and girders, the concrete must be of low permeability and free from chlorides to maximize the resistance-to-earth. No reinforcing steel within the concrete support structures shall contact the elevated steel bridge members. Where steel columns are supported on concrete foundations, the anchor bolts shall be electrically isolated from the column by use of insulating pads, sleeves and washers. In no event shall any part of an isolated structure be allowed to electrically float independent of the negative return. Concrete shall be sealed	C - Compliant		TranSystems	WJC	10/21/2022	DS - Plans		Yes				
189	03 Traction Power	01 DC Cable	002 Foundation Electric Isolation	PHA-P	IDCM 14.4.1.4	Where steel members are to be used for construction of elevated structures, the steel supports shall be free to drain and shall not be enclosed at the base. All exposed steel shall be painted to resist atmospheric corrosion.	C - Compliant		TranSystems	WJC	10/21/2022	DS - Plans		Yes				
190	05 Mech/Elec/Plumb	07 General Mechanical	006 Water Supply and Distribution/007 Wastewater Collection and Conveyance/Plumbing	PHA-P	IDCM 14.5.1.1	All metallic pressure piping such as water mains and force drainage mains shall be double electrically isolated at the point where the piping leaves or enters the transit structure. Buried or concrete-embedded insulating fittings shall be avoided; all insulating fittings shall be accessible for testing. Where it is necessary to install an insulator in soil or concrete, provisions shall be made for bonding by attaching lead wires to each side of the fitting, and terminating the leads in an accessible test box.	C - Compliant		Milhouse	MAC	10/27/2022	DS - Specifications		Yes				
191	03 Traction Power	01 DC Cable	002 Foundation Electric Isolation	PHA-P	IDCM 14.5.1.2	The D.C. positive and negative traction power cables shall be installed in nonmetallic conduits such as fiberglass reinforced epoxy encased in concrete.	C - Compliant		Facet	SM	10/21/2022	DS - Plans		Yes				
192	03 Traction Power	01 DC Cable	002 Foundation Electric Isolation	PHA-P	IDCM 14.5.1.2	All metallic electrical conduit passing from negative referenced structure(s) to earth-grounded structure(s) shall be made electrically discontinuous by use of 18" (min) PVC conduit. Continuity shall be broken before piping enters soil.	C - Compliant		Facet	SM	10/28/2022	DS - Plans and DS - Specifications	Conduits coming in to structure from underground are RTRC	Yes				
193	06 Civil	01 Structural	001 Foundations	PHA-P	IDCM 14.5.1.4	Reinforcing steel placed within concrete footings and foundations exposed to earth shall have a minimum cover of 3 in. Back faces of concrete abutment walls and retaining walls that are protected by an effective waterproofing system shall have a minimum concrete cover to the reinforcing steel of 3 in. Reinforcing steel embedded in concrete exposed primarily to the atmosphere shall have a minimum cover of 3 in, except for steel reinforcements contained within the parapet walls and decks of aerial rail reinforced concrete structures, which shall have a minimum 3 in. concrete cover	PC - Partially Compliant	3	TranSystems	WJC	10/21/2022	DS - Plans	Reinforcing steel placed within concrete footings and foundations exposed to earth have a minimum cover of 3 in. All other reinforcement has a minimum cover of 2 in according to IDCM 7.4.1.1(a)(7).	Yes				
194	06 Civil	01 Structural	001 Foundations	PHA-P	IDCM 14.5.1.5	The use of Epoxy-coated Re-bar shall be used at all locations, including, but not limited to: (see list)	C - Compliant		TranSystems	WJC	10/21/2022	DS - Plans		Yes				
195	06 Civil	01 Structural	001 Foundations	PHA-P	IDCM 14.5.1.5	Epoxy-coated steel reinforcement shall have a minimum concrete cover of 3 in.	NA - Not Applicable		TranSystems	WJC	10/21/2022	DS - Plans	All epoxy coated reinforcement has a minimum cover of 2 in according to IDCM 7.4.1.1(a)(7).	Yes				
196	06 Civil	01 Structural	001 Foundations	PHA-P	IDCM 14.5.1.5	Steel reinforcement of concrete footings and caissons shall be exempt from the requirements when not subject to de-icing salts.	C - Compliant		TranSystems	WJC	10/21/2022	DS - Plans		Yes				

Item No.	Certifiable Element	Certifiable Sub-Element	Certifiable Item	SSC Reference PHA - P, TVA - T, ITP - I	Design Criteria Reference/Source/Standard/Specification #	Description	Compliance Status	DVI Process #	Design Verification						CTA Review			
									Responsible Organization	Reviewed By (Initials)	Date of Verification	Means of Verification	Comments	Ready for CTA Review	Reviewed By	Comments	Date Accepted	Status (Open, Closed, SOIL, DVI, CSCC)
197	03 Traction Power	01 DC Cable	002 Foundation Electric Isolation	PHA-P	IDCM 14.6.2	Where portions of existing utility structures are to be removed, the utilities instructions shall be followed it shall first be determined if the metallic elements are conducting currents (including stray D.C.). If current flow along the structure is detected, bonding procedures shall be instituted prior to cutting or removal. Abandoned streetcar rail within the pavement of the Public Way is being used as a grounding grid by the utilities. If in any doubt, consult the CTA or the City Board of Electrolysis.	NA - Not Applicable		TranSystems	MJL	10/12/2022	O	Designers confirmed with ComEd and CTA that streetcar tracks in this area are not used as grounding.	Yes				
198				PHA-P	IDCM 15.3.5	The Consultant shall provide the required conduit and cable feeds to stub-up locations in the customer assistant kiosk for normal and reliable power. The Consultant shall be responsible for continuing these feeds and conduit to all required equipment and appurtenances within the station's kiosk. The Consultant shall provide required conduits from the Revenue Equipment Room to the Customer Assistant Kiosk with stub-ups for the mounted Station Information Center (SIC). The Consultant shall be responsible for all wiring within the Kiosk.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
199				PHA-P	IDCM 15.3.5	The electrical work shall conform to the requirements of Chicago Electrical Code, Underwriter's Laboratories, NEMA, National Electrical Code and ANSI. Refer to Section 10, Electrical for details.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans and DS - Specifications		Yes				
200	05 Mech/Elec/Plumb	03 Lighting	006 Illuminated Signage/Exit Signage	NA - Not Applicable	IDCM 16.6	The Consultant shall also be responsible for the coordination and assuring that provisions have been made for the required mountings, hardware, junction boxes, terminations of cables and conduits at specific locations and circuit breakers to complete the entire signage and graphic system.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
201	06 Civil	05 Platform Canopy	001 Signage	NA - Not Applicable	IDCM 16.6	Ceiling-mounted signs in the stationhouses and on platforms shall maintain a minimum vertical clearance of 7'-6" from the floor. Canopy mounted signs in bus terminals shall maintain a minimum clearance of 12 ft 6 in from the pavements under the sign. All signs shall be level and at the same elevation.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
202	05 Mech/Elec/Plumb	03 Lighting	006 Illuminated Signage/Exit Signage	NA - Not Applicable	IDCM 16.6	Signs shall utilize standard high output (HO) fluorescent lamps with T-8, HO recessed base. Ballast shall be Class P operable at -29 o C (-20o F).	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
203	05 Mech/Elec/Plumb	03 Lighting	006 Illuminated Signage/Exit Signage	NA - Not Applicable	IDCM 16.6	Sign enclosures shall be constructed of No. 16 gauge aluminum, minimum.	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
204	05 Mech/Elec/Plumb	03 Lighting	006 Illuminated Signage/Exit Signage	NA - Not Applicable	IDCM 16.6	Access to sign interior shall be by means of a continuous piano hinged door. Doors shall be capable of being self supporting with non removable supports when in the open position.	C - Compliant		SOM	SD	10/20/2022	DS - Specifications		Yes				
205	05 Mech/Elec/Plumb	04 Fire Alarm/Suppression	001 Fire Alarm System	NA - Not Applicable	IDCM 17.4.11	17.4.11 Fire Protection; (see list)	NA - Not Applicable		Milhouse	MAC	10/28/2022	NA		Yes				
206				PHA-P	IDCM 17.5.3	17.5.3 Exit Capacities; Methods of calculating exiting capacities at station platforms, mezzanines, concourses, corridors, stairs, escalators, ramps, and moving sidewalks shall be based upon the latest edition of the National Fire Protection Association's "NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Stations".	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
207	06 Civil	05 Platform Canopy	002 Emergency Egress Doors	PHA-P	IDCM 17.5.3.1	17.5.3.1 Doors and Gates; Shall be a minimum of 3 feet wide. Egress capacity shall be based upon the latest edition of the National Fire Protection Association's "NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Stations".	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
208	06 Civil	05 Platform Canopy	005 Turnstiles	PHA-P	IDCM 17.5.3.2	17.5.3.2 Fare Collection Equipment; Egress capacity shall be based upon the latest edition of the National Fire Protection Association's "NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Stations".	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
209				PHA-P	IDCM 17.5.3.4	17.5.3.4 Exit Routes ; Exit routes shall not expose the patron or employee to a greater hazard. Routes shall be kept free of manholes, hatches, other types of potential encumbrances and clear of stored materials and equipment which are not safety related. Track Access Stairs (stairs at the ends of the platform) are for use by CTA personnel only and are not for use in an emergency.	C - Compliant		SOM	SD	10/20/2022	DS - Plans		Yes				
210	04 Communications	03 OCC Systems	002 Telephones	PHA-P	IDCM 17.7.1	17.7.1 Telephone Systems; The general locations and types of the CTA and public telephones are covered in Chapter 12, Communications Systems.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
211	04 Communications	05 PA System	002 PA Control Console	PHA-P	IDCM 17.7.3	17.7.3 Public Address (PA); The PA is the primary means to alert patrons to general conditions as well as emergency situations and direct egress from the station. The general features are covered in Chapter 12, Communications Systems.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
212	04 Communications	03 OCC Systems	003 Intrusion and Fire Alarms	PHA-P	IDCM 17.7.4	17.7.4 Alarms; A supervised, selectively coded alarm system meeting the requirements of NFPA 72A shall be provided for the following:	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
213	04 Communications	03 OCC Systems	003 Intrusion and Fire Alarms	PHA-P	IDCM 17.7.4	Fire Protection. Detectors shall be located as designated in Chapter 9, Mechanical, and Chapter 12, Communications Systems.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
214	04 Communications	03 OCC Systems	001 Control Center Integration	PHA-P	IDCM 17.7.4	Equipment supervision. See Chapter 10, Electrical.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
215	04 Communications	03 OCC Systems	001 Control Center Integration	PHA-P	IDCM 17.7.4	Security. See Chapter 12, Communications Systems.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
216	04 Communications	03 OCC Systems	003 Intrusion and Fire Alarms	PHA-P	IDCM 17.7.4	Alarms are transmitted via DTS, which shall meet the intent of NFPA 72D.	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
217	03 Traction Power	02 Contact Rail	001 Contact Rail / 002 Insulator Chair - Porcelain / 003 Anchors	PHA-P	IDCM 17.9.1	17.9.1 Power Distribution System; The following Safety and Security features are covered in Chapter 10, Electrical: (see list)	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				
218				PHA-P	IDCM 17.9.2	17.9.2 A.C. Power Distribution System; The following Safety and Security features are covered in Chapter 10, Electrical: (see list)	C - Compliant		Facet	JCM	10/27/2022	DS - Plans		Yes				

I. Notes and Restrictions

II. Design Verification

Name:

Signature:

Title:

Organization:

III. SSRC Acceptance - Design

Name:

Signature / REA #

Title:

CONFORMANCE CHECKLIST INSTRUCTIONS

No.	Header	Instructions	Responsible Party
1	Item No.	Enter consecutive identification numbers for each safety and security certifiable item.	CTA
2	Certifiable Element	Enter the Certifiable Element from the current CEL/CIL document	CTA
3	Certifiable Item	Enter the Certifiable Item from the current CEL/CIL document	CTA
4	Related Hazard	Enter the respective description from the tab titled, "Related Hazard"	DOR
5	Design Criteria Reference	Enter the section number of the requirement specified in the Compendium of Design Criteria.	CTA
6	Description	Enter a description of the associated requirement.	CTA
7	Source/Standard	Enter the source, code, specifications or standard which forms the basis of the design criteria.	Contractor
8	Specification Reference	Enter the specification section, drawing number, and/or contract reference for the design criteria.	Contractor
9	Status	Enter Status: Compliance, Non-Compliance, Partial Compliance	Contractor
10	Initials	Enter initials of the Design Contractor’s designated person who verified the incorporation of the requirement into the final design.	Contractor
11	Date	Enter date Designer verification of the requirement was completed.	Contractor
12	Means of Verification	Enter the method used to verify that the requirement has been incorporated into the final design. Provide document number, title, and date of acceptance for submittals. Provide reference location for other documentation as required.	Contractor
13	Status	Enter Status: Compliance, Non-Compliance, Partial Compliance	Contractor
14	Initials	Enter initials of the Construction Contractor’s designated person who verified the incorporation of the requirement into the delivered, as-built, installed and/or received item.	Contractor
15	Date	Enter date Construction Contractor verification of the requirement was completed.	Contractor
16	Means of Verification	Enter the method used to verify the incorporation of specified safety and security requirements into the delivered item. Provide document number, title, and date of acceptance for submittals. Provide reference location for other documentation as required.	Contractor
17	Status	Enter Status: Compliance, Non-Compliance, Partial Compliance	Contractor
18	Initials	Enter initials of the Installation/Testing Contractor’s designated person who verified the incorporation of the requirement into the delivered, as-built, installed and/or received item.	Contractor
19	Date	Enter date Installation/Testing Contractor verification of the requirement was completed.	Contractor
20	Means of Verification	Enter the method used to verify the incorporation of specified safety and security requirements into the installed/tested item. Provide document number, title, and date of acceptance for submittals. Provide reference location for other documentation as required.	Contractor
21	Notes and Restrictions	Enter notes and restrictions as needed.	SSRC
22	Verification Signature Block (Design/Construction Installation/Testing)	Completed and signed by the Design/Construction/Installation/Testing Contractor’s designated lead for final verification.	Contractor
23	Safety and Security Review Committee (SSRC) Acceptance Signature Block	Completed by the SSRC Chair or designee for HART acceptance.	SSRC

APPENDIX J

SHORING TOWERS AVAILABLE FOR RE-USE:
PHOTOS AND DRAWINGS

GENERAL INFORMATION – APPENDIX J

1. RELATED DOCUMENTS

A. Photos of the shoring towers on site.
B. Drawings of the shoring towers.
C. Shop drawings of the shoring towers.

2. SUMMARY

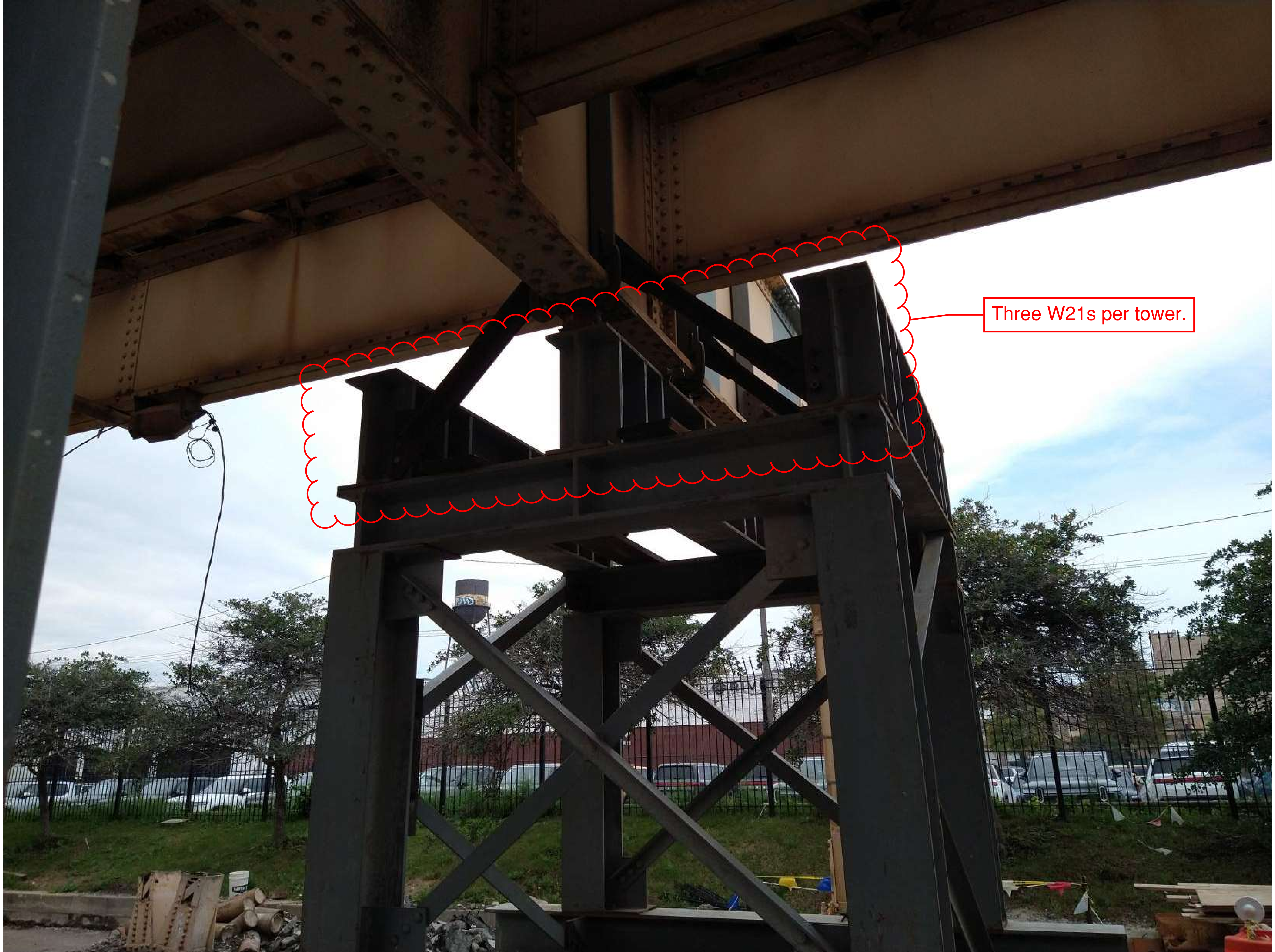
A. This Appendix provides information regarding the existing shoring towers from the Damen Station project (Contract D-7-135), hereafter referred to as “the shoring towers,” available for re-use on the State and Lake Station project’s construction, hereafter referred to as “the project.” The shoring towers can be used in their current condition if it is determined to be feasible for meeting the requirements of the project. Alternatively, the shoring towers may be modified or used for fabricating new shoring.

3. RESPONSIBILITIES OF THE CONTRACTOR

A. It is the responsibility of the contractor to ensure any re-use or modification of the shoring towers provides structurally adequate support to the existing structures, meets the requirements of the project, and follows the applicable codes, standards, or regulations. Additionally, the General Notes of SX-001, “Suggested Shoring Notes,” shall be adhered to for use of the shoring towers, whether as-is or in a modified condition.
B. The shoring towers prior to their installation or use on the project, whether used as-is or in a modified condition, shall have sealed plans and calculations by an Illinois licensed Structural Engineer (as necessary) submitted to the Commissioner for approval.
C. Any transportation of, modifications to, assembly of, or disassembly of the shoring towers.
D. Restoration of the storage site where the shoring towers reside.
E. Instigation of any communications regarding the shoring towers.
F. Retrieval of the shoring towers shall be at the Chicago Transit Authority’s (CTA) Lawndale Yard.
G. When the shoring towers are no longer necessary for completion of the project, the contractor shall disassemble and deliver them back to the CTA’s Lawndale Yard.

Photo showing different tower heights.

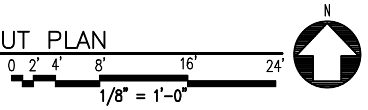

Four W12s per tower.



Three W21s per tower.

Body of tower.
9' x 13' out-to-out
dimension at
base beams.

1
S1.0
SHORING LAYOUT PLAN
1/8" = 1'-0"



DESIGN LOADS (PROVIDED BY SIMPSON GUMPERTZ AND HEGER)

	VERTICAL LOAD (kips)	LATERAL LOAD (E/W) (kips)	LATERAL LOAD (N/S) (kips)
D+L+I	214	0	0
D+L+I+WL+LF+N+OF (N/S DIRECTION)	224	17	8
D+L+I+WL+LF+N+OF (E/W DIRECTION)	214	31	1
D+W+LF (N/S DIRECTION)	79	17	5
D+W+LF (E/W DIRECTION)	85	34	0

STRUCTURAL STEEL

1. FABRICATION AND ERECTION OF STRUCTURAL STEEL MEMBERS SHALL BE IN ACCORDANCE WITH SECTION 505, STEEL STRUCTURES OF THE IDOT SSRBC AND PART 4, ERECTION, CHAPTER 15 OF THE AREMA MANUAL UNLESS NOTED OTHERWISE.
2. ALL STRUCTURAL STEEL SHALL CONFORM TO THE FOLLOWING STANDARDS UNO:

STEEL WIDE FLANGES	ASTM A992
STEEL ANGLES AND PLATES	ASTM A36
STEEL SHORING TOWER ANGLES AND PLATES	ASTM A572, GR. 50

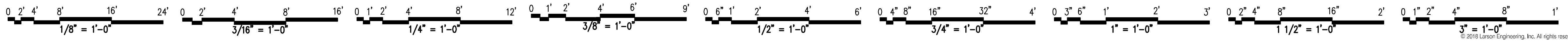
3. ALL FILLER METAL USED IN WELDING SHALL BE 70 KSI YIELD, LOW-HYDROGEN.
4. ALL WELDING SHALL BE BY CERTIFIED WELDERS AND SHALL CONFORM TO THE "STRUCTURAL WELDING CODE", AWS D1.5 AND MEET AISC MINIMUM REQUIREMENTS FOR WELD SIZE.
5. FIELD CONNECTIONS ARE TO BE BOLTED AND INSTALLED IN ACCORDANCE WITH THE "SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS AND ALL ADDITIONAL REQUIREMENTS SET OUT BY IDOT SSRBS AND PART 4, ERECTION, CHAPTER 15 OF THE AREMA MANUAL." BOLTS ARE TO BE TIGHTENED PER CTA INFRASTRUCTURE DESIGN CRITERIA MANUAL (IDCM), SECTION 5.1. USE MIN 7/8"ø SC A325 HIGH STRENGTH BOLTS UNLESS NOTED OTHERWISE. ANY HOLES DRILLED INTO EXISTING STRUCTURE OR WHERE RIVETS ARE REPLACED FOR PURPOSES OF TEMPORARY SHORING ARE TO BE FILLED W/ 7/8"ø A325 GALVANIZED BOLTS AS A PERMANENT SOLUTION. BOLTS ARE TO BE FULLY TIGHTENED. SLIP CRITICAL BOLTS TO BE REPLACED AFTER BEING FULLY TENSIONED ONCE.
6. WOOD TIMBER MATS SHALL BE DOUGLAS FIR OR SPRUCE PINE FUR NO 2 OR BETTER, AS DEFINED BY THE NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION "DESIGN VALUES FOR VISUALLY GRADED STRUCTURAL LUMBER" LATEST EDITION.

INSTALLATION INSTRUCTIONS:

1. PROVIDE CONCRETE JERSEY BARRIERS PROTECTION FOR ALL SHORING EXPOSED TO ALLEY OR STREET TRAFFIC. SIDEWALKS MAY NEED TO BE CLOSED AND BLOCKED OFF. JERSEY BARRIERS TO BE ANCHORED DOWN CONNECTION TO BE VERIFIED BY GENERAL CONTRACTOR.
2. GENERAL CONTRACTOR TO PROVIDE SMOOTH AND LEVEL TEMPORARY CONCRETE PADS FOR PLACEMENT OF HARDWOOD MATS.
3. SHORING WILL BE ERECTED OVER CRANE MATS AS SHOWN ON THE PLANS AND OTHER MISC DETAIL CONNECTIONS.
4. JACKING TO TAKE PLACE DURING SHUTDOWN AND/OR BETWEEN TRAINS ONLY.
5. NO WELDING IS PERMITTED TO EXISTING STRUCTURE.
6. JACK CAPACITY TO BE 113 KIPS. JACKS TO BE CAPABLE OF MECHANICALLY LOCKING INTO PLACE SO THAT HYDRAULICS ARE NOT REQUIRED. JACKS USED ON THIS PROJECT WILL BE 100 TON BVA HL1002 AND 100 TON ENERPAC CLP-1002.
7. NEW COLUMNS AT BENT PLATES TO BE INSTALLED PRIOR TO INSTALLATION OF NEW FOOTING PER DIRECTION GIVEN IN RFI #15.

SEQUENCING:
1. BENT LINES 2218 AND 2222 TO BE SHORED AT THE SAME TIME.
2. BENT LINES 2219 TO BE SHORED.
3. BENT LINES 2223 AND 2224 TO BE SHORED AT THE SAME TIME.
4. BENT LINES 2225 AND 2226 TO BE SHORED AT THE SAME TIME.
5. BENT LINES 2227 AND 2228 TO BE SHORED AT THE SAME TIME.
6. SHORING SEQUENCE SUBJECT TO CHANGE UPON FIELD CONDITIONS. MAXIMUM (4) BENTS SHORED AT THE SAME TIME PER THE EOR DIRECTION.

SHEET NOTES:
1. VERIFY DIMENSIONS AND ELEVATIONS WITH EXISTING CONDITIONS.
2. VERIFY DIMENSIONS WITH NEW WORK AT BENT LINES TO AVOID INTERFERENCES.



Project Permit #: N/A

Larson
Engineering, Inc.
1488 Bond Street , Suite 100
Naperville, IL 60563-6503
630.357.0540 Fax: 630.357.0164
www.larsonengr.com

CLIENT:
METROPOLITAN
STEEL INC.
1931 EAST 177TH ST
LANSING, IL 60438

TEMPORARY SHORING FOR
CTA GREENLINE STATION
LAKE STREET
DAMEN AVE TO ASHLAND AVE
CHICAGO, IL

SEAL
Amber DellAngelo
AMBER D. DELLANGELO
081-007232
Digitally signed by Amber D. DellAngelo
Date: 2022.02.10 15:29:40-06'00'

Date: 2/102022 Expires: 11/30/2022
IL Design Firm #: 184-001442

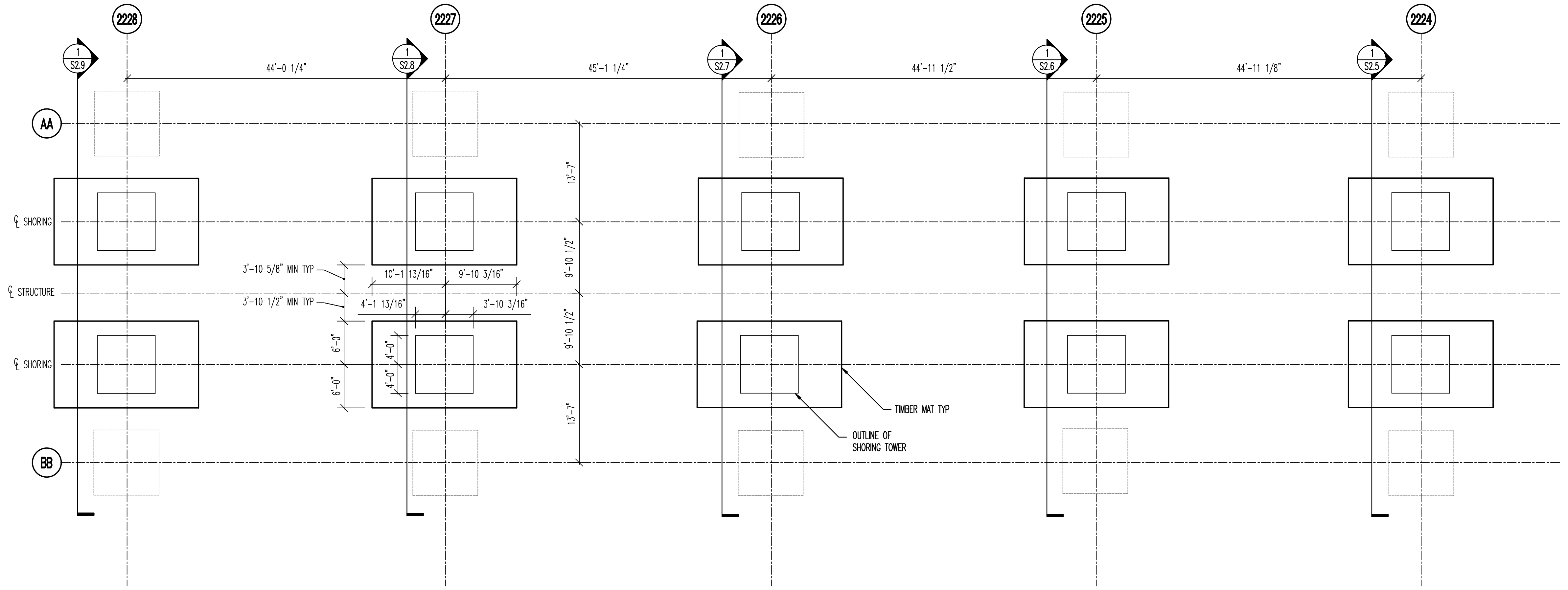
No.	Date	Description
	1/13/2022	FOR REVIEW
	2/10/2022	FOR REVIEW

Project#: 21210838.000
Drawn by: TB
Checked by: RAF

Sheet Title:
SHORING LAYOUT PLAN

S1.0

Structural Sheet: of 14



1 S1.1 SHORING LAYOUT PLAN

1/8" = 1'-0"

0 2' 4' 8' 16' 24'
1/8" = 1'-0"
N

DESIGN LOADS (PROVIDED BY SIMPSON GUMPERTZ AND HEGER)

	VERTICAL LOAD (kips)	LATERAL LOAD (E/W) (kips)	LATERAL LOAD (N/S) (kips)
D+L+I	214	0	0
D+L+I+WL+LF+N+OF (N/S DIRECTION)	224	17	8
D+L+I+WL+LF+N+OF (E/W DIRECTION)	214	31	1
D+W+LF (N/S DIRECTION)	79	17	5
D+W+LF (E/W DIRECTION)	85	34	0

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6. JACK CAPACITY TO BE 113 KIPS. JACKS TO BE CAPABLE OF MECHANICALLY LOCKING INTO PLACE SO THAT HYDRAULICS ARE NOT REQUIRED. JACKS USED ON THIS PROJECT WILL BE 100 TON BVA HL1002 AND 100 TON ENERPAC CLP-1002.
7. NEW COLUMNS AT BENT PLATES TO BE INSTALLED PRIOR TO INSTALLATION OF NEW FOOTING PER DIRECTION GIVEN IN RFI #15.

SEQUENCING:

1. BENT LINES 2218 AND 2222 TO BE SHORED AT THE SAME TIME.
2. BENT LINES 2219 TO BE SHORED.
3. BENT LINES 2223 AND 2224 TO BE SHORED AT THE SAME TIME.
4. BENT LINES 2225 AND 2226 TO BE SHORED AT THE SAME TIME.
5. BENT LINES 2227 AND 2228 TO BE SHORED AT THE SAME TIME.
6. SHORING SEQUENCE SUBJECT TO CHANGE UPON FIELD CONDITIONS. MAXIMUM (4) BENTS SHORED AT THE SAME TIME PER THE EOR DIRECTION.

SHEET NOTES:

1. VERIFY DIMENSIONS AND ELEVATIONS WITH EXISTING CONDITIONS.
2. VERIFY DIMENSIONS WITH NEW WORK AT BENT LINES TO AVOID INTERFERENCES.

0 2' 4' 8' 16' 24' 1/8" = 1'-0"
0 2' 4' 8' 16' 3/16" = 1'-0"
0 1' 2' 4' 8' 12' 1/4" = 1'-0"
0 1' 2' 4' 6' 9' 3/8" = 1'-0"
0 6" 1' 2' 4' 6' 1/2" = 1'-0"
0 4" 8" 16" 32" 4' 3/4" = 1'-0"
0 3" 6" 1' 2' 3' 1" = 1'-0"
0 2" 4" 8" 16" 2' 1 1/2" = 1'-0"
0 1" 2" 4" 8" 1' 3" = 1'-0"

Project Permit #: N/A

Larson Engineering, Inc.
1488 Bond Street , Suite 100
Naperville, IL 60563-6503
630.357.0540 Fax: 630.357.0164
www.larsonengr.com

CLIENT:
METROPOLITAN STEEL INC.
1931 EAST 177TH ST
LANSING, IL 60438

TEMPORARY SHORING FOR CTA GREENLINE STATION
LAKE STREET
DAMEN AVE TO ASHLAND AVE
CHICAGO, IL

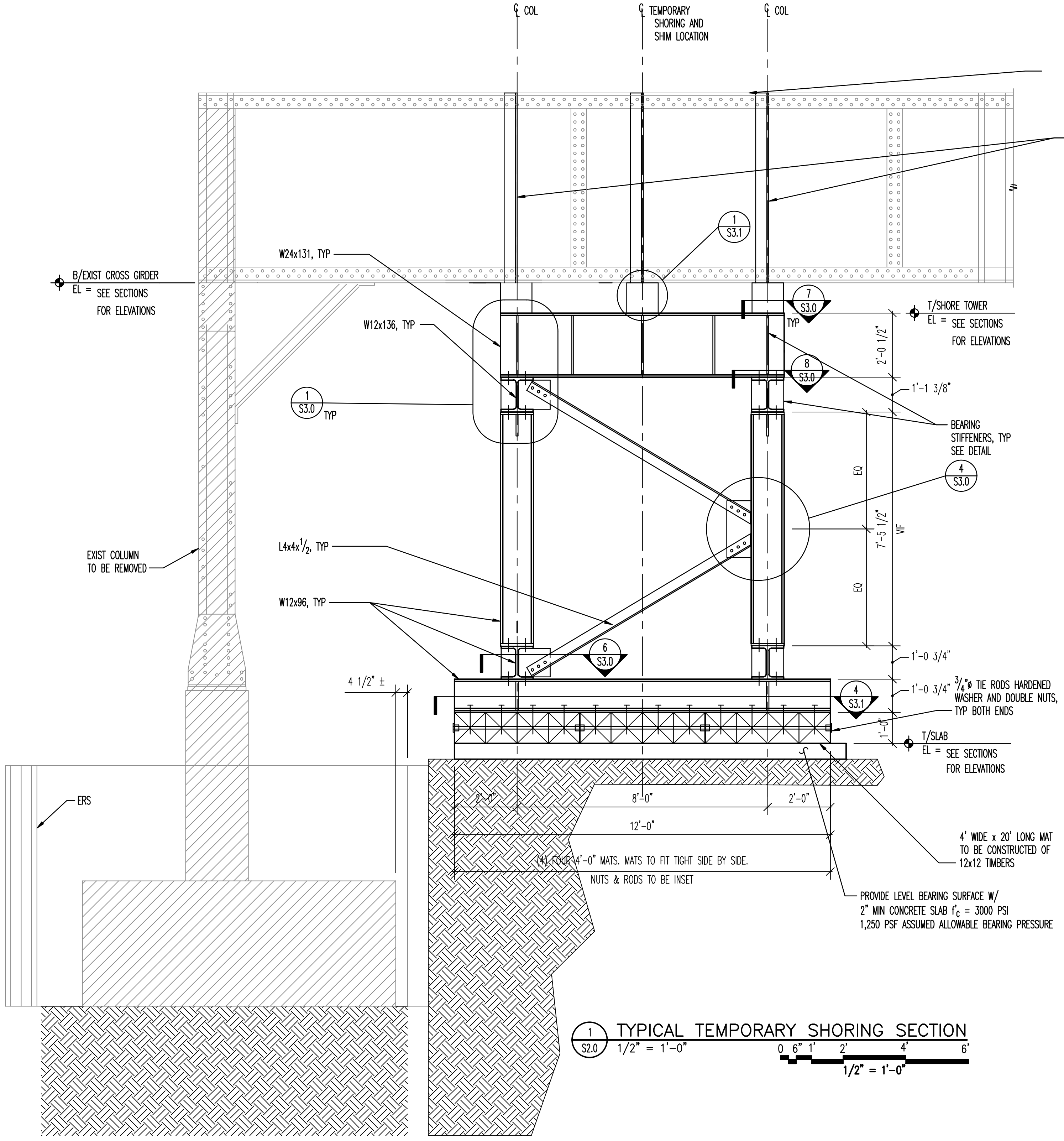
SEAL
AMBER D. DELLANGELO
081-007232
Amber Dellangelo
Date: 2/102022 Expires: 11/30/2022
IL Design Firm #: 184-001442

No.	Date	Description
	1/13/2022	FOR REVIEW
	2/10/2022	FOR REVIEW

Project#: 21210838.000
Drawn by: TB
Checked by: RAF
Sheet Title:
SHORING LAYOUT PLAN

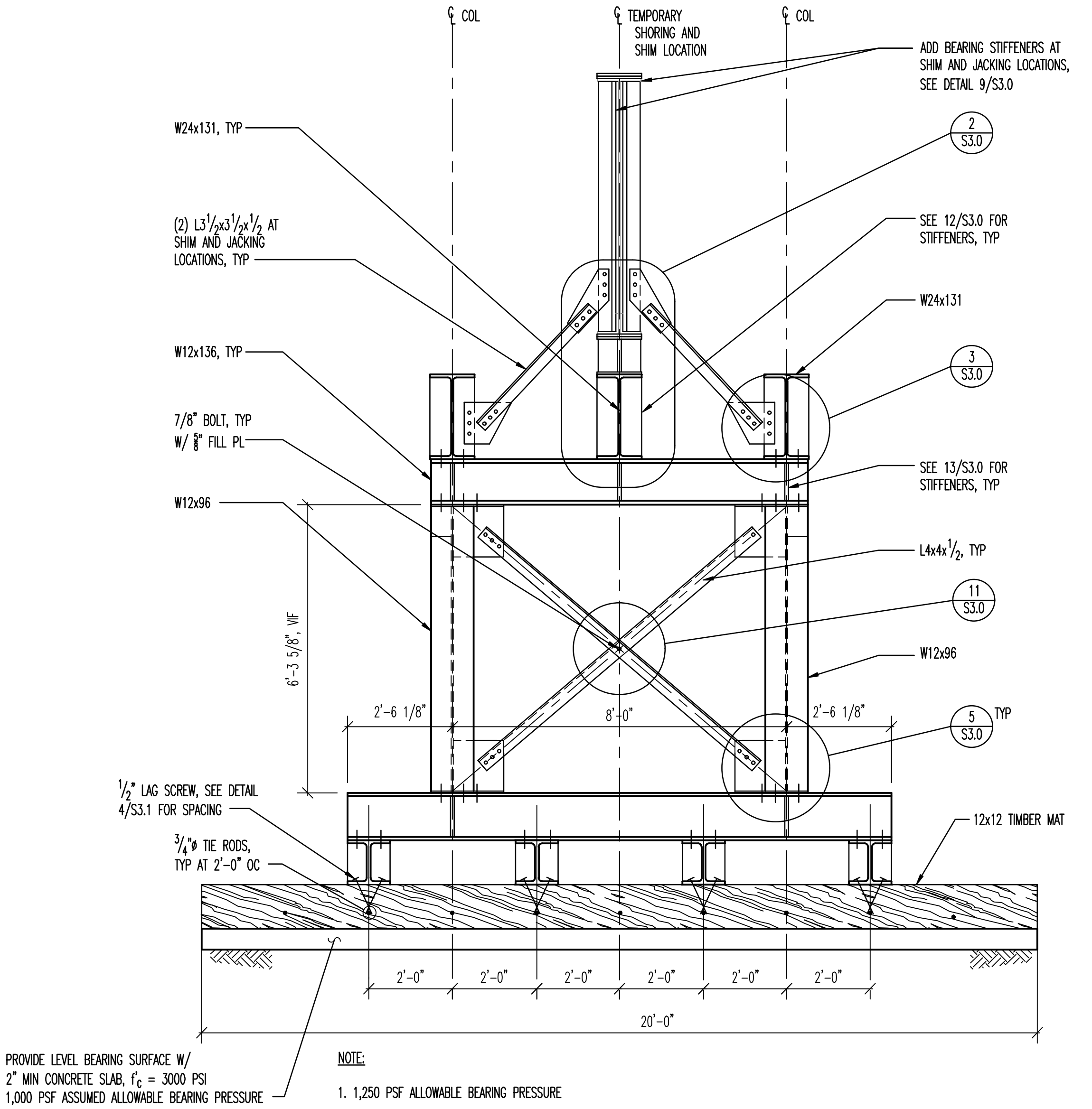
S1.1

Structural Sheet: of 14



① S2.0 TYPICAL TEMPORARY SHORING SECTION
1/2" = 1'-0"

0 6" 1' 2' 4' 6'
1/2" = 1'-0"



NOTE:

1. 1,250 PSF ALLOWABLE BEARING PRESSURE

② S2.0 TYPICAL TEMPORARY SHORING SECTION
1/2" = 1'-0"

0 6" 1' 2' 4' 6'
1/2" = 1'-0"

0 2' 4' 8' 16' 24'
1/8" = 1'-0"

0 2' 4' 8' 16'
3/16" = 1'-0"

0 1' 2' 4' 8' 12'
1/4" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 6" 1' 2' 4' 6'
1/2" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"

0 3" 6" 1' 2' 3'
1" = 1'-0"

0 2" 4" 8" 16" 2'
1 1/2" = 1'-0"

0 1" 2" 4" 8" 1'
3" = 1'-0"

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CHICAGO, IL

SEAL

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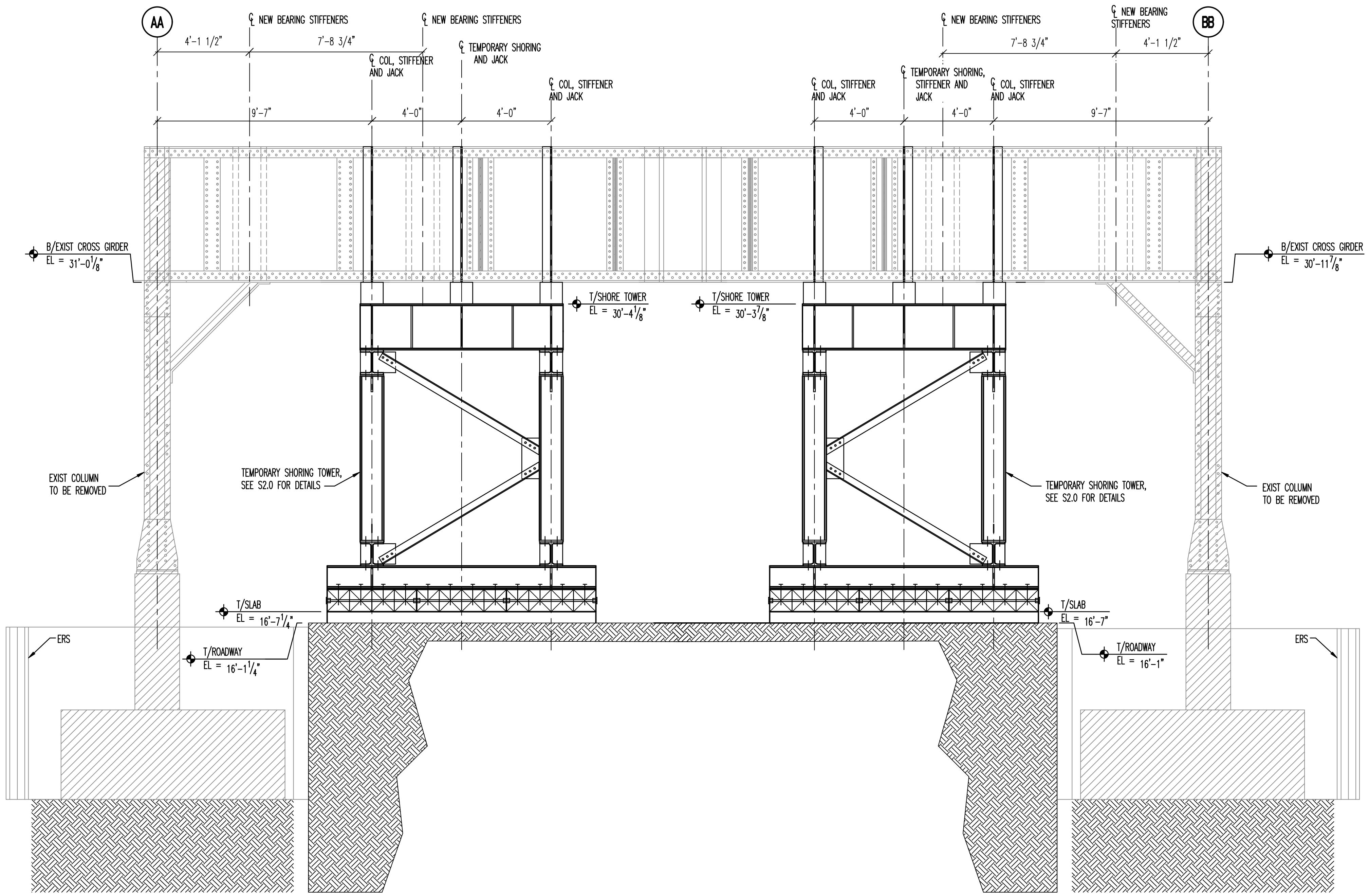
	2/10/2022	FOR REVIEW

Project#: 21210838.000
Drawn by: TB
Checked by: RAF

Sheet Title:
PHASE 2
SHORING TOWER SECTIONS

S2.0

Structural Sheet: of 14



1
S2.1
TEMPORARY SHORING SECTION @ BENT LINE 2218
3/8" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 2' 4' 8' 16' 24'
1/8" = 1'-0"

0 2' 4' 8' 16'
3/16" = 1'-0"

0 1' 2' 4' 8' 12'
1/4" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 6" 1' 2' 4' 6'
1/2" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"

0 3" 6" 1' 2' 3'
1" = 1'-0"

0 2" 4" 8" 16" 2'
1 1/2" = 1'-0"

0 1" 2" 4" 8" 1'
3" = 1'-0"

Project Permit #: N/A

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Engineering, Inc.
1488 Bond Street , Suite 100
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630.357.0540 Fax: 630.357.0164
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STEEL INC.
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LANSING, IL 60438

TEMPORARY SHORING FOR
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Amber Dellangelo

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Project#: 21210838.000

Drawn by: TB

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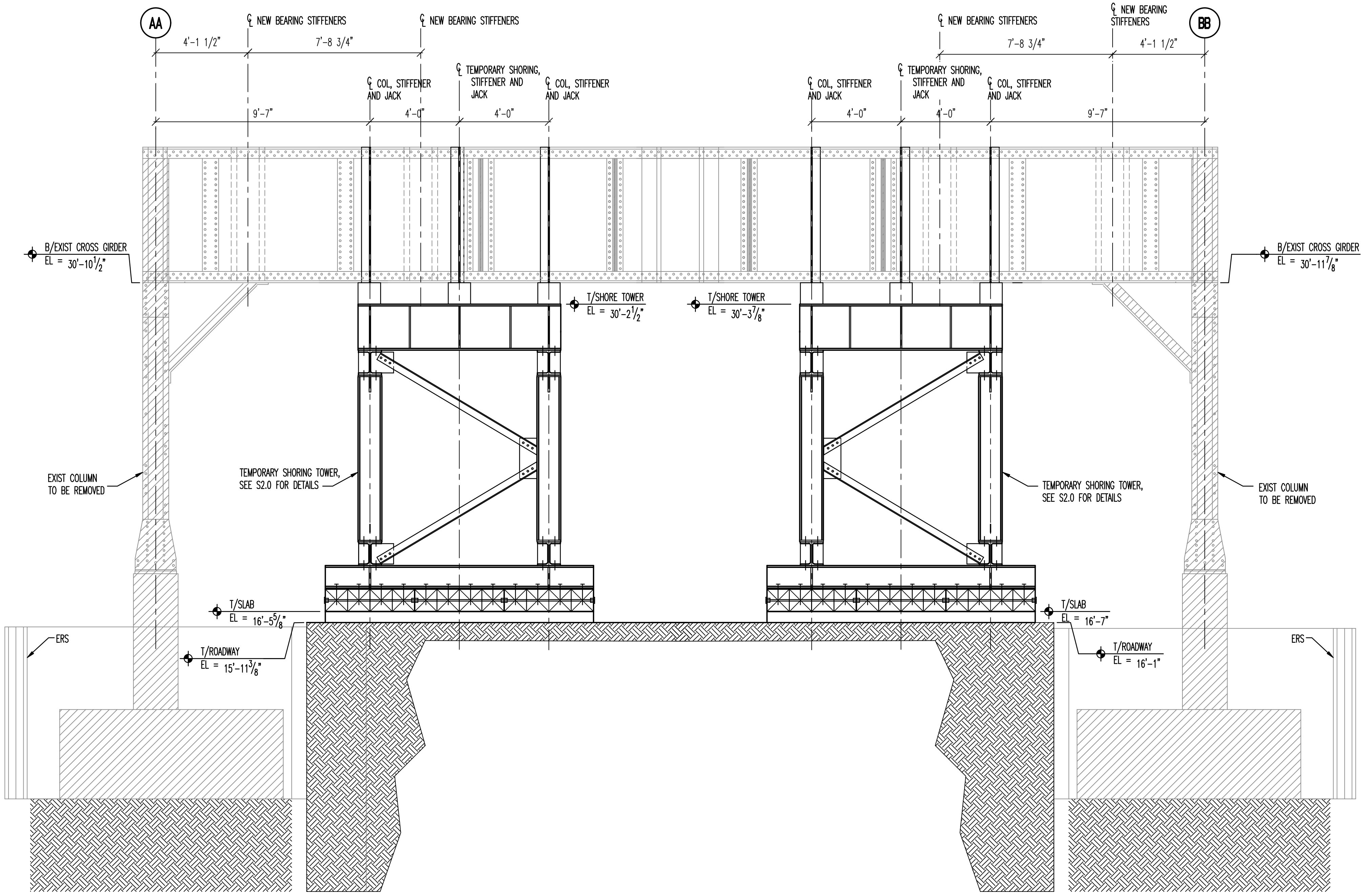
Sheet Title:
TEMPORARY SHORING
SECTIONS @ BENT LINE 2218

S2.1

Structural Sheet: of 14



1 / S2.2 TEMPORARY SHORING SECTION @ BENT LINE 2219
3/8" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 2' 4' 8' 16' 24' — 1/8" = 1'-0"
0 2' 4' 8' 16' — 3/16" = 1'-0"
0 1' 2' 4' 8' 12' — 1/4" = 1'-0"
0 1' 2' 4' 6' 9' — 3/8" = 1'-0"
0 6" 1' 2' 4' 6' — 1/2" = 1'-0"
0 4" 8" 16" 32" 4' — 3/4" = 1'-0"
0 3" 6" 1' 2' 3' — 1" = 1'-0"
0 2" 4" 8" 16" 2' — 1 1/2" = 1'-0"
0 1" 2" 4" 8" 1' — 3" = 1'-0"

Project Permit #: N/A

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1488 Bond Street , Suite 100
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STEEL INC.
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LANSING, IL 60438

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CHICAGO, IL

SEAL
AMBER D. DELLANGELO 081-007232
Amber DellAngelo
Date: 2/102022 Expires: 11/30/2022
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Drawn by: TB
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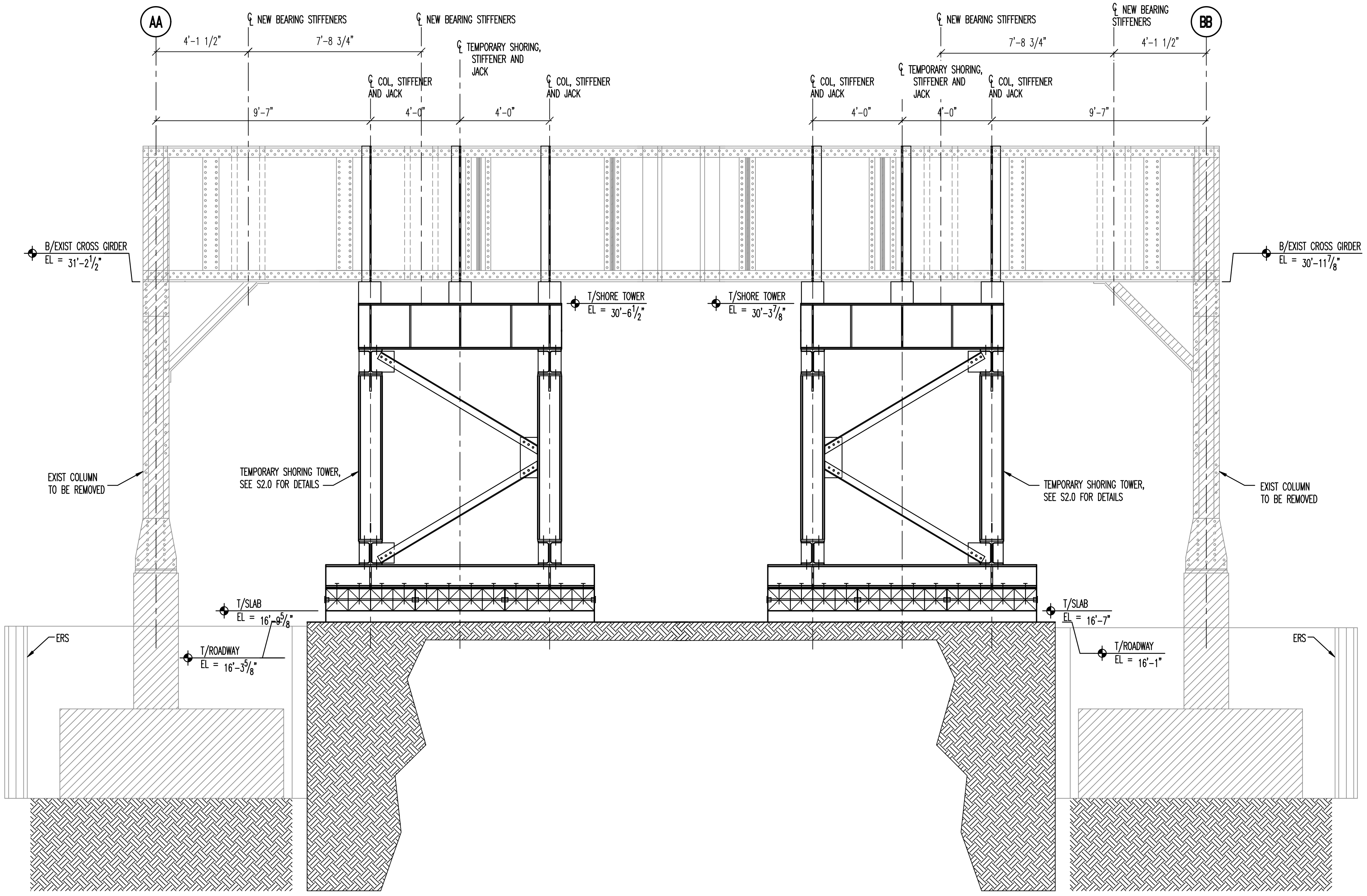
Sheet Title:
TEMPORARY SHORING
SECTIONS @ BENT LINE 2219

S2.2

Structural Sheet: of 14



1 S2.3 TEMPORARY SHORING SECTION @ BENT LINE 2222

3/8" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 2' 4' 8' 16' 24' 1/8" = 1'-0"

0 2' 4' 8' 16' 3/16" = 1'-0"

0 1' 2' 4' 8' 12' 1/4" = 1'-0"

0 1' 2' 4' 6' 9' 3/8" = 1'-0"

0 6" 1' 2' 4' 6' 1/2" = 1'-0"

0 4" 8" 16" 32" 4' 3/4" = 1'-0"

0 3" 6" 1' 2' 3' 1" = 1'-0"

0 2" 4" 8" 16" 2' 1 1/2" = 1'-0"

0 1" 2" 4" 8" 1' 3" = 1'-0"

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SEAL
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DELLANGELO
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Amber Dellangelo

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Project#: 21210838.000

Drawn by: TB

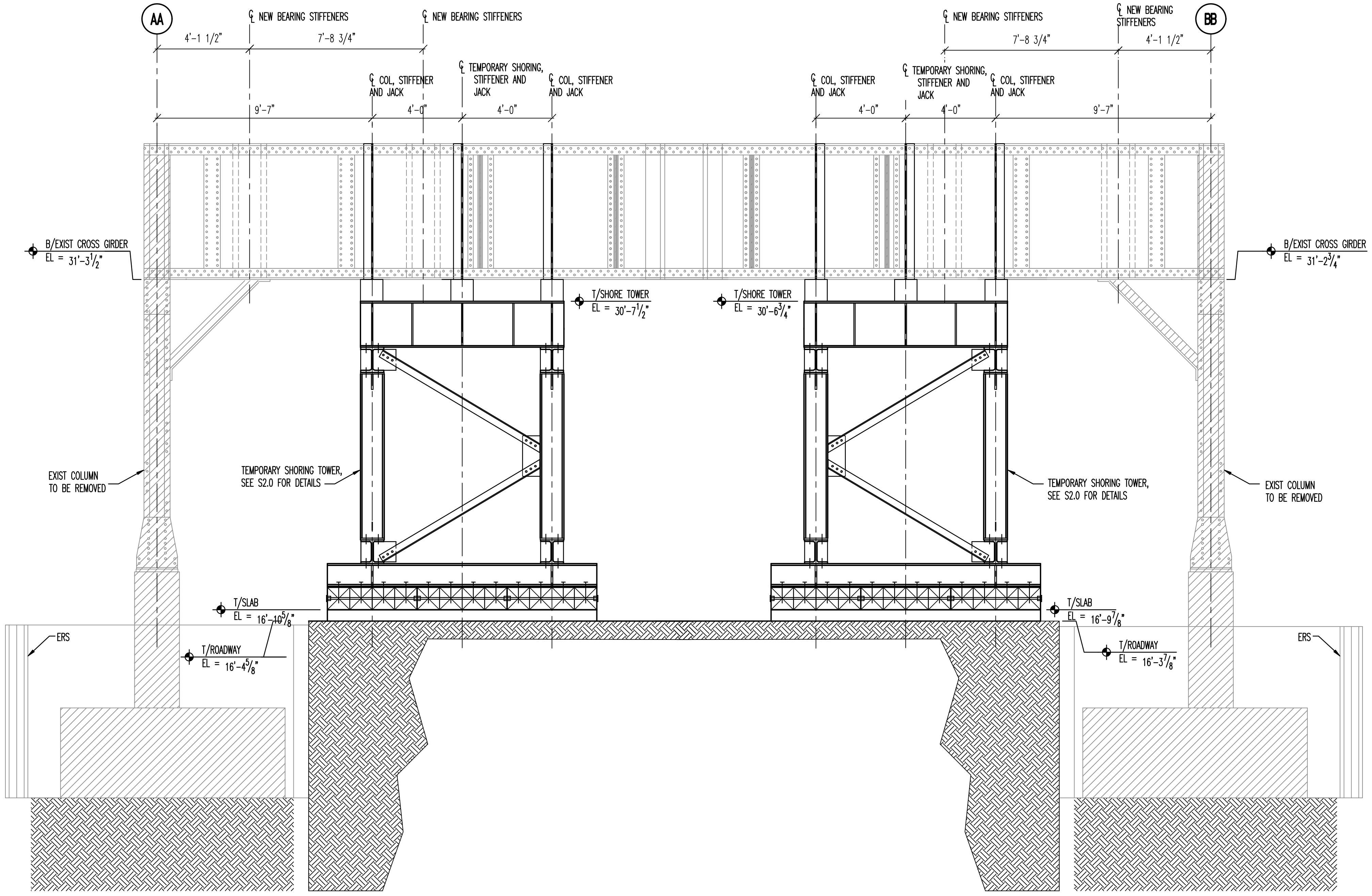
Checked by: RAF

Sheet Title:

TEMPORARY SHORING
SECTIONS @ BENT LINE 2222

S2.3

Structural Sheet: of 14



1 S2.4 TEMPORARY SHORING SECTION @ BENT LINE 2223
3/8" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 2' 4' 8' 16' 24' 1/8" = 1'-0"
0 2' 4' 8' 16' 3/16" = 1'-0"
0 1' 2' 4' 8' 12' 1/4" = 1'-0"
0 1' 2' 4' 6' 9' 3/8" = 1'-0"
0 6" 1' 2' 4' 6' 1/2" = 1'-0"
0 4" 8" 16" 32" 4' 3/4" = 1'-0"
0 3" 6" 1' 2' 3' 1" = 1'-0"
0 2" 4" 8" 16" 2' 1 1/2" = 1'-0"
0 1" 2" 4" 8" 1' 3" = 1'-0"

Project Permit #: N/A

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TEMPORARY SHORING FOR
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LAKE STREET
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CHICAGO, IL

SEAL
AMBER D.
DELLANGELO
081-007232
Amber DellAngelo
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No.	Date	Description
	1/13/2022	FOR REVIEW
	2/10/2022	FOR REVIEW

Project#: 21210838.000

Drawn by: TB

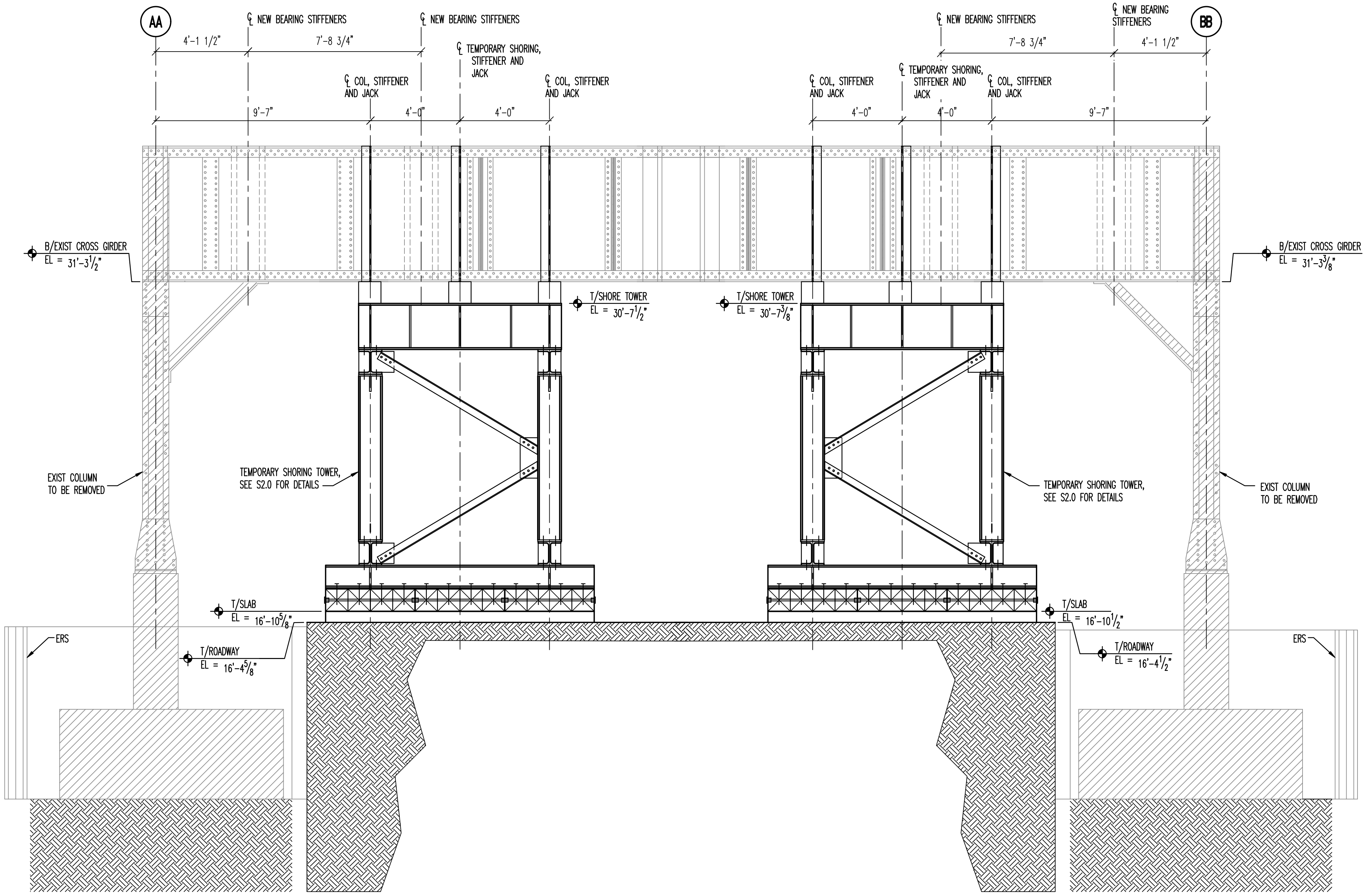
Checked by: RAF

Sheet Title:

TEMPORARY SHORING
SECTIONS @ BENT LINE 2223

S2.4

Structural Sheet: of 14



1 / S2.5 TEMPORARY SHORING SECTION @ BENT LINE 2224

3/8" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 2' 4' 8' 16' 24' 1/8" = 1'-0"

0 2' 4' 8' 16' 3/16" = 1'-0"

0 1' 2' 4' 8' 12' 1/4" = 1'-0"

0 1' 2' 4' 6' 9' 3/8" = 1'-0"

0 6" 1' 2' 4' 6' 1/2" = 1'-0"

0 4" 8" 16" 32" 4' 3/4" = 1'-0"

0 3" 6" 1' 2' 3' 1" = 1'-0"

0 2" 4" 8" 16" 2' 1 1/2" = 1'-0"

0 1" 2" 4" 8" 1' 3" = 1'-0"

Project Permit #: N/A

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STEEL INC.
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LANSING, IL 60438

TEMPORARY SHORING FOR
CTA GREENLINE STATION
LAKE STREET
DAMEN AVE TO ASHLAND AVE
CHICAGO, IL

SEAL
LICENSED STRUCTURAL ENGINEER
AMBER D.
DELLANGELO
081-007232
STATE OF ILLINOIS

Date: 2/102022 Expires: 11/30/2022
IL Design Firm #: 184-001442

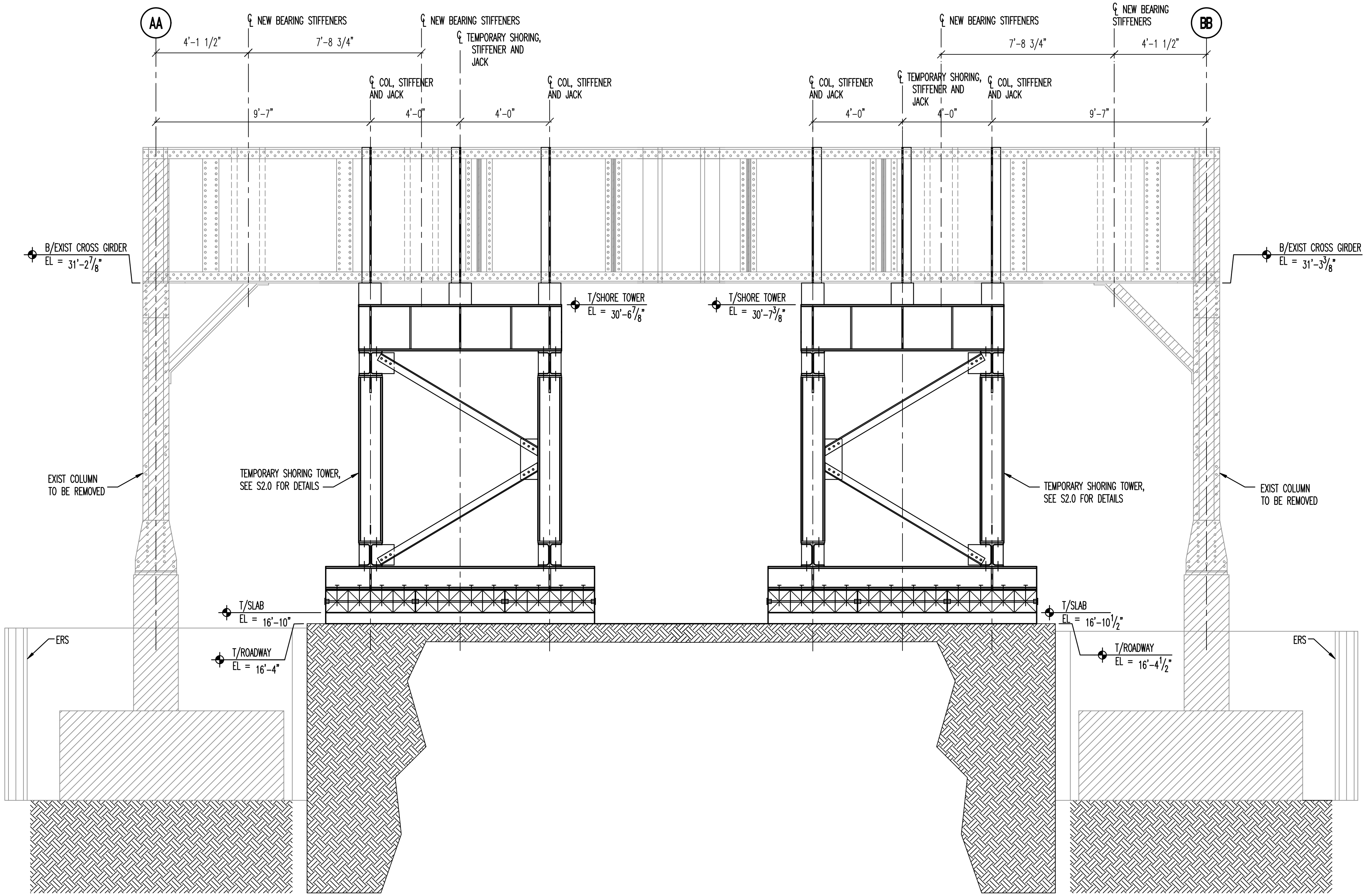
No.	Date	Description
	1/13/2022	FOR REVIEW
	2/10/2022	FOR REVIEW

Project#: 21210838.000
Drawn by: TB
Checked by: RAF

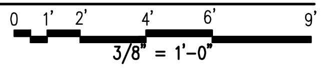
Sheet Title:
TEMPORARY SHORING
SECTIONS @ BENT LINE 2224

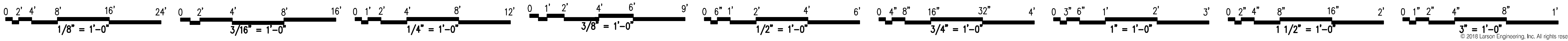
S2.5

Structural Sheet: of 14



1 S2.6 TEMPORARY SHORING SECTION @ BENT LINE 2225
3/8" = 1'-0"





Project Permit #: N/A

Larson Engineering, Inc.
1488 Bond Street , Suite 100
Naperville, IL 60563-6503
630.357.0540 Fax: 630.357.0164
www.larsonengr.com

CLIENT:

METROPOLITAN STEEL INC.
1931 EAST 177TH ST
LANSING, IL 60438

TEMPORARY SHORING FOR CTA GREENLINE STATION
LAKE STREET
DAMEN AVE TO ASHLAND AVE
CHICAGO, IL

SEAL

LICENSED STRUCTURAL ENGINEER
AMBER D. DELLANGELO
081-007232
STATE OF ILLINOIS

Date: 2/102022 Expires: 11/30/2022
IL Design Firm #: 184-001442

No.	Date	Description
	1/13/2022	FOR REVIEW
	2/10/2022	FOR REVIEW

Project#: 21210838.000

Drawn by: TB

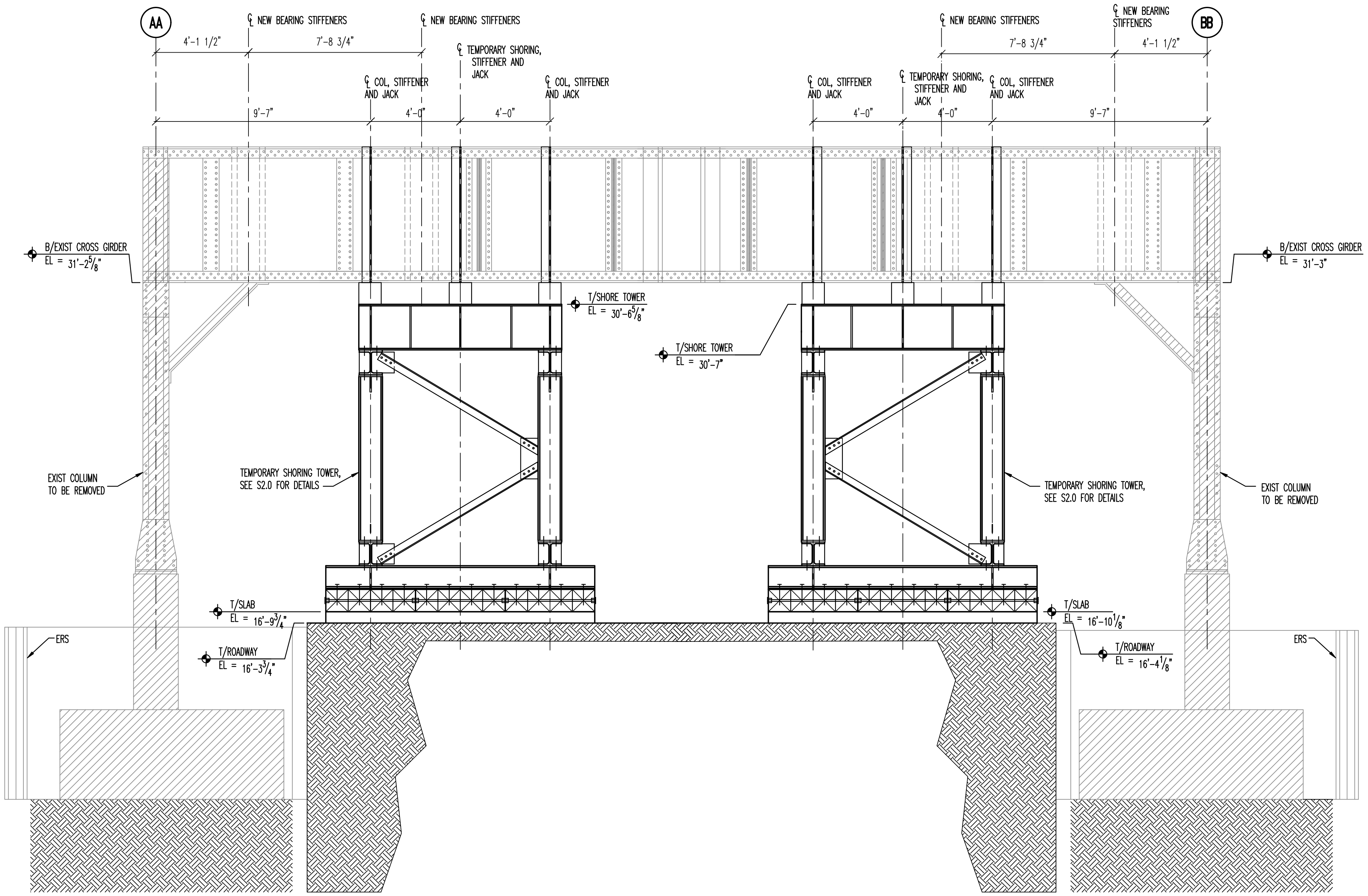
Checked by: RAF

Sheet Title:

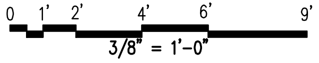
TEMPORARY SHORING SECTIONS @ BENT LINE 2225

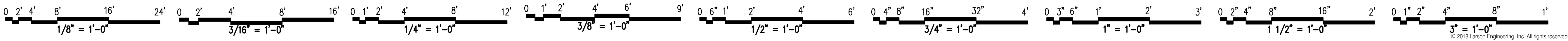
S2.6

Structural Sheet: of 14



1 S2.7 TEMPORARY SHORING SECTION @ BENT LINE 2226
3/8" = 1'-0"





Project Permit #: N/A

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SEAL
AMBER D. DELLANGELO
081-007232
Amber Dellangelo

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IL Design Firm #: 184-001442

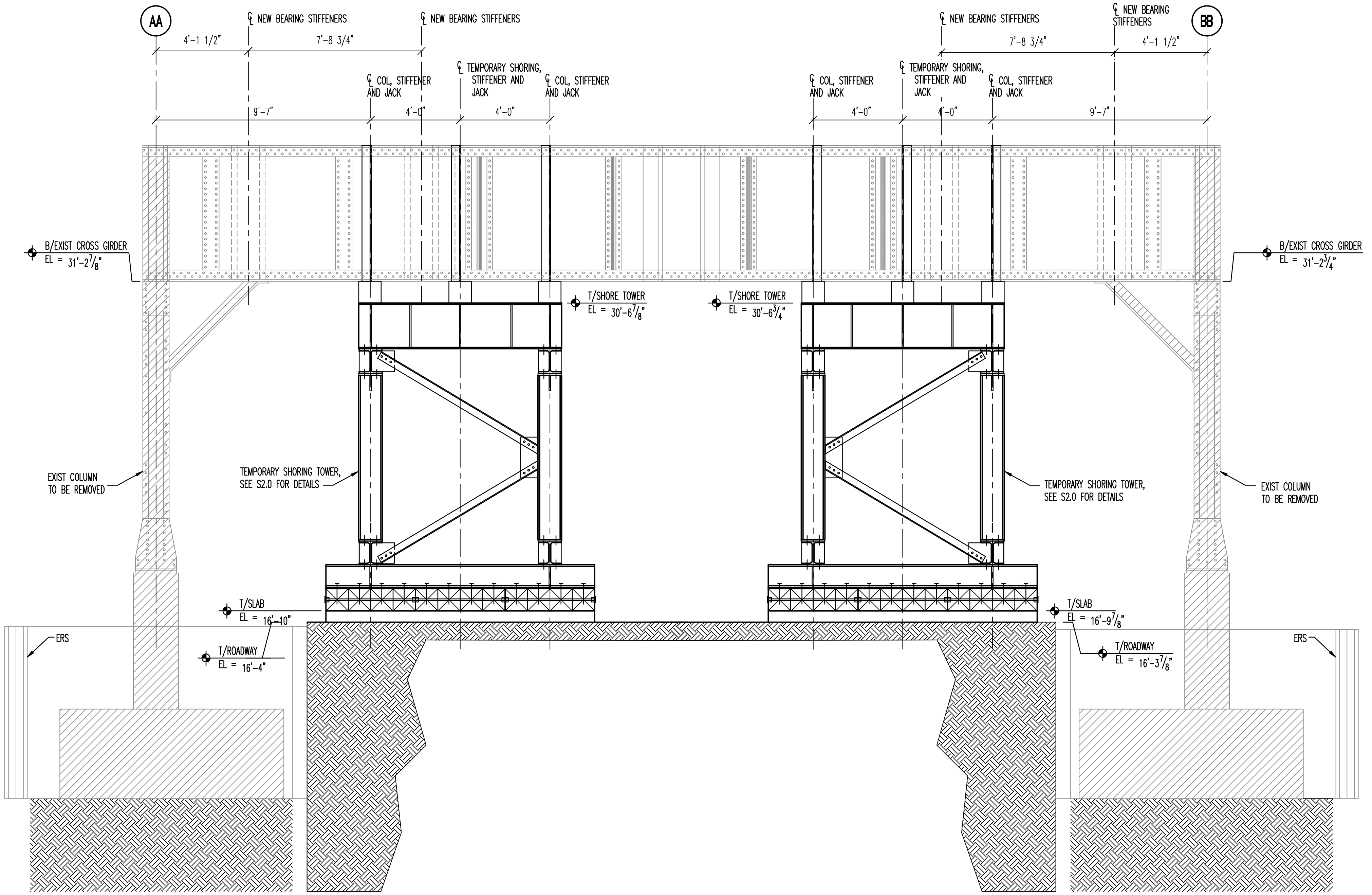
No.	Date	Description
	1/13/2022	FOR REVIEW
	2/10/2022	FOR REVIEW

Project#: 21210838.000
Drawn by: TB
Checked by: RAF

Sheet Title:
TEMPORARY SHORING SECTIONS @ BENT LINE 2226

S2.7

Structural Sheet: of 14



1 / S2.8 TEMPORARY SHORING SECTION @ BENT LINE 2227
3/8" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 2' 4' 8' 16' 24' 1/8" = 1'-0"
0 2' 4' 8' 16' 3/16" = 1'-0"
0 1' 2' 4' 8' 12' 1/4" = 1'-0"
0 1' 2' 4' 6' 9' 3/8" = 1'-0"
0 6" 1' 2' 4' 6' 1/2" = 1'-0"
0 4" 8" 16" 32" 4' 3/4" = 1'-0"
0 3" 6" 1' 2' 3' 1" = 1'-0"
0 2" 4" 8" 16" 2' 1 1/2" = 1'-0"
0 1" 2" 4" 8" 1' 3" = 1'-0"

Project Permit #: N/A

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630.357.0540 Fax: 630.357.0164
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LANSING, IL 60438

TEMPORARY SHORING FOR
CTA GREENLINE STATION
LAKE STREET
DAMEN AVE TO ASHLAND AVE
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SEAL
AMBER D.
DELLANGELO
081-007232
Amber Dellangelo

Date: 2/102022 Expires: 11/30/2022
IL Design Firm #: 184-001442

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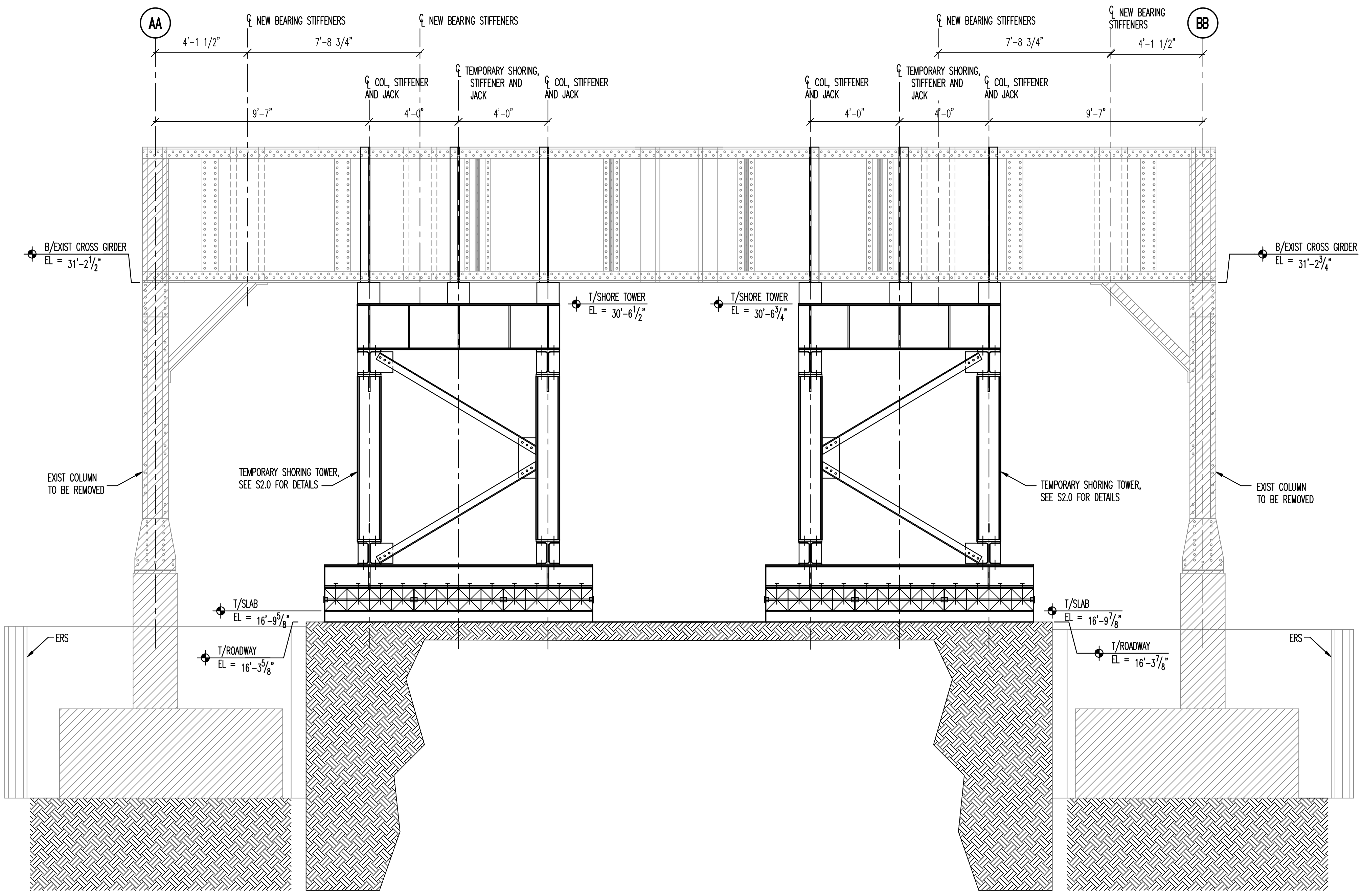
Project#: 21210838.000
Drawn by: TB
Checked by: RAF

Sheet Title:
TEMPORARY SHORING SECTIONS @ BENT LINE 2227

S2.8

Structural Sheet: of 14



1
S2.9
TEMPORARY SHORING SECTION @ BENT LINE 2228
3/8" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 2' 4' 8' 16' 24'
1/8" = 1'-0"

0 2' 4' 8' 16'
3/16" = 1'-0"

0 1' 2' 4' 8' 12'
1/4" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 6" 1' 2' 4' 6'
1/2" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"

0 3" 6" 1' 2' 3'
1" = 1'-0"

0 2" 4" 8" 16" 2'
1 1/2" = 1'-0"

0 1" 2" 4" 8" 1'
3" = 1'-0"

Project Permit #: N/A

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Amber Dellangelo

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	1/13/2022	FOR REVIEW
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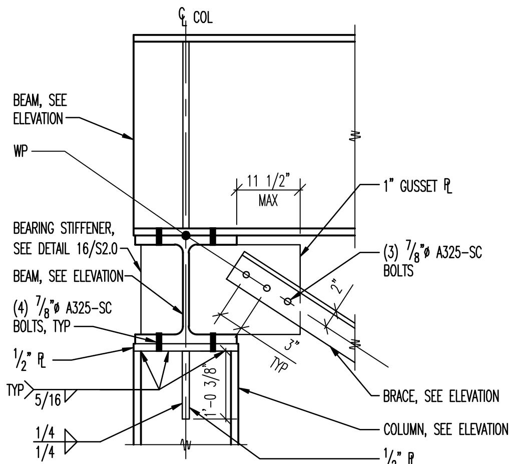
Project#: 21210838.000
Drawn by: TB
Checked by: RAF

Sheet Title:
TEMPORARY SHORING SECTIONS @ BENT LINE 2228

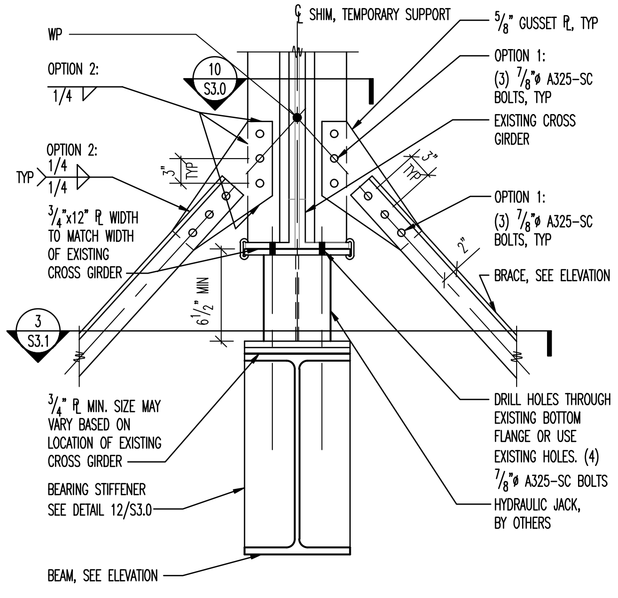
S2.9

Structural Sheet: of 14



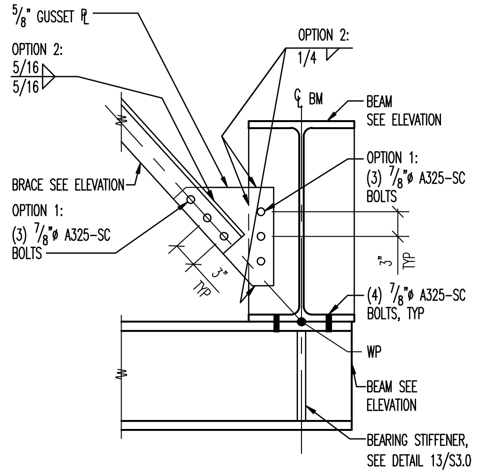
1 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



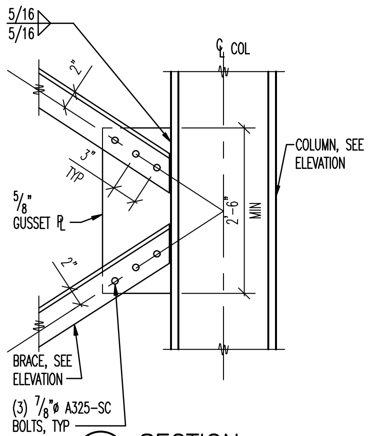
2 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



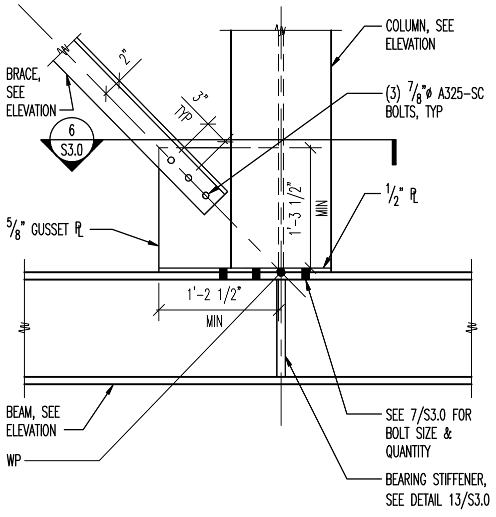
3 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



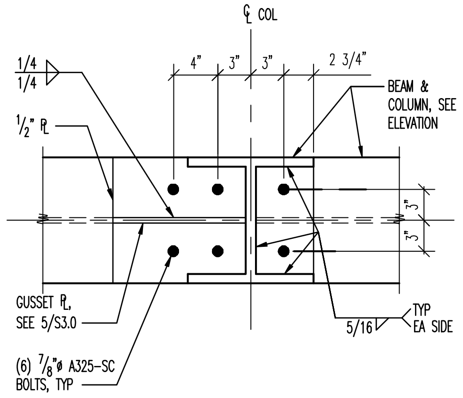
4 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



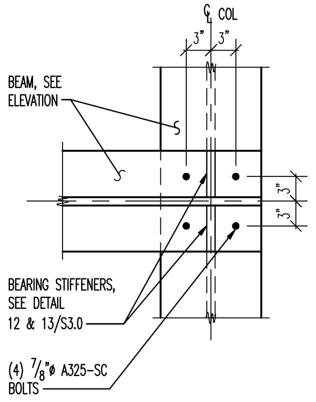
5 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



6 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



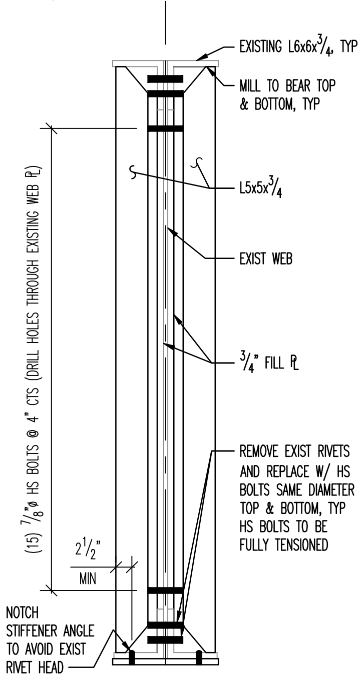
7 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"

NOT USED

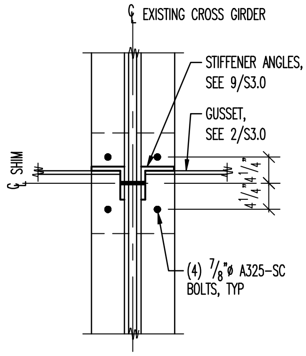
8 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



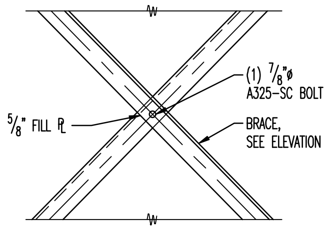
9 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



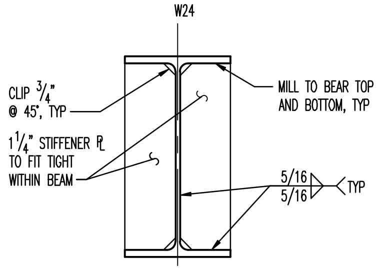
10 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



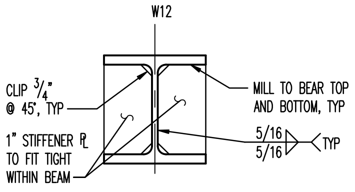
11 SECTION
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



12 W24 BEARING STIFFENER DETAIL
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"



13 W12 BEARING STIFFENER DETAIL
S3.0 3/4" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"

0 2' 4' 8' 16' 24' 1/8" = 1'-0"
0 2' 4' 8' 16' 3/16" = 1'-0"
0 1' 2' 4' 8' 12' 1/4" = 1'-0"
0 1' 2' 4' 6' 9' 3/8" = 1'-0"
0 6" 1' 2' 4' 6' 1/2" = 1'-0"
0 4" 8" 16" 32" 4' 3/4" = 1'-0"
0 3" 6" 1' 2' 3' 1" = 1'-0"
0 2" 4" 8" 16" 2' 1 1/2" = 1'-0"
0 1" 2" 4" 8" 1' 3" = 1'-0"

Project Permit #: N/A

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CLIENT:
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LANSING, IL 60438

TEMPORARY SHORING FOR CTA GREENLINE STATION
LAKE STREET
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CHICAGO, IL

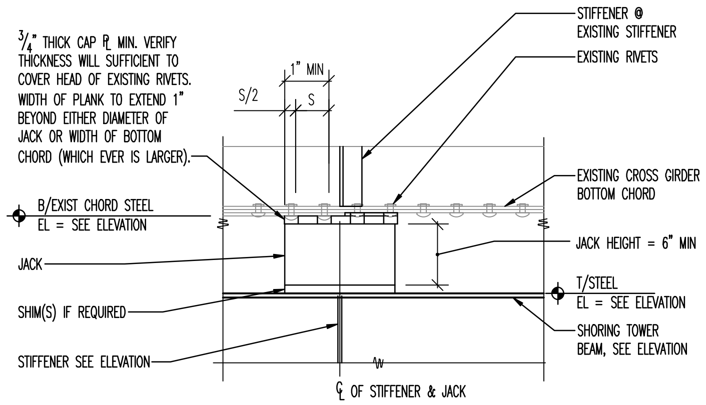
SEAL
AMBER D. DELLANGELO
081-007232
Date: 2/102022 Expires: 11/30/2022
IL Design Firm #: 184-001442

No.	Date	Description
	1/13/2022	FOR REVIEW
	2/10/2022	FOR REVIEW

Project#: 21210838.000
Drawn by: TB
Checked by: RAF
Sheet Title:
DETAILS

S3.0

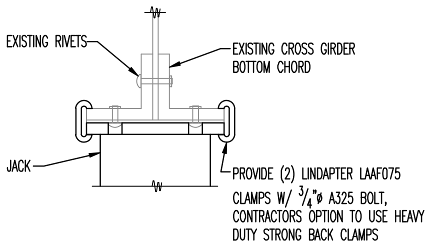
Structural Sheet: of 14



1 / S3.1 TYP JACK DETAIL @ CROSS GIRDER STEP

1 1/2" = 1'-0"

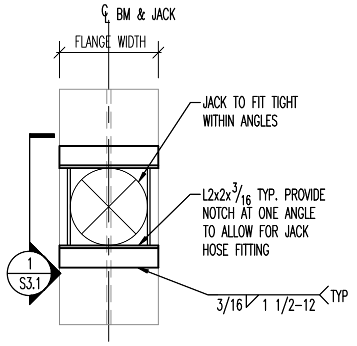
0 2" 4" 8" 16" 2'
1 1/2" = 1'-0"



2 / S3.1 CLAMP DETAIL @ JACK

1 1/2" = 1'-0"

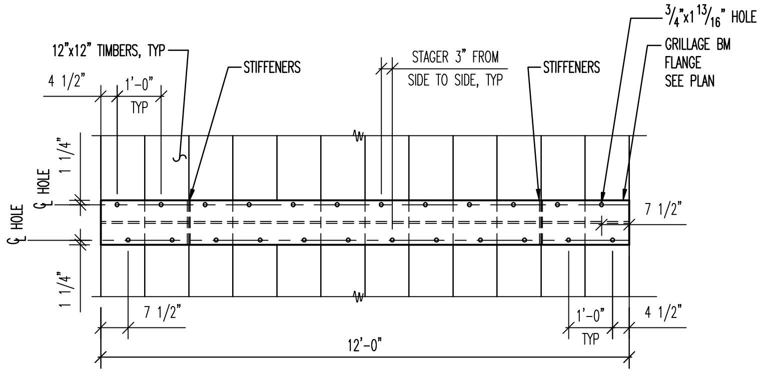
0 2" 4" 8" 16" 2'
1 1/2" = 1'-0"



3 / S3.1 PLAN @ JACK SEAT

1 1/2" = 1'-0"

0 2" 4" 8" 16" 2'
1 1/2" = 1'-0"



4 / S3.1 STIFFENERS AND HOLD PATTERNS AT GRILLAGE BEAM

1/2" = 1'-0"

0 6" 1' 2' 4' 6'
1/2" = 1'-0"

0 2' 4' 8' 16' 24'
1/8" = 1'-0"

0 2' 4' 8' 16'
3/16" = 1'-0"

0 1' 2' 4' 8' 12'
1/4" = 1'-0"

0 1' 2' 4' 6' 9'
3/8" = 1'-0"

0 6" 1' 2' 4' 6'
1/2" = 1'-0"

0 4" 8" 16" 32" 4'
3/4" = 1'-0"

0 3" 6" 1' 2' 3'
1" = 1'-0"

0 2" 4" 8" 16" 2'
1 1/2" = 1'-0"

0 1" 2" 4" 8" 1'
3" = 1'-0"

Project Permit #: N/A

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081-007232

Amber DellAngelo

Date: 2/102022 Expires: 11/30/2022
IL Design Firm #: 184-001442

No.	Date	Description
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	2/10/2022	FOR REVIEW

Project#: 21210838.000

Drawn by: TB

Checked by: RAF

Sheet Title:

DETAILS

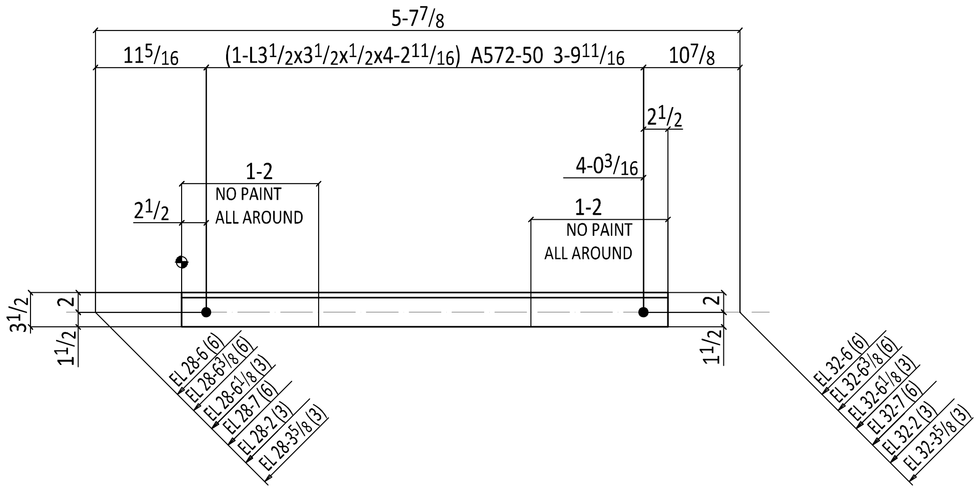
S3.1

Structural Sheet: of 14

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	27	VERTICAL BRACE				PRIME	47
1D1	27	L3 1/2x3 1/2x1/2	4	2 11/16	A572-50		47
		FIELD BOLTS					
	54	7/8 Dia A307	0	2 1/2		+1HD WASH	

Total weight : 1266



27 VERTICAL BRACES 1D1

SHOP NOTE:
TOE DIRECTION NEAR SIDE
FIELD BOLTS:
2-7/8Diax2 1/2 A307 +1HD WASH [total=54]

REF. DRG. 1E8

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

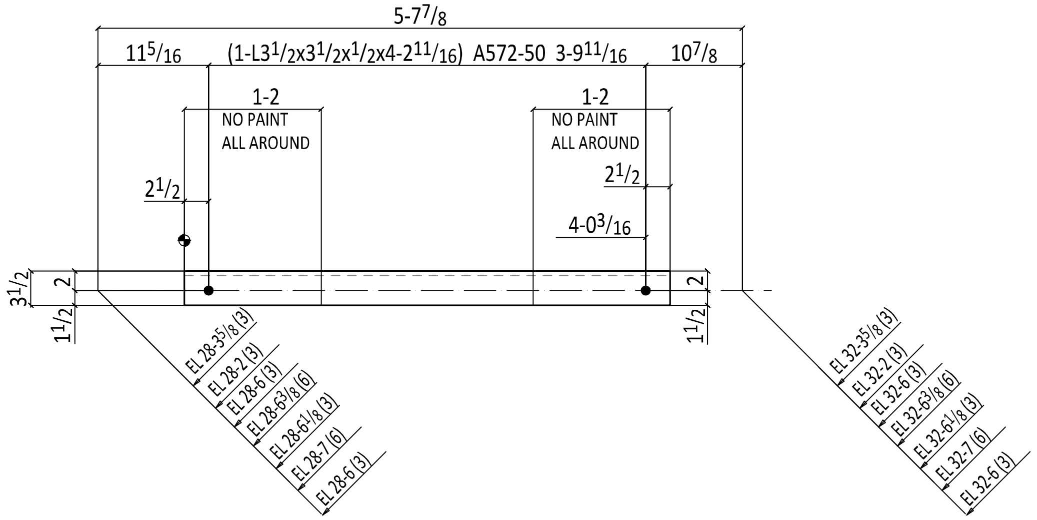
DESCRIPTION: BRACING DETAIL

DATE 08-03-2022 | JOB No. 704 | DRG No. 1D1 | REV. A

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	IN	STEEL GRADE	REMARKS	Weight Unit
	27	VERTICAL BRACE				PRIME	47
1D2	27	L$3^1/_2$x$3^1/_2$x$^1/_2$	4	$2^{11}/_{16}$	A572-50		47
		FIELD BOLTS					
	54	$^7/_8$ Dia A307	0	$2^1/_2$		+1HD WASH	

Total weight : 1266



27 VERTICAL BRACES 1D2

SHOP NOTE:
TOE DIRECTION FAR SIDE
FIELD BOLTS:
2-$^7/_8$Diax$2^1/_2$ A307 +1HD WASH [total=54]

REF. DRG. 1E8

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. $^{15}/_{16}$"	WELD SIZE U.N.O. $^1/_4$" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. $^1/_2$"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

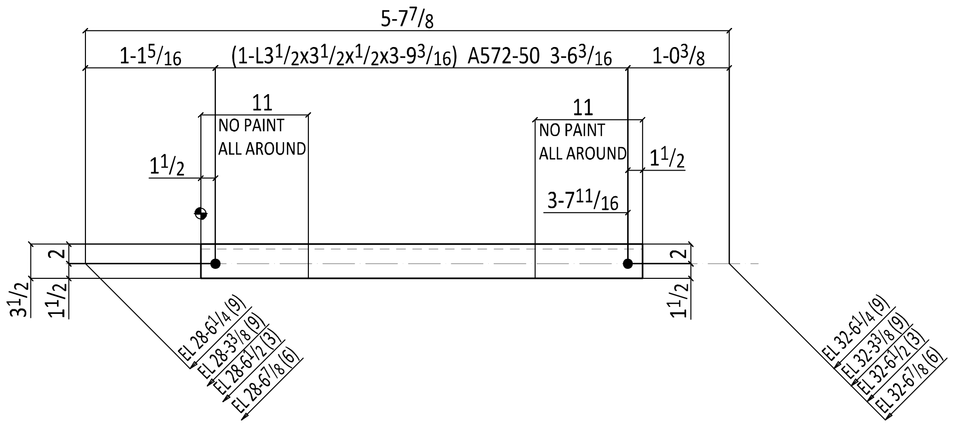
DESCRIPTION: BRACING DETAIL

DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1D2	A

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	27	**VERTICAL BRACE**				**PRIME**	**42**
1D3	**27**	**L3$^1/_2$x3$^1/_2$x$^1/_2$**	**3**	**9$^3/_{16}$**	**A572-50**		**42**
		FIELD BOLTS					
	54	**$^7/_8$ Dia A307**	**0**	**2$^1/_2$**		**+1HD WASH**	

Total weight : 1129



27 VERTICAL BRACES 1D3

SHOP NOTE:
TOE DIRECTION FAR SIDE
FIELD BOLTS:
2-$^7/_8$Diax2$^1/_2$ A307 +1HD WASH [total=54]

REF. DRG. 1E8

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. $^{15}/_{16}$"
WELD SIZE U.N.O. $^1/_4$" UN
FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. $^1/_2$"
WELD ELECTRODES U.N.O. E70xx
SURFACE PREP U.N.O. SSPC-SP3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

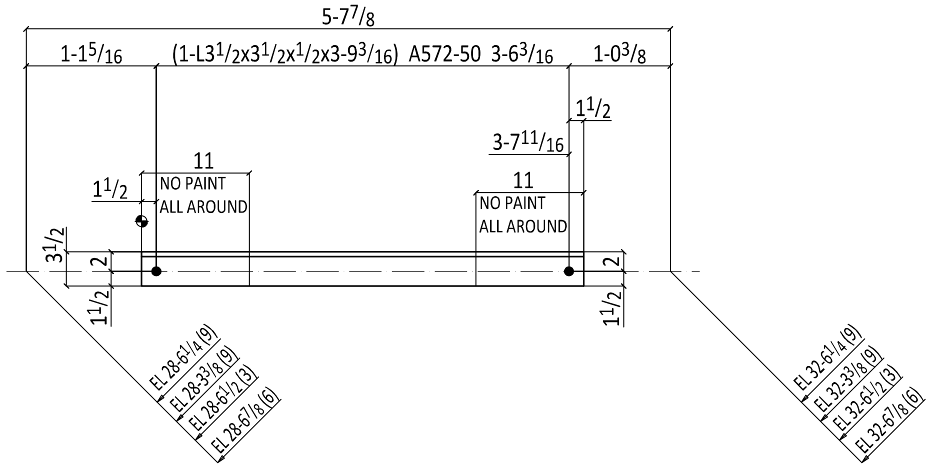
SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---
PROJECT: CTA GREEN LINE SHORING TOWERS
DESCRIPTION: BRACING DETAIL
DATE 08-03-2022
JOB No. 704
DRG No. 1D3
REV. A

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	27	VERTICAL BRACE				PRIME	42
1D4	27	L3 1/2x3 1/2x1/2	3	9 3/16	A572-50		42
		FIELD BOLTS					
	54	7/8 Dia A307	0	2 1/2		+1HD WASH	

Total weight : 1129



27 VERTICAL BRACES 1D4

SHOP NOTE:
TOE DIRECTION NEAR SIDE
FIELD BOLTS:
2-7/8Diax2 1/2 A307 +1HD WASH [total=54]

REF. DRG. 1E8

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

SYNERGY STEEL STRUCTURES, INC.
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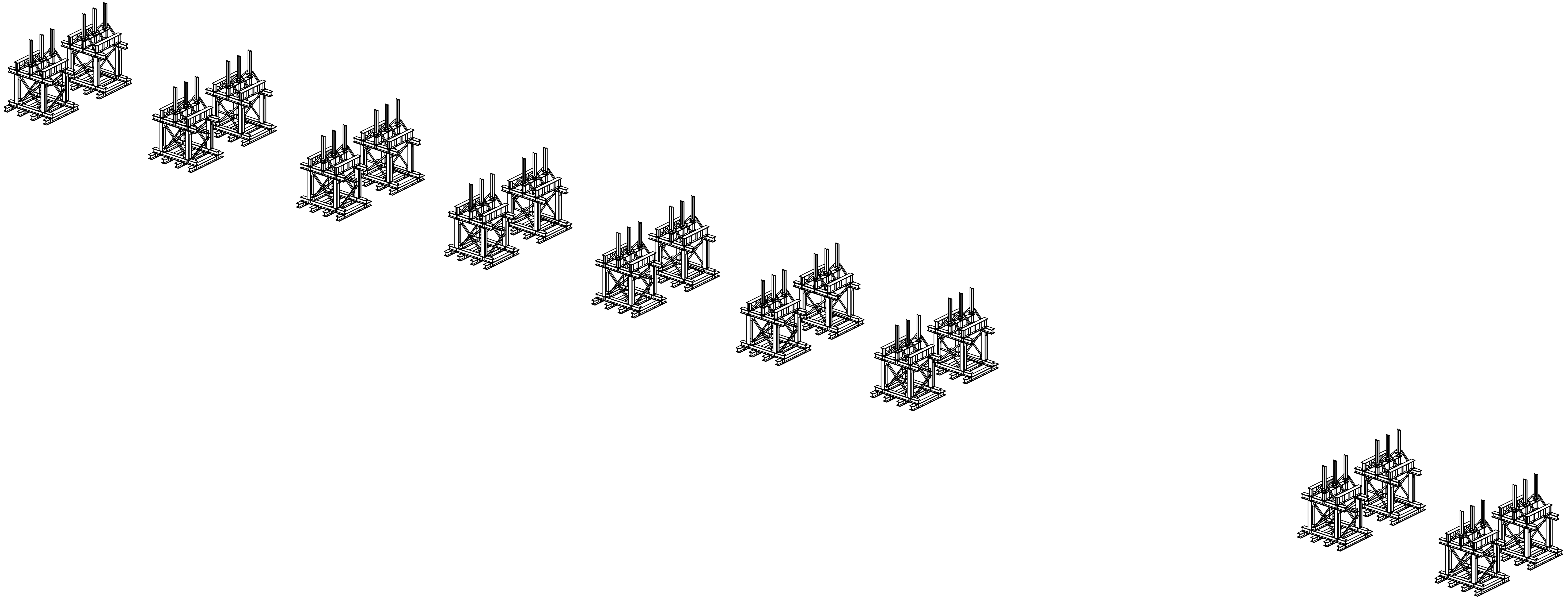
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: BRACING DETAIL

DATE 08-03-2022 JOB No. 704 DRG No. 1D4 REV. A



ISOMETRIC VIEW

REF. DRG.--

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. $^1/_4$" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: ISOMETRIC VIEW

DATE 08-03-2022	JOB No. 704	DRG No. 1E0	REV. A

SHORING LAYOUT PLAN

(REF. DWG. 1/S1.0)

NOTE:

1.FOR TOS ELEVATIONS REFER SECTION VIEW 1E3 THRU 1E7.

2.ALL CONNECTION BOLTS ARE 7/8" DIA-SC A325 HEAVY HEX BOLTS. (GALV) UNO.

APPROVER PLEASE VERIFY/CONFIRM:

NOTE-1:- PLEASE CONFIRM OUTLINE OF SHORING DIMENSION IS CENTER LINE OF COLUMN DIMENSION AS PER STRUCTURAL SECTION "S1.0".

NOTE-2:- PLEASE VERIFY IN FIELD DIMENSION BETWEEN EXISTING COLUMNS

SEQUENCING:

1.BENT LINES 2218 & 2222 TO BE SHORED AT THE SAME TIME.
2.BENT LINES 2219 TO BE SHORED.
3.BENT LINES 2223 & 2224 TO BE SHORED AT THE SAME TIME.
4.BENT LINES 2225 & 2226 TO BE SHORED AT THE SAME TIME.
5.BENT LINES 2227 & 2228 TO BE SHORED AT THE SAME TIME.
6.SHORING SEQUENCE SUBJECT TO CHANGE UPON FIELD CONDITION. MAXIMUM (4) BENTS SHORED AT THE SAME TIME PER THE EOR DIRECTION.

REF. DRG. S1.0

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. 1/4" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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Lansing, IL 60438
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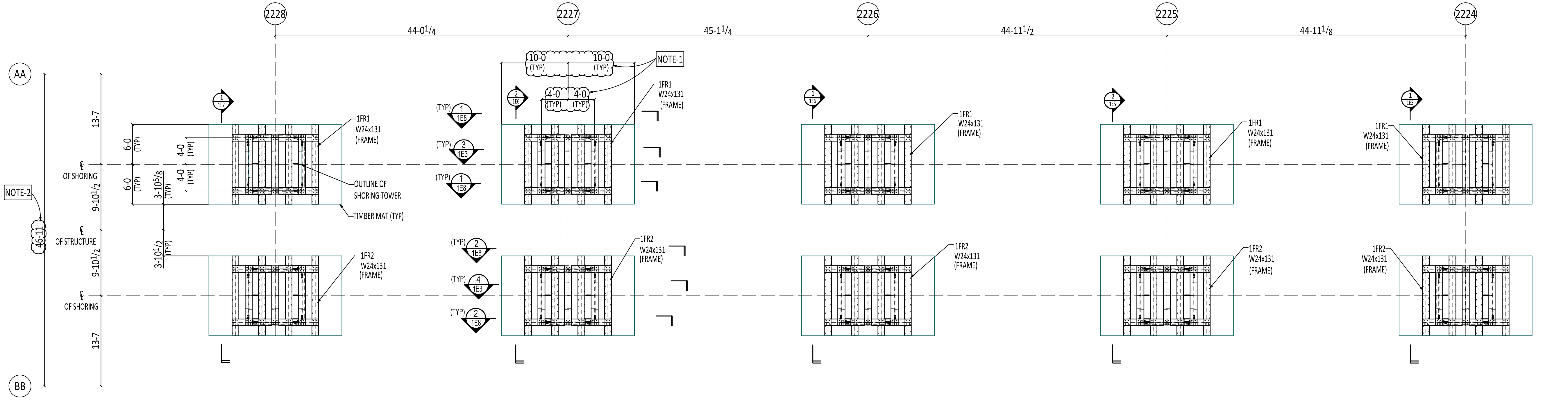
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: SHORING LAYOUT PLAN

DATE 08-03-2022	JOB No. 704	DRG No. 1E1	REV. A



SHORING LAYOUT PLAN

(REF. DWG. 1/S1.1)

NOTE:

1.FOR TOS ELEVATIONS REFER SECTION VIEW 1E3 THRU 1E7.

2.ALL CONNECTION BOLTS ARE $^7/_8$" DIA-SC A325 HEAVY HEX BOLTS. (GALV) UNO.

APPROVER PLEASE VERIFY/CONFIRM:

NOTE-1:-ON PLAN S1.1, SHORING OUTLINE & TIMBER MAT DIMENSION LOOKS OFF CENTER IN EAST WEST DIRECTION FOR BENT LINE 2227, PLEASE ADVISE IF THOSE ARE CORRECT & THIS IS APPLICABLE FOR ALL BENT LINES SHOWN ON S1.1.

NOTE-2:- PLEASE VERIFY IN FIELD DIMENSION BETWEEN EXISTING COLUMNS

SEQUENCING:

1.BENT LINES 2218 & 2222 TO BE SHORED AT THE SAME TIME.
2.BENT LINES 2219 TO BE SHORED.
3.BENT LINES 2223 & 2224 TO BE SHORED AT THE SAME TIME.
4.BENT LINES 2225 & 2226 TO BE SHORED AT THE SAME TIME.
5.BENT LINES 2227 & 2228 TO BE SHORED AT THE SAME TIME.
6.SHORING SEQUENCE SUBJECT TO CHANGE UPON FIELD CONDITION.
MAXIMUM (4) BENTS SHORED AT THE SAME TIME PER THE EOR DIRECTION.

REF. DRG. S1.1

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. $^1/_4$" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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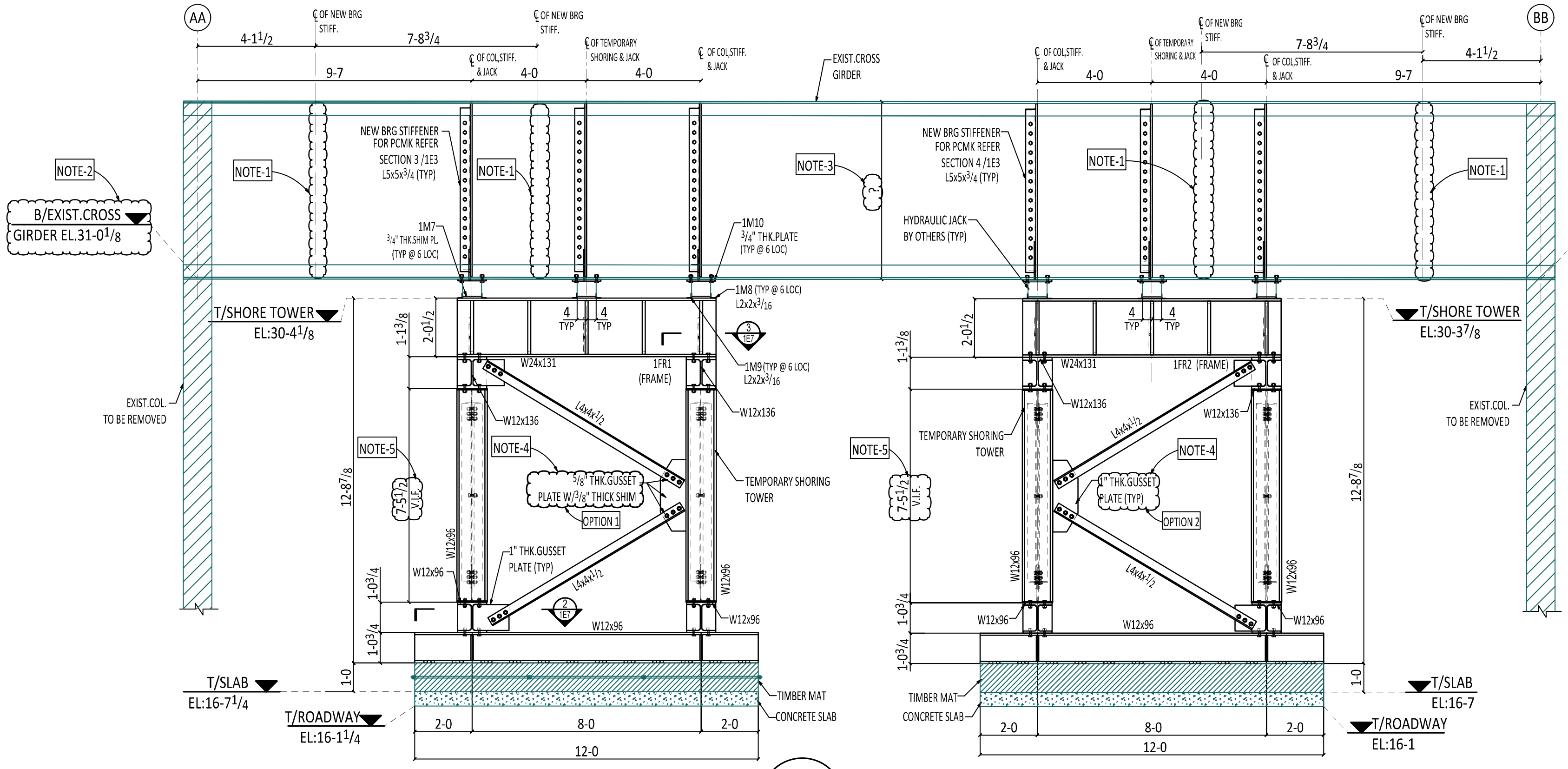
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: SHORING LAYOUT PLAN

DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1E2	A

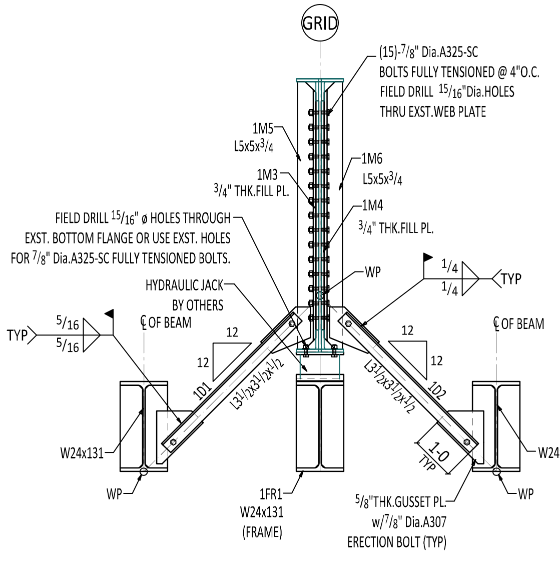


1 SECTION VIEW

1E3

(REF:1/S2.1)

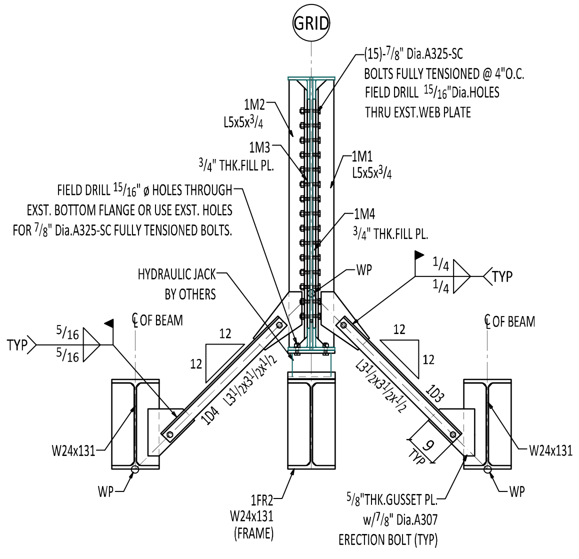
TEMPORARY SHORING SECTION @ BENT LINE 2218



3 SECTION VIEW

1E3

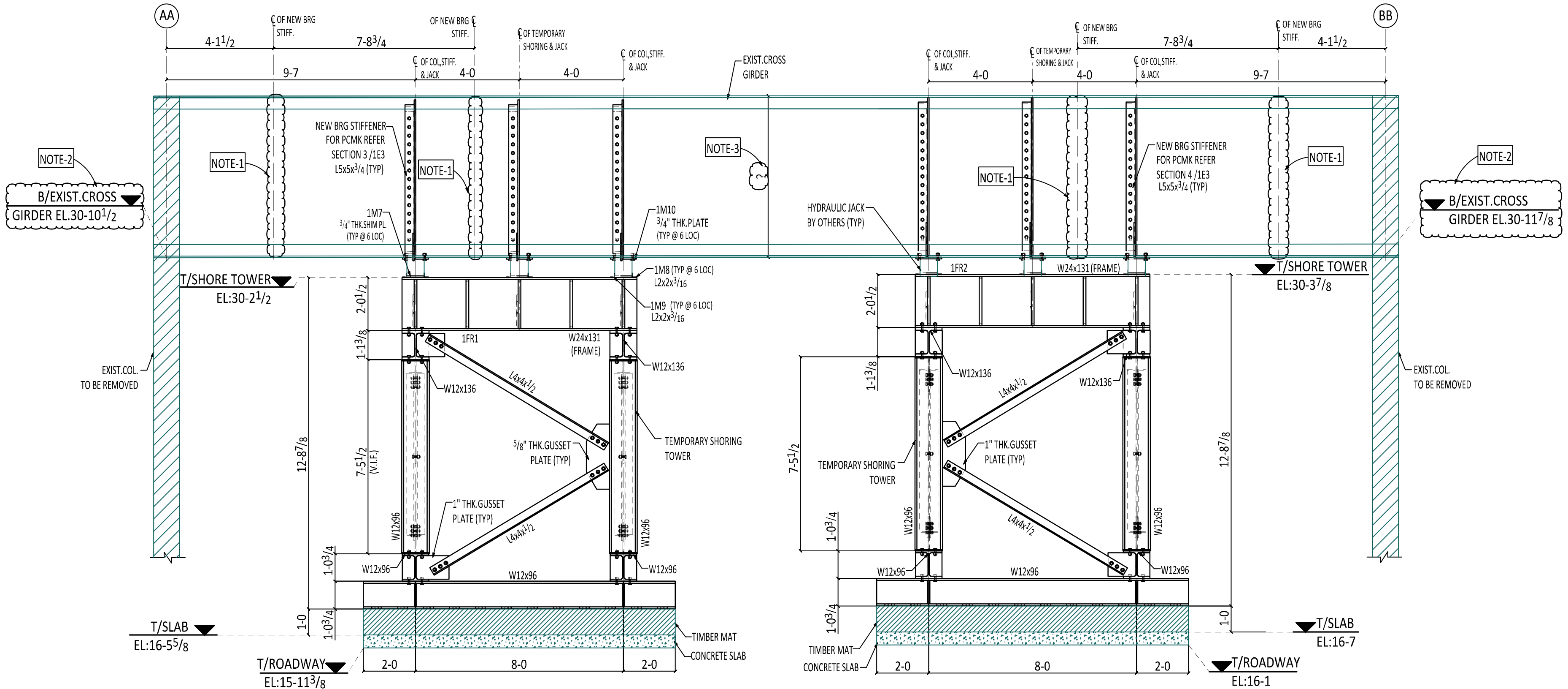
(REF:2/S3.0)



4 SECTION VIEW

1E3

(REF:2/S3.0)



2 SECTION VIEW

1E3

(REF:1/S2.2)

TEMPORARY SHORING SECTION @ BENT LINE 2219

APPROVER PLEASE VERIFY/CONFIRM:

NOTE-1:-STRUCTURAL SECTION VIEWS DRAWINGS S2.1 THRU S2.9 SHOWS NEW BEARING STIFFENER DIMENSIONS AT EXISTING GIRDER, BUT NO ANY SECTION IS CALLED OUT FOR NEW BEARING STIFFENERS. PLEASE ADVISE DO WE NEED TO FOLLOW SECTION "9/S3.0" FOR STIFFENERS AT MARKED LOCATIONS.

NOTE 2:-PLEASE VERIFY IN FIELD CLOUDED EXISTING BOTTOM OF GIRDER ELEVATION.

NOTE-3:-PLEASE PROVIDE ACTUAL DEPTH OF EXISTING CROSS GIRDER AT EVERY BENT LINE, AS IT AFFECTS ON NEW BEARING STIFFENERS HEIGHT.

NOTE-4:- STRUCTURAL SECTION "4/S3.0" SHOWS 5/8" THICK GUSSET PLATE BUT AT OTHER END OF VERTICAL BRACE 1" THICK GUSSET PLATE IS SHOWN IN SECTION "1/S3.0". PLEASE REFER BOTH OPTIONS SHOWN IN SECTION "1/ 1E3" AND ADVISE WHICH OPTION IS GOOD TO PROCEED.

NOTE-5:-TYPICAL TEMPORARY SHORING SECTIONS "1/S2.0 & 2/S2.0" SHOWS DIFFERENT COLUMN DEPTH DIMENSIONS. PLEASE CONFIRM WE HAVE FOLLOWED AS PER SHOWN IN SECTION "1/S2.0" ALONG EACH BENT LINES.

REF. DRG. S2.1,S2.2,S3.0

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. 1/4" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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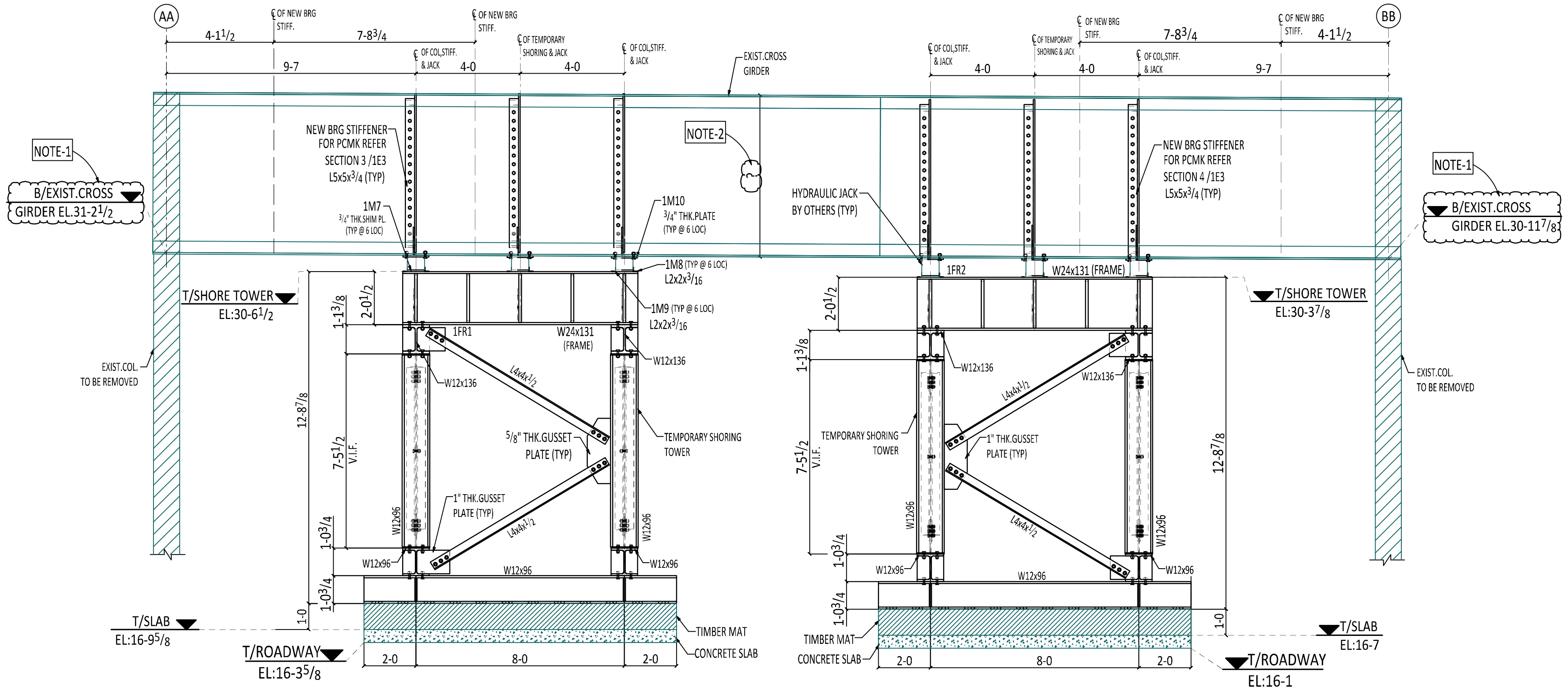
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: SHORING SECTION

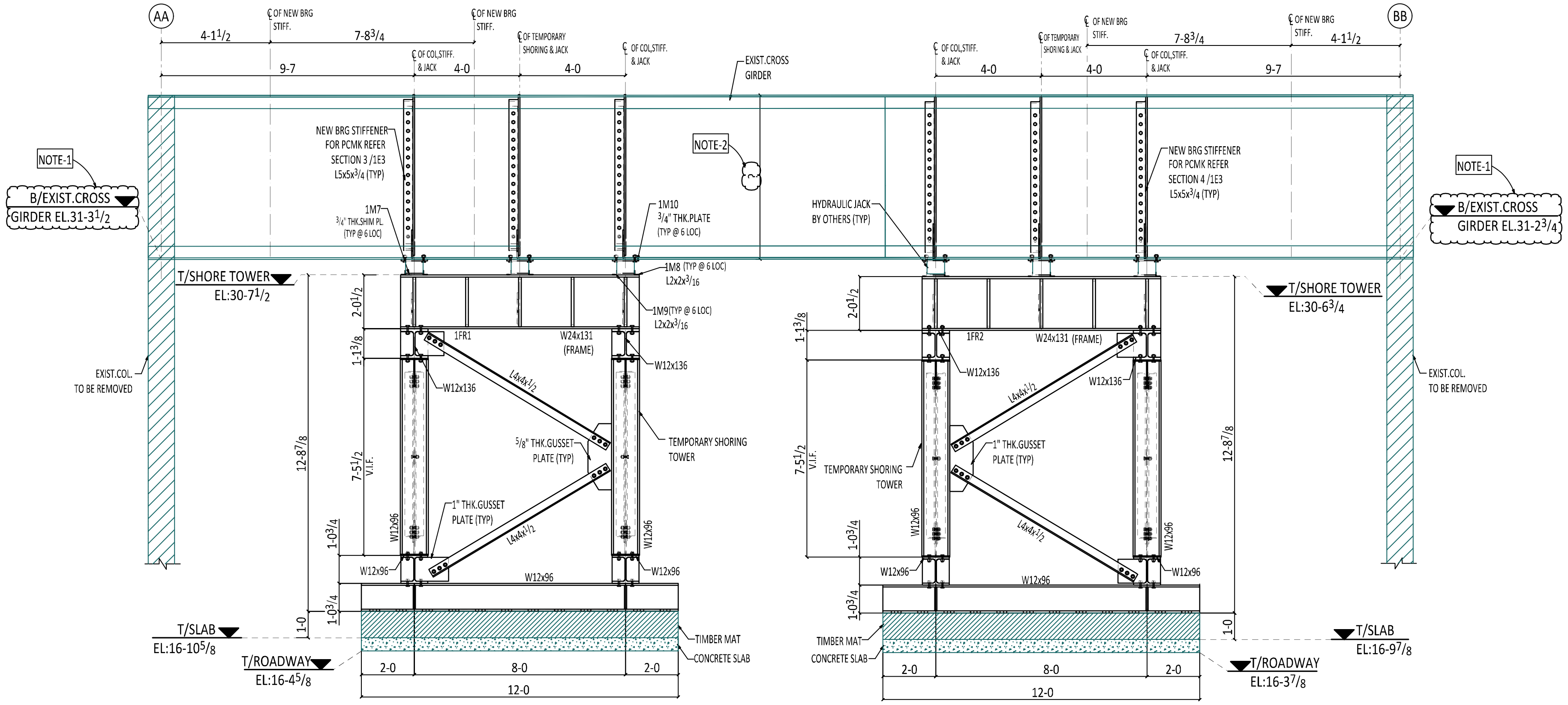
DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1E3	A



1 SECTION VIEW 1E4

(REF:1/S2.3)

TEMPORARY SHORING SECTION @ BENT LINE 2222



2 SECTION VIEW 1E4

(REF:1/S2.4)

TEMPORARY SHORING SECTION @ BENT LINE 2223

APPROVER PLEASE VERIFY/CONFIRM:
NOTE-1:-PLEASE VERIFY CLOUDED EXISTING BOTTOM OF GIRDER ELEVATION.
NOTE-2:-PLEASE PROVIDE ACTUAL DEPTH OF EXISTING CROSS GIRDER AT EVERY BENT LINE AS IT AFFECTS ON NEW BEARING STIFFENERS HEIGHT.

V.I.F.--INDICATES VERIFY IN FIELD

REF. DRG. S2.3,S2.4

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. 1/4" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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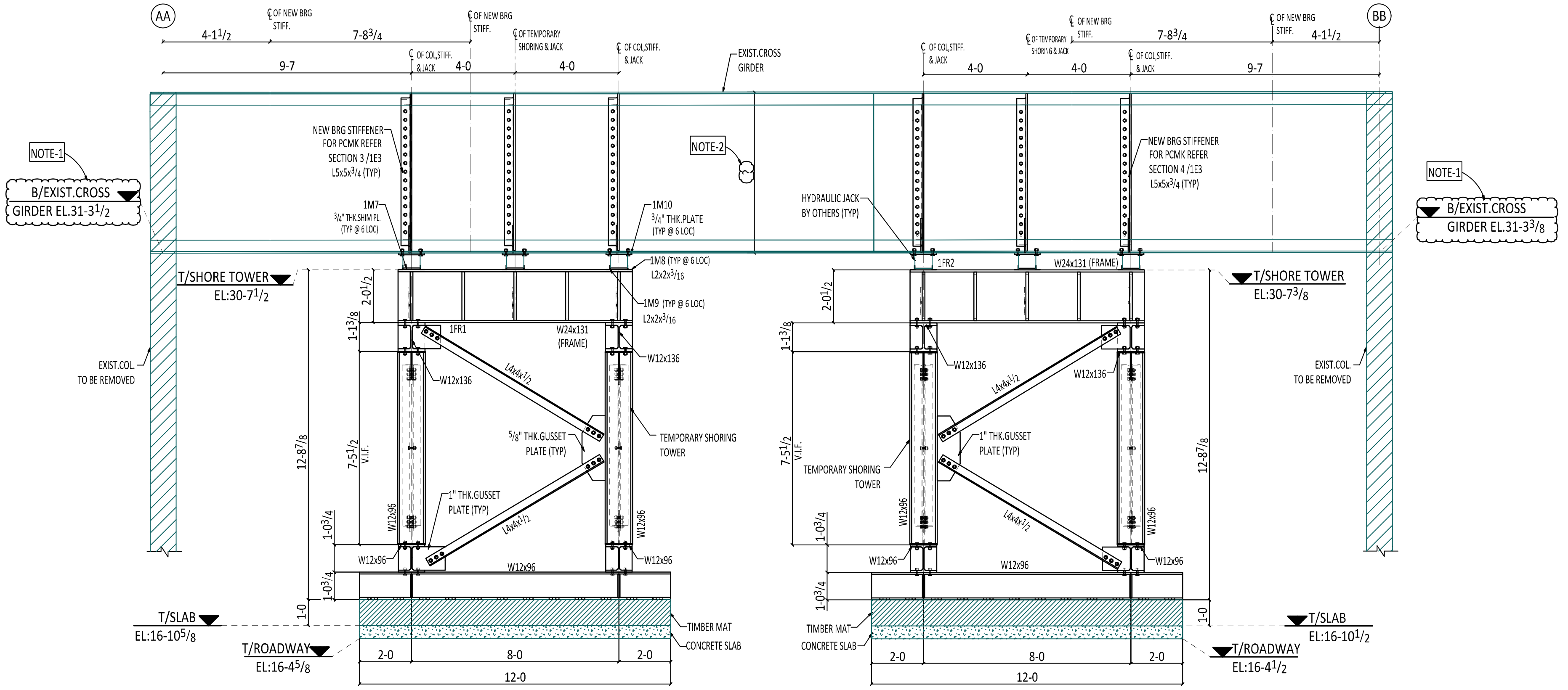
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: SHORING SECTION

DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1E4	A

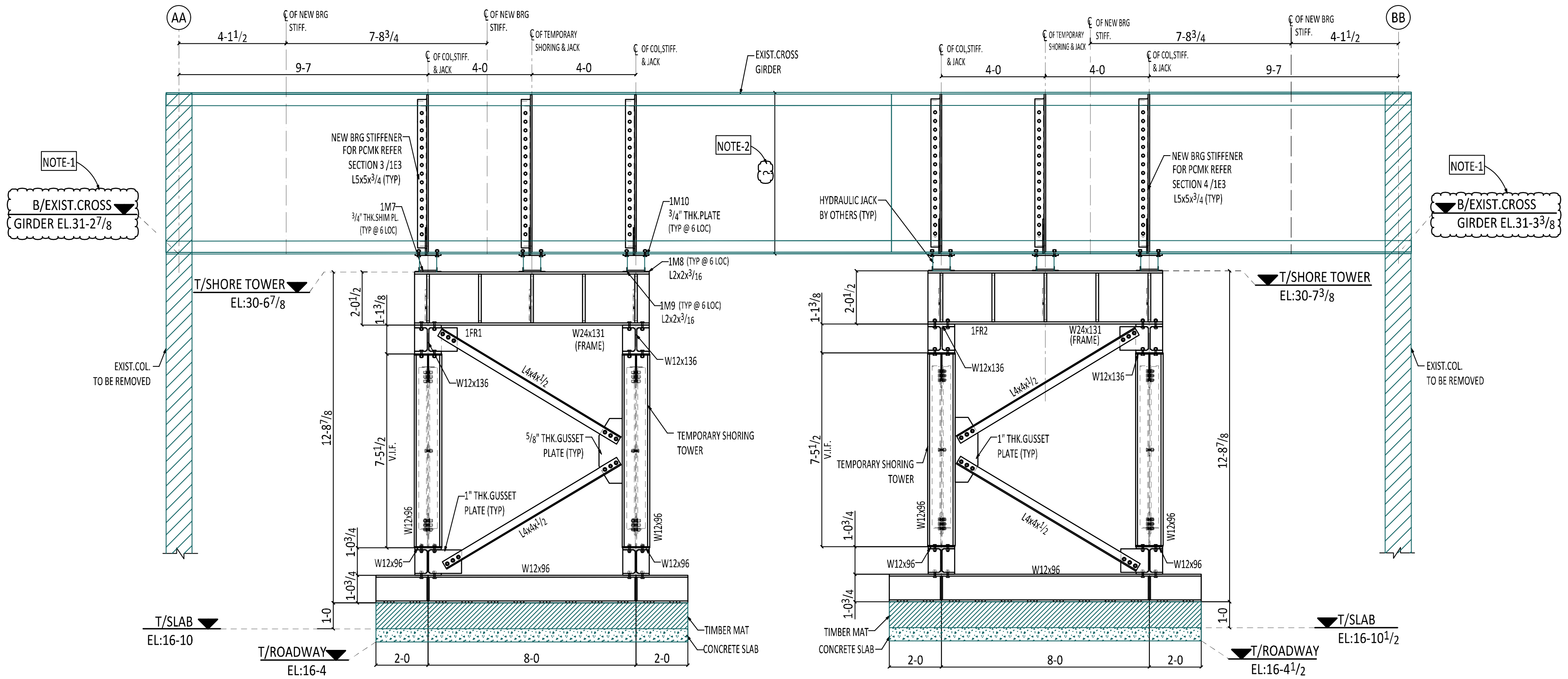


1 SECTION VIEW

1E5

(REF:1/S2.5)

TEMPORARY SHORING SECTION @ BENT LINE 2224



2 SECTION VIEW

1E5

(REF:1/S2.6)

TEMPORARY SHORING SECTION @ BENT LINE 2225

APPROVER PLEASE VERIFY/CONFIRM:
NOTE-1:-PLEASE VERIFY CLOUDED EXISTING BOTTOM OF GIRDER ELEVATION.
NOTE-2:-PLEASE PROVIDE ACTUAL DEPTH OF EXISTING CROSS GIRDER AT EVERY BENT LINE AS IT AFFECTS ON NEW BEARING STIFFENERS HEIGHT.

V.I.F.--INDICATES VERIFY IN FIELD

REF. DRG. S2.5,S2.6

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. 1/4" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

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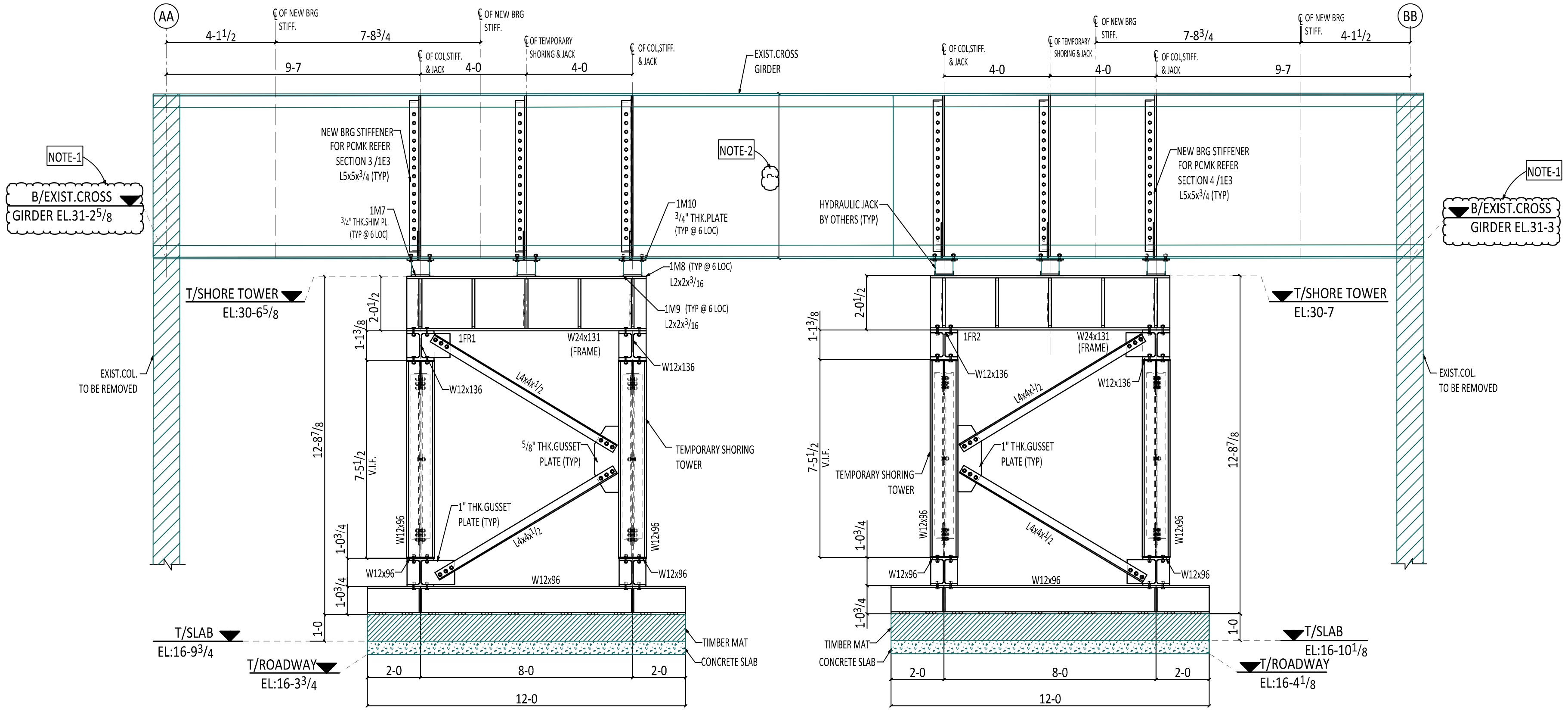
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: SHORING SECTION

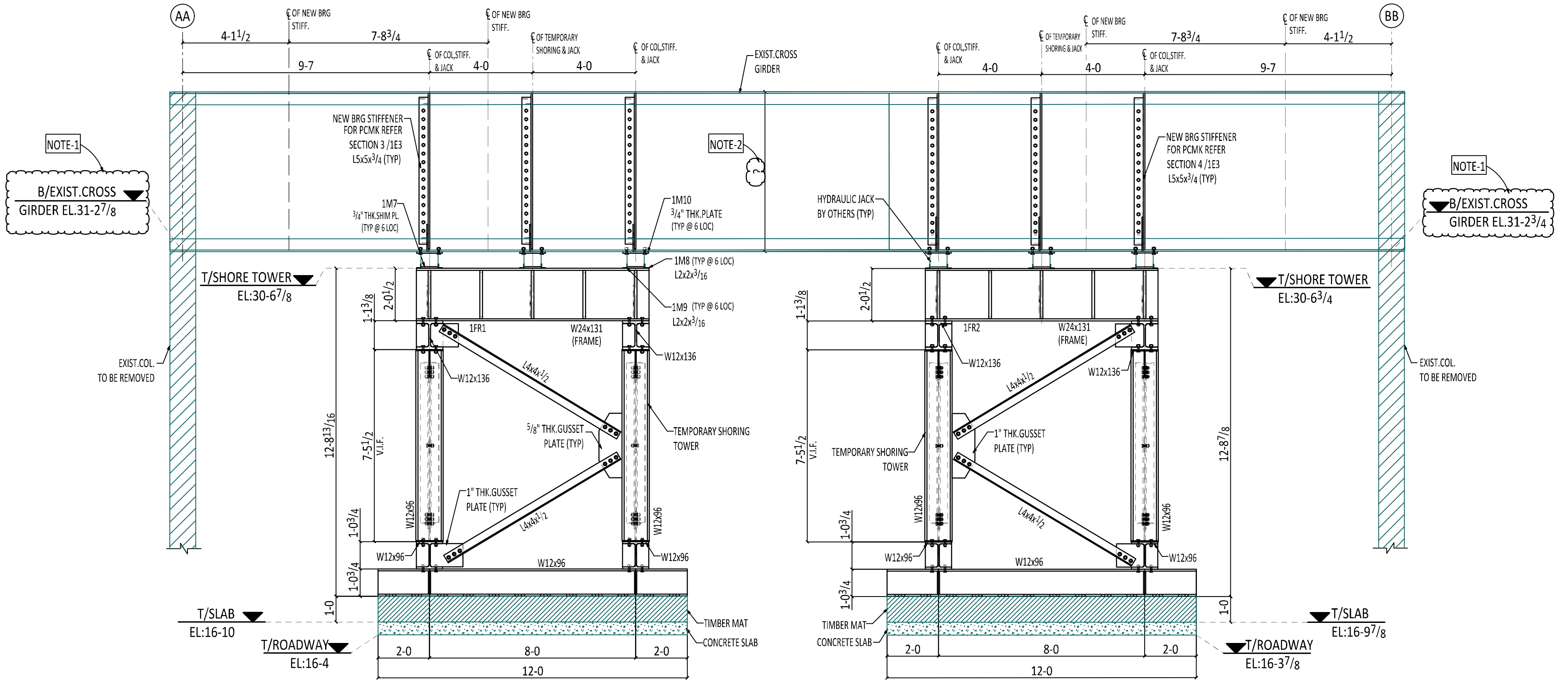
DATE 08-03-2022	JOB No. 704	DRG No. 1E5	REV. A



1 / 1E6 SECTION VIEW

(REF:1/S2.7)

TEMPORARY SHORING SECTION @ BENT LINE 2226



2 / 1E6 SECTION VIEW

(REF:1/S2.8)

TEMPORARY SHORING SECTION @ BENT LINE 2227

APPROVER PLEASE VERIFY/CONFIRM:
NOTE-1:-PLEASE VERIFY CLOUDED EXISTING BOTTOM OF GIRDER ELEVATION.
NOTE-2:-PLEASE PROVIDE ACTUAL DEPTH OF EXISTING CROSS GIRDER AT EVERY BENT LINE AS IT AFFECTS ON NEW BEARING STIFFENERS HEIGHT.

V.I.F.--INDICATES VERIFY IN FIELD

REF. DRG. S2.7,S2.8

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. 1/4" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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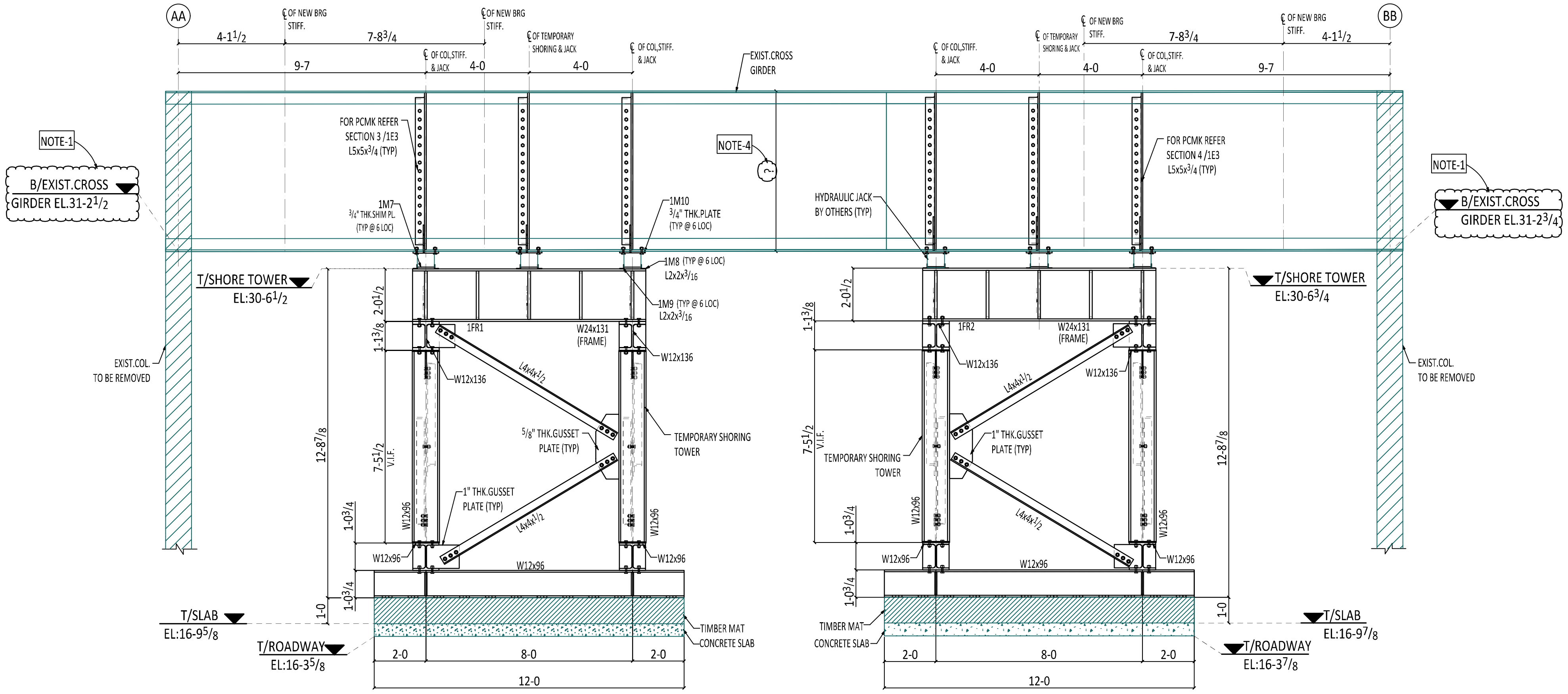
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: SHORING SECTION

DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1E6	A

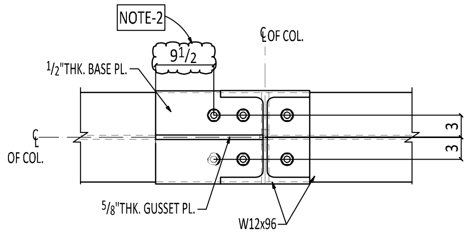


1
1E7

SECTION VIEW

(REF:1/S2.9)

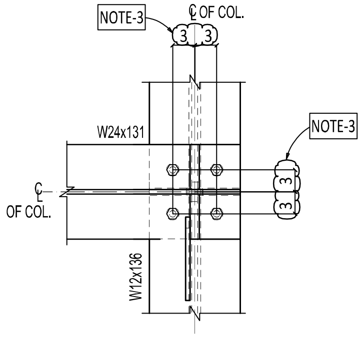
TEMPORARY SHORING SECTION @ BENT LINE 2228



2
1E7

SECTION VIEW

(REF:6/S3.0)



3
1E7

SECTION VIEW

(REF:7/S3.0)

APPROVER PLEASE VERIFY/CONFIRM:
NOTE 1:-PLEASE VERIFY CLOUDED EXISTING BOTTOM OF GIRDER ELEVATION.
NOTE-2:-PLEASE ADVISE ON REQUIREMENT OF BOLT ROWS AT EXTENDED BASE PLATE LOCATION.
NOTE-3:-STANDARD BEAM GAGE DIMENSION IS 5 1/2" BUT SECTION SHOWS 6" GAGE DIMENSION.
PLEASE CONFIRM WE ARE USING 6" GAGE AS PER GIVEN IN SECTION "7/S3.0"
NOTE-4:-PLEASE PROVIDE ACTUAL DEPTH OF EXISTING CROSS GIRDER AT EVERY BENT LINE
AS IT AFFECTS ON NEW BEARING STIFFENERS HEIGHT.

V.I.F.--INDICATES VERIFY IN FIELD

REF. DRG. S2.9,S3.0

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. 1/4" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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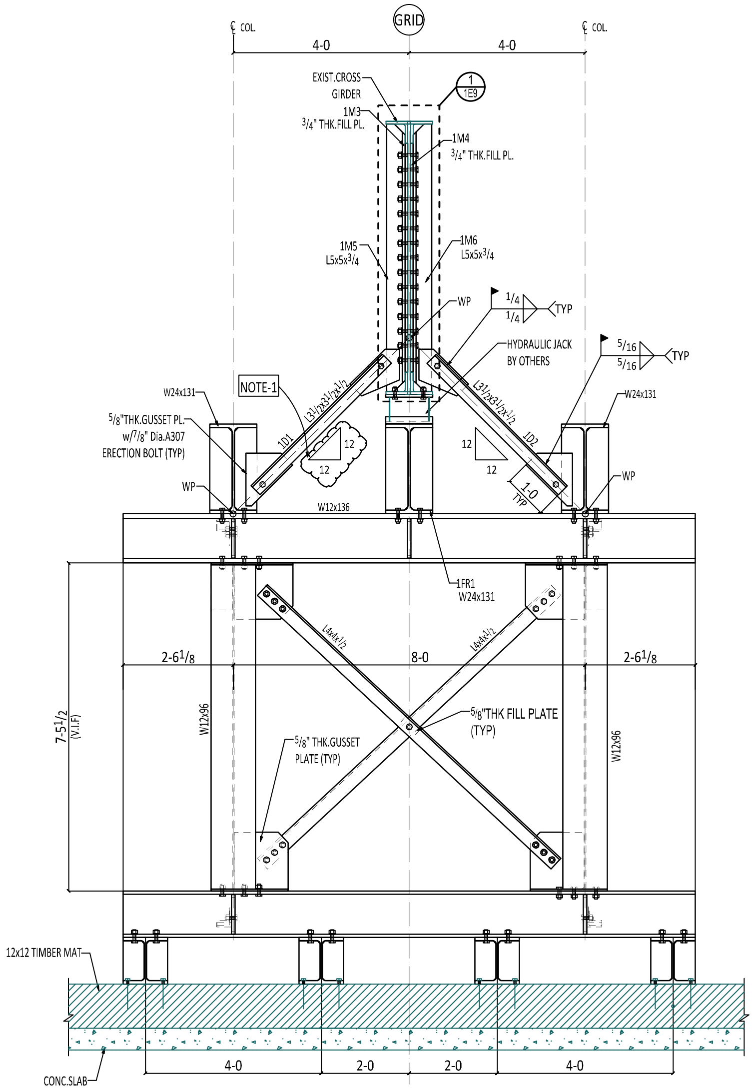
CUSTOMER NAME: ---

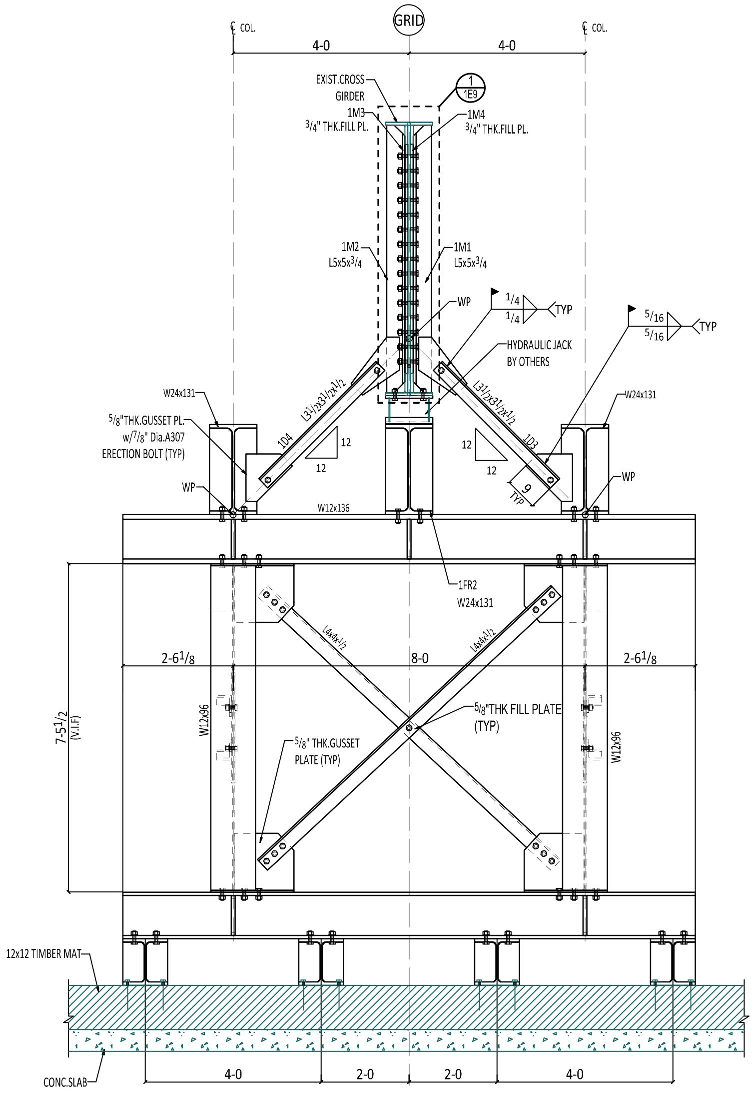
PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: SHORING SECTION

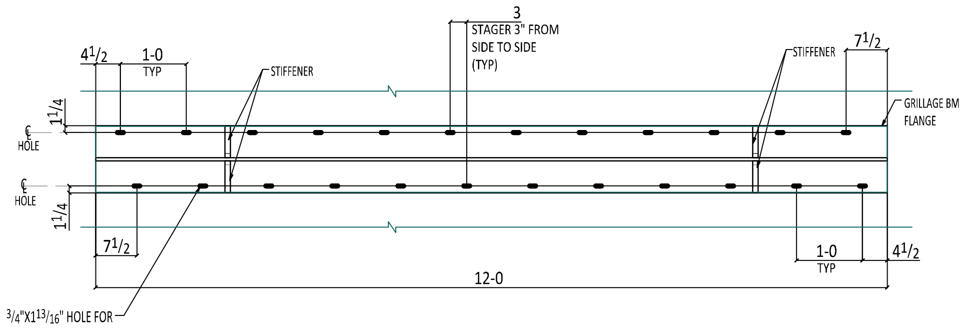
DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1E7	A



1
1E8
SECTION VIEW
(REF:2/S2.0)



2
1E8
SECTION VIEW
(REF:2/S2.0)



STIFFERNERS & HOLE PATTERNS AT GRILLAGE BEAM

(REF:4/S3.1)

APPROVER PLEASE VERIFY/CONFIRM:
NOTE-1:- PLEASE VERIFY BEVEL OF BRACE

REF. DRG. S2.0,S3.1

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. 1/4" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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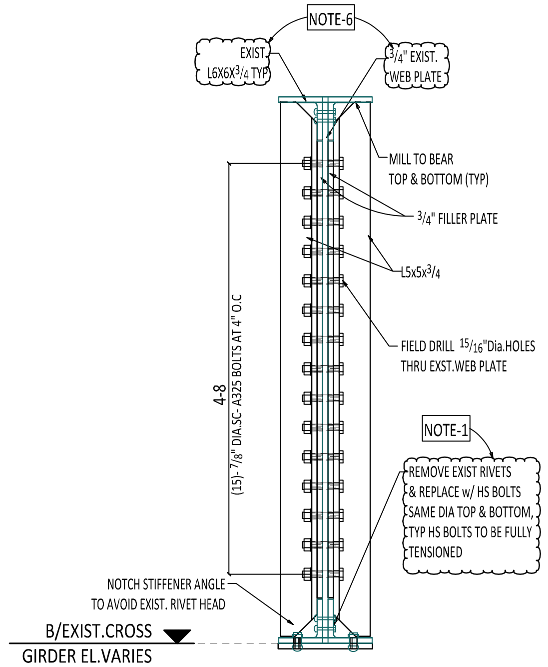
PROJECT: CTA GREEN LINE SHORING TOWERS

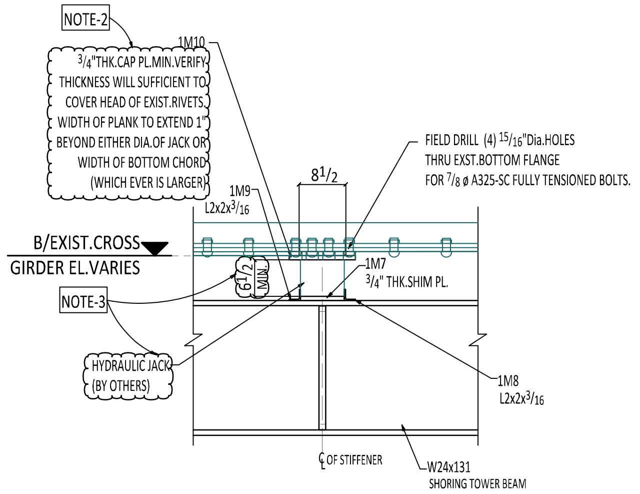
DESCRIPTION: SHORING SECTION

DATE 08-03-2022	JOB No. 704	DRG No. 1E8	REV. A



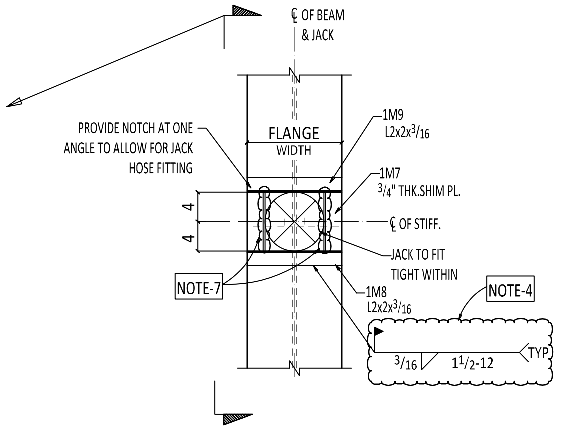
1 / 1E9 DETAIL VIEW

(REF:9/S3.0)



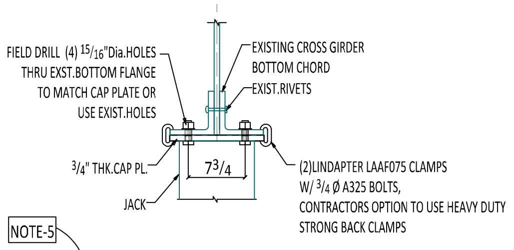
TYP JACK DETAIL @ CROSS GIRDER STEP

(REF:1/S3.1)



PLAN @ JACK SEAT

(REF:3/S3.1)



CLAMP DETAIL @ JACK

(REF:2/S3.1)

APPROVER PLEASE VERIFY/CONFIRM:

NOTE-1:- PLEASE PROVIDE EXISTING RIVETS DIAMETER TO PROVIDE SAME DIAMETER HS BOLTS AS PER GIVEN IN NOTE.
ALSO, PLEASE CONFIRM RIVETS SHOULD REPLACE ONLY AT STIFFENER ANGLE LOC.

NOTE-2:- PLEASE VERIFY IN FIELD THICKNESS OF EXISTING RIVETS SO WE CAN PROVIDE THICKNESS OF PL. AS PER GIVEN IN NOTE

NOTE-3:- INSTALLATION INSTRUCTIONS NOTE-6 GIVEN ON DRAWING "S1.0" SHOWS TWO PRODUCT CODES 100 TON BVA HL 1002 & 100 TON ENERPAC CLP- 1002 FOR JACK. BUT WE ARE NOT CLEAR HOW THEY ARE USING (2) JACKS AT SAME LOCATION.
ALSO PLEASE NOTE PRODUCT CODE OF BVA HL 1002 SHOULD BE HL-10002

NOTE-4:- STRUCTURAL SECTION "3/S3.1" SHOWS L2X2 SHOP WELDED WITH FRAME BUT WE HAVE PROVIDED THEM FIELD WELDED TO POSSIBLE EASE OF JACK INSTALLATION, PLEASE CONFIRM

NOTE-5:- DETAIL 2/S3.0 INDICATES $^{3}/_{4}$" PL OVER THE JACK FASTEN TO BOT. CHORD OF GIRDER WITH $^{7}/_{8}$"Ø A325 BOLTS WHEREAS PER DETAIL 2/S3.1 SAME PLATE TIGHTEN TO BOT. CHORD OF GIRDER WITH (2) CLAMPS, PLEASE ADVISE IF THIS IS CORRECT.

NOTE-6:- PLEASE VERIFY IN FIELD EXISTING GIRDER SECTION SIZES

NOTE-7:- PER DETAIL 3/S3.1, ON TWO SIDES OF JACK, ANGLE IS SHOWN, HOWEVER WE ARE NOT CLEAR WHAT STEEL IS THERE ON OTHER TWO SIDES. PICTORICALLY IT LOOKS LIKE PLATES, PLEASE ADVISE. IF YES , PLEASE ADVISE ON PLATE THICKNESS.

REF. DRG.S3.0,S3.1

A	08-09-2022	ISSUED FOR APPROVAL	YPB	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. --	WELD SIZE U.N.O. $^{1}/_{4}$" UN	FINISH --
TYPICAL COPE RADIUS U.N.O. --	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. --

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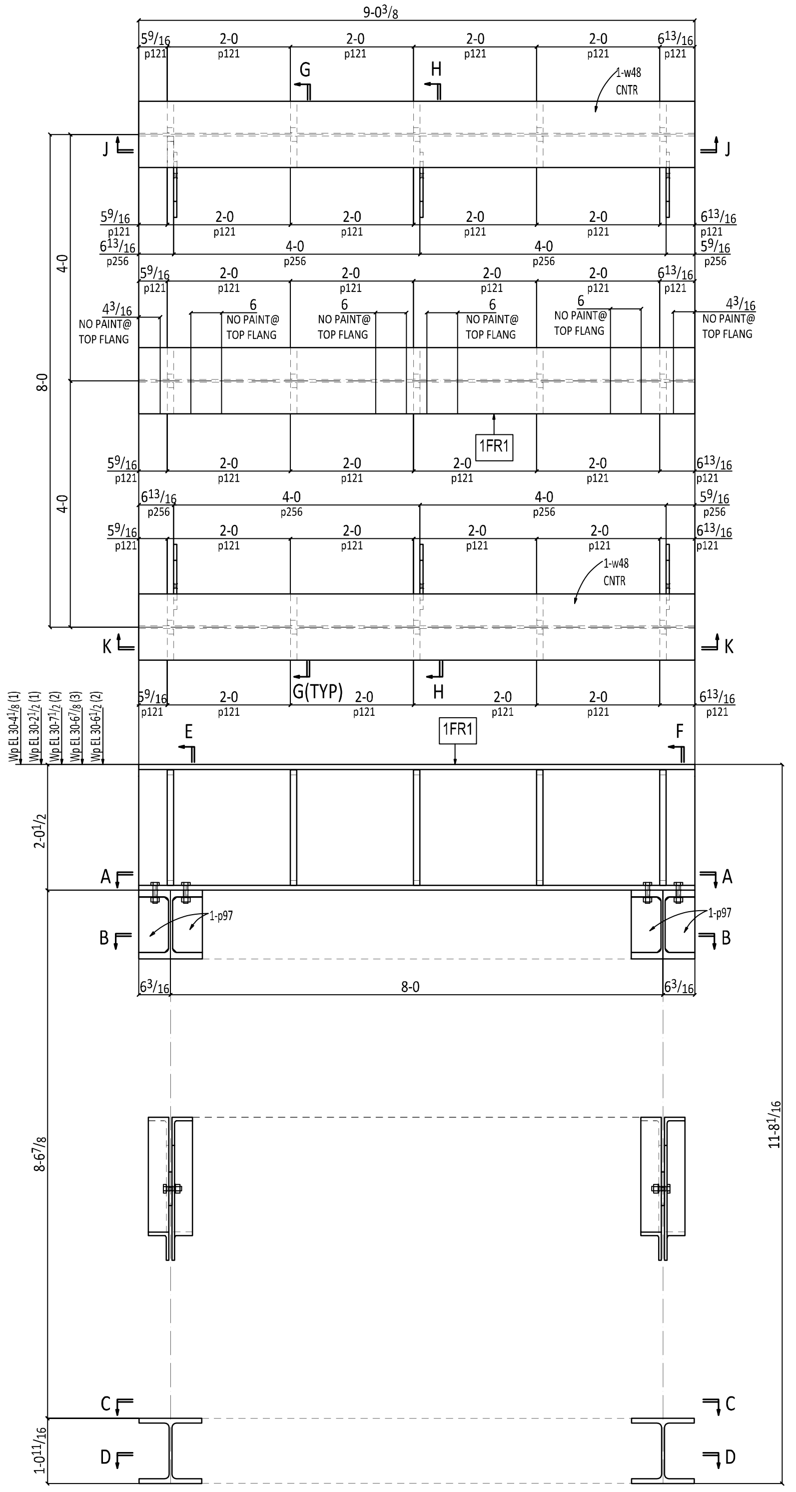
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

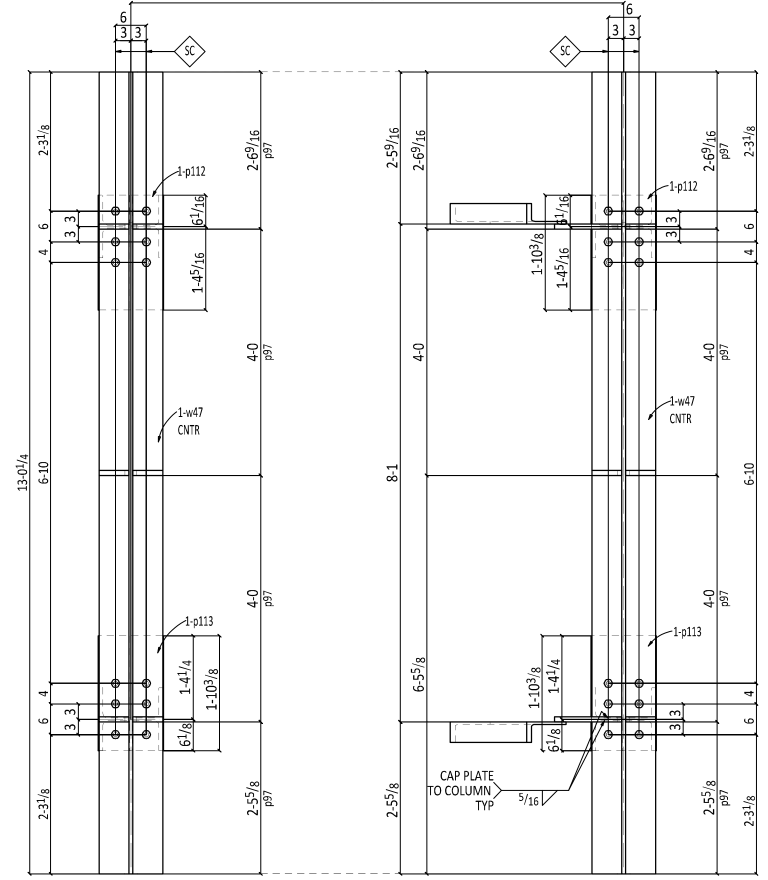
DESCRIPTION: SHORING SECTION

DATE 08-03-2022	JOB No. 704	DRG No. 1E9	REV. A

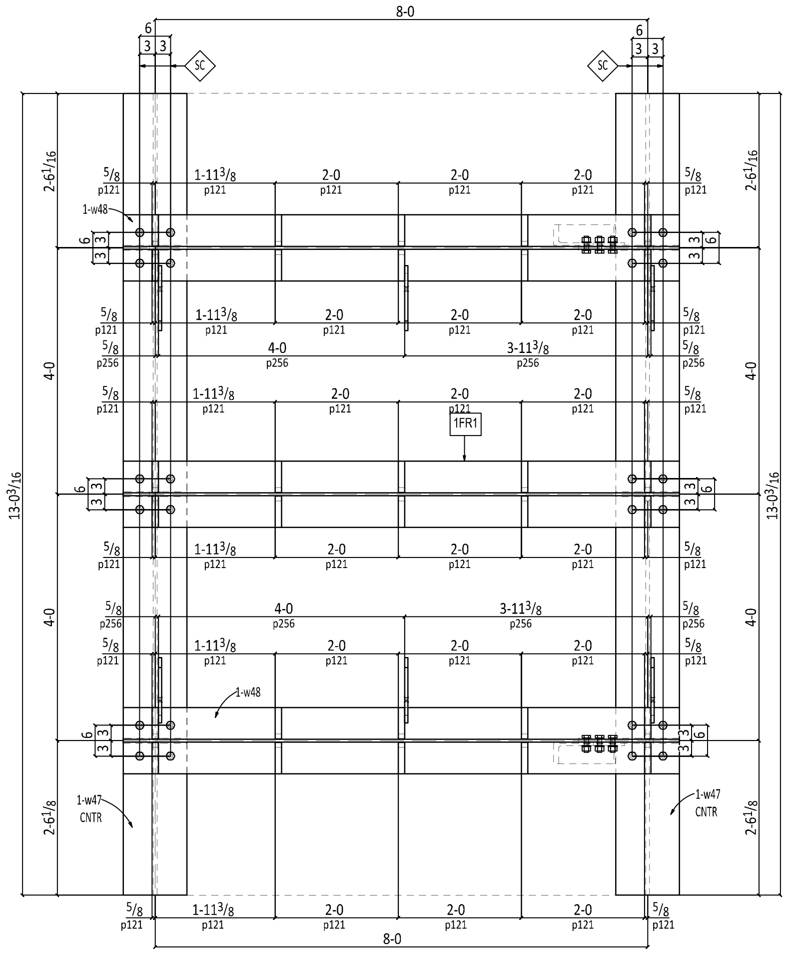


9 FRAMES 1FR1

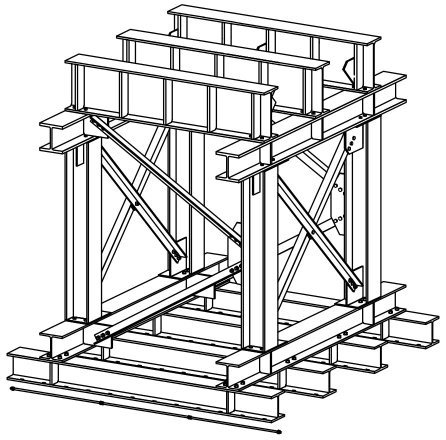
SHOP BOLTS (Unless Noted):
58-$^7/_8$Diax3 A325SC +1HD WASH (Galv)[total=522]



Section B-B
1FR1



Section A-A
1FR1
Shop Bolt-
24-$^7/_8$ Dia x $3^1/_2$ + 1HD wash(galv)



ISO VIEW

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	9	FRAME				PRIME	21341
1FR1	9	W24x131	9	$0^3/_8$	A992		1183
w48	18	W24x131	9	$0^3/_8$	A992		1183
w47	18	W12x136	13	$0^3/_{16}$	A992		1770
w58	18	W12x96	13	$0^3/_{16}$	A992		1250
w73	36	W12x96	12	0	A992		1152
w15	36	W12x96	7	$4^1/_2$	A992		708
a42	36	L4x4x$^1/_2$	9	$1^1/_2$	A572-50		117
a29	18	L4x4x$^1/_2$	8	$0^9/_{16}$	A572-50		103
a26	18	L4x4x$^1/_2$	7	$9^{13}/_{16}$	A572-50		100
p121	279	PL$1^1/_4$x$6^1/_8$	1	$10^1/_2$	A572-50		49
p127	18	PL1x$10^{13}/_{16}$	1	$3^1/_4$	A572-50		47
p96	18	PL1x$10^{13}/_{16}$	1	$1^1/_{16}$	A572-50		40
p76	198	PL1x$5^{13}/_{16}$	0	$10^{13}/_{16}$	A572-50		18
p97	90	PL1x$5^{13}/_{16}$	0	$10^{13}/_{16}$	A572-50		18
p114	36	PL$^5/_8$x$14^7/_8$	1	4	A572-50		42
p85	36	PL$^5/_8$x$14^{11}/_{16}$	1	$3^1/_2$	A572-50		40
p256	54	PL$^5/_8$x$12^{11}/_{16}$	1	$2^3/_8$	A572-50		32
p105	18	PL$^5/_8$x$10^3/_4$	2	6	A572-50		57
p117	18	PL$^5/_8$x4	0	$5^1/_4$	A572-50		4
p112	18	PL$^1/_2$x$12^{11}/_{16}$	1	$10^3/_8$	A572-50		40
p113	18	PL$^1/_2$x$12^{11}/_{16}$	1	$10^3/_8$	A572-50		40
p82	36	PL$^1/_2$x$12^{11}/_{16}$	1	$9^1/_{16}$	A572-50		38
p306	36	PL$^1/_2$x$5^{13}/_{16}$	1	$0^3/_8$	A572-50		10
p132	18	PL$^3/_{16}$x4	0	9	A572-50		2
p133	18	PL$^3/_{16}$x4	0	9	A572-50		2
	216	$^7/_8$ Dia A325SC	0	$3^1/_2$		+1HD WASH Galv	1
	522	$^7/_8$ Dia A325SC	0	3		+1HD WASH Galv	1
	324	$^7/_8$ Dia A325SC	0	$2^3/_4$		+1HD WASH Galv	1
	324	$^7/_8$ Dia A325SC	0	$2^1/_2$		+1HD WASH Galv	1

Total weight : 192066

REF. DRG. 1E3

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. $^{15}/_{16}$"	WELD SIZE U.N.O. $^1/_4$" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. $^1/_2$"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC SP-3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

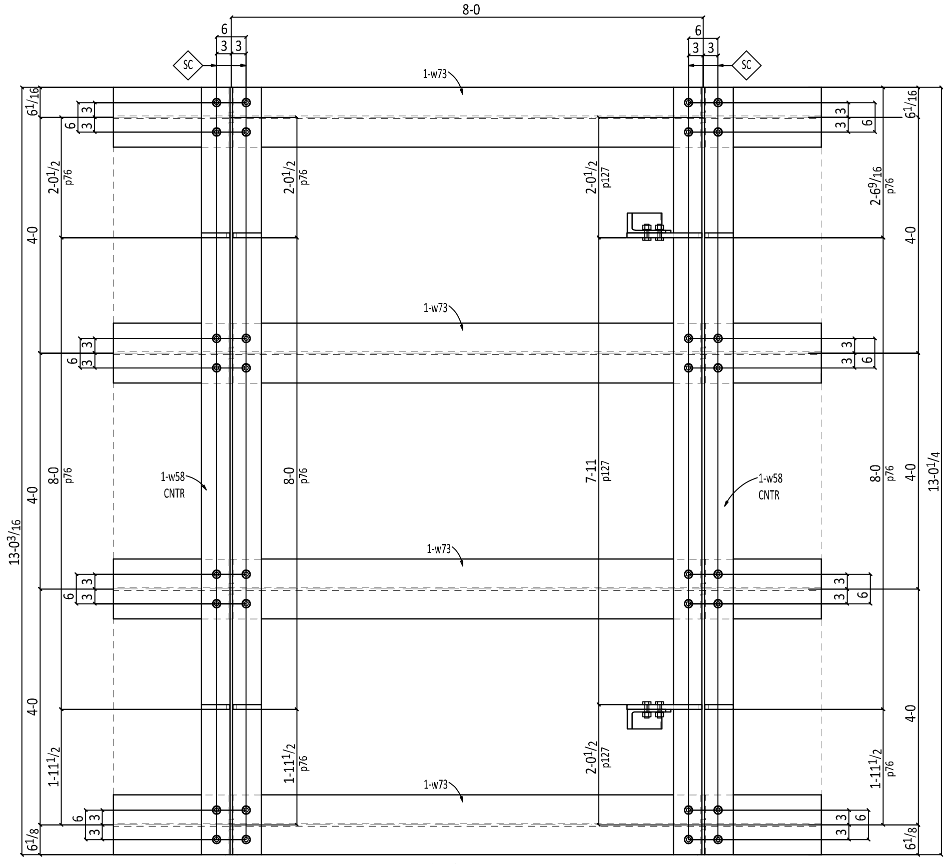
PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: FRAME DETAIL

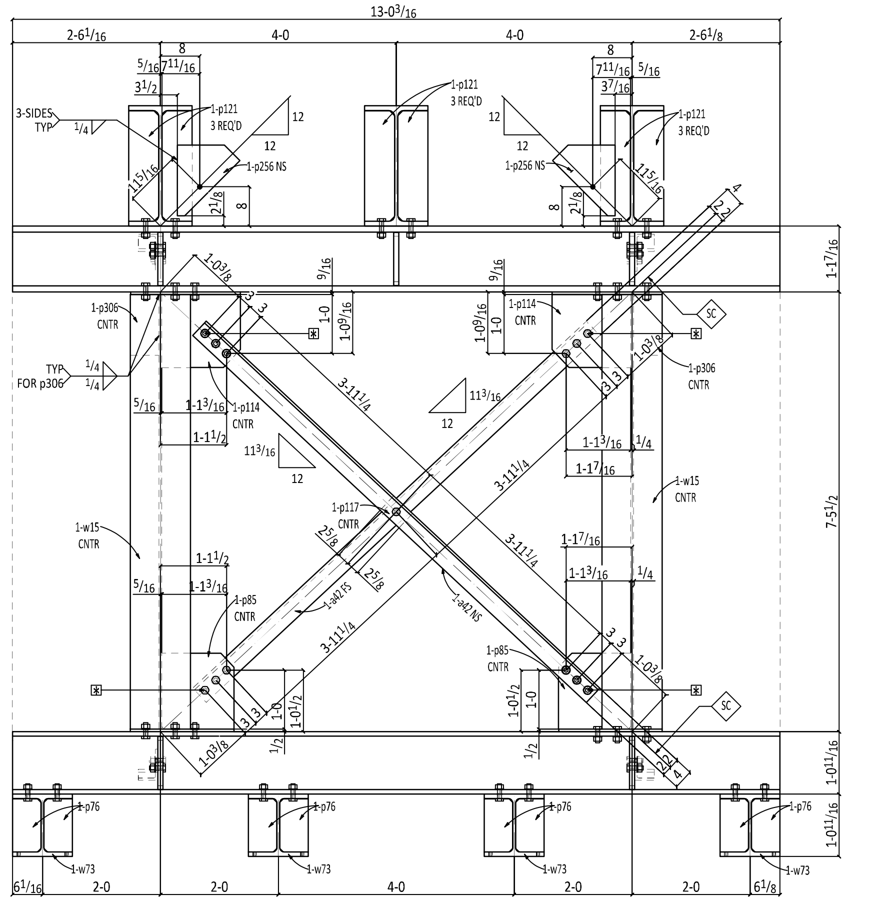
DATE 08-03-2022 JOB No. 704 DRG No. 1FR1 REV. A

WORK THIS SHEET WITH FR1a & FR1b

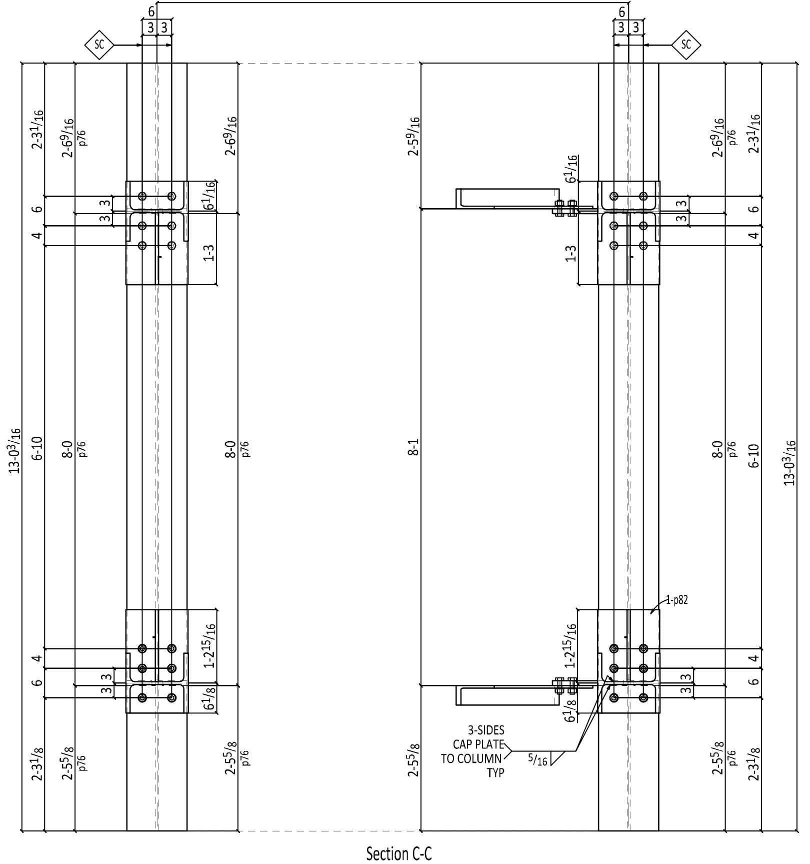
SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND



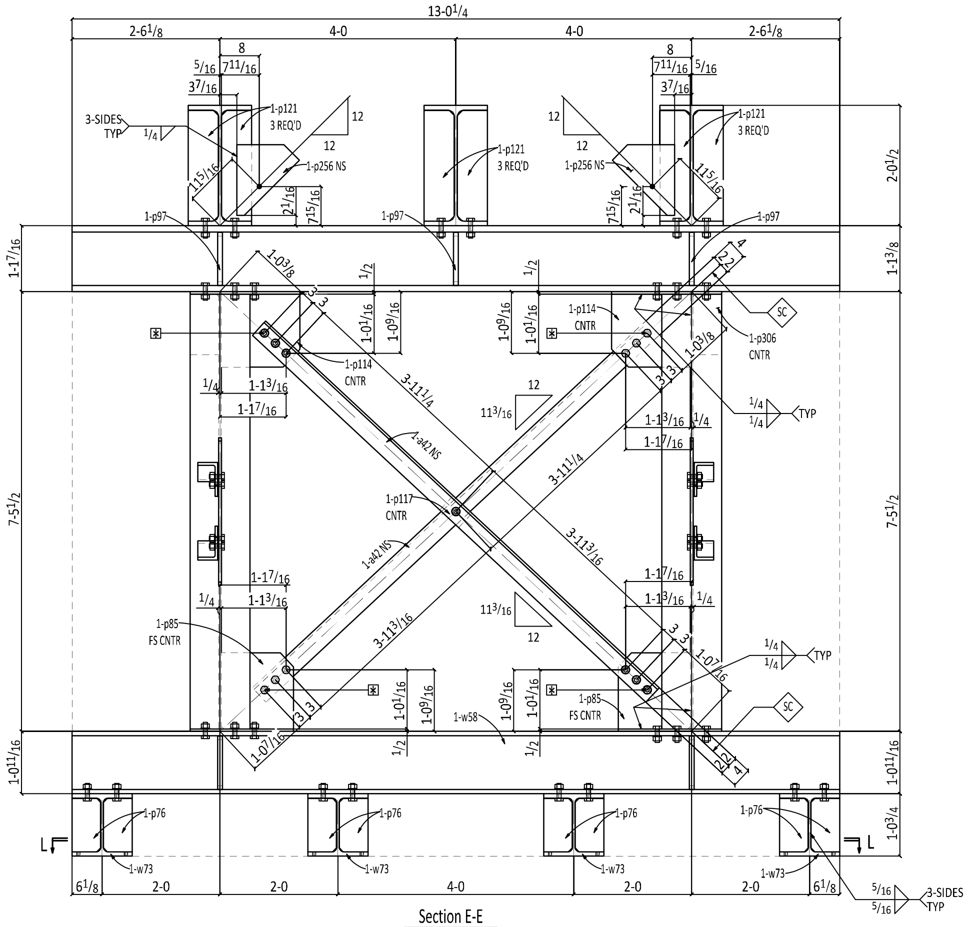
Section D-D
1FR1



Section F-F
1FR1
SHOP BOLTS ▩ Indicates
12 - 7/8 Dia x 21/2+1 HD WASH (Galv)



Section C-C
1FR1
Shop Bolts-
24 - 7/8 Dia x 31/2+1 HD WASH (galv)



Section E-E
1FR1
SHOP BOLTS ▩ Indicates
12 - 7/8 Dia x 21/2+1 HD WASH (Galv)

WORK THIS SHEET WITH FR1 & FR1b

REF. DRG. 1E3

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC SP-3

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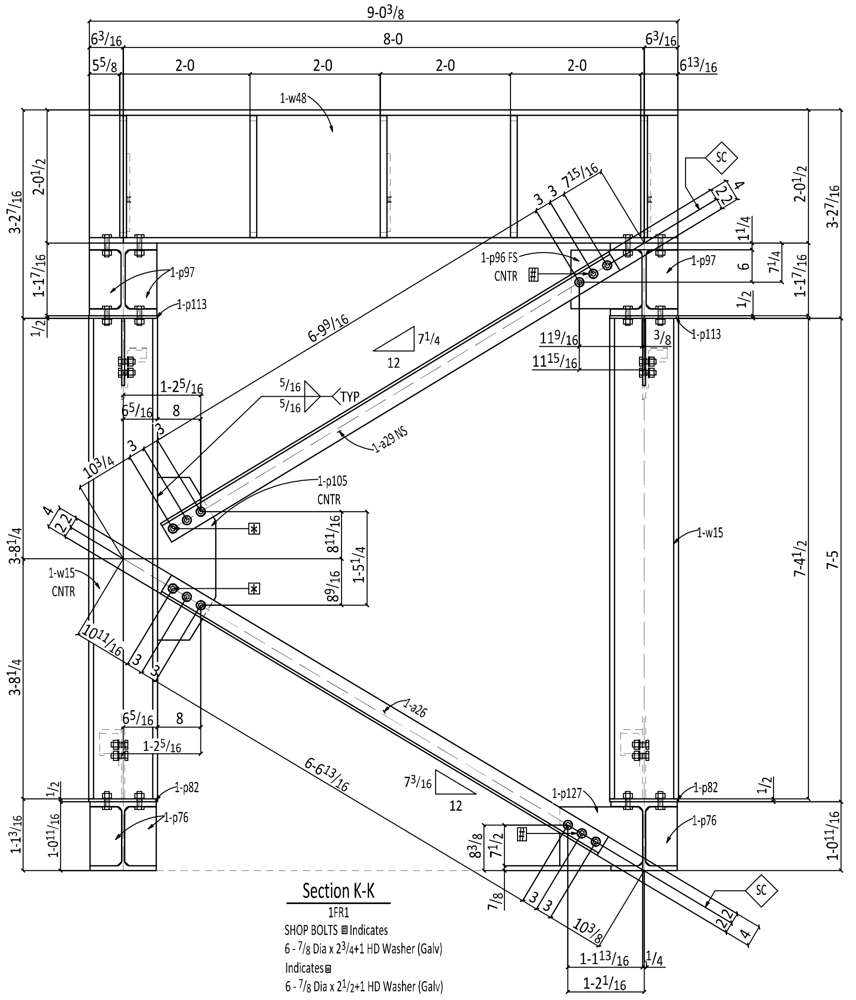
SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: FRAME DETAIL

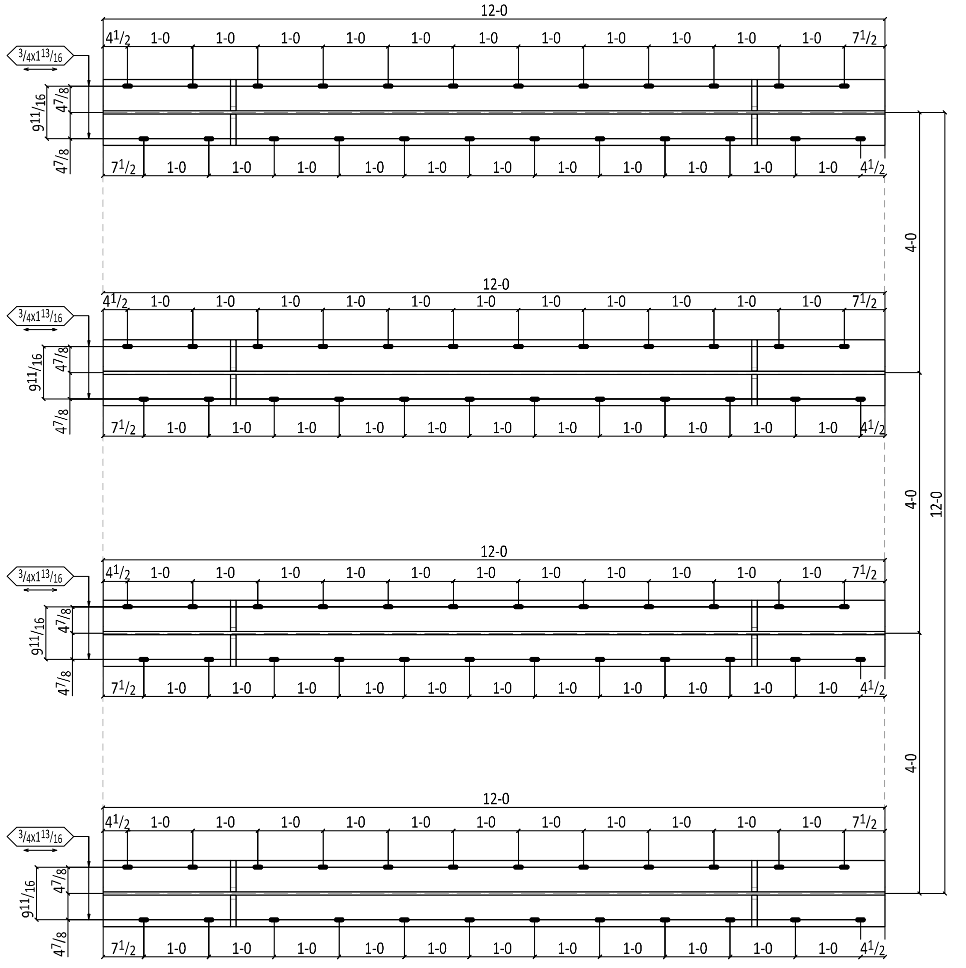
DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1FR1a	A



Section K-K

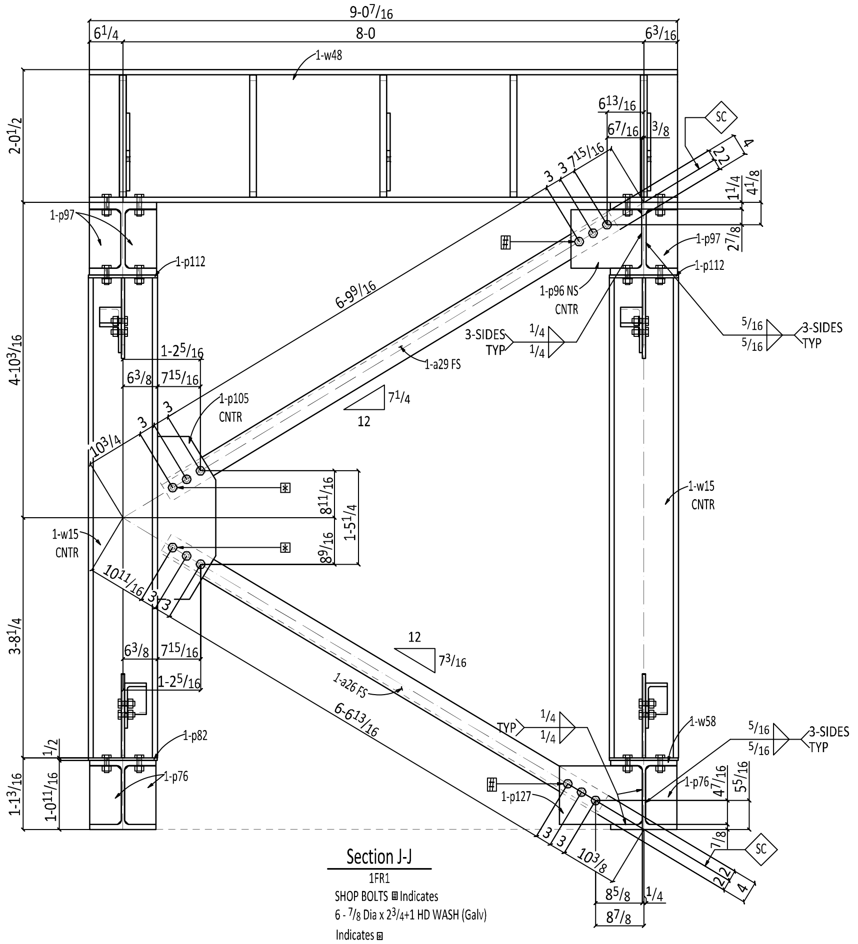
1FR1

SHOP BOLTS ⊞ Indicates
6 - 7/8 Dia x 2 3/4+1 HD Washer (Galv)
Indicates ⊠
6 - 7/8 Dia x 2 1/2+1 HD Washer (Galv)



SectionL-L

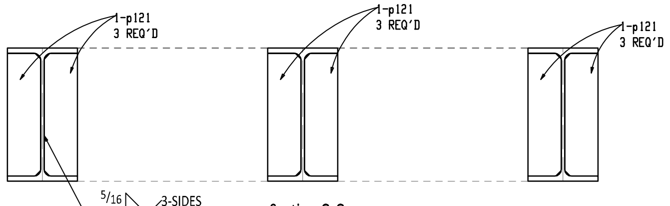
1FR1



Section J-J

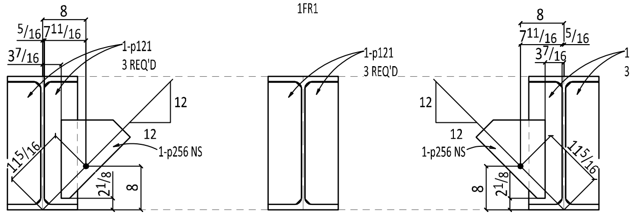
1FR1

SHOP BOLTS ⊞ Indicates
6 - 7/8 Dia x 2 3/4+1 HD WASH (Galv)
Indicates ⊠
6 - 7/8 Dia x 2 1/2+1 HD WASH (Galv)



Section G-G

1FR1



Section H-H

1FR1

WORK THIS SHEET WITH FR1&FR1a

SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND

REF. DRG. 1E3

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC SP-3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

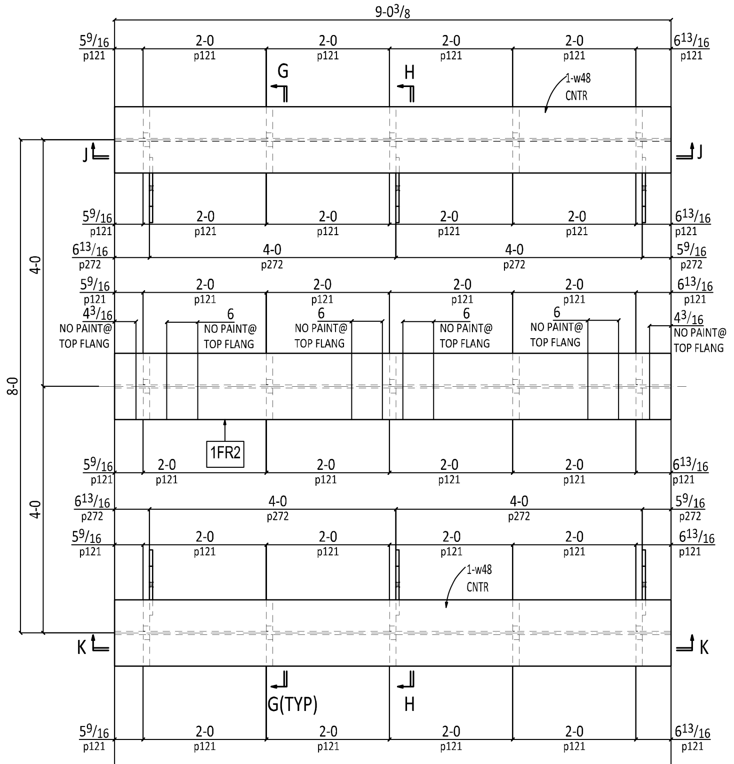
SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

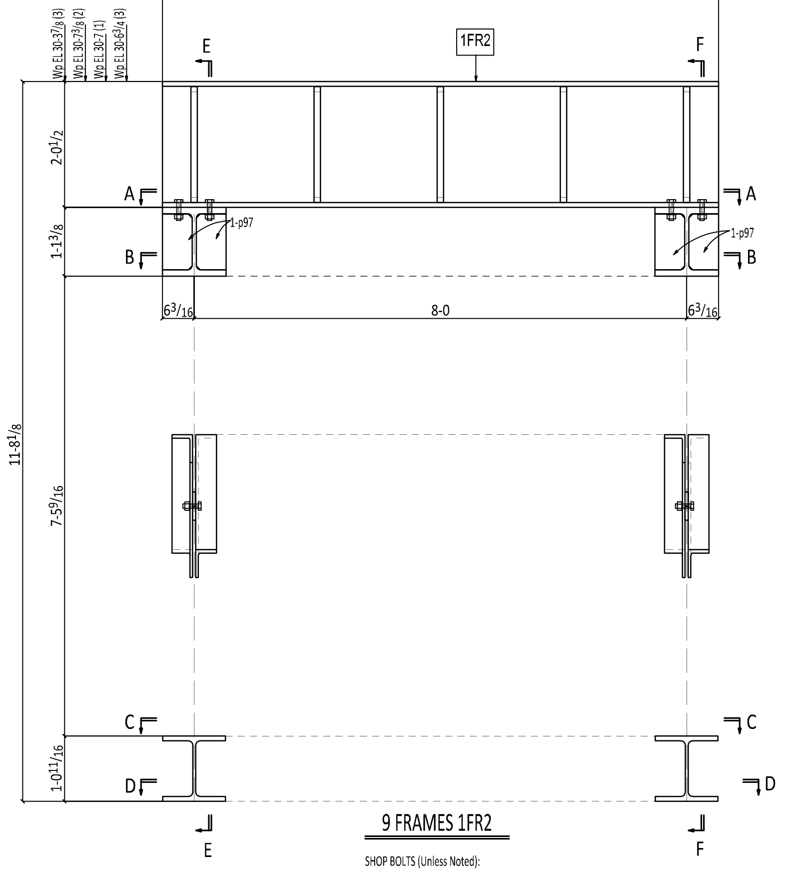
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: FRAME DETAIL

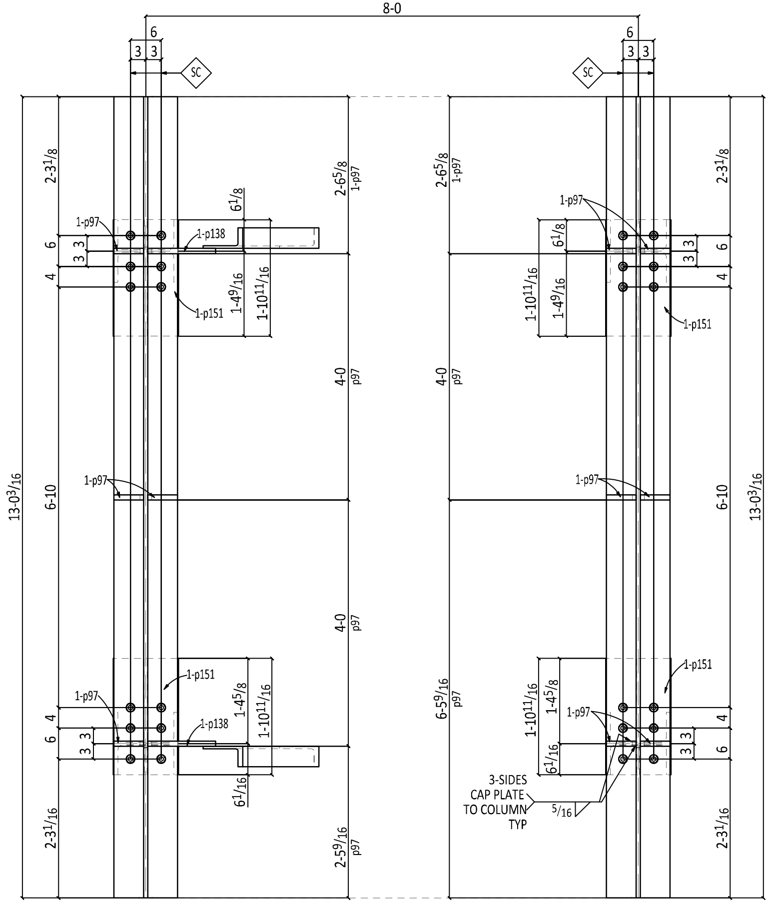
DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1FR1b	A



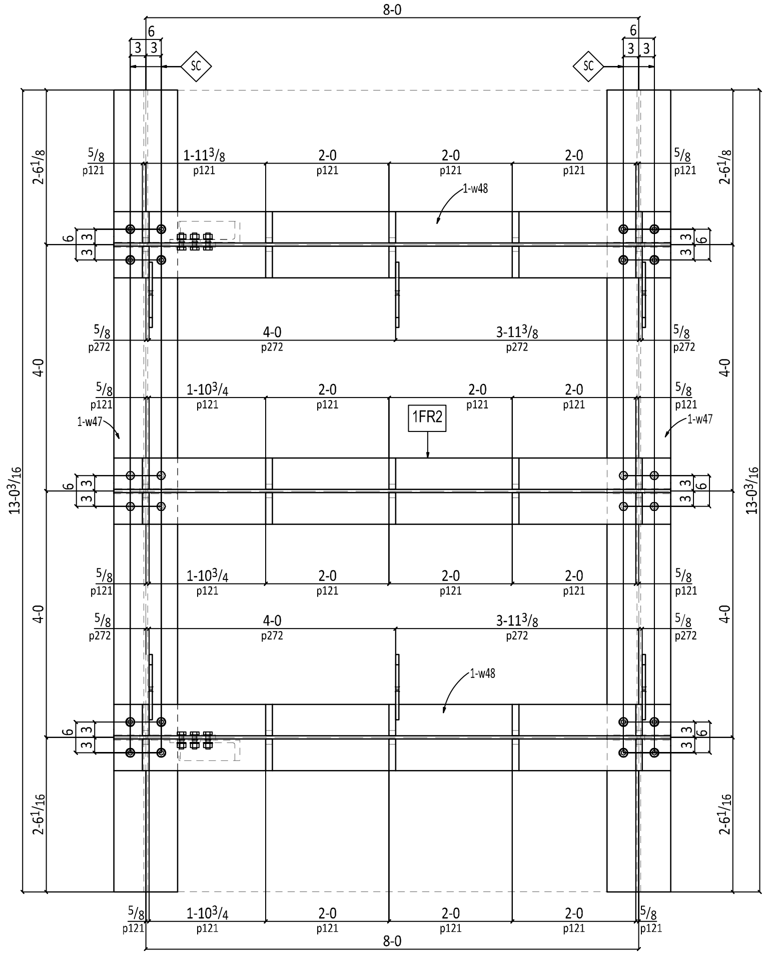


9 FRAMES 1FR2

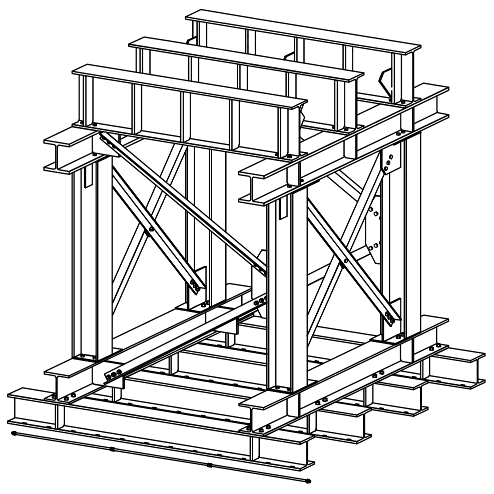
SHOP BOLTS (Unless Noted):
58-$\frac{7}{8}$Diax3 A325SC +1HD WASH [total=522]



Section B-B
1FR2



Section A-A
1FR2
Shop Bolt-
24-$\frac{7}{8}$ Dia x 3$\frac{1}{2}$ + 1HD WAH (Galv)



ISO VIEW

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH		STEEL	REMARKS	Weight
			FT	IN	GRADE		Unit
	9	FRAME				PRIME	21363
1FR2	9	W24x131	9	0$\frac{3}{8}$	A992		1183
w48	18	W24x131	9	0$\frac{3}{8}$	A992		1183
w47	18	W12x136	13	0$\frac{3}{16}$	A992		1770
w58	18	W12x96	13	0$\frac{3}{16}$	A992		1250
w73	36	W12x96	12	0	A992		1152
w15	36	W12x96	7	4$\frac{1}{2}$	A992		708
a42	36	L4x4x$\frac{1}{2}$	9	1$\frac{1}{2}$	A572-50		117
a85	9	L4x4x$\frac{1}{2}$	8	0$\frac{9}{16}$	A572-50		103
a87	9	L4x4x$\frac{1}{2}$	8	0$\frac{9}{16}$	A572-50		103
a77	9	L4x4x$\frac{1}{2}$	8	0$\frac{3}{8}$	A572-50		103
a86	9	L4x4x$\frac{1}{2}$	8	0$\frac{3}{8}$	A572-50		103
p121	270	PL1$\frac{1}{4}$x6$\frac{1}{8}$	1	10$\frac{1}{2}$	A572-50		49
p139	18	PL1x10$\frac{13}{16}$	1	0$\frac{7}{8}$	A572-50		40
p138	18	PL1x10$\frac{13}{16}$	1	1$\frac{3}{16}$	A572-50		40
p148	18	PL1x10$\frac{9}{16}$	2	6	A572-50		90
p76	198	PL1x5$\frac{13}{16}$	0	10$\frac{13}{16}$	A572-50		18
p97	90	PL1x5$\frac{13}{16}$	0	10$\frac{13}{16}$	A572-50		18
p169	36	PL$\frac{5}{8}$x15$\frac{1}{2}$	1	4$\frac{5}{16}$	A572-50		45
p170	36	PL$\frac{5}{8}$x15$\frac{1}{2}$	1	4$\frac{5}{16}$	A572-50		45
p272	54	PL$\frac{5}{8}$x12$\frac{11}{16}$	1	0$\frac{7}{8}$	A572-50		29
p167	18	PL$\frac{5}{8}$x4	0	4$\frac{5}{16}$	A572-50		3
p151	72	PL$\frac{1}{2}$x12$\frac{11}{16}$	1	10$\frac{11}{16}$	A572-50		41
p306	36	PL$\frac{1}{2}$x5$\frac{13}{16}$	1	0$\frac{3}{8}$	A572-50		10
	216	$\frac{7}{8}$ Dia A325SC	0	3$\frac{1}{2}$		+1HD WASH Galv	1
	522	$\frac{7}{8}$ Dia A325SC	0	3		+1HD WASH Galv	1
	432	$\frac{7}{8}$ Dia A325SC	0	2$\frac{3}{4}$		+1HD WASH Galv	1
	216	$\frac{7}{8}$ Dia A325SC	0	2$\frac{1}{2}$		+1HD WASH Galv	1

Total weight : 192269

REF. DRG. 1E3

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. $\frac{15}{16}$"	WELD SIZE U.N.O. $\frac{1}{4}$" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. $\frac{1}{2}$"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC SP-3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

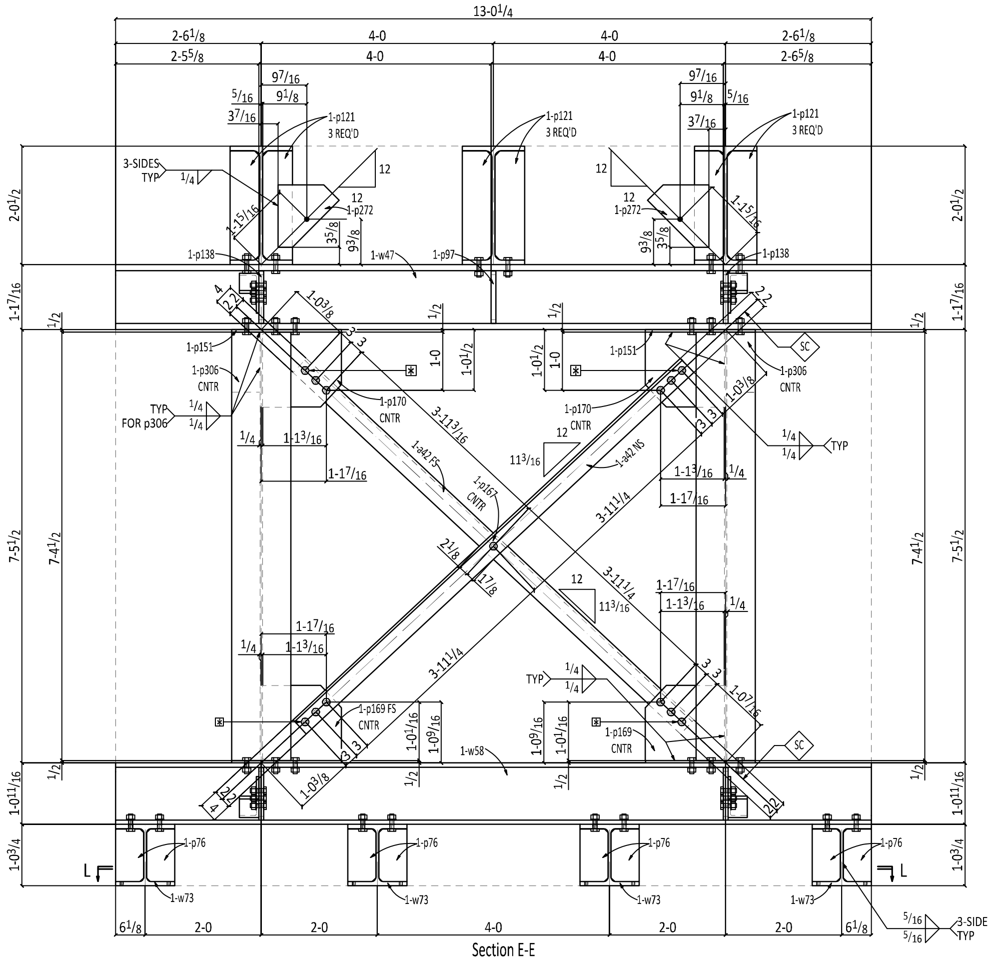
PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: FRAME DETAIL

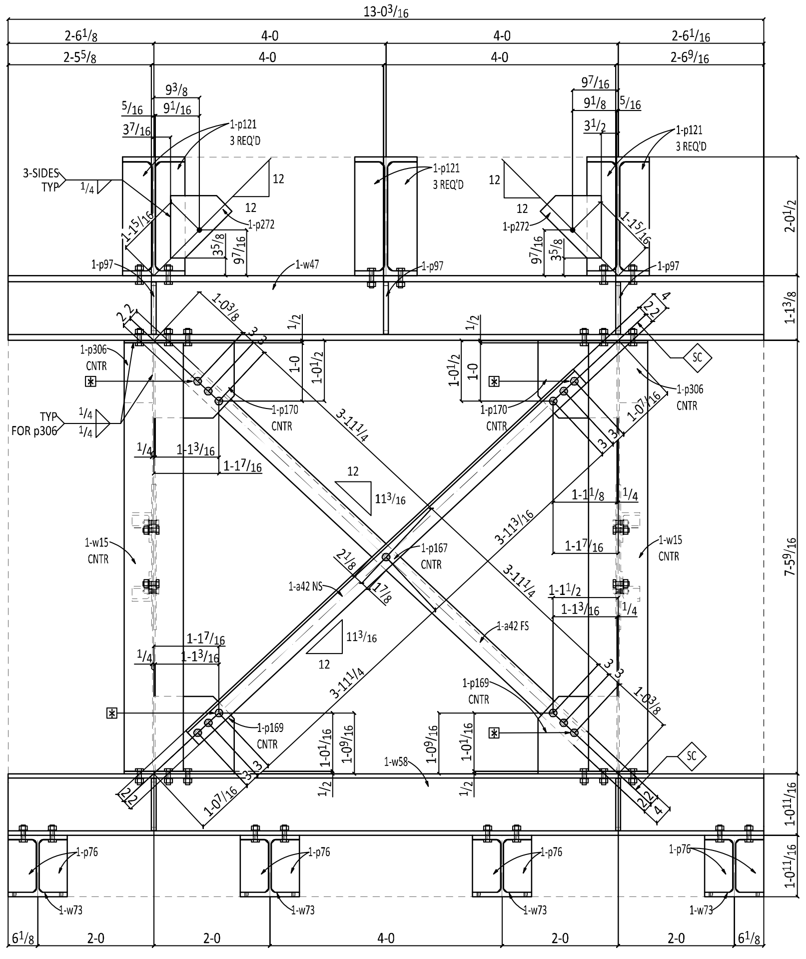
DATE 08-03-2022	JOB No. 704	DRG No. 1FR2	REV. A

WORK THIS SHEET WITH 1FR2a & 1FR2b

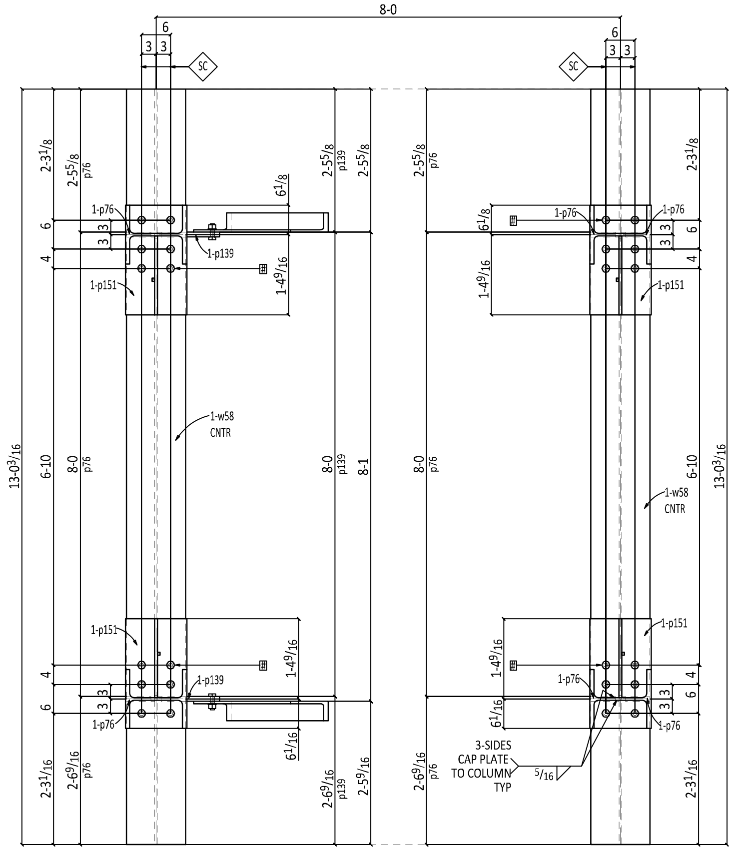
SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND



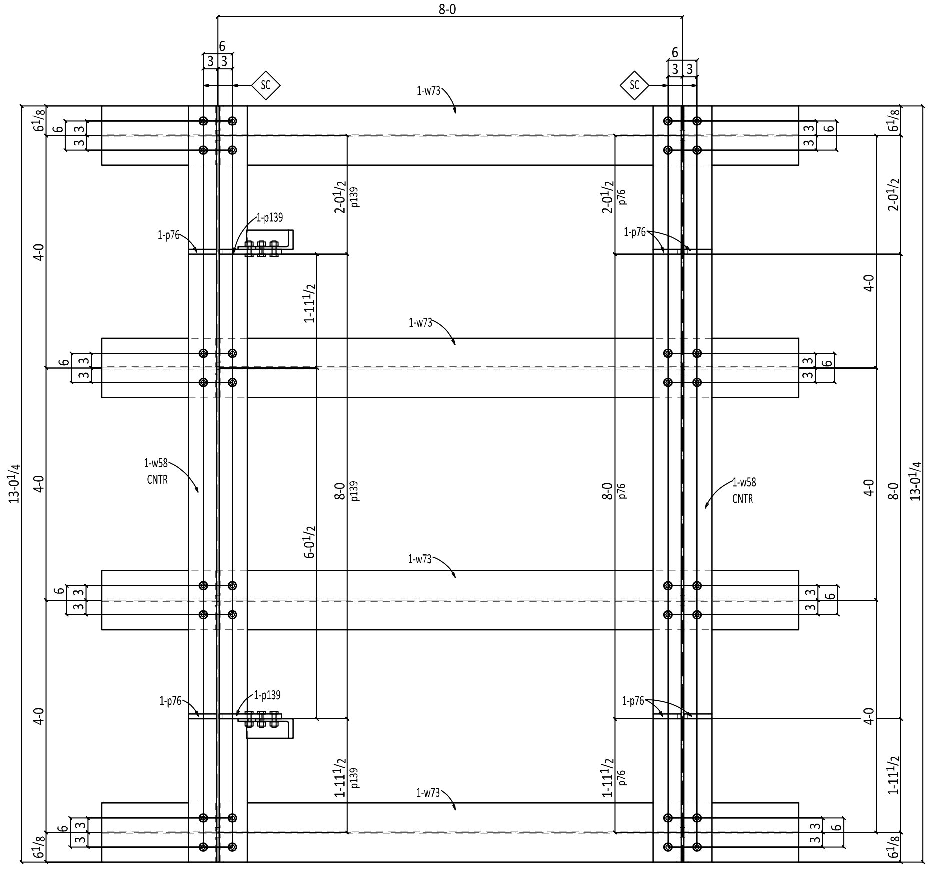
Section E-E
1FR2
SHOP BOLTS ▣ Indicates
12 - 7/8 Dia x 2 1/2+1 HD WASH (Galv)



Section F-F
1FR2
SHOP BOLTS ▣ Indicates
12 - 7/8 Dia x 2 1/2+1 HD WASH (Galv)



Section C-C
1FR2
SHOP BOLTS ▣ Indicates
24 - 7/8 Dia x 2 3/4+1 HD WASH (Galv)



Section D-D
1FR2

WORK THIS SHEET WITH 1FR2 & FR2b

REF. DRG. 1E3

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC SP-3

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Fax. 708-418-7398

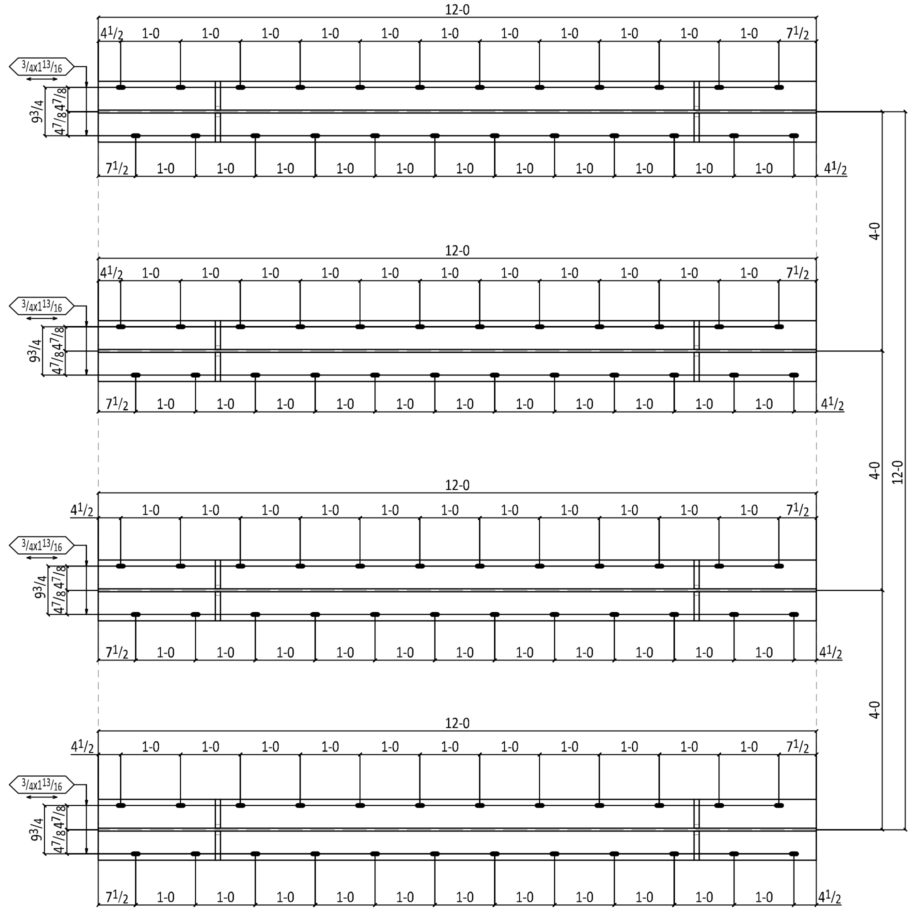
SSS
SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

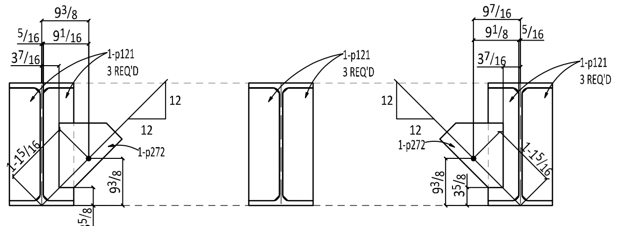
PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: FRAME DETAIL

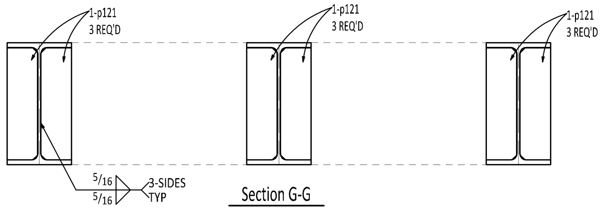
DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1FR2a	A



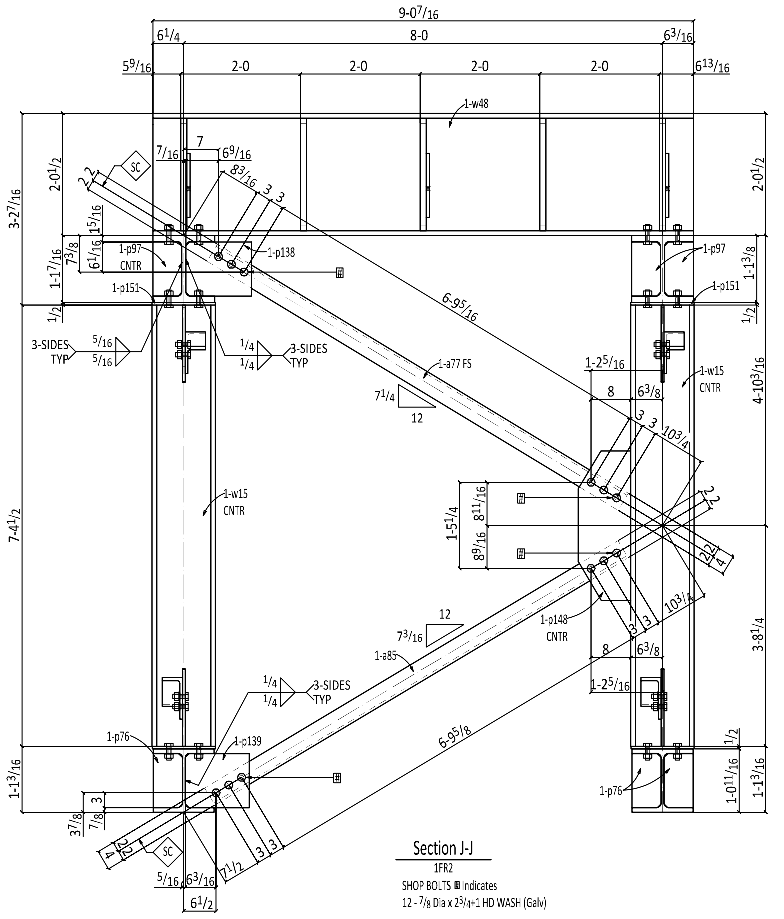
Section L-L
1FR2



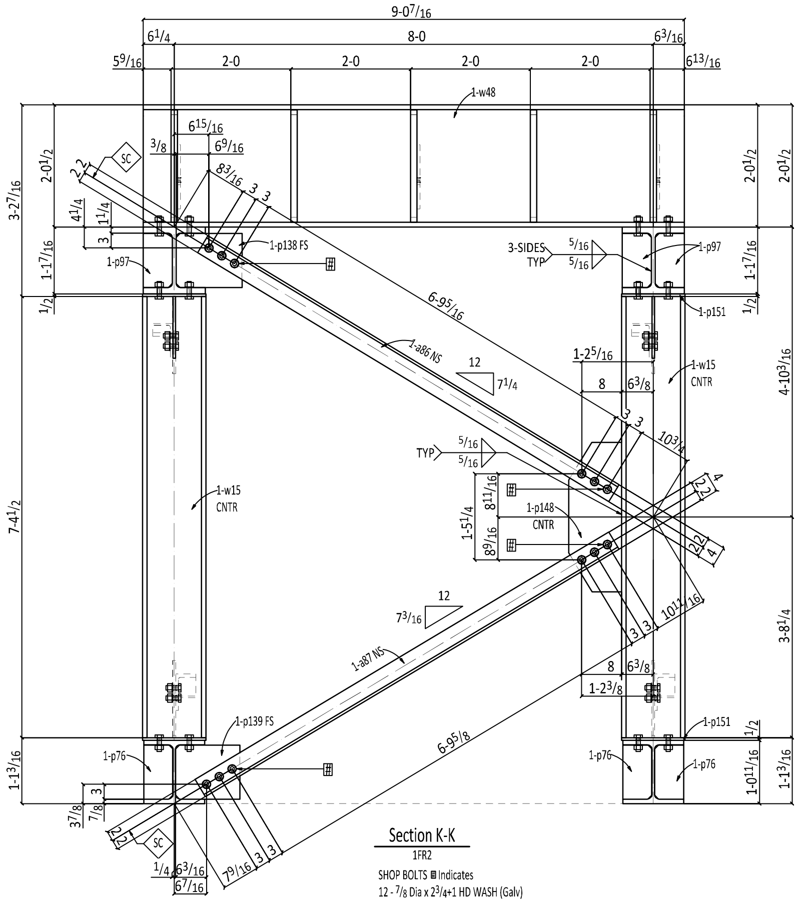
Section H-H
1FR2



Section G-G
1FR2



Section J-J
1FR2
SHOP BOLTS ▪ Indicates
12 - 7/8 Dia x 2 3/4+1 HD WASH (Galv)



Section K-K
1FR2
SHOP BOLTS ▪ Indicates
12 - 7/8 Dia x 2 3/4+1 HD WASH (Galv)

WORK THIS SHEET WITH FR2 & FR2b

REF. DRG. 1E3

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC SP-3

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Lansing, IL 60438
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Fax. 708-418-7398

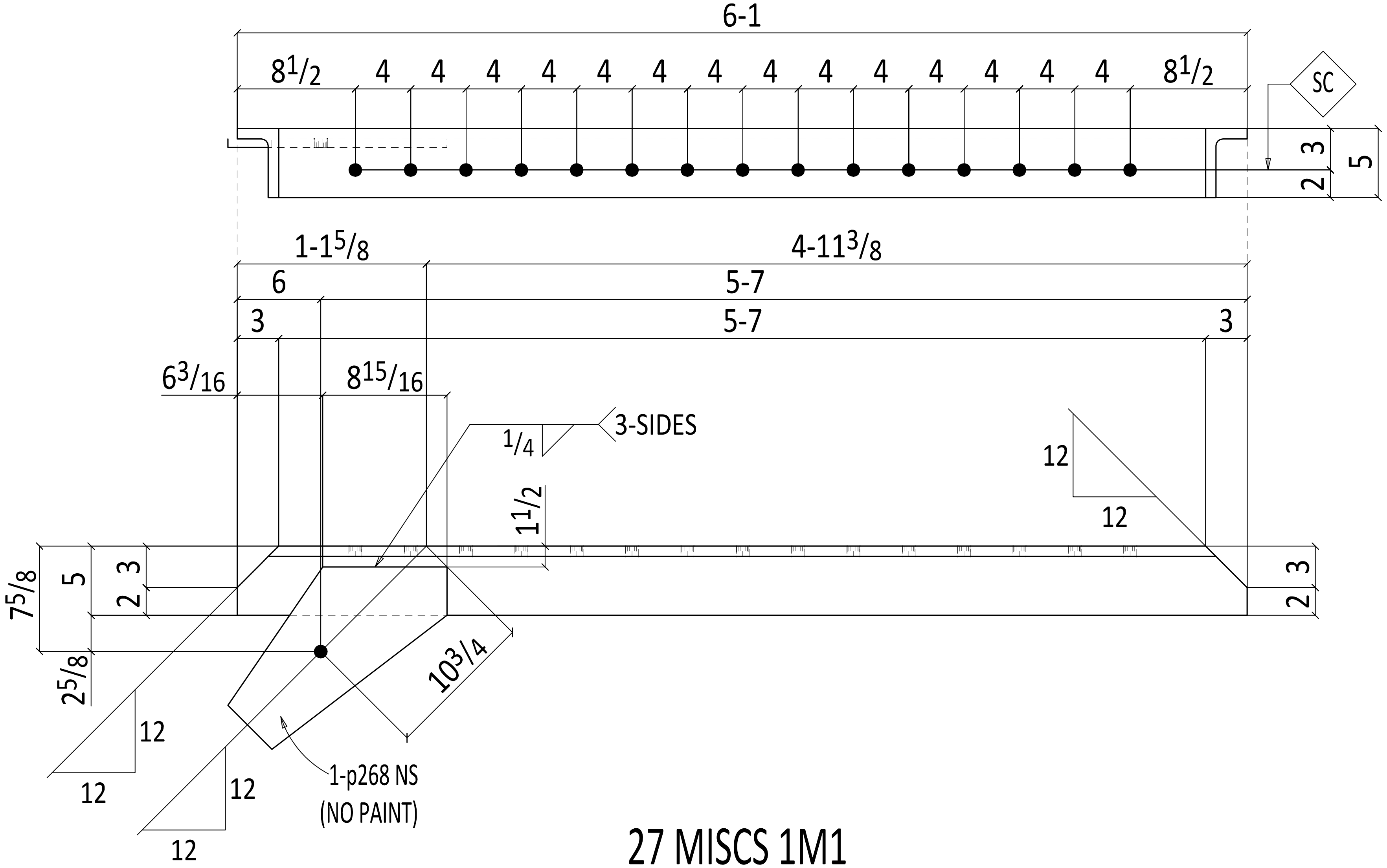
SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: FRAME DETAIL

DATE 08-03-2022	JOB No. 704	DRG No. 1FR2b	REV. A



27 MISCS 1M1

FIELD BOLTS:
15-$^{7}/_{8}$Diax5 A325SC +1HD WASH Galv [total=405]

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	27	MISC				PRIME	181
1M1	27	L5x5x$^{3}/_{4}$	6	1	A572-50		144
p268	27	PL$^{5}/_{8}$x13$^{3}/_{16}$	1	3$^{13}/_{16}$	A572-50		37
		FIELD BOLTS					
	405	$^{7}/_{8}$ Dia A325SC	0	5		+1HD WASH Galv	

Total weight : 4876

REF. DRG. 1E8

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. $^{15}/_{16}$"	WELD SIZE U.N.O. $^{1}/_{4}$" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. $^{1}/_{2}$"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
Fax. 708-418-7398

SYNERGY STEEL STRUCTURES, INC.
sssfabrication.com

CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: MISC DETAIL

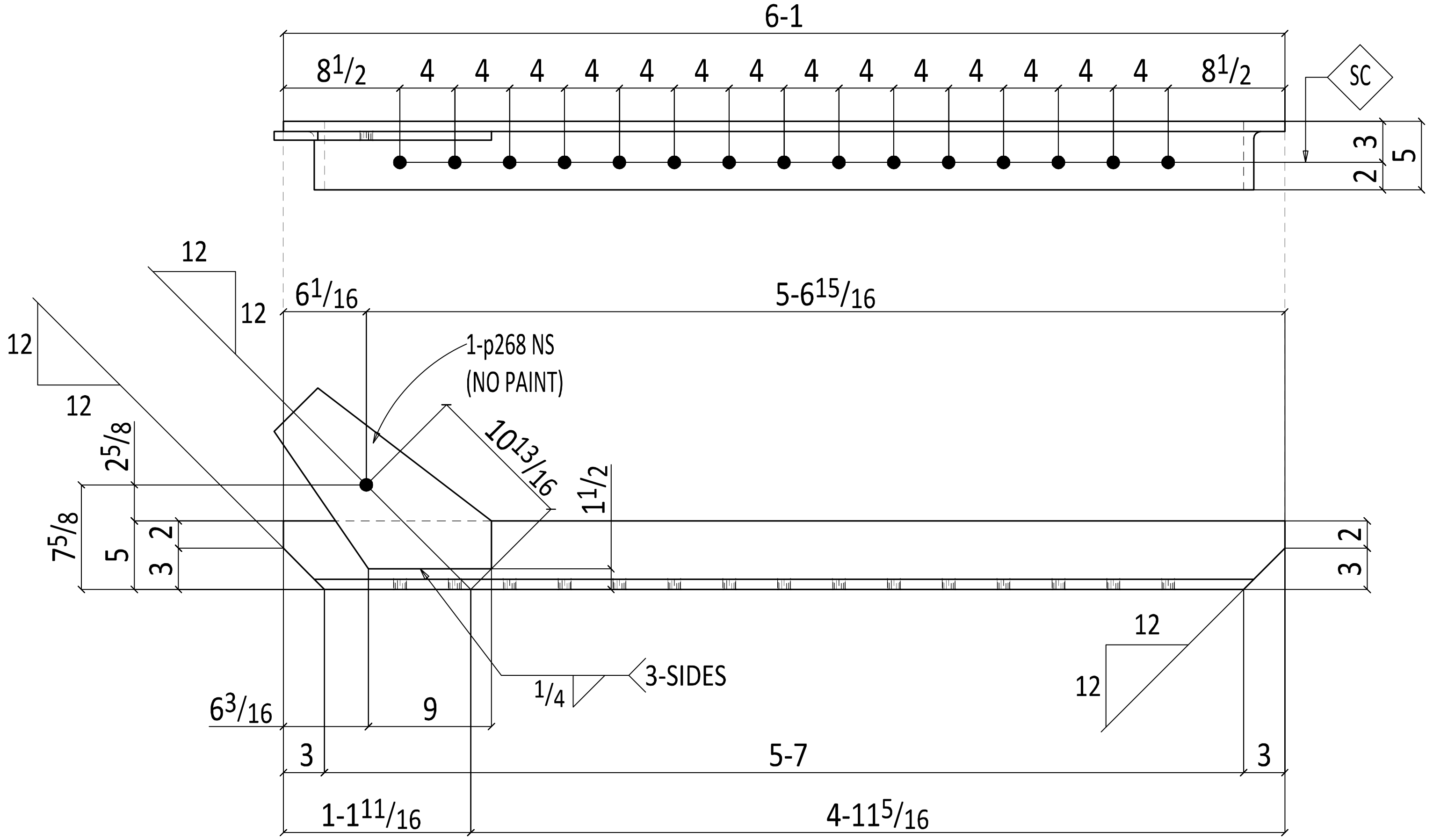
DATE 08-03-2022 JOB No. 704 DRG No. 1M1 REV. A

SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	27	MISC				PRIME	181
1M2	27	L5x5x3/4	6	1	A572-50		144
p268	27	PL5/8x133/16	1	313/16	A572-50		37

Total weight : 4876



27 MISCS 1M2

REF. DRG. 1E8

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

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CUSTOMER NAME: ---

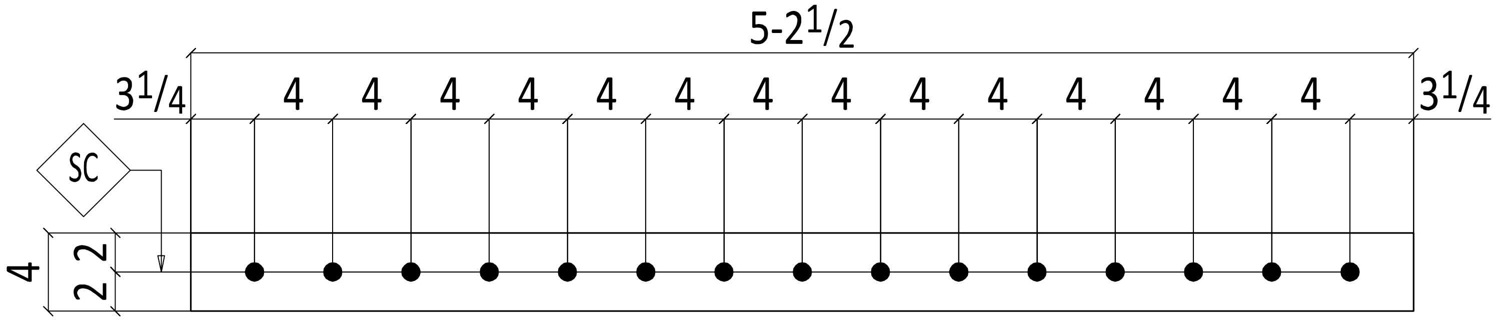
PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: MISC DETAIL

DATE 08-03-2022 JOB No. 704 DRG No. 1M2 REV. A

SHOPE NOTE :-

SC ---PROVIDE 3" NO PAINT ALL AROUND



54 PLATES 1M3

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH		STEEL	REMARKS	Weight
			FT	IN	GRADE		Unit
	54	PLATE				PRIME	53
1M3	54	PL3/4x4	5	2 1/2	A572-50		53

Total weight : 2871

REF. DRG. 1E8

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

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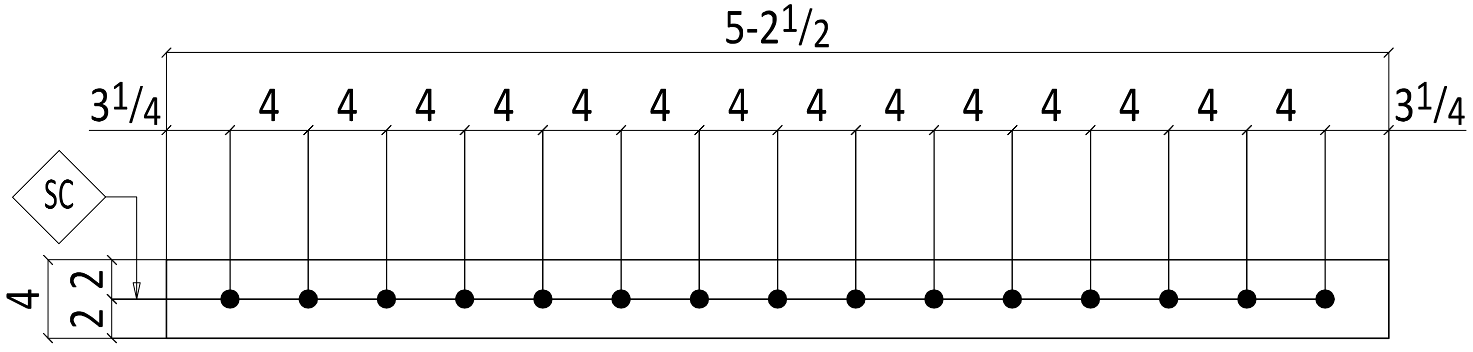
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: MISC DETAIL

DATE 08-03-2022 | JOB No. 704 | DRG No. 1M3 | REV. A

SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND



54 PLATES 1M4

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	54	PLATE				PRIME	53
1M4	54	PL$\frac{3}{4}$x4	5	$2\frac{1}{2}$	A572-50		53

Total weight : 2871

REF. DRG. 1E8

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. $\frac{15}{16}$"
WELD SIZE U.N.O. $\frac{1}{4}$" UN
FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. $\frac{1}{2}$"
WELD ELECTRODES U.N.O. E70xx
SURFACE PREP U.N.O. SSPC-SP3

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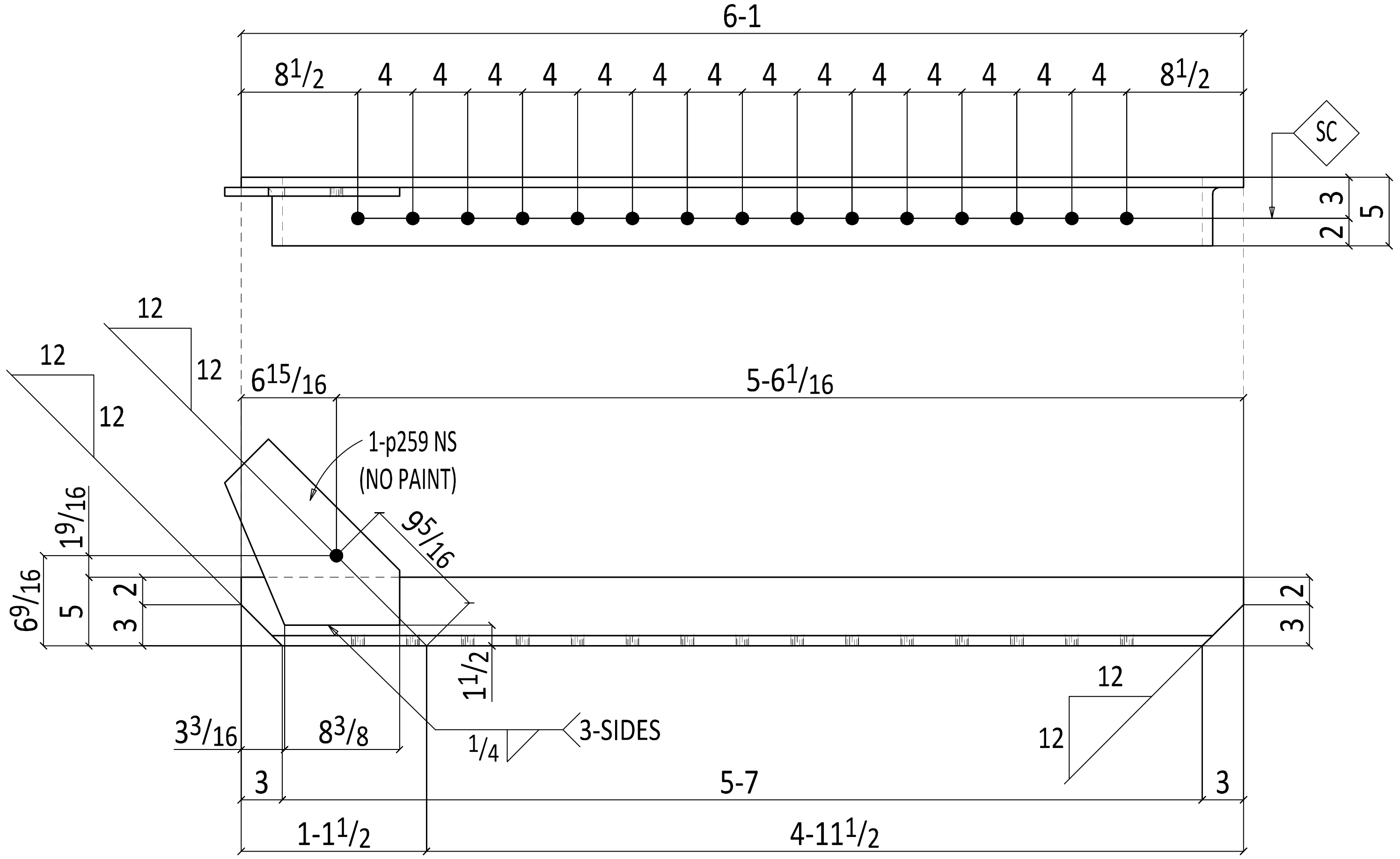
CUSTOMER NAME: ---
PROJECT: CTA GREEN LINE SHORING TOWERS
DESCRIPTION: MISC DETAIL
DATE 08-03-2022
JOB No. 704
DRG No. 1M4
REV. A

SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH		STEEL	REMARKS	Weight
			FT	IN	GRADE		Unit
	27	MISC				PRIME	174
1M5	27	L5x5x3/4	6	1	A572-50		144
p259	27	PL5/8x123/4	1	19/16	A572-50		31

Total weight : 4701



27 MISCS 1M5

REF. DRG. 1E8

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

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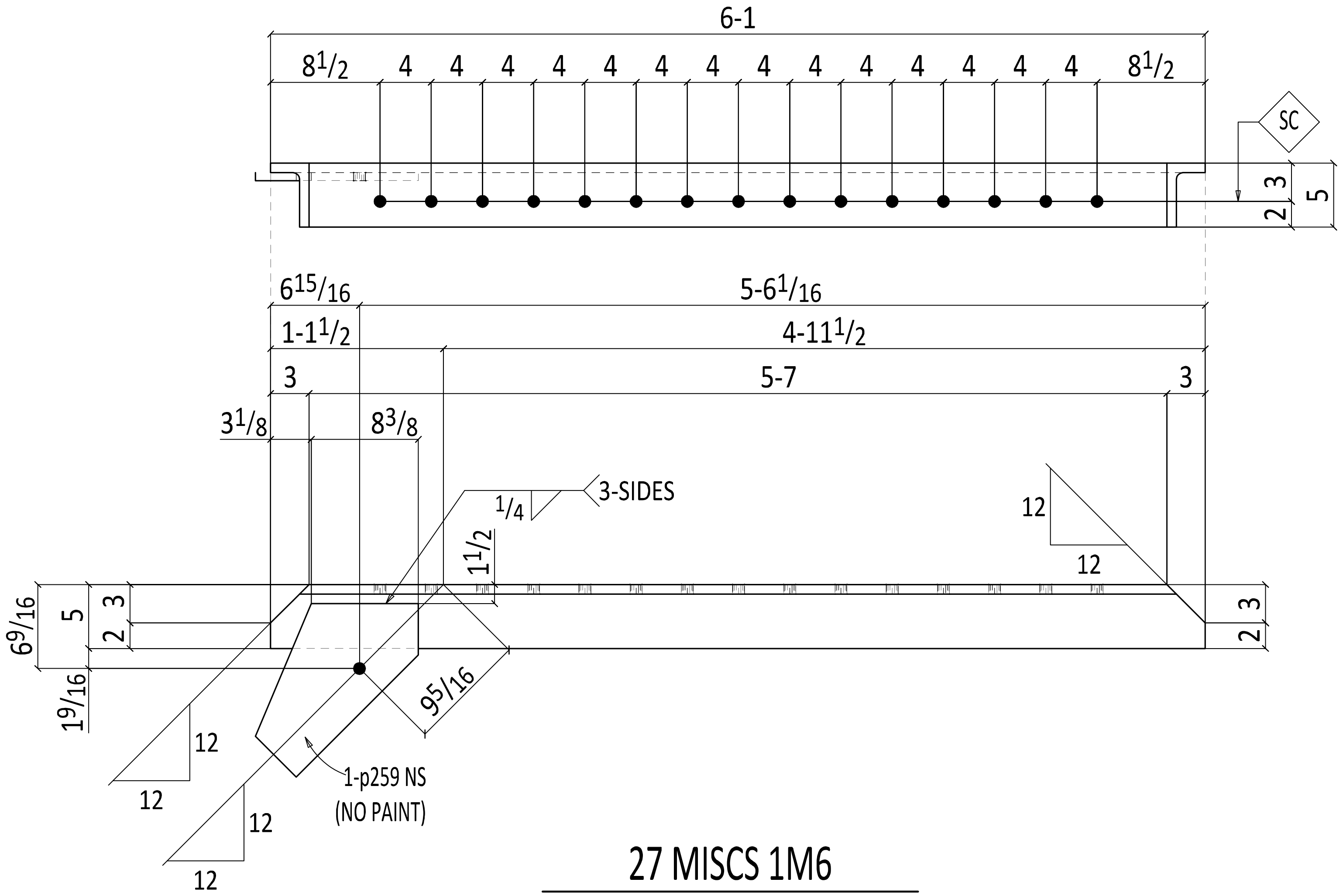
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: MISC DETAIL

DATE 08-03-2022 | JOB No. 704 | DRG No. 1M5 | REV. A

SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND



27 MISCS 1M6

FIELD BOLTS:
15-7/8Diax5 A325SC +1HD WASH Galv [total=405]

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	27	MISC				PRIME	174
1M6	27	L5x5x3/4	6	1	A572-50		144
p259	27	PL5/8x12 3/4	1	1 9/16	A572-50		31
		FIELD BOLTS					
	405	7/8 Dia A325SC	0	5		+1HD WASH Galv	

Total weight : 4701

REF. DRG. 1E8

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

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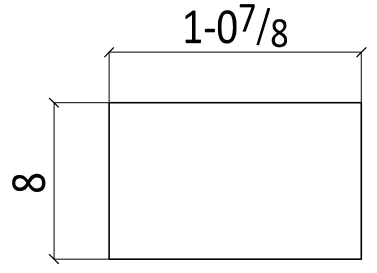
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: MISC DETAIL

DATE 08-03-2022 JOB No. 704 DRG No. 1M6 REV. A

SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND



57 PLATES 1M7

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH		STEEL	REMARKS	Weight
			FT	IN	GRADE		Unit
	57	PLATE				PRIME	22
1M7	57	PL3/4x8	1	0 7/8	A572-50		22

Total weight : 1251

REF. DRG. 1E3

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

17500 S. Paxton Ave
Lansing, IL 60438
Ph. 708-474-2777
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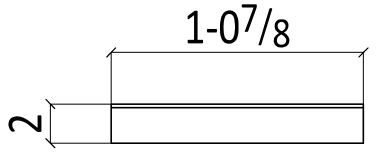
CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: MISC DETAIL

DATE 08-03-2022 JOB No. 704 DRG No. 1M7 REV. A



57 ANGLES 1M8

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	57	ANGLE				NO PAINT	3
1M8	57	L2x2x$^{3}/_{16}$	1	0$^{7}/_{8}$	A572-50		3

Total weight : 150

REF. DRG. 1E3

REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY
A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS

REVISIONS

TYPICAL HOLE SIZE U.N.O. $^{15}/_{16}$"	WELD SIZE U.N.O. $^{1}/_{4}$" UN	FINISH NO PAINT
TYPICAL COPE RADIUS U.N.O. $^{1}/_{2}$"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. ---

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CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

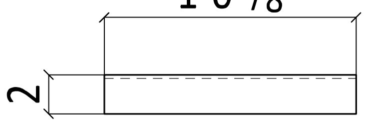
DESCRIPTION: MISC DETAIL

DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1M8	A

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH		STEEL	REMARKS	Weight
			FT	IN	GRADE		Unit
	57	ANGLE				NO PAINT	3
1M9	57	$L2x2x^{3}/_{16}$	1	$0^{7}/_{8}$	A572-50		3

Total weight : 150



57 ANGLES 1M9

REF. DRG. 1E3

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. $^{15}/_{16}$"	WELD SIZE U.N.O. $^{1}/_{4}$" UN	FINISH NO PAINT
TYPICAL COPE RADIUS U.N.O. $^{1}/_{2}$"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. ---

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Lansing, IL 60438
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CUSTOMER NAME: ---

PROJECT: CTA GREEN LINE SHORING TOWERS

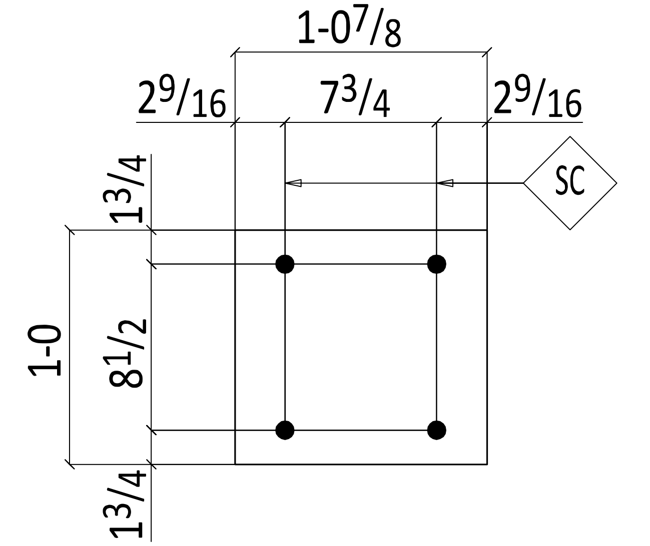
DESCRIPTION: MISC DETAIL

DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1M9	A

BILL OF MATERIAL

MARK	QTY	DESCRIPTION	LENGTH FT	LENGTH IN	STEEL GRADE	REMARKS	Weight Unit
	54	PLATE				PRIME	33
1M10	54	PL3/4x12	1	07/8	A572-50		33
		FIELD BOLTS					
	216	7/8 Dia A325SC	0	23/4		+1HD WASH Galv	
	108	LINDAPTER LAAF075 Clamps				BUY OUT	
		w/ 3/4 Dia Bolt					

Total weight : 1774



54 PLATES 1M10

FIELD BOLTS:
4-7/8Diax2 3/4 A325SC +1HD WASH Galv [total=216]

REF. DRG. 1E3

A	08-09-2022	ISSUED FOR APPROVAL	GMD	JPS
REV	DATE	DESCRIPTION	DRWN BY	CHK'D BY

REVISIONS

TYPICAL HOLE SIZE U.N.O. 15/16"	WELD SIZE U.N.O. 1/4" UN	FINISH ONE COAT STANDARD SHOP PRIMER
TYPICAL COPE RADIUS U.N.O. 1/2"	WELD ELECTRODES U.N.O. E70xx	SURFACE PREP U.N.O. SSPC-SP3

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PROJECT: CTA GREEN LINE SHORING TOWERS

DESCRIPTION: MISC DETAIL

DATE	JOB No.	DRG No.	REV.
08-03-2022	704	1M10	A

SHOPE NOTE :-
SC ---PROVIDE 3" NO PAINT ALL AROUND