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Geotechnical Evaluation

West Segment 2

August 29, 2014

Revision 0

Southwest LRT Project Technical Report

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Contents

List of Appendices

Executive Summary

This technical memorandum presents the *Geotechnical Evaluation of West Segment 2* of the Southwest Light Rail Transit (SWLRT) project in Hennepin County. This document combines eight separate memorandums, included in the appendices, under one cover. They provide the details of the geotechnical findings and recommendations for the following areas:

- **Nine Mile Creek Bridge -** This preliminary report provides the results of the initial soil borings along the alignment of the proposed Nine Mile Creek Bridge from approximate STA 2216+94 to STA 2230+45 and to provide preliminary recommendations for the bridge foundation and approach embankment supports. A final geotechnical report will be prepared after final geotechnical borings are completed. See Appendix A.
- **Golden Triangle Area** – This preliminary report provides general construction comments and recommendations between STA 2230+50 to STA 2253+91 for the proposed construction of the track, Golden Triangle Station, parking lot construction, retaining walls RTW-W205, RTW-W215 and a land bridge extending from the north end of the station platform to the south abutment of the Bridge over Shady Oak Road/TH 212. A discussion of general civil and roadway discussion is also included. A final geotechnical report will be prepared when the full scope of the field investigation program has been completed. See Appendix B
- **Bridge over Shady Oak Road and TH 212** – This Foundation Analysis Design Recommendation (FADR) report addresses the geotechnical evaluation for the proposed light rail bridge over Shady Oak Road and TH 212 in Eden Prairie. It includes the recommendations for the design and construction of bridge foundations and associated embankments. See Appendix C
- **Retaining Walls W206, W207 and W209** – This purpose of this letter is to provide you and the design team with a summary of our gathered historical soil boring information in the area of retaining walls RTW-W206, RTW-W207, and RTW-W209 and to provide preliminary retaining wall closing design information. A final geotechnical report should be prepared after final geotechnical design borings are completed. See Appendix D
- **Retaining Walls W207D, W209, W210 and W211** – This design report addresses the design and construction of four retaining walls RTW-W207D, RTW-W209, RTW-W210 and RTW-W211 that will support the track embankment near the 62 Tunnel segment in Eden Prairie and Minnetonka. See Appendix E
- **TH 62 Tunnel Crossing** – This FADR report addresses the geotechnical evaluation for the design of the tunnel to be constructed under Highway 62 in Eden Prairie and Minnetonka. See Appendix F
- **Opus Area** – This FADR report addresses the preliminary geotechnical evaluation for the proposed Opus Area construction between STA 2314+00 to STA 2362+00. The following sections provide our recommendations for the design and construction of the five pedestrian underpasses, retaining walls RTW-W212 and RTW-W213 and general track construction. See Appendix G

- **Opus Station** – This Geotechnical Evaluation Report addresses the proposed Opus Station Platform, from STA 2325+92 to STA 2328+62 in Minnetonka. The site of the proposed platform station is located east of Bren Road East and approximately 338 feet south of Bren Road West. See Appendix G

This information was used in other elements of the project development including preliminary site plans, station plans, roadway improvements and traffic analysis.

Appendix A

Nine Mile Creek Bridge

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August 29, 2014 Project BL-13-00213

Mr. Don Demers
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Re: Results of Field Exploration and Preliminary Bridge Recommendations – 30% Design
9 Mile Creek Bridge
STA 2216+94 to STA 2230+45
Southwest LRT, West Segment 2
Eden Prairie, Minnesota

Dear Mr. Demers:

This purpose of this letter is to provide you and the design team with the results of our initial soil borings along the alignment of the proposed 9 Mile Creek Bridge from approximate Track STA 2216+94 to STA 2230+45 and to provide preliminary recommendations for the bridge foundation and approach embankment supports. A final geotechnical report should be prepared after final geotechnical borings are completed.

This preliminary report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for general track construction and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Subsurface Investigation Summary

A.1. Summary of Borings Taken

The Southwest Light Rail Transit Project Office (SPO) requested preliminary subsurface soil and groundwater information in the area of the proposed 9 Mile Creek Bridge. Six (6) standard penetration soil borings were performed in the general area. The table below provides information on the borings including numbering, track stationing, and the ground surface elevation at the boring location:

Table 1. Soil Boring Information for 9 Mile Creek Bridge

Boring	Bridge Structure	Approximate Track Station	Surface Elevation at Boring Location (ft)
2012SB	West Abutment Embankment	2214+00	856.7
2027SB	West Bridge Abutment	2216+54	859.3
2028SB	Pier 1 and Pier 2	2218+69	850.6
2092SB	Pier 7	2225+50	855.2
2029SB	Pier 8	2226+84	844.6
2030SB	Pier 9	2227+92	846.2

A.2. Description of Foundation Soil Conditions

The description of soil conditions provided below is divided into two major areas including the west abutment and pier locations.

West Abutment Borings:

The borings performed near the west abutment include Borings 2012SB and 2027SB.

Fill and topsoil were encountered in the upper 12 to 20 feet of the borings, consisting of poorly graded sand with silt, silty sand, clayey sand, and lean clay.

Swamp deposits consisting of slightly organic to organic peat, clays, silty sands, and silts were encountered at Boring 2027SB starting at a depth of 20 feet, or elevation 839, and extending to a depth of 54 feet, or elevation 805.

Beneath the fill and swamp deposits, the borings encountered glacially deposited soils to the termination depth of the borings. The glacial soils consisted of interbedded clays and sands with varying amounts of gravel. The majority of the soils consisted of silty sand, sandy lean clay, poorly graded sand and clayey sand.

Penetration resistances in the fill soils and swamp deposits were variable and ranged from 2 to 23 blows per foot (BPF). The glacially deposited soils had penetration resistances ranging from 10 to 79 BPF, indicating rather stiff to hard conditions in the clays, and loose to very dense conditions in the sandy soils.

Pier Borings:

The general soil profile at the pier locations where borings were performed consist of 7 to 15 feet of topsoil and fill at the surface consisting of lean clay, sandy lean clay, organic clay, silty sand, and poorly graded sand.

Below the fill, all of the borings, with the exception of Boring 2030SB, encountered swamp deposits to depths of 16 to 29 feet. The swamp deposits consisted of peat, organic clay, lean clay, and silt with varying amounts of organics.

Beneath the swamp deposits, alternating layers of glacially deposited clays and sands were encountered to termination depths of the borings, with the exception of Boring 2028SB, which encountered a layer of alluvial silts at a depth of 29 feet. The glacial deposits generally consisted of poorly graded sand with silt, lean clay, sandy lean clay, poorly graded sand, clayey sand and silty sand.

The penetration resistances recorded in the fill ranged from 3 to 46 BPF, indicating the soils were likely variably compacted and portions of the fill were placed in an uncontrolled manner. The native sands and clays had penetration resistance values ranging from 6 to 60 BPF, indicating loose to very dense consistencies in the sandy soils and medium to hard consistencies in the clayey soils. Isolated layers of loose sand or medium consistency clays were encountered within the profiles. It appears the loose sands were a product of a “blow up” condition that commonly occurs when the auger encounters groundwater at depth and the difference in pressures locally loosens the saturated sands. The medium consistency clays were likely a result of a saturated sand seam that loosened the surrounding clay soils.

A.3. Groundwater

Groundwater was encountered at all boring locations at depths ranging from 10 to 22 ½ feet beneath the surface, or elevations ranging from 823 ½ to 846 ½ feet. We anticipate groundwater levels will fluctuate but will generally be encountered between elevations 840 and 844, based on the elevation of the culvert crossing beneath Flying Cloud Drive, related to 9 Mile Creek. The variation in groundwater levels was likely due to the borehole not being left open long enough for water to reach its hydrostatic level.

Piezometers may be valuable to more accurately determine the groundwater elevation along the proposed bridge alignment. Seasonal and annual fluctuations in groundwater levels should also be expected.

B. Design and Construction Considerations

Based on the preliminary engineering plans provided by AECOM, it appears the west abutment will begin at STA 2216+94, and the east abutment will be at STA 2230+45. It is anticipated there will be 10 piers with bridge spans ranging from 105 to 125 feet. The entire length of the bridge will be about 1,355 feet.

The following design and construction items were considered and will be addressed in our preliminary evaluation. We recommend a final geotechnical program be established and performed upon final design of the bridge:

- Axial loads for the bridge were not known at the time of this report. We have provided baseline recommendations for 12.0-inch and 16.0-inch closed end pipe piles using factored loads of 120 tons and 140 tons.
- Lateral loads at the bridge piers are also unknown at the time of this report. We will provide recommended maximum lateral loads for 12.0-inch piles and 16.0-inch piles, assuming a 1/4-inch wall thickness and a one-inch limit for lateral movement.
- We anticipate that embankments on the order of 16 to 20 feet will be constructed at the abutments. At this time, we anticipate the bridge approaches will be constructed of soil embankments, however, alternative design recommendations for construction and support of the embankments will be discussed.
- Due to the presence of highly compressible swamp deposits and variably compacted fill materials, it is our opinion the use of spread footing foundations will not be feasible for this structure to control settlement. Our recommendations are based on the assumption that the bridge will consist of pile-supported foundations.

C. Preliminary Recommendations

New approach embankments are anticipated as part of the proposed 9-Mile Creek bridge construction. Retaining walls RTW-W201, RTW-202C, RTW-W203, and RTW-W204 will abut the bridge and act as wing walls for the approach embankments. RTW-W201 extends to the south approximately 500 feet past the approach embankment.

Based on the borings performed in the area of the west abutment and retaining walls RTW-W201 and RTW-W202C, we anticipate these walls will be pile supported. Based on the anticipated soils near the east abutment and retaining walls RTW-W203 and RTW-W204, we anticipate these walls will likely be supported on spread footing foundations. However, due to the existing site terrain, we were unable to perform borings in this area and a final boring program should be completed in this area to confirm our assumptions prior to final design.

Based on the AECOM plans, we anticipate finished grade at the piers will be near or at existing grades, and fills on the order of 16 to 20 feet will be needed at the abutments. We have assumed the moist unit weight of the anticipated fill soils is 120 pounds per cubic foot (pcf).

Below in this report, you will find our preliminary recommendations regarding pile supported foundations.

C.1. East Approach Embankment

C.1.a. Embankment Settlement

The service limit state (settlement) of one-inch will control design of the east abutment. Based on the anticipated fill heights of up to 15 feet for the embankment approaches, total settlement magnitudes are expected to exceed one-inch, and we are anticipating the settlement to be between 1 ½ and 2 inches.

Due to the anticipated settlements and the varying composition of the underlying soils at the east embankment location, preliminary estimates for the time rate of consolidation under the full embankment height indicate that it could take up to 3 months to reduce the long-term settlement of the embankment to under 1 inch under a preloading condition.

C.2. West Approach Embankment

C.2.a. Embankment Settlement

Boring 2027SB at the west abutment encountered 20 feet of fill overlying 27 feet of peat overlying organic clay. If 20 feet of new fill was placed at the west abutment location, further consolidation of the organic soils at depth will occur. We estimate new settlements on the order of 2 feet could occur. The first 1 1/2 feet will occur in the first 6 months and the remaining 1/2-foot of secondary consolidation over 30 years under a preload condition.

C.2.b. Waiting Period and Downdrag

A 6-month waiting period after preloading the embankment would be required to reduce post-construction settlement from 2 feet to 1/2-foot for the west approach. Long-term re-ballasting of the track would be required if this approach is used.

Retaining wall piling and the west abutment piling will be subject to downdrag due to the embankment settlement. Some of the piles could be driven with no downdrag if they are out of the influence of the embankment load such as the piles constructed at the toe of the retaining walls opposite the fill side (high side) of the walls.

Based on the proposed embankment fill height at the west bridge abutment, the estimated unfactored downdrag (negative skin friction) for design of the bridge abutment is provided in the table below.

Table 2. Downdrag Load and Influence Elevation – 12.0-inch & 16.0-inch Closed End Pipe Piles, Top of Pile Elevation = 853

Boring	Substructure	Pile Size, Outside Diameter (Inches)	Approximate Embankment Increase (feet)	Estimated Downdrag Load (tons)[1]	Downdrag Influence Elevation (feet)
2027SB	West Bridge Abutment	12.0	17-20	42	805
		16.0		62	805

[1]The estimated downdrag (negative skin friction) values given are unfactored

No raise in grade is anticipated in the area of the proposed piers, therefore, we do not anticipate downdrag forces contributing additional load to the piles.

C.2.c. Lightweight Fill

An alternative to limit settlement to less than 1-inch for the west embankment is to use of Expanded Polystyrene (EPS) foam blocks. EPS blocks would be used to within 5 to 6 feet from the tracks. Also, to balance the stresses from the 5 to 6 feet of sand on top of the EPS block, the EPS blocks would have to extend into the existing fill. The extent of the lightweight fill would have to be determined by additional soil borings. We recommend keeping all of the EPS foam blocks above the high water table to prevent the potential for buoyancy during high water conditions.
Based on our calculations, by replacing 6 feet or more of conventional granular fill material weighing 120 pcf with blocks of Expanded Polystyrene (commonly known as Geofoam) weighing 1.5 pcf in the approach embankments, the long term settlements would be reduced significantly (approaching 1 inch).

C.2.d. Alternate Bridge Design

A third option to reduce settlement of the approach west embankment would include adding length to the bridge structure and moving the abutments to better ground. By adding 200 to 300 feet of bridge structure to the west, the approach embankments will be founded on more suitable soils and embankment heights will be reduced. The exact additional length of bridge necessary to reduce settlement problems would need to be determined by future borings for the purpose of estimating construction costs. At this time, we recommend assuming the new abutment would be near Station 2215+00.

C.3. Pile Supported Bridge

We understand there will be two abutments and 10 piers with bridge spans of 105 to 125 feet to support the bridge. For preliminary design recommendations, we analyzed subsurface conditions for pile support at the abutments and piers using Borings 2012SB, 2027SB, 2028SB, 2029SB, 2030SB, and 2092SB.

C.3.a. Design Methodologies

We used the computer program UniPile, version 5.0.0.33, to estimate the static nominal geotechnical resistance (R_n) of the 12.0- and 16.0-inch outside-diameter, 1/4-inch thick wall, closed-ended pipe piles for support of the bridge abutments and piers. UniPile software was developed by UniSoft Geotechnical Solutions Ltd. and can calculate pile resistance using a variety of methods.

For our analysis, we utilized the Beta-method, an effective stress method, to estimate the static geotechnical resistance for these pile. This method determines shaft resistance using Bjerrum-Burland beta coefficients (β), which are based on soil type and effective friction angle. We estimated the β values for each layer using Figure 9.20 from the Federal Highway Administration (FHWA) Publication No. NHI-05-042, Design and Construction of Driven Pile Foundations, April 2006. The Beta-method determines end bearing resistance using toe bearing capacity factors (N_t), which are also based on soil type and effective friction angle. We estimated the N_t values from Table 9-6 of the April 2006 FHWA publication identified previously.

C.3.b. Nominal Bearing Capacities and Associated Resistance Factors

For situations where subsurface exploration and static calculations have been completed, we recommend that the following φ_{dyn} factors be used.

Table 3. Recommended Pile Driving Resistance Factors (ϕ_{dyn})

Specified Construction Control	ϕ_{dyn}
MnDOT Pile Formula 2012 (MPF12) for Pipe Pile Sections	0.50
Wave Equation and Pile Driving Analyzer (PDA)	0.65

We calculated the nominal resistance of the piles in compression. The following tables summarize the anticipated pile depths based on the factored load ($\Sigma\gamma Q_n$) for 12.0-inch and 16.0-inch pipe pile sections based on the maximum vertical loads provided by AECOM. The following tables summarize the anticipated pile depths based on the factored load ($\Sigma\gamma Q_n$) for 12.0- and 16.0-inch, outside-diameter pipe pile with a wall thickness of 1/4 inch. The tables provide a PDA length (i.e., φ_{dyn} of 0.65) and a MPF12 formula length (i.e., φ_{dyn} of 0.50) for each location. We assumed a cutoff elevation of about 1 foot above the anticipated bottom-of-pile-cap elevation. Please refer to the attached nominal bearing resistance graphs for a detailed profile of pile resistances as a function of depth. We also wish to note that if pile capacities were not met within the depth of our borings, we extended the soil profile within *UniPile* version 5.0.0.33, under the assumption that the soils encountered at termination depth of the borings extended to deeper depths.

As you review the tables below, you will notice several pier locations as well as the east abutment were not analyzed. Borings were not performed at these locations during our preliminary analysis, so pile length estimates are not possible. Pile length estimates for the remaining pier and abutment locations will be performed during the final design program.

Table 4. Summary of Anticipated Pile Lengths - PDA

Boring/Substructure	Anticipated Cutoff Elevation (feet)	$\Sigma\gamma Q_n$ (tons)	R_n (tons)	O.D. of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2012SB (West Abutment Embankment)	856	120	185 [370 kips]	12.0	807	49
				16.0	812	44
		140	215 [430 kips]	12.0	806	50
				16.0	808	48
2027SB (West Bridge Abutment)	852	120	185 [370 kips]	12.0	776	76
				16.0	789	63
		140	215 [430 kips]	12.0	772	80
				16.0	782	70
2028SB (Pier 1)	844	120	185 [370 kips]	12.0	779	65
				16.0	787	57
		140	215 [430 kips]	12.0	775	69
				16.0	784	60
2028SB (Pier 2)	840	120	185 [370 kips]	12.0	777	63
				16.0	785	55
		140	215 [430 kips]	12.0	773	67
				16.0	782	58
2092SB (Pier 7)	839	120	185 [370 kips]	12.0	787	52
				16.0	795	44
		140	215 [430 kips]	12.0	785	54
				16.0	790	49
2029SB (Pier 8)	839	120	185 [370 kips]	12.0	784*	55
				16.0	792*	47
		140	215 [430 kips]	12.0	780*	59
				16.0	789*	50
2030SB (Pier 9)	845	120	185 [370 kips]	12.0	799	46
				16.0	811	34
		140	215 [430 kips]	12.0	797	48
				16.0	809	36

*-Note: The estimated tip elevation and approximate length exceed the depth of exploration at these locations. We extrapolated the soil properties below the depth of exploration.

Table 5. Summary of Anticipated Pile Lengths – MPF12

Boring/Substructure	Anticipated Cutoff Elevation (feet)	$\Sigma\gamma Q_n$ (tons)	R_n (tons)	O.D. of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2012SB (West Abutment Embankment)	856	120	240 [480 kips]	12.0	801	55
				16.0	807	49
		140	280 [560 kips]	12.0	800	56
				16.0	806	50
2027SB (West Bridge Abutment)	852	120	240 [480 kips]	12.0	766	86
				16.0	779	74
		140	280 [560 kips]	12.0	758	94
				16.0	775	77
2028SB (Pier 1)	844	120	240 [480 kips]	12.0	771	73
				16.0	781	63
		140	280 [560 kips]	12.0	766	78
				16.0	777	67
2028SB (Pier 2)	840	120	240 [480 kips]	12.0	769	71
				16.0	779	61
		140	280 [560 kips]	12.0	764	76
				16.0	775	65
2092SB (Pier 7)	839	120	240 [480 kips]	12.0	785	54
				16.0	788	51
		140	280 [560 kips]	12.0	777	62
				16.0	787	52
2029SB (Pier 8)	839	120	240 [480 kips]	12.0	777*	62
				16.0	787*	52
		140	280 [560 kips]	12.0	772*	67
				16.0	782*	57
2030SB (Pier 9)	845	120	240 [480 kips]	12.0	796	49
				16.0	808	37
		140	280 [560 kips]	12.0	788	57
				16.0	798	47

*-Note: The estimated tip elevation and approximate length exceed the depth of exploration at these locations. We extrapolated the soil properties below the depth of exploration.

C.3.c. Uplift Capacities

Currently, a tension resistance line is not provided on the Nominal Bearing Graphs attached to this report. If piles will experience tension loads, please let us know and we'll revise our recommendations accordingly.

C.4. Pile Spacing and Group Effect

In our opinion, the working capacities of piles spaced at least 3 pile diameters apart need not be reduced due to group effects. If a closer spacing is ultimately selected, we recommend having a geotechnical engineer evaluate the magnitude of the group effect, and the extent to which the working capacities should be reduced.

The lateral capacity for each pile should be reduced, depending on the actual spacing and the location of the pile within the pile cap. We recommend using pile spacing reductions (group action) for the various pile spacing's as identified in the table below.

Table 6. Pile Spacing

Pile CTC Spacing (in the direction of loading)	Row 1	Row 2	Row 3 and Higher
3D	0.8	0.4	0.3
4D	0.9	0.63	0.5
5D	1.0	0.85	0.7

Linearly interpolated from AASHTO 2012 6th Edition, Table 10.7.2.4-1.

C.5. Lateral Pile Analyses

The following table provides the soil parameters used for the lateral pile analyses and p-y curve generation, which was performed the computer program LPILE (2013). Based on the soils encountered in the borings, we used the default lateral modulus of subgrade reaction values included in LPILE. For the purposes of our preliminary evaluation, we used the soil parameters encountered in Boring 2027SB, which in our opinion represents the worst case soil conditions for lateral pile resistance

Table 7. Soil Parameters used for the Lateral Pile Analyses and P-Y Curve Generation

Layer Top Depth (feet)	Layer Bottom Depth (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction (degrees)	Undrained Shear Strength (psf)	Material Type
0	7.5	125	NA	750	Soft Clay
7.5	13.5	58	28	NA	Sand (Reese)
13.5	20.5	11	NA	150	Soft Clay
20.5	40.5	16	NA	350	Soft Clay
40.5	47.5	38	27	NA	Sand (Reese)
47.5	57.5	63	32	NA	Sand (Reese)
57.5	62.5	63	NA	5875	Stiff Clay w/o Free Water
62.5	67.5	58	38	NA	Sand (Reese)
67.5	77.5	68	NA	3225	Stiff Clay w/o Free Water
77.5	102.5	68	NA	2700	Stiff Clay w/o Free Water
102.5	114.5	63	35	NA	Sand (Reese)

For our lateral analyses, we assumed a pile top located 5 feet below the ground surface. The maximum lateral load in our analyses is for a loading condition assuming 1-inch of deflection at the pile top with a fixed-head condition. We assumed a pile wall thickness of 1/4-inch, a steel yield strength of 45 ksi, and concrete infill with a compressive strength of 3 ksi for our analyses. Please refer to the attachments for the shear force and bending moments within the pile at service loads of 120 tons for the 12.0-inch and 140 tons for the 16.0-inch closed-end pipe pile.

C.6. Pile Driving System and Installation

Using an under- or over-sized pile-driving hammer can be detrimental to the successful installation of piling. Prior to system acceptance, we therefore recommend performing a wave equation analysis modeling prospective contractors' pile installation systems. The wave equation analysis is used to estimate probable driving stresses and pile penetration resistance based on the type of hammer proposed, the specified pile type/size and the site-specific material conditions which, when combined, help evaluate system suitability. Our firm can discuss the requirements and limitations of wave equation analyses and, if needed, perform them.

C.7. Subcut and Dewatering Recommendations and Backfill Requirements for Pile Supported Structures

The pile caps for the abutments and piers will be excavated down to proposed bottom of foundation elevations. We expect fill soils at the bottom of pile caps at all locations except for the most easterly pier or abutment where they could extend into the glacial till soils. We expect the soils to be stable at most locations. The exception may be where pile caps extend below elevation 845 where groundwater may be encountered. If groundwater is at or near the bottom of the pile cap, we recommend the pile cap area be subcut 2 feet and replaced with clean 1-inch crushed rock to provide a construction platform for placing the pile cap concrete.

C.8. Retaining Wall Construction

At this time, we assume the retaining walls adjacent to the west bridge abutment will be pile supported and based on the anticipated soils near the east abutment we assumed the retaining walls abutting the east bridge abutment will be supported on spread footing foundations. However, final design borings should be completed to confirm the soils conditions and foundation alternatives for the retaining walls. Please refer to the tables above in section C.2.b and the axial capacity graphs located in the Appendix for pile capacities at the boring locations.

We recommend using Select Granular Modified 10% for Structure Backfill. Select Granular Modified 10% shall comply with Specification 3149.2B2, modified to 10% or less passing the 0.075 mm (#200) sieve. Compaction specifications should meet the requirements of MnDOT 2105.3F.

We recommend backfill material be placed in uniform layers approximately parallel to the profile, extending the full width of the retaining structures. We recommend backfill material be placed in lift thicknesses less than 12 inches. A waiting period may be needed prior to the placement of the track or any concrete to allow for settlement of embankment. We recommend installing geotechnical instrumentation and monitoring the settlement of the embankment. Once the geotechnical engineer is comfortable with the rate of settlement, construction may proceed.

C.9. Recommended Design Soil Parameters (e.g. Coefficient of Friction, Lateral Earth Pressure Coefficients, etc.)

The recommended soil parameters to be used for design are as follows:

Table 8. Recommended Soil Parameters

Soil Type	Angle of Internal Friction (degrees)	Effective unit Weight (pcf)	Coefficient of Sliding Friction Rough Concrete	Active Earth Pressure Coefficient	At-Rest Earth Pressure Coefficient
Select Granular Borrow	35	120	0.6	0.27	0.43
Granular Borrow	30	120	0.5	0.33	0.50
Fill: Sands	30	120	0.5	0.33	0.50
Fill: Lean Clay	22	115	0.4	0.45	0.63
Fill: Clayey Sand	28	130	0.4	.036	0.53
Native Sands	32	130	0.5	0.31	0.47
Native Lean Clay	27	130	0.35	0.38	0.55
Native Clayey Sand	28	135	0.4	0.36	0.53

D. Procedures

D.1. Penetration Test Borings

The penetration test borings were drilled with an ATV-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

Penetration test boreholes that met the Minnesota Department of Health (MDH) Environmental Borehole criteria were sealed with an MDH-approved grout.

D.2. Material Classification and Testing

D.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars, bags or thin wall tubes and returned to our facility for review, storage and laboratory testing.

D.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures.

D.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled with a bentonite grout.

E. Qualifications

E.1. Variations in Subsurface Conditions

E.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

E.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

E.2. Continuity of Professional Responsibility

E.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

E.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

E.3. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F. General

This report should be considered preliminary in nature and may be revised upon final design parameters and the completion of the full geotechnical program. In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If you have any questions about this Report, please contact Josh Kirk at 952.995.2222 or jkirk@braunintertec.com or Ray Huber at 952.995.2260 or rhuber@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal-Project Engineer
License Number: 45005

Reviewed by:

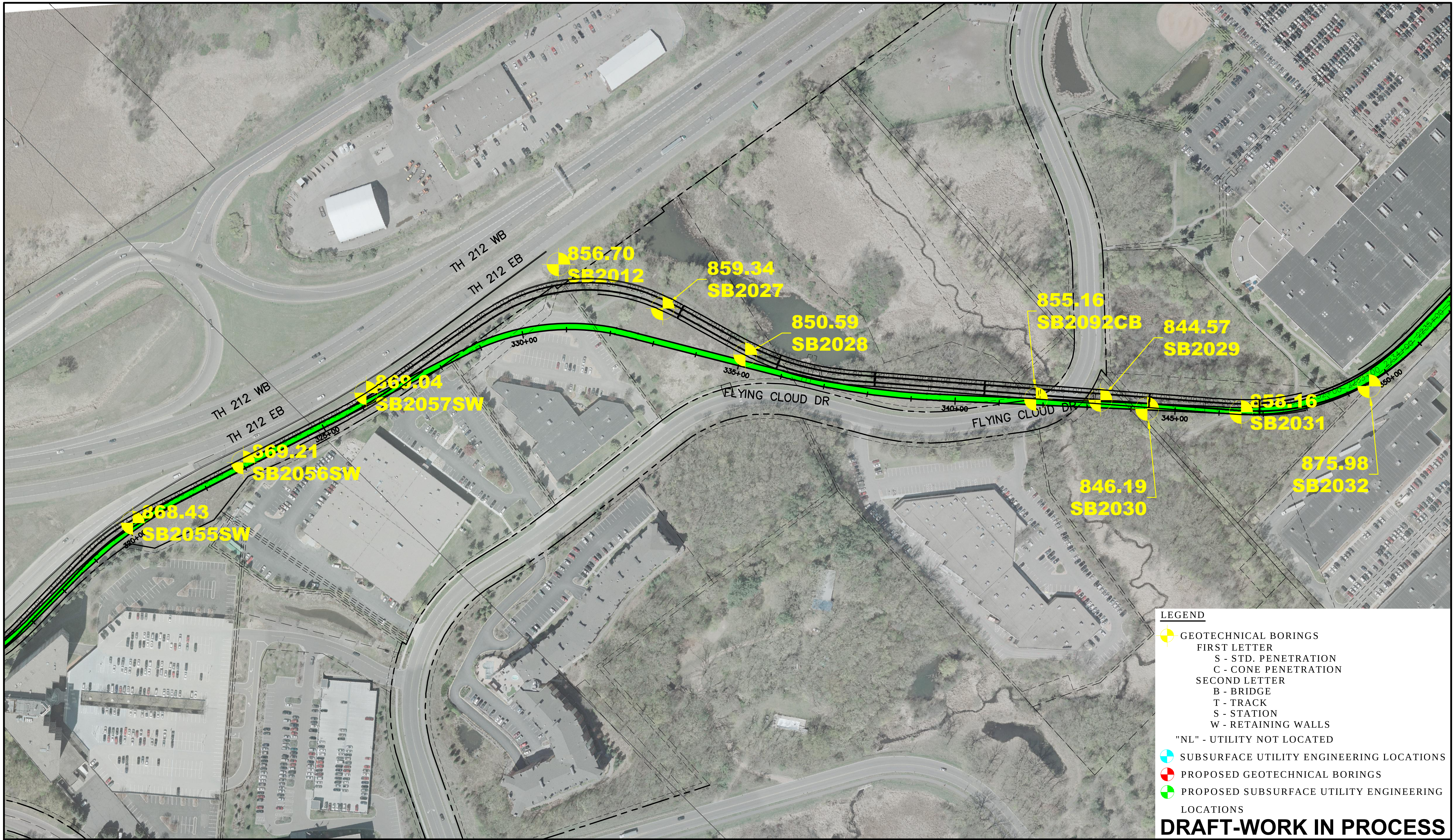
Ray A. Huber, PE
Vice President-Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Boring Location Sketch
Preliminary Engineering Plan and Profile Pages - Nine Mile Creek Bridge
Standard Penetration Test Borings 2012SB, 2027SB, 2028SB, 2029SB, 2030SB and 2092SB
Nominal Bearing Resistance Graphs
Lateral Analysis Results
Descriptive Terminology of Soil

APPENDIX



SOUTHWEST Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 6 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

NORTH

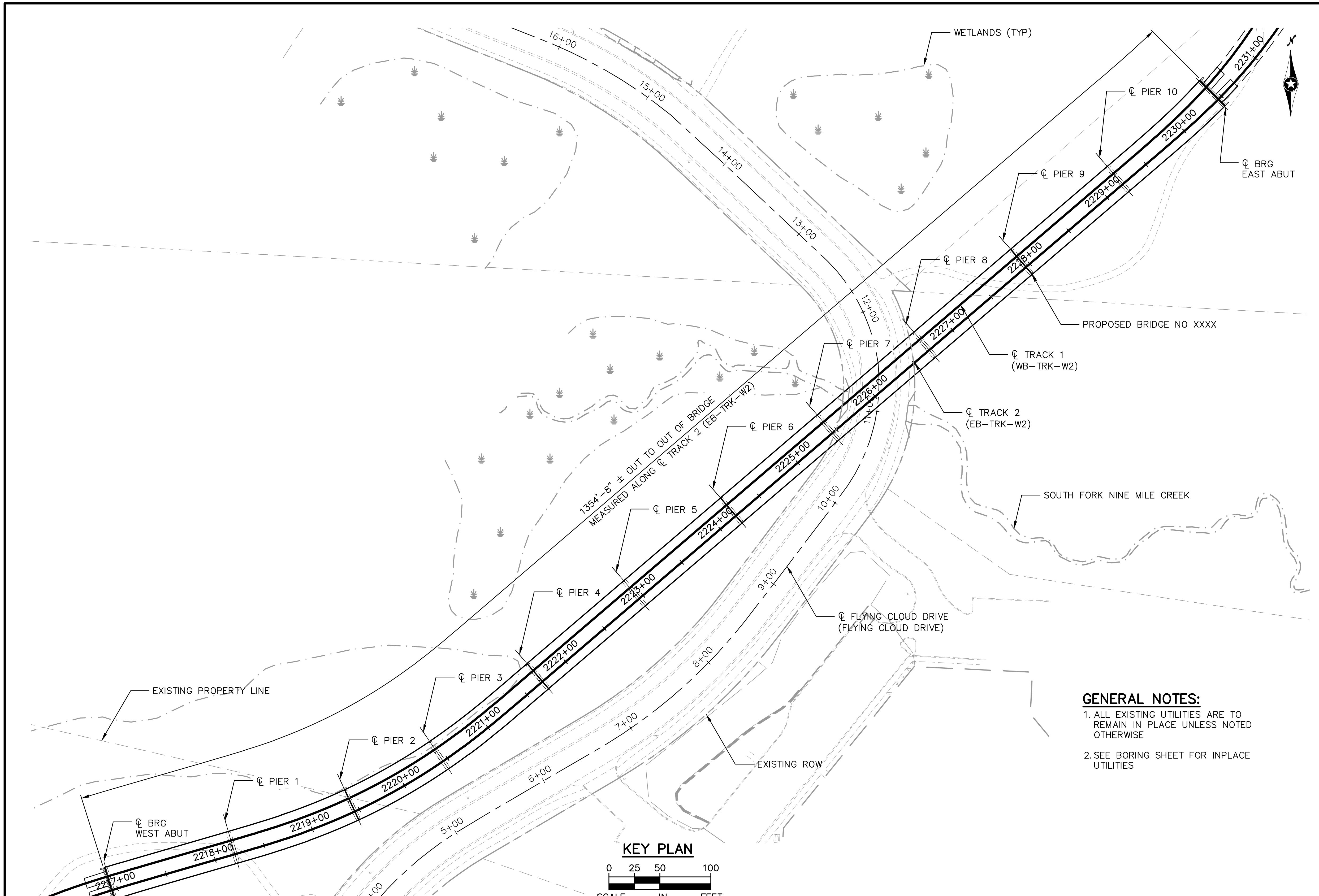
0 50 100 200

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.

Aug. 28 2014 11:31 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



KEY PLAN

0 25 50 100
SCALE IN FEET

GENERAL NOTES:

1. ALL EXISTING UTILITIES ARE TO REMAIN IN PLACE UNLESS NOTED OTHERWISE
2. SEE BORING SHEET FOR INPLACE UTILITIES

DESIGN DATA

2012 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS
6TH EDITION AND CURRENT INTERIMS

SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA
(REVISION 2.0)

LOAD AND RESISTANCE FACTOR DESIGN METHOD

LRV & MV LOAD DIAGRAM SHOWN ON SHEET 54

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4000 PSI, n = 8
fy = 60000 PSI

PRESTRESSED CONCRETE:
f'c = 9000 PSI, n = 1
fpu = 270 KSI
0.6" DIAMETER LOW RELAXATION STRANDS
0.75 fpu FOR INITIAL PRESTRESS

DESIGN SPEED: OVER = 25/55 MPH (LRT)
UNDER = 30 MPH

APPROXIMATE DECK AREA: 44,000 SQ FT

LIST OF SHEETS

SHEET NO.	DESCRIPTION
49	KEY PLAN
50–52	GENERAL PLAN AND ELEVATION
53	BRIDGE SURVEY
54	TRANSVERSE SECTION & LOADING DIAGRAMS
55–59	BORINGS
60	BRIDGE DETAILS
61	AESTHETICS

PROPOSED TYPE OF STRUCTURE

DECK:
MN63 PRESTRESSED CONCRETE BEAMS (SIMPLE SPANS) WITH 9" CAST-IN-PLACE CONCRETE DECK
ALL BARS EPOXY COATED
DIRECT FIXATION TRACK

SUBSTRUCTURE:
PARAPET ABUTMENTS SUPPORTED ON 12" CIP CONCRETE PILES

HAMMERHEAD PIERS SUPPORTED ON 16" CIP CONCRETE PILES

DEPTH OF STRUCTURE:
±7'-8" TOP OF LOW RAIL TO LOW BRIDGE
4± BEAM LINES

AESTHETICS:
TO BE DETERMINED

PRELIMINARY PLAN BRIDGE NO. XXXXX

SOUTHWEST LIGHT RAIL OVER FLYING CLOUD DRIVE
0.5 MI NORTHEAST OF THE INTERSECTION OF TH 212
AND VALLEY VIEW ROAD IN EDEN PRAIRIE

105' & 125' PRESTRESSED CONCRETE BEAM SPANS
32'-6" RAILWAY
0°-0'-0" SKEW

BRIDGE ID NO 501

KEY PLAN

SEC 12 T 116N R 22W
CITY OF EDEN PRAIRIE HENNEPIN COUNTY

APPROVED: ______ STATE BRIDGE ENGINEER DATE

JOB NO: T9N635 STATE PROJECT NO: 9909-01 MNDOT REVIEW:

DES: AAM	DRA: BR
CHK: PLR	CHK: PLR

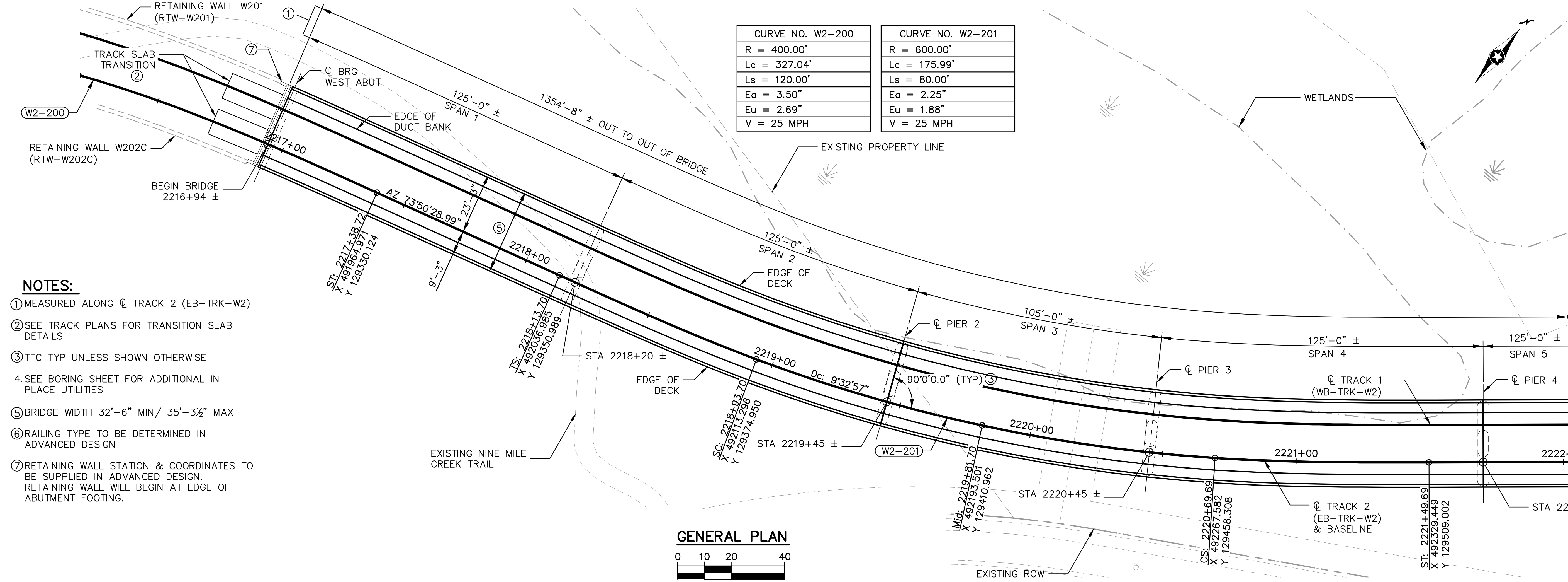
NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM
PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
NINE MILE CREEK
BRIDGE XXXXX (LRT)
KEY PLAN

DISCIPLINE: STRUCTURES
SHEET NAME: W2-STU-BRID-NMCK-LRT-GEN



CURVE NO. W2-200
R = 400.00'
Lc = 327.04'
Ls = 120.00'
Ea = 3.50"
Eu = 2.69"
V = 25 MPH

CURVE NO. W2-201
R = 600.00'
Lc = 175.99'
Ls = 80.00'
Ea = 2.25"
Eu = 1.88"
V = 25 MPH

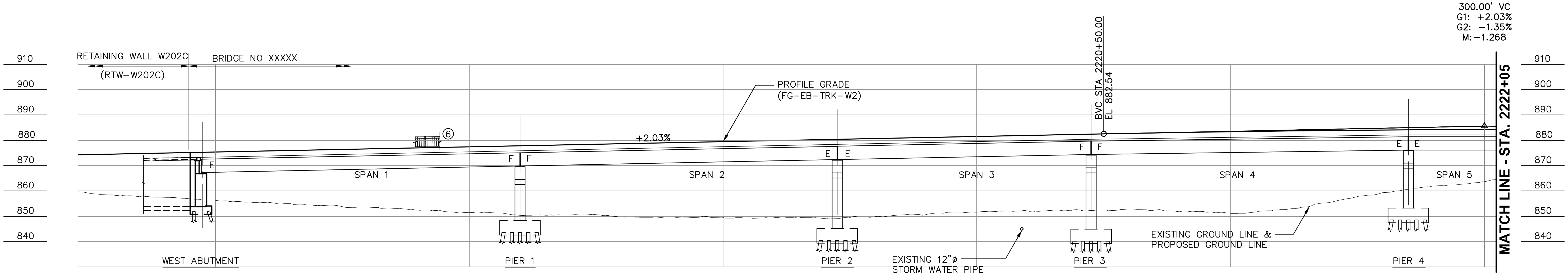
NOTES:

1. MEASURED ALONG ℄ TRACK 2 (EB-TRK-W2)
2. SEE TRACK PLANS FOR TRANSITION SLAB DETAILS
3. TTC TYP UNLESS SHOWN OTHERWISE
4. SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES
5. BRIDGE WIDTH 32'-6" MIN/ 35'-3½" MAX
6. RAILING TYPE TO BE DETERMINED IN ADVANCED DESIGN
7. RETAINING WALL STATION & COORDINATES TO BE SUPPLIED IN ADVANCED DESIGN. RETAINING WALL WILL BEGIN AT EDGE OF ABUTMENT FOOTING.

GENERAL PLAN

SCALE 0 10 20 40 IN FEET

PVI STA 2222+00.00
PVI ELEV 885.59
300.00' VC
G1: +2.03%
G2: -1.35%
M: -1.268



GENERAL ELEVATION

SCALE 0 10 20 40 IN FEET

DES: AAM	DRA: BR
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

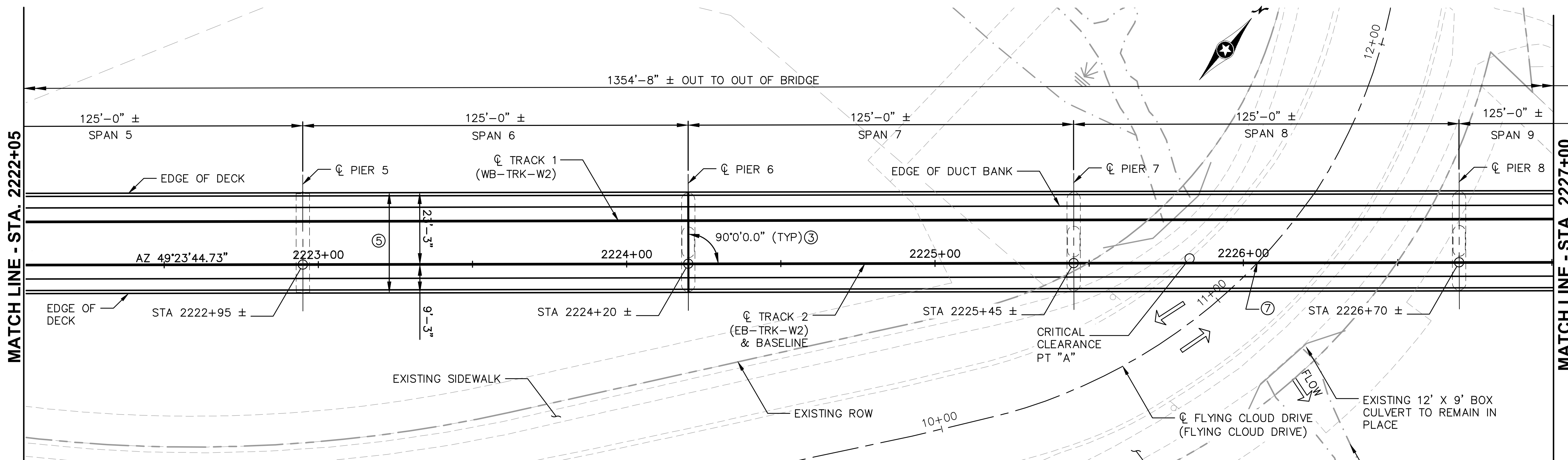
METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
NINE MILE CREEK
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-BRID-NMCK-LRT-GPE-001



NOTES:

①MEASURED ALONG ℄ TRACK 2 (EB-TRK-W2)

③TTC TYP UNLESS SHOWN OTHERWISE

4.SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES

⑤BRIDGE WIDTH 32'-6" (SPANS 5-10)

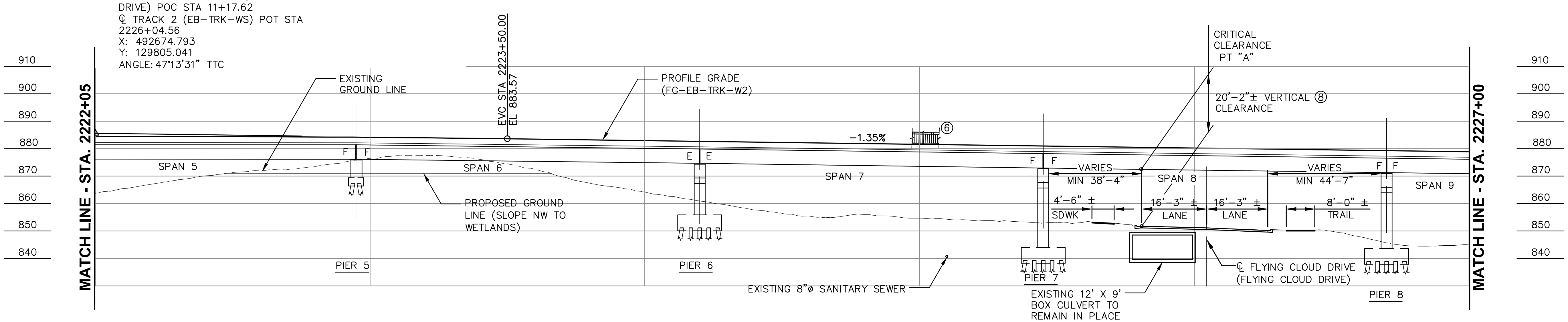
⑥RAILING TYPE TO BE DETERMINED IN ADVANCED DESIGN

⑦CONTROL POINT
℄ FLYING CLOUD DRIVE (FLYING CLOUD DRIVE) POC STA 11+17.62
℄ TRACK 2 (EB-TRK-WS) POT STA 2226+04.56
X: 492674.793
Y: 129805.041
ANGLE: 47°13'31" TTC

⑧LIDAR DATA USED IN VERTICAL CLEARANCE CHECK. VERTICAL CLEARANCE ALLOWS FOR A FUTURE ROADWAY ELEVATION RAISE ABOVE THE 100 YEAR HWL. POTENTIAL OPPORTUNITY TO LOWER PROFILE AND DELETE SPAN 11 WILL BE ADDRESSED IN ADVANCED DESIGN.

GENERAL PLAN

0 10 20 40
SCALE IN FEET



GENERAL ELEVATION

0 10 20 40
SCALE IN FEET

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

DES: AAM DRA: BR
CHK: PLR CHK: PLR

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

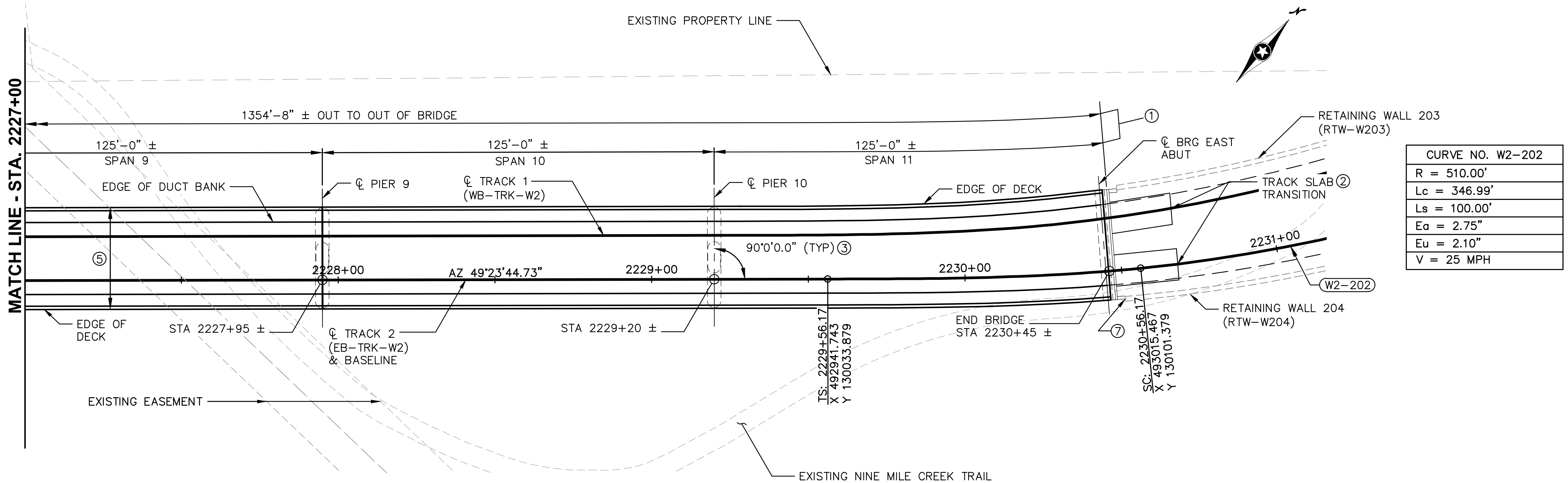
WEST - VOLUME 2 (STRUCTURES)
NINE MILE CREEK
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-BRID-NMCK-LRT-GPE-002

SHEET 51 OF 203

Aug. 01 2014 08:08 am V:\3200_PEC-W\CAD\SEGMENT-W2\SHEET\STRUCTURES\W2-STU-BRG-NMCK.dwg By: maurisakb



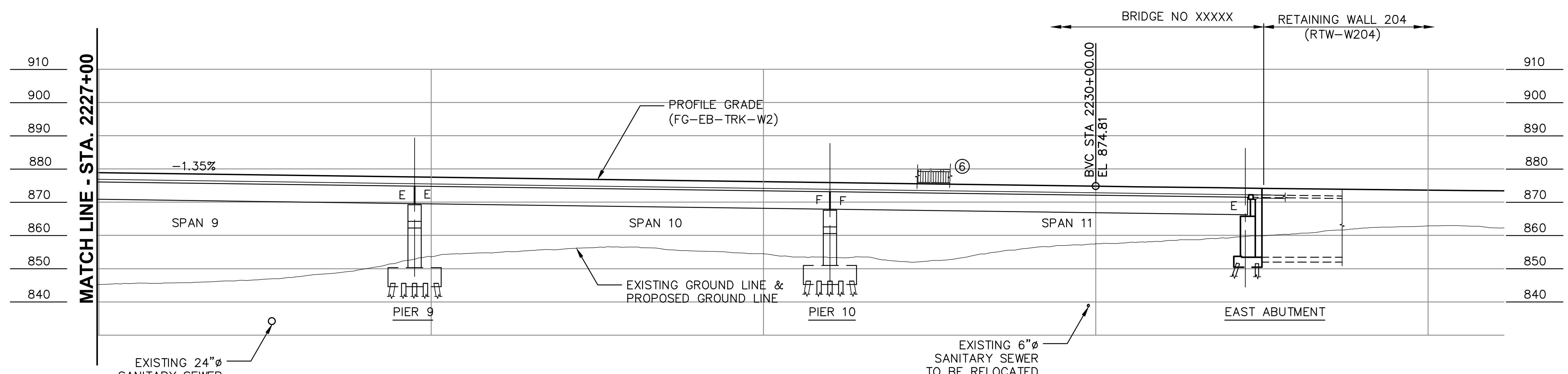
CURVE NO. W2-202
R = 510.00'
Lc = 346.99'
Ls = 100.00'
Ea = 2.75"
Eu = 2.10"
V = 25 MPH

GENERAL PLAN

0 10 20 40
SCALE IN FEET

NOTES:

1. ① MEASURED ALONG ℄ TRACK 2 (EB-TRK-W2)
2. ② SEE TRACK PLANS FOR TRANSITION SLAB DETAILS
3. ③ TTC TYP UNLESS SHOWN OTHERWISE
4. SEE BORING SHEET FOR ADDITIONAL IN PLACE UTILITIES
5. ⑤ BRIDGE WIDTH 32'-6" MIN/ 35'-3½" MAX
6. ⑥ RAILING TYPE TO BE DETERMINED IN ADVANCED DESIGN
7. ⑦ RETAINING WALL STATION & COORDINATES TO BE SUPPLIED IN ADVANCED DESIGN. RETAINING WALL WILL BEGIN AT EDGE OF ABUTMENT FOOTING.



GENERAL ELEVATION

0 10 20 40
SCALE IN FEET

DES: AAM	DRA: BR
CHK: PLR	CHK: PLR

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST - VOLUME 2 (STRUCTURES)
NINE MILE CREEK
BRIDGE XXXXX (LRT)
GENERAL PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-BRID-NMCK-LRT-GPE-003

SHEET 52 OF 203

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2012SB	856.7 (Surveyed)

Location: Hennepin Co. Coordinate: X=491648 Y=12904 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine **7507**

Hammer **CME Automatic Calibrated**

Drilling Completed **7/19/13**

Depth	Elev.	Classification
1.5	855.2	CLAYEY SAND, trace roots, dark brown, moist, (SC), topsoil fill
4.0	852.7	SILTY SAND, fine- to medium-grained, trace Gravel, with Clay inclusions, dark gray and brown, moist, (SM), fill
7.0	849.7	CLAYEY SAND, trace Gravel, dark brown and gray, wet, (SC), fill
12.0	844.7	SILTY SAND, fine- to medium-grained, trace Gravel, dark brown, moist to 10 feet then waterbearing, (SM), fill
19.0	837.7	SILTY SAND, fine- to coarse-grained, trace Gravel, with Clay lenses and seams, brown, waterbearing, loose to medium dense, (SM) till
34.0	822.7	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff to hard, (CL), till
42.0	814.7	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, gray, waterbearing, medium dense, (SP), outwash
		SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff, (CL), till

Water level symbol at 10 ft.

SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	12			
12	11			
8	14			
4	18			
10	16			
10	20			
16	25			
16	11			
18	10			qp=2 tsf
13	16			qp=2 tsf
20	12			qp=1 1/2 tsf
32	16			qp=2 1/2 tsf
15	11			
20	18			qp=1 1/2 tsf
15	15			
15*	15			
20	12			*No sample recovery. Switched to mud rotary drilling method after 40-foot sample.
21	16			qp=1 1/2 tsf

Index Sheet Code 3.0

(Continued Next Page)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2012SB**	**856.7** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff, (CL), till *(continued)*	X	23	14				qp=2 tsf
				PD						
	49.0 / 807.7			X	20	17				
50			POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, medium dense to dense, (SP), outwash	PD						
				X	32	12				
				PD						
55				X	38	12				
				PD						
60	59.0 / 797.7		SILTY SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, dense, (SM), till	X	48	13				
				PD						
65	64.0 / 792.7		CLAYEY SAND, trace Gravel, gray, wet, hard, (SC), till	X	47	9				qp=4 tsf
				PD						
70	69.0 / 787.7		SILTY SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, dense, (SM), till	X	54	11				
				PD						
75	74.0 / 782.7		CLAYEY SAND, trace Gravel, gray, wet, hard, (SC), till	X	41	12				
				PD						
80				X	46	14				
				PD						
85	84.0 / 772.7		SANDY LEAN CLAY, trace Gravel, gray, wet hard, (CL), till	X	45	17				
				PD						
90										

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2012SB**	**856.7** (Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
95	96.0 / 760.7		SANDY LEAN CLAY, trace Gravel, gray, wet hard, (CL), till *(continued)*	PD	44	17				

Bottom of Hole - 96 feet.
Water observed at 10 feet with 9 1/2 feet of hollow-stem auger in the ground.
Boring then sealed with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2027SB	859.3 (Surveyed)

Location: Hennepin Co. Coordinate: X=491886 Y=129301 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7504

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 9/10/13

Depth / Elev.	Classification	SPT N60	MC (%)	Other Tests Or Remarks
0.5 / 858.8	LEAN CLAY, brown, moist, (CL), topsoil fill			
5.0 / 854.3	LEAN CLAY, brown, moist, (CL), fill	23		
7.0 / 852.3	CLAYEY SAND, fine- to medium-grained, with Gravel, brown, moist to wet, (SC), fill	11		
14.0 / 845.3	CLAYEY SAND, trace Gravel, brown, wet, (SC), fill	6	13	
		10	12	P200=31%
		2		Sand lenses at 12 feet.
20.0 / 839.3	POORLY GRADED SAND with SILT, fine- to medium-grained, with Lean Clay lenses at 15 feet, gray, waterbearing, (SP-SM), fill	4		
		2		
27.0 / 832.3	PEAT, with fibers and roots, black, wet, (PT), swamp deposit	3		
		TW		
		5		Trace fibers at 25 feet.
	LEAN CLAY, with fibers and shells, black, wet, (CL), swamp deposit.	6	68	Occasional Sand lenses at 26 feet. OC=7%
		6		
		5		
		TW		Su=1,545 psf; WD=79 pcf
		6	94	OC=14%; LL=91; PL=82, PI=9
		3		Occasional layers of Peat at 44 feet.

Depth scale: 5, 10, 15 (water level symbol), 20, 25, 30, 35, 40, 45

Index Sheet Code 3.0

(Continued Next Page)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2027SB**	**859.3** *(Surveyed)*

DEPTH	Depth / Elev.	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
		LEAN CLAY, with fibers and shells, black, wet, (CL), swamp deposit. *(continued)*		5				
	47.0 / 812.3	SILTY SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, (SM), swamp deposit		13				
50	49.0 / 810.3	SILT, trace roots and organics, gray, waterbearing, (ML), swamp deposit	PD	7				Switched to mud rotary drilling method after 50-foot sample.
55	54.0 / 805.3	SILTY SAND, fine- to medium-grained, with Gravel, gray to 60 feet then brown, waterbearing, medium dense to very dense, (SM), till	PD	22				
60			PD	71	12			P200=13%
65	64.0 / 795.3	SILTY CLAY, with Silt layers, gray, wet, hard, (CL-ML), till	PD	47	23			LL=26; PL=20; PI=6
70	69.0 / 790.3	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, very dense, (SP), outwash	PD	79				
75	74.0 / 785.3	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff, (CLS), till	PD	19				qp=2 tsf
80			PD	24				qp=1 1/2 tsf
85	84.0 / 775.3	CLAYEY SAND, with Sand lenses from 85 to 95 feet, gray, wet, very stiff to hard, (SC), till	PD	27	12			P200=36%
90								

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2027SB**	**859.3** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
				X	51					
				PD						
95				X	20					
				PD						
100			CLAYEY SAND, with Sand lenses from 85 to 95 feet, gray, wet, very stiff to hard, (SC), till *(continued)*	X	18					
105				PD						
	109.0 / 750.3									
110				X	36					
115			SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense, (SM), till	PD						
120				X						
	121.0 / 738.3		Bottom of Hole - 121 feet. Water observed at 15 feet with 15 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.							

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2028SB	850.6 (Surveyed)

Location: Hennepin Co. Coordinate: X=492093 Y=129359 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7506

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 9/11/13

Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
0.6 / 850.0	LEAN CLAY, dark brown, moist, (CL), topsoil fill					
7.0 / 843.6	SANDY LEAN CLAY, trace Gravel, brown, wet, (CLS), fill	15				
		9				
12.0 / 838.6	ORGANIC CLAY, with Peat layers, with wood fibers, dark brown and black, wet, (OL), fill	4	41			OC=7%
		4				
15.0 / 835.6	LEAN CLAY, with Silty Sand lenses, gray, wet, (CL), fill	9				
22.0 / 828.6	PEAT, with fibers, black, wet, (PT), swamp deposit	12				
		TW				
		6*				*No sample recovery.
29.0 / 821.6	ORGANIC CLAY, with fibers and shells, gray, wet, (OL), swamp deposit Peat and Sand layers at 27 feet.	2	183			P200=78% OC=20%
		TW				
		1				
32.0 / 818.6	ELASTIC SILT, gray, wet, loose, (MH), alluvium	7				
37.0 / 813.6	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, gray, waterbearing, medium dense, (SP-SM), outwash	15				
		16				
	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense to dense, (SP-SM), outwash	22				
		23	15			P200=6%
		20				

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

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(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2028SB**	**850.6** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
45–54		SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense to dense, (SP-SM), outwash *(continued)* Fine grained at 50 feet with occasional Lean Clay lenses.	PD	31, 25, 21					Switched to mud rotary driling method after 50-foot sample.
54–59	54.0 / 796.6	CL	LEAN CLAY, gray, wet, very stiff, (CL), till	PD	25					
59–90	59.0 / 791.6	CLS	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to very stiff, (CLS), till Waterbearing Sand layer at 80 feet. Silty Sand layer from 84 to 86 feet.	PD	12, 19, 19, 32, 23					Waterbearing Sand layer at 80 feet. Silt Sand layer from 84 to 86 feet.

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2028SB	850.6 (Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
				X	30					
			Silty Sand layer at 94 feet.	PD						
95				X	10					Silty Sand layer at 94 feet.
				PD						
100				X	17					
105			SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to very stiff, (CLS), till *(continued)*	PD						
110				X	23*					*No sample recovery.
115				PD						
120	121.0 / 729.6			X	11					

Bottom of Hole - 121 feet.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2029SB	844.6 (Surveyed)

Location: Hennepin Co. Coordinate: X=492736 Y=129857 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7506

Hammer CME Automatic Calibrated

SHEET 1 of 2

Drilling Completed 9/16/13

Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
0.5 / 844.1	LEAN CLAY, dark brown, moist, (CL), topsoil fill					
7.0 / 837.6	LEAN CLAY, with Gravel, brown, moist, (CL), fill	23 46				
14.0 / 830.6	SILTY SAND, fine- to medium-grained, with Gravel, brown, moist, (SM), fill	26 26 13	7			P200=13%
16.0 / 828.6	LEAN CLAY, with fibers, gray, wet, (CL), swamp deposit	6				
24.0 / 820.6	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, loose, (SP), outwash	8				
29.0 / 815.6	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff, (CL), till	9				
34.0 / 810.6	CLAYEY SAND, trace of Gravel, brown, wet, rather stiff, (SC), till	11	11			P200=56%
44.0 / 800.6	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense, (SP), outwash	12 17				

Depth scale: 5, 10, 15 (water level ▼), 20, 25, 30, 35, 40, 45

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Soil Class: Rock Class: Edit: Date: 7/18/14

N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213-MNDOT.GPJ

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2029SB**	**844.6** (Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SANDY LEAN CLAY, trace Gravel, brown, wet, stiff to very stiff, (CL), till *(continued)*		25					
50	51.0				16					
	793.6		Bottom of Hole - 51 feet. Water observed at 15 feet with 15 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.							

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2030SB	846.2 (Surveyed)

Location: Hennepin Co. Coordinate: X=492825 Y=129917 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine **7506**

Hammer **CME Automatic Calibrated**

SHEET 1 of 3

Drilling Completed **9/12/13**

Depth	Elev.	Classification	Other Tests Or Remarks
0.8	845.4	SILTY SAND, fine- to medium-grained, dark brown, dry, (SM), topsoil fill	
7.0	839.2	POORLY GRADED SAND, fine- to medium-grained, with Gravel, brown, moist, (SP), fill	
24.0	822.2	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to stiff, (CL), till	qp=1 3/4 tsf; qp=2 1/2 tsf; *No sample recovery. Pushed rock. 50 blows per 6-inch set.
37.0	809.2	CLAYEY SAND, fine- to medium-grained, with Gravel, gray and brown, wet, medium dense to dense, (SC), till	Occasional Lean Clay and Silty lenses at 34 feet.
44.0	802.2	POORLY GRADED SAND with SILT, fine- to medium-grained, with occasional Clay lenses, with Gravel, brown, medium dense to very dense, (SP-SM), outwash	P200=12%

SPT N60 (top to bottom): 10, 14, 11, 10, 14, 9, TW, 11, *, 22, 39, 38, 38, 41, 48, 43, 30

Remarks by depth: qp=1 3/4 tsf (at ~8 ft); qp=2 1/2 tsf (at ~10.5 ft); water level symbol at ~22 ft.

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2030SB**	**846.2** *(Surveyed)*

DEPTH	*Depth / Elev.*	*Lithology*	*Classification*	*Drilling Operation*	*SPT N60* / *REC (%)*	*MC (%)* / *RQD (%)*	*COH (psf)* / *ACL (ft)*	*γ (pcf)* / *Core Breaks*	*Soil / Rock*	*Other Tests Or Remarks* / *Formation or Member*
	47.0 / 799.2		CLAYEY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, very dense, (SC), till *(continued)*	X	60					P200=39%
				X	34					
50				X	36					Switched to mud rotary drilling method after 50-foot sample.
				PD						
55				X	30					
			SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense, (SM), till	PD						
60				X	21					
				PD						
65				X	42					Sandy Silty layers at 65 feet.
	69.0 / 777.2			PD						
70				X	21					
			CLAYEY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense, (SC), till	PD						
75				■	32					P200=31%
	79.0 / 767.2			PD						
80				X	29					
			SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff, (CLS), till	PD						
85				X	21					
				PD						
90	90.0									

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2030SB**	**846.2** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	756.2				21					
95			POORLY GRADED SAND, fine- to medium-grained, with Gravel, brown and gray, waterbearing, medium dense to dense, (SP), outwash		23					
100	101.0 / 745.2				41					

Bottom of Hole - 101 feet.
Water obseved at 22 1/2 feet while drilling.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
	9 Mile Creek Bridge	SWLRT	2092SB	855.2 (Surveyed)

Location: Hennepin Co. Coordinate: X=492631 Y=129755 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7504

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 5/7/14

Depth / Elev.	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
1.5 / 853.7	Silty Sand, trace roots, dark brown, moist. (SM), topsoil fill						
6.0 / 849.2	Poorly Graded Sand with Silt, fine- to medium-grained, with Gravel, with frequent lenses of Lean Clay, brown, moist. (SP-SM), fill		16	6			
			30	8			
12.0 / 843.2	Silty Sand, fine- to medium-grained, with Gravel, brown and gray, moist. (SM), fill		18	10			
			20	7			
15.0 / 840.2	Sandy Lean Clay, trace Gravel, gray and black, moist. (CL), fill		3	18			
17.5 / 837.7	Highly Organic Silt, wtih fibers, trace shells, black. (OH), swamp deposit		6	98			OC = 23% Switched to mud rotary drilling method after 15-foot sample.
23.0 / 832.2	SILTY SAND, fine- to coarse-grained, with Gravel, light gray, wet to waterbearing, medium dense. (SM), till	PD	17	12			
		PD	22	11			
		PD	*				*No sample taken at 22 1/2 feet.
27.5 / 827.7	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, light gray, waterbearing, medium dense. (SP) outwash	PD	21	21			
37.0 / 818.2	SANDY LEAN CLAY, trace Gravel, gray, wet, medium to rather stiff. (CL), till	PD	9	14			
		PD	6	12			
		PD	10	13			DD = 124 pcf
		PD	11	13			
	CLAYEY SAND, with Gravel, brownish gray to gray, wet, stiff to very stiff. (SC), till	PD	16	13			
		PD	18	12			DD = 128 pcf
		PD	24	11			

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
	9 Mile Creek Bridge	**SWLRT**	**2092SB**	**855.2** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			CLAYEY SAND, with Gravel, brownish gray to gray, wet, stiff to very stiff. (SC), till *(continued)*	⊠	23	14				
	47.0 / 808.2			PD						
			SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff. (CL), till	⊠	23	14				
50				PD						
				⊠	26	12				
	53.0 / 802.2			PD						
55			CLAYEY SAND, with Gravel, with frequent layers of Lean Clay, brownish gray, wet, very stiff to hard. (CL), till	⊠						
				PD						
60				⊠	31	13				DD = 126 pcf
				PD						
65				⊠	33	12				
	67.0 / 788.2			PD						
70			SILTY SAND, fine- to medium-grained, reddish brown, wet, dense. (SM), till	⊠	37	18				
				PD						
75				⊠	39	19				
				PD						
80				⊠	34	17				
				PD						
85				⊠	47	18				
				PD						
90										

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

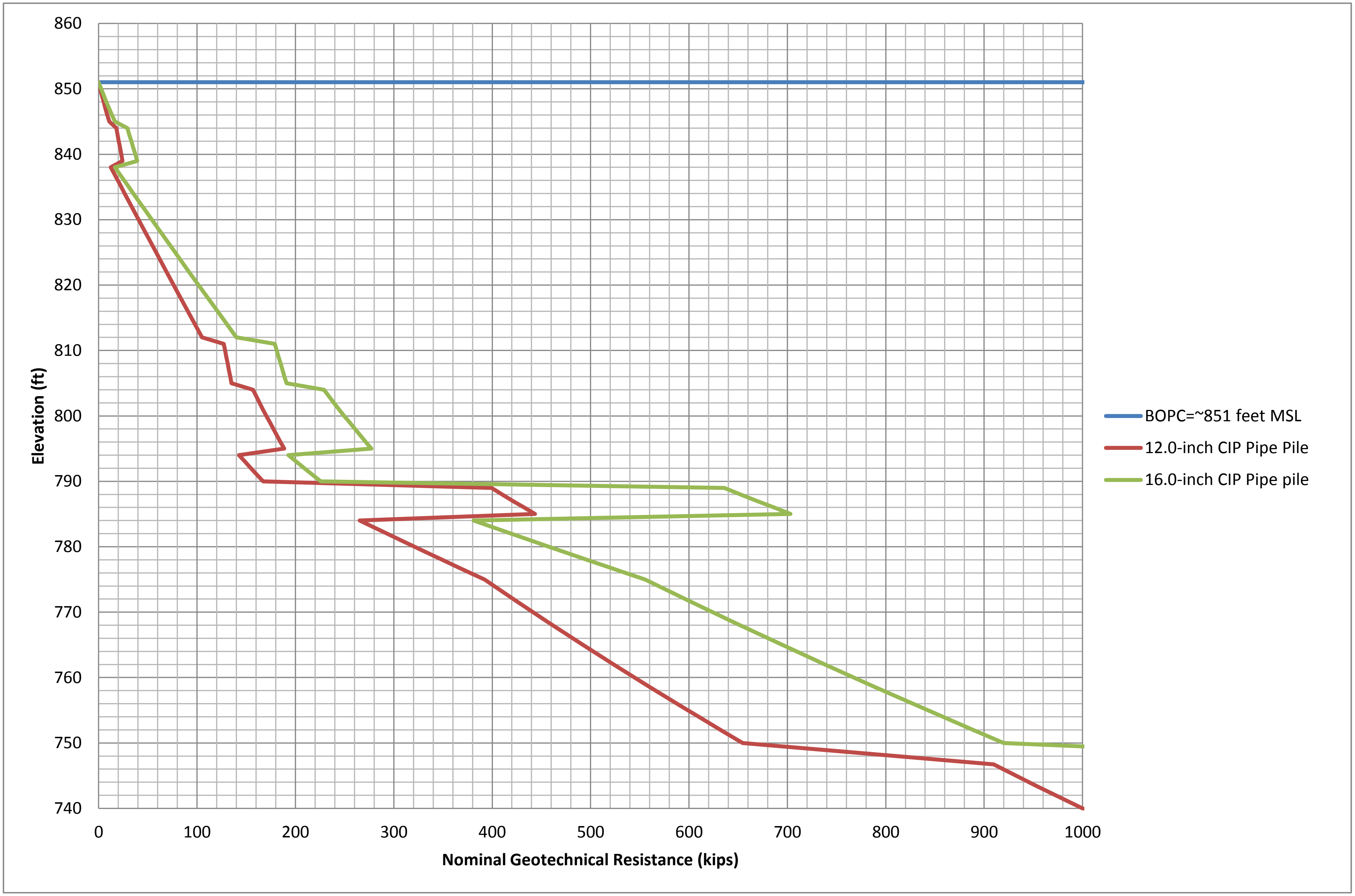
Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
	9 Mile Creek Bridge	**SWLRT**	**2092SB**	**855.2** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SILTY SAND, fine- to medium-grained, reddish brown, wet, dense. (SM), till *(continued)*	X	41	17				
	93.0 762.2			PD						
95			SILTY SAND, fine- to medium-grained, with frequent layers of Silt, reddish brown, wet, dense. (SM), till	X	48	15				
				PD						
100	101.0 754.2			X	48	19				DD = 119 pcf

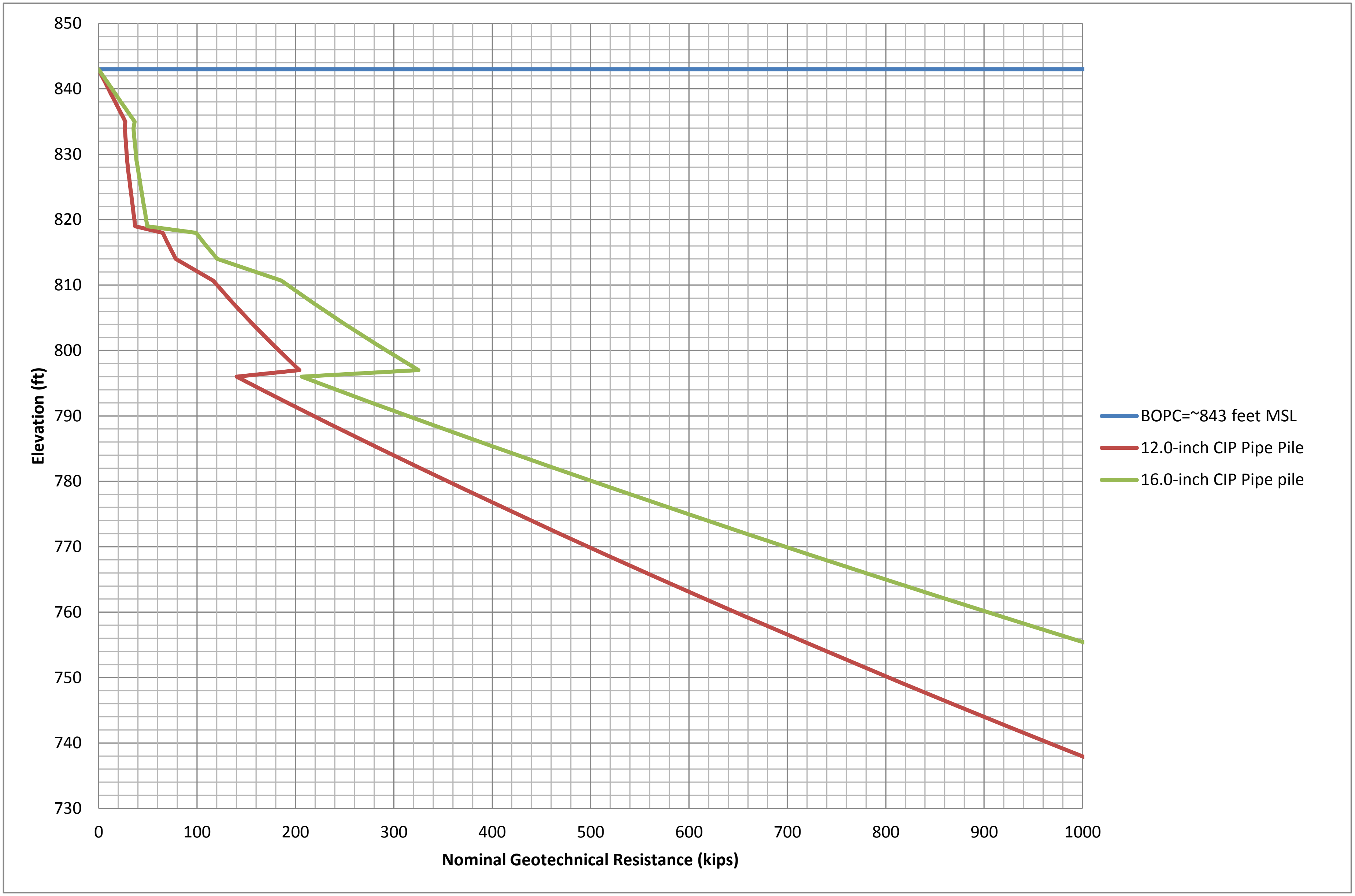
Bottom of Hole - 101 feet.
Water observed at 15 feet while drilling.
Boring then sealed with bentonite grout.

9-Mile Creek Bridge - West Abutment
Boring: 2027SB
12.0 and 16.0-inch Closed Ended Pipe Pile

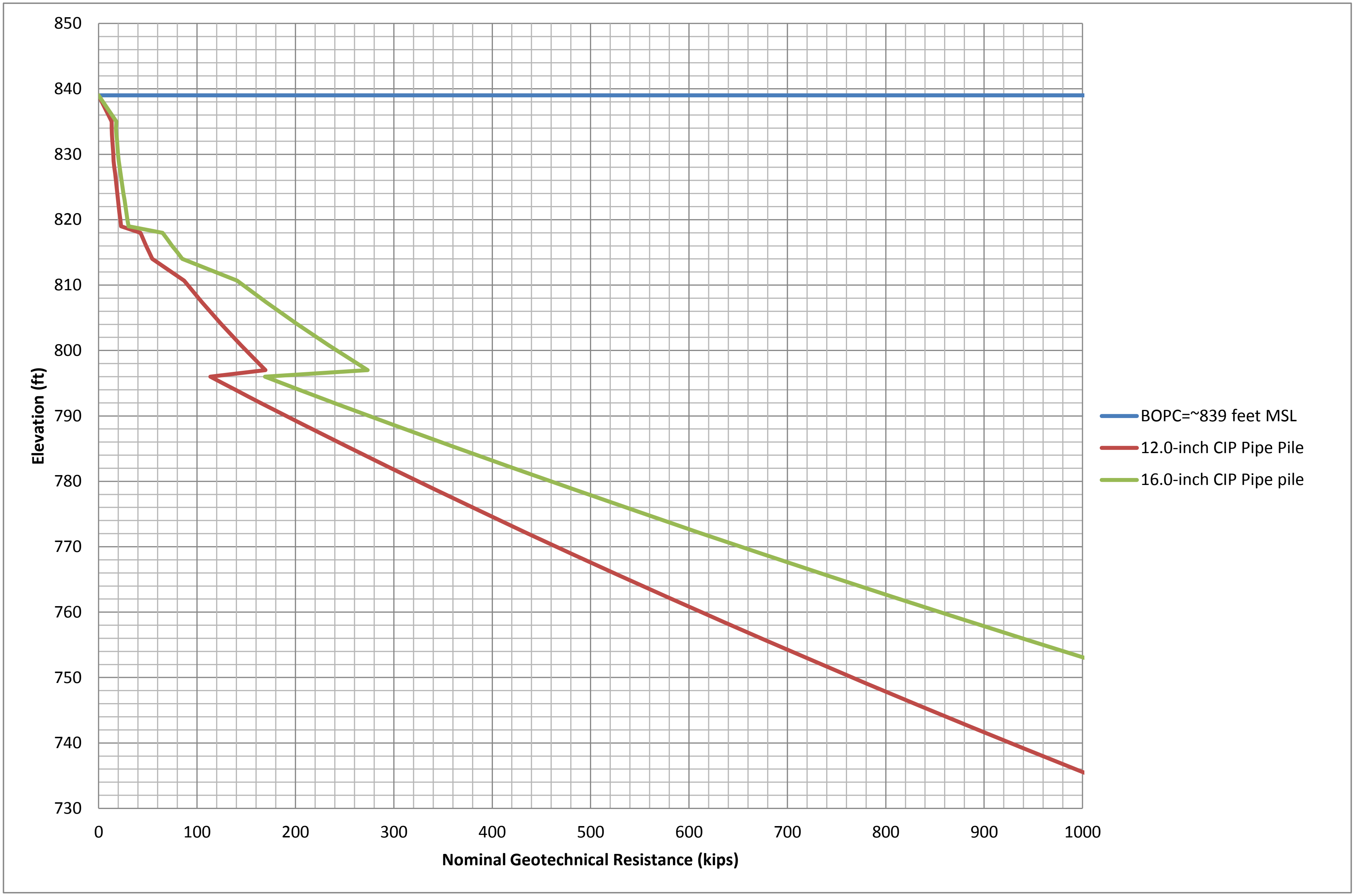


Braun Project No. BL-13-00213

9-Mile Creek Bridge - Pier 1
Boring: 2028SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile

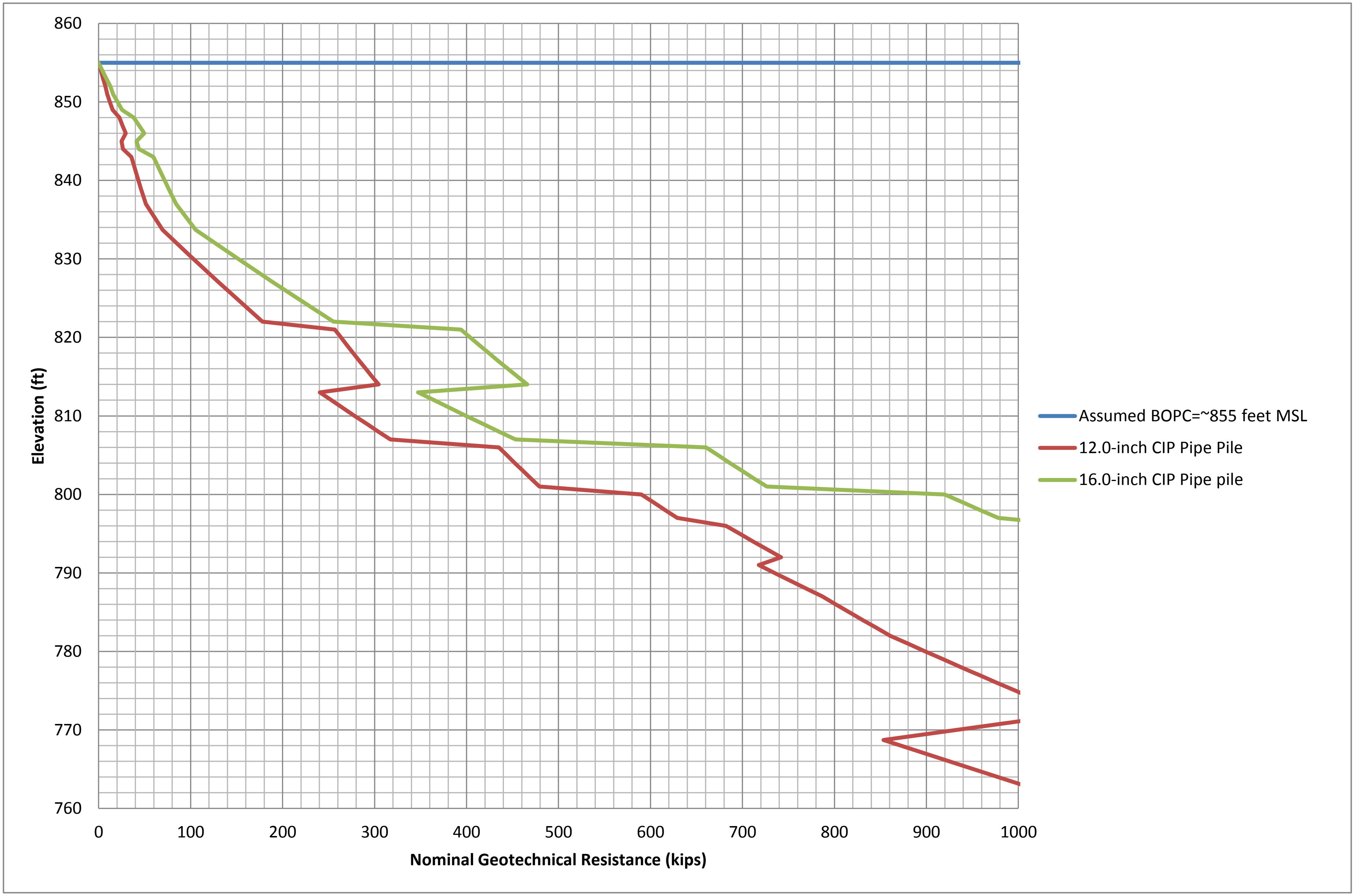


9-Mile Creek Bridge - Pier 2
Boring: 2028SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



BRAUN INTERTEC

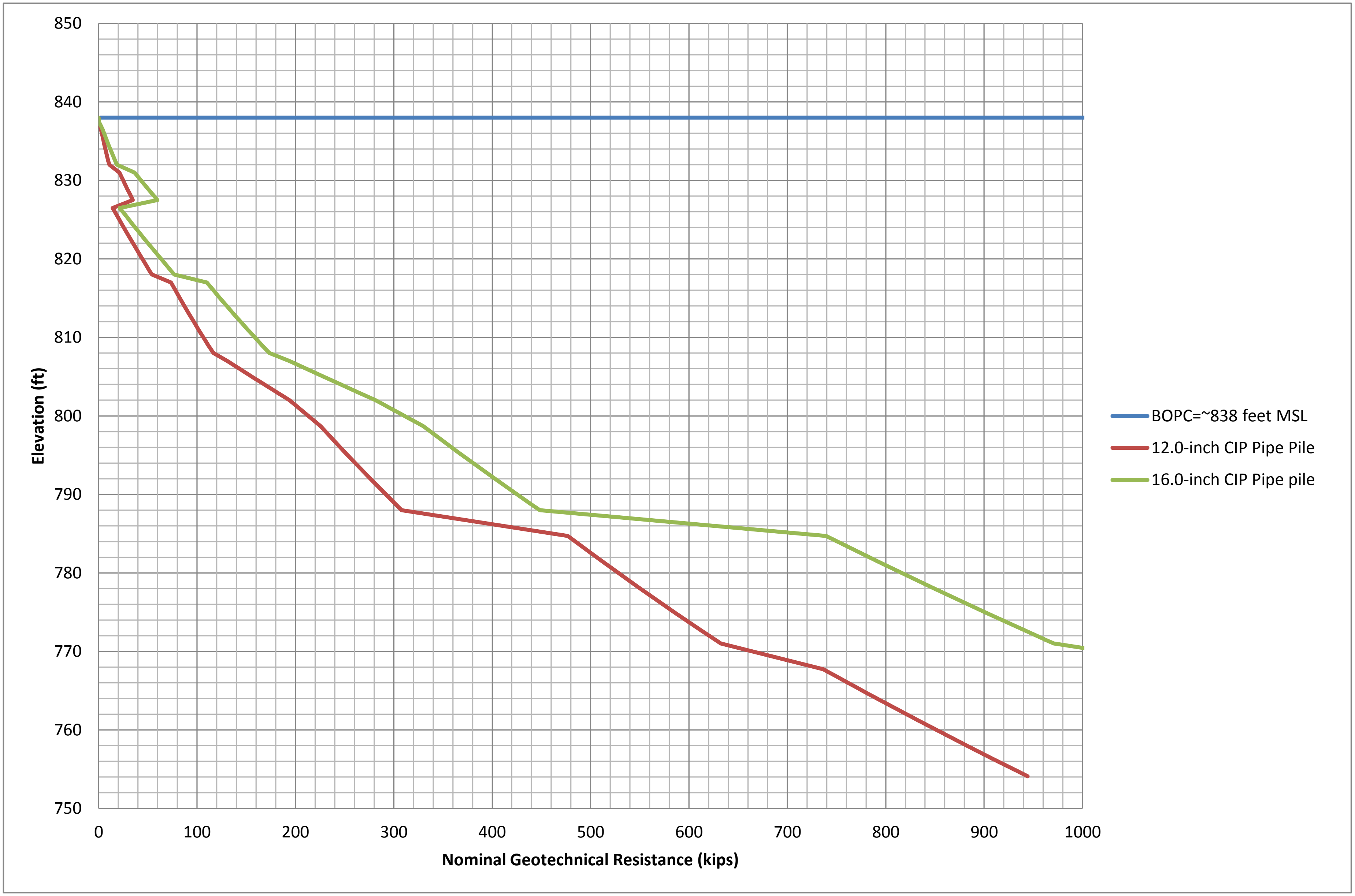
9-Mile Creek Bridge - West Abutment Embankment
Boring: 2012SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



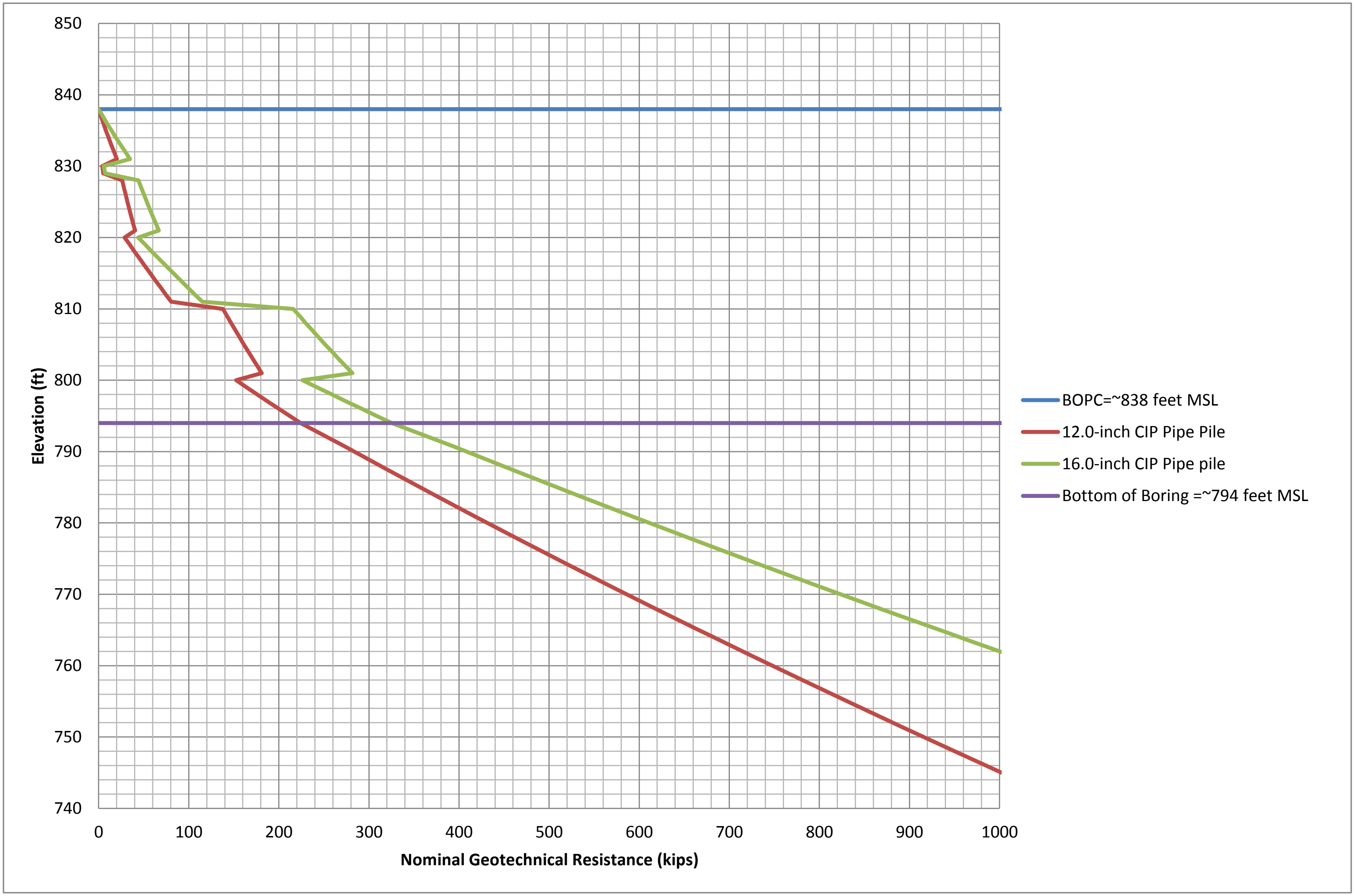
Braun Project No. BL-13-00213

BRAUN INTERTEC

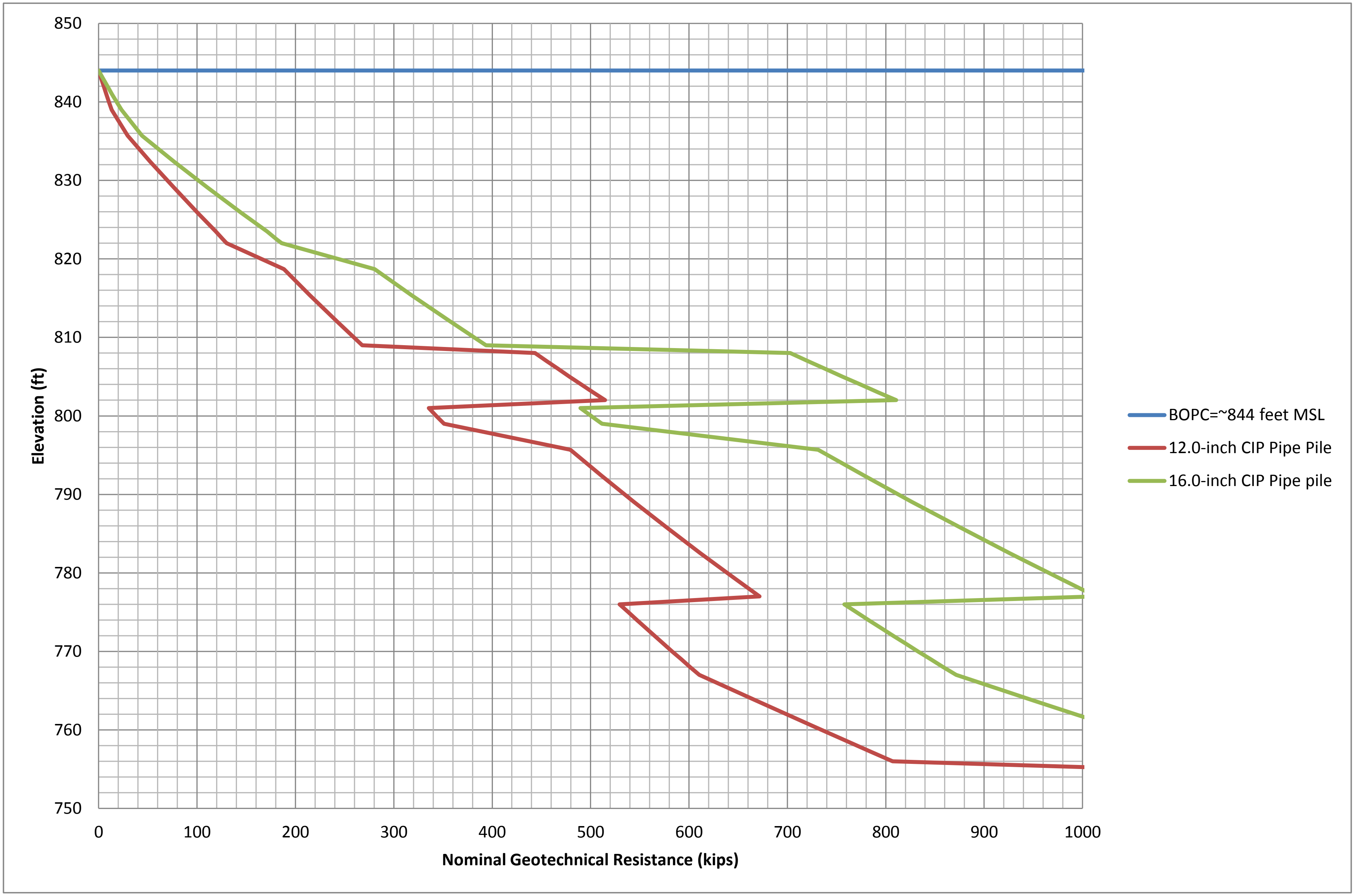
9-Mile Creek Bridge - Pier 7
Boring: 2092SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



9-Mile Creek Bridge - Pier 8
Boring: 2029SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



9-Mile Creek Bridge - Pier 9
Boring: 2030SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile

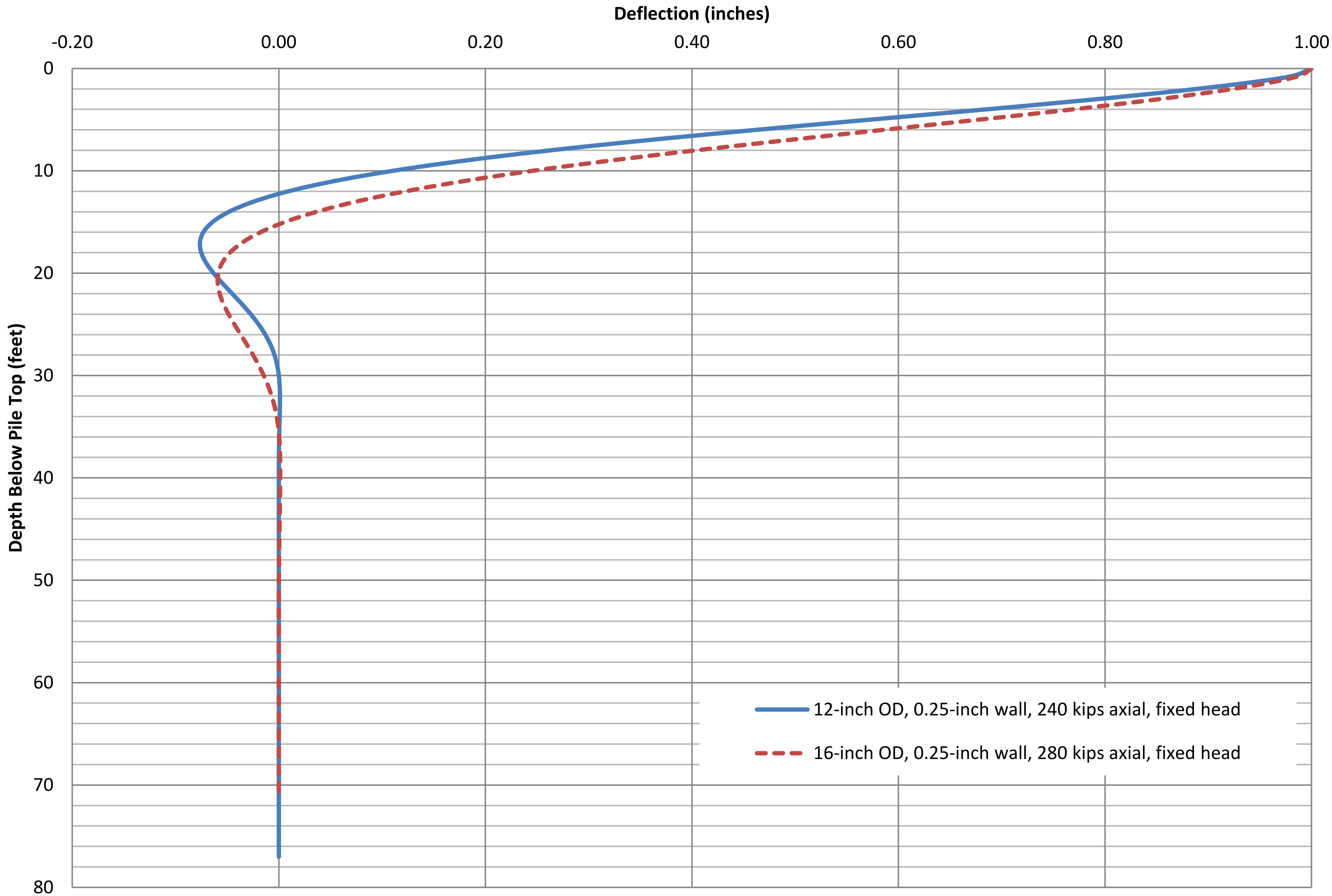


Braun Project No. BL-13-00213

BRAUN INTERTEC

Lateral Analysis Results - Deflection

Boring: 2027SB

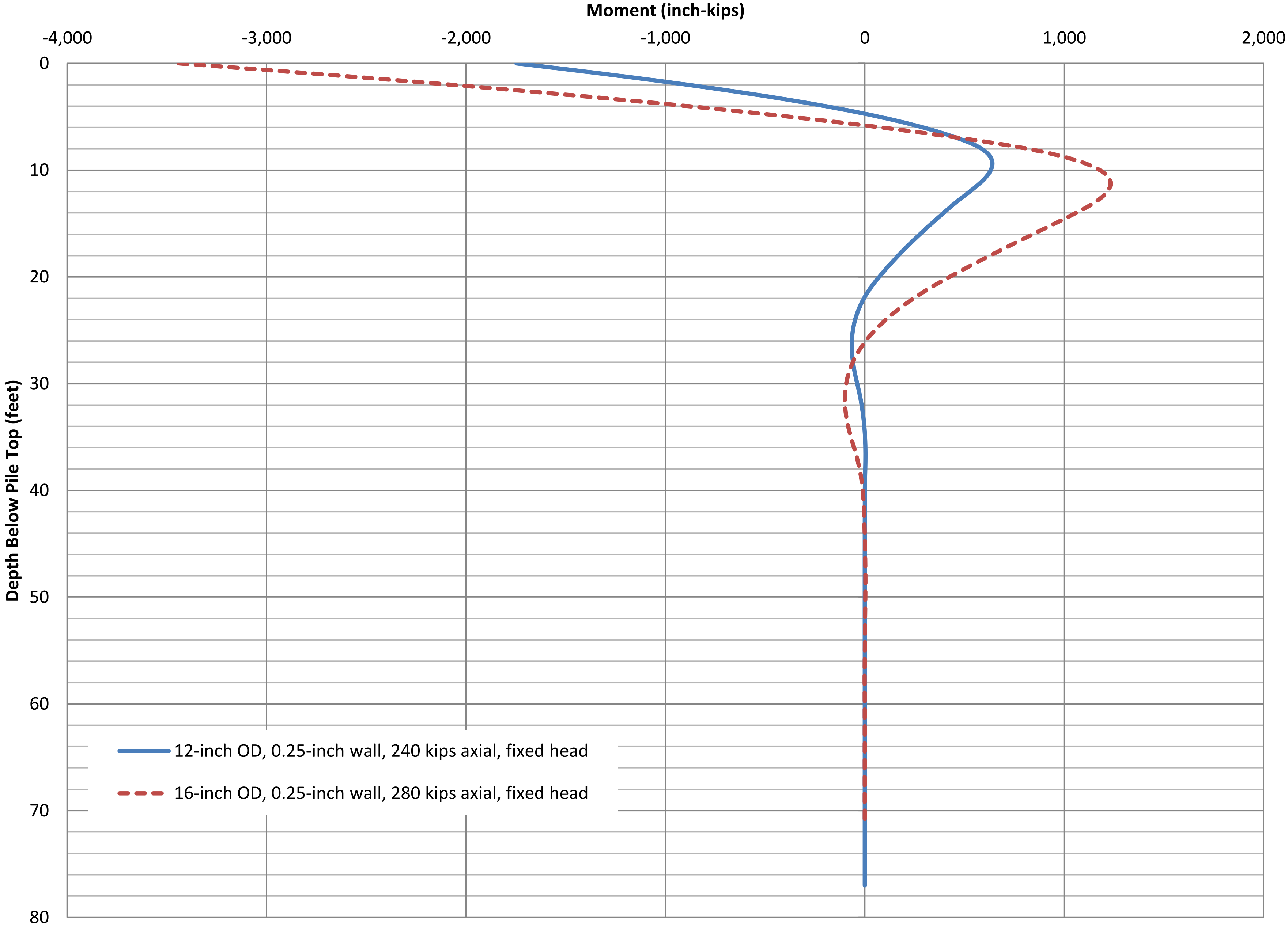


Braun Project No. BL-13-00213

BRAUN INTERTEC

Lateral Analysis Results - Moment

Boring: 2027SB

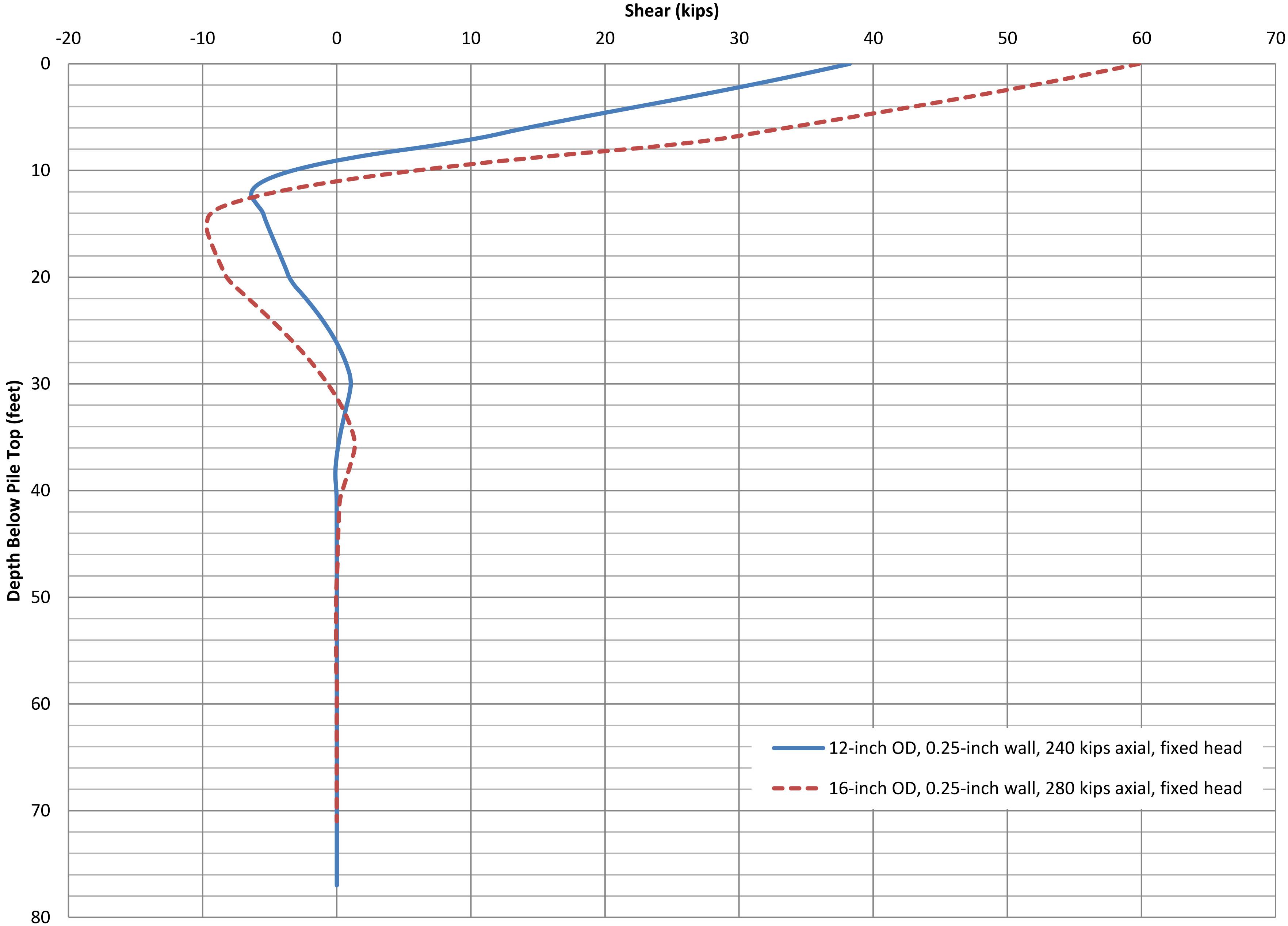


Braun Project No. BL-13-00213

BRAUN INTERTEC

Lateral Analysis Results - Shear

Boring: 2027SB



Braun Project No. BL-13-00213

BRAUN INTERTEC

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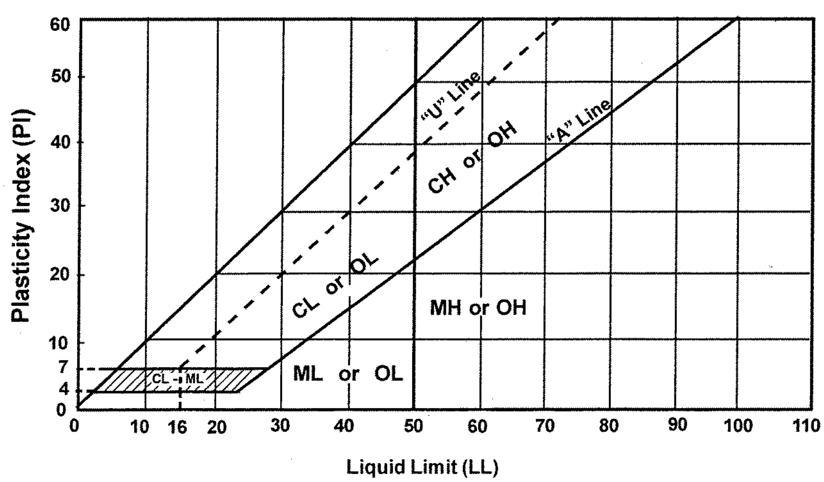
Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liqiuid limit, %	C	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P200	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
  Coarse .... 3/4" to 3"
  Fine .... No. 4 to 3/4"
Sand
  Coarse .... No. 4 to No. 10
  Medium .... No. 10 to No. 40
  Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix B

Golden Triangle Area

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August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Results of Field Exploration and Preliminary Recommendations
Proposed Golden Triangle Station Area and Land Bridge – 30% Design
STA 2231+50 to STA 2253+91
Southwest LRT, West Segment 2
Eden Prairie, Minnesota

Dear Mr. Demers:

This purpose of this letter is to provide you and the design team with our soil boring results and preliminary discussions and recommendations regarding the construction between the Nine Mile Creek Bridge and the Shady Oak/TH 212 Bridge in the area we describe in this report as the Golden Triangle Station Area.

The following preliminary report provides general construction comments and recommendations between STA 2230+50 and STA 2253+91 for the proposed construction of the track, Golden Triangle station platform, parking lot construction, retaining walls RTW-W205 and RTW-W215, and a land bridge extending from the north end of the station platform to the south abutment of the Bridge over Shady Oak Road/TH 212. A discussion of general civil and roadway discussion is also included. A final geotechnical report should be prepared when the full scope of the field investigation program has been completed.

This preliminary report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for pole foundations for the Overhead Contact System, (OCS) will be addressed in separate reports.

A. Results

A.1. Exploration Logs

A.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated. They also present the results of penetration resistance, laboratory tests performed on penetration test samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

A.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, penetration resistance testing performed for the project, laboratory test results, and available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

A.2. Geologic Profile

The Southwest Light Rail Transit Project Office (SPO) requested subsurface soil and groundwater information between the Nine Mile Creek Bridge and the Bridge over Shady Oak Road/TH212 in the area of the proposed Golden Triangle station platform. Nine (9) standard penetration soil borings were performed in this area. Logs of the borings are included in the Appendix. A Boring Location Sketch is also included.

A.2.a. Topsoil

Borings 2032ST and 2034ST initially encountered one to three feet of topsoil overlying fill soils. The topsoil consisted of sandy lean clay and silty sand that was black and moist to wet. A layer of buried topsoil consisting of slightly organic clayey sand was encountered 14 to 17 feet below the surface at boring 2034ST.

A.2.b. Aggregate Base and Bituminous

Four borings (2035CSS, 2036SS, 2037SS, and 2025SB) encountered aggregate at the surface and one boring (2037SS) encountered bituminous at the surface. The bituminous appeared to be three inches in thickness with an underlying aggregate base about six inches thick. The surface aggregate encountered at the other boring locations varied from 12 to 24 inches in thickness.

A.2.c. Fill

Fill was encountered at the majority of the boring locations and consisted of poorly graded sand (SP), poorly graded sand with silt (SP-SM), silty sand (SM), silty clay (CL-ML), clayey sand (SC), lean clay (CL), sandy lean clay (CL), and peat (PT). Table 1 below illustrates the depth and type of fill material encountered.

Table 1. Fill Depths

Boring No.	Boring Elevation (ft)	Approximate Depth of Fill (ft)	Elevation at Bottom of Fill (ft)	Fill Composition
2032ST	876.0	12	864	SC, CLS (topsoil)
2033ST	878.2	12	866	SP-SM,SM
2034ST	880.1	19	861	CLS, SC, SM (topsoil)
2035CSS	867.7	12	856	SM, SC, Aggregate
2036SS	863.8	12	852	CLS, CL, Aggregate
2037SS	863.3	12	851	CLS, Bituminous
2025SB	880.7	27	854	SP, CLS, SC, Aggregate
2026SB	879.5	22	857	SP-SM, SM, SC, CLS, Aggregate

Penetration resistances varied from 4 blows per foot (BPF) to 56 blows per six inches although, some of the higher penetration resistances were likely influenced by encountering rock or debris in the sampler.

A.2.d. Swamp Deposits

Borings 2036SS, 2037SS, 2083ST, and 2026SB encountered swamp deposited soils to depths of 24, 19, 14, and 24 feet, respectively. The swamp deposited soils consisted of peat (PT) , lean clay (CL), organic fat clay (OH), organic silt (OH), and organic clay (OL) that was gray, dark brown and black, containing various amounts of fibers or shells.

A.2.e. Alluvium

Alluvium was encountered 19 to 22 feet below the surface at boring 2037SS and 14 to 17 feet below the surface at boring 2083ST. The alluvial deposits consisted of silt (ML) that was gray and wet. Penetration resistances varied from 3 to 7 blows per foot (BPF), indicating the alluvial silts were very loose to loose.

A.2.f. Glacial Till

Glacial till soils were encountered throughout the soil profile beneath the fill, swamp deposits and alluvial soils. The tills consisted of silty sand (SM), clayey sand (SC), and sandy lean clay (CLS). The till soils contained a trace of gravel to gravel with cobbles and were moist to wet or waterbearing and were brown to gray. Penetration resistances varied from 9 BPF to 90 blows per six inches, indicating the sands were generally medium dense to very dense and the cohesive soils were generally rather stiff to hard. The higher blow counts may have been due to gravel and cobbles encountered by the sampler.

A.2.g. Glacial Outwash

Glacial outwash soils were also frequently encountered throughout the soil profile. The glacial outwash soils consisted of poorly graded sand (SP) and poorly graded sand with silt (SP-SM). The sands generally contained some gravel. Penetration resistances varied from 2 BPF to 50 blows per 5 inches, indicating the soil was very loose to very dense. The lower blow counts may have been due to hydrostatic pressures causing a “blow up” condition within the auger, artificially loosening the soils, while the higher blow counts may have been due to gravel and cobbles encountered by the sampler.

A.2.h. Sandstone Bedrock

Boring 2083ST encountered the St. Peter sandstone at a depth of 84 feet, extending to 96 feet, the termination depth of the boring. Rock coring was not performed to obtain undisturbed samples of the sandstone.

A.3. Groundwater

Due to the impermeable nature of the clayey soils, and mud rotary drilling techniques, the depth of the static groundwater level was difficult to determine and the boring logs likely do not reflect the actual groundwater levels. It appears that water is perched on top of and between clayey soils and within sandy soil layers at depth. Piezometers may be needed to determine more accurate groundwater levels. Groundwater was measured or estimated to be located at the depths shown below in Table 2.

Table 2. Groundwater Summary

Location	Surface Elevation	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
2032ST	876.0	22	854
2033ST	878.2	NE	NE
2034ST	880.1	32	848
2035CSS	867.7	12	856
2036SS	863.8	24	840
2037SS	863.3	22	841
2083ST	856.7	15	842
2024SB	880.7	20	861
2026SB	879.5	15	864 1/2

The highly variable groundwater elevations may be due to lack of time for water to rise to its hydrostatic pressure in the borehole. Organic soils were encountered as high as elevation 857 at the ground surface. It is possible the groundwater is as high as this elevation. Piezometers would be needed to verify the actual groundwater levels.

B. Golden Triangle Area General Recommendations

B.1. Site History

The area surrounding the Golden Triangle Station is known to contain deep deposits of organic soils. Past construction in the area has generally included the excavation and removal of these organic soils, and replacement with either imported sand or nearby non-organic soils. The parking lots and landscaped areas; however, have not always been corrected. Based on our past experience in the area, we understand the existing parking lot east of the station, where a new parking lot is being proposed, has settled around six feet since the fill was placed over the organic soils more than 10 years ago. The depth of the organic soils may be underrepresented by our borings in some areas as the borings that have been performed were performed in areas that were most easily accessible. The transition area between the deep organic deposits appears to be near STA 2241+00, or the existing W 70th Street Cul De Sac. We anticipate glacial deposits generally be encountered beneath shallow fill deposits south of this location.

The project team should be aware that any raises in grade in the area of the organic soils will result in settlement of the underlying soil and could cause collateral damage of existing structures, utilities and surface features.

B.2. Pile Foundations

We recommend the use of driven pile foundations to support the station platform and land bridge north of the station to the abutment of the Bridge over Shady Oak Road/TH 212 due to the deep fill and swamp deposits. The following subsections provide preliminary estimates of pile lengths based on our preliminary boring program. We recommend a final boring program be performed to investigate the subsurface conditions at pertinent structure locations.

B.2.a. Design Methodologies – Pile-Supported Structures

B.2.a.1. Pile Capacity – LRFD (Land Bridge)

We used the computer program UniPile, version 5.0.0.33, to estimate the static nominal geotechnical resistance (R_n) of the 12.75- and 16.0-inch outside-diameter, 1/4-inch thick wall, closed-ended pipe piles for support of the proposed land bridge. UniPile software was developed by UniSoft Geotechnical Solutions Ltd. and can calculate pile resistance using a variety of methods.

For our analysis, we utilized the Beta-method, an effective stress method, to estimate the static geotechnical resistance for these pile. This method determines shaft resistance using Bjerrum-Burland beta coefficients (β), which are based on soil type and effective friction angle. We estimated the β values for each layer using Figure 9.20 from the Federal Highway Administration (FHWA) Publication No. NHI-05-042, Design and Construction of Driven Pile Foundations, April 2006. The Beta-method determines end bearing resistance using toe bearing capacity factors (N_t), which are also based on soil type and effective friction angle. We estimated the N_t values from Table 9-6 of the April 2006 FHWA publication identified previously.

B.2.a.2. Downdrag

We do not expect downdrag will act on the piling, as no raise in grade anticipated in the area of the proposed land bridge. It appears a raise in grade of approximately 5 feet is proposed on the north end of the station platform. Downdrag will impact the pile length in this area, the magnitude of which will be determined upon final design of the structure.

B.2.b. Nominal Bearing Capacities and Associated Resistance Factors

For situations where subsurface exploration and static calculations have been completed, we recommend that the following φ_{dyn} factors be used.

Table 3. Recommended Pile Driving Resistance Factors (ϕ_{dyn})

Specified Construction Control	ϕ_{dyn}
MnDOT Pile Formula 2012 (MPF12) for Pipe Pile Sections	0.50
Wave Equation and Pile Driving Analyzer (PDA)	0.65

We have constructed two tables which summarize the anticipated pile depths based on the factored load ($\Sigma\gamma Q_n$) for 12.75- and 16.0-inch, outside-diameter pipe pile with a wall thickness of 1/4 inch. The tables provide a PDA length (i.e., φ_{dyn} of 0.65) and a MPF12 formula length (i.e., φ_{dyn} of 0.50) for each location. We assumed a cutoff elevation of about 1 foot above the existing ground surface. Please refer to the nominal bearing resistance graphs in the Appendix and the anticipated pile length tables below, using PDA Analysis and the MPF 12 for a detailed profile of pile resistances and anticipated pile lengths.

Table 4. Summary of Anticipated Pile Lengths – PDA Analysis

Boring	Anticipated Cutoff Elevation (feet)	Factored Load $\Sigma\gamma Q_n$ (tons)	Nominal Resistance R_n (tons)	Outside Diameter of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2035CSS	869	120	185 [370 kips]	12.75	809	60
				16.0	814	55
		140	215 [430 kips]	12.75	804	65
				16.0	814	55
2036SS	865	120	185 [370 kips]	12.75	800	65
				16.0	810	55
		140	215 [430 kips]	12.75	795	70
				16.0	805	60
2083ST	858	120	185 [370kips]	12.75	783	75
				16.0	793	65
		140	215 [430 kips]	12.75	783	75
				16.0	788	70

Table 5. Summary of Anticipated Pile Lengths – MPF12 Analysis

Boring	Anticipated Cutoff Elevation (feet)	Factored Load $\Sigma\gamma Q_n$ (tons)	Nominal Resistance R_n (tons)	Outside Diameter of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2035CSS	869	120	240 [480 kips]	12.75	799	70
				16.0	814	55
		140	280 [560 kips]	12.75	794	75
				16.0	809	60
2036SS	865	120	240 [480 kips]	12.75	790	75
				16.0	800	65
		140	280 [560 kips]	12.75	785	80
				16.0	795	70
2083ST	858	120	240 [480 kips]	12.75	778	80
				16.0	783	75
		140	280 [560 kips]	12.75	778	80
				16.0	783	75

B.2.c. Uplift Capacities

Currently, a tension resistance line is not provided on the Nominal Bearing Graphs attached to this report. If piles will experience tension loads, please let us know and we'll revise our recommendations accordingly.

B.2.d. Pile Spacing and Group Effect

In our opinion, the working capacities of piles spaced at least 3 pile diameters apart need not be reduced due to group effects. If a closer spacing is ultimately selected, we recommend having a geotechnical engineer evaluate the magnitude of the group effect, and the extent to which the working capacities should be reduced.

The lateral capacity for each pile should be reduced, depending on the actual spacing and the location of the pile within the pile cap. We recommend using pile spacing reductions (group action) for the various pile spacing's as identified in the table below.

Table 6. Pile Spacing

Pile CTC Spacing (in the direction of loading)	Row 1	Row 2	Row 3 and Higher
3D	0.8	0.4	0.3
4D	0.9	0.63	0.5
5D	1.0	0.85	0.7

Linearly interpolated from Table 10.7.2.4-1 of the AASHTO LRFD Bridge Design Manual, 6th Edition.

B.3. Lateral Pile Analyses

The following table provides the soil parameters used for the lateral pile analyses and p-y curve generation, which was performed using the computer program LPILE (2013). Based on the soils encountered in the borings, we used the default lateral modulus of subgrade reaction values included in LPILE. For the purposes of our preliminary evaluation, we used the soil parameters encountered in Boring 2083ST.

Table 7. Soil parameters used for the lateral pile analyses and p-y curve generation

Layer Top Depth (feet)	Layer Bottom Depth (feet)	Effective Unit Weight (pcf)	Internal Angle of Friction (degrees)	Undrained Shear Strength (psf)	Material Type
0	2.5	NA	NA	NA	Air
2.5	9.5	18	NA	150	Soft Clay
9.5	16.5	28	NA	100	Soft Clay
16.5	21.5	43	26	NA	Sand (Reese)
21.5	24.5	53	32	NA	Sand (Reese)
24.5	33.5	50	32	NA	Sand (Reese)
33.5	39.5	55	33	NA	Sand (Reese)
39.5	44.5	63	NA	3000	Stiff Clay w/o Free Water
44.5	54.5	55	NA	1500	Stiff Clay w/o Free Water
54.5	71.5	56	NA	1800	Stiff Clay w/o Free Water
71.5	76.5	63	NA	2400	Stiff Clay w/o Free Water
76.5	86.5	58	35	NA	Sand (Reese)
83.0	101.0	65	40	NA	Sand (Reese)

For our lateral analyses, we assumed a pile top located 2 1/2 feet above the existing ground surface. The maximum lateral load in our analyses is for a loading condition assuming 1-inch of deflection at the pile top with a fixed-head condition. We assumed a pile wall thickness of 1/4-inch, a steel yield strength of 45 ksi, and concrete infill with a compressive strength of 3 ksi for our analyses. Please refer to the attachments for the deflection, shear force and bending moments within the pile at service loads of 120 and 140 tons for the 12.75-inch and 16.0-inch closed-end pipe pile, respectively.

B.4. Golden Triangle Station Platform

As mentioned previously, we estimate the transition area between the organic soils and the native glacial soils in the area of the station is West 70th Street. To provide uniform settlement across the platform station, we recommend pile supporting the entire platform rather than soil correcting just the south end of the platform and pile supporting the north end of the platform.

B.5. Retaining Wall Construction

B.5.a. Retaining Wall RTW-W205

Retaining wall RTW-W205 is proposed to be a cast-in-place (CIP) walls extending from station 2233+00 to 2238+00. It has an exposed height of up 10 feet and a stem height up to about 15 feet. The wall will largely be cut into an existing berm supporting a walking trail.

Spread footings are proposed to be used for the wall. The soil conditions in the area of the wall appear to be suitable to support the wall after the removal of any fill and organic soil. The borings in this area, 2032ST and 2033ST encountered fill 12 feet below the surface at both boring locations corresponding to elevations 864 to 866. It appears the bottom of footings for the wall will be near elevation 861 so the footings should bear on competent natural soil. The fill below the tracks should be removed and replaced or recompacted.

B.5.b. Retaining Wall RTW-W215

Retaining wall RTW-W215 is proposed to be a soldier pile retaining wall extending from about STA 2249+00 to about STA 2251+00. The tracks along the walls will be supported by driven pile. The wall appears to be designed to retain the existing embankment of the ShopHQ parking lot, with approximately 10 feet of exposed height. . The wall is currently proposed to be supported by driven piles. We anticipate the embedment depth of the soldier pile wall will be near 35 feet, however, the embedment depth may change based on final design.

There is a possibility the wall may be located in an area of predominantly good soil, or in an area that was previous soil corrected, and there is the possibility spread footing could be used to support the wall instead of soldier piles. Without cross sections and more borings it is difficult for us to determine if it is feasible to excavate any unsuitable soils in the area of the wall, if present at all, and use spread footings to support the wall.

B.5.c. Retaining Wall Backfill Recommendations

We recommend the foundation soils for the CIP walls be surface compacted with a vibratory sheepsfoot compactor prior to filling to proposed footing elevations. The excavation should then be backfilled with Select Granular Modified 10% or crushed rock to re-establish grade. If groundwater is encountered, temporary dewatering is recommend with sumps and pumps to control groundwater.

Abutment and retaining wall backfill shall meet the material and compaction specifications noted below in Table 8.

Table 8. Material and Compaction Specifications for Backfill and Fill

Material	Material Specification	Compaction Specification
Fill placed beneath Footings	3149.2B2	2105.3F
Leveling Pad Beneath Footings	3138.2B	2211.3C
Retaining Wall Backfill	3149.2B2*	21053.3F

*We recommend backfill material used against retaining structures shall consist of Select Granular Modified 10%. Select Granular Modified 10% shall comply with Specification 3149.2B2, modified to 10% or less passing the 0.075 mm (#200) sieve.

B.5.d. General Soldier Pile Wall Recommendations

Based on the plan and profile drawings, we anticipate the majority of the soil being retained by the soldier pile wall will consist of fill (either imported sand or on-site sands or clays) over existing soils. We anticipate soldier piles will be embedded into native glacial soils at depth.

Preliminary lateral earth parameters to be used in wall design are provided in Table 9 below. The parameters shown have not been reduced by safety factors. This table will be updated once the final boring program is complete.

Saturated unit weights are recommended to account for the potential build up of hydrostatic pressure behind undrained support structures. We recommend that saturated unit weights be reduced by 62.4 pounds per cubic foot for strata or portions of a stratum extending below the groundwater levels at the structure location or as noted on the borings

Table 9. Parameters for Sheet Pile Wall Design

Geologic Material	Saturated Unit Weight (pcf)	Friction Angle (deg)	K_A	K_O	K_P
Select Granular Borrow	120	35	.28	.42	3.69
Sand Fill (SP, SP-SM)	120	30	.33	.50	3.00
Sand Fill (SM, SC)	125	28	.36	.53	2.76
Clay Fill (CL)	125	26	.39	.56	2.56
Swamp Deposit Soils (PT)	75	14	.61	.76	1.63
Swamp Deposit Soils (OL, ML)	90	22	.46	.62	2.20
Glacial Sands (SP, SP-SM)	120	32	.31	.47	3.25
Glacial Lean Clay (CL)	130	28	.36	.53	2.76

We recommend installing draintile along the entire length on the inside of the proposed retaining wall. We anticipate on-site clays and sands will be used to backfill behind the soldier pile retaining wall. We recommend free-draining sand with less than 5 percent particles passing a 200 sieve and less than 50 percent passing a 40 sieve should be used as backfill within 2 feet of the soldier pile wall so that infiltrating water can drain down to the perimeter drainage system. Draintile should be placed within the provided sand section to remove any excess water build up behind the wall.

B.6. Guideway Subgrade Preparation (between Nine Mile Creek Bridge and West 70th Street)

A five-foot section below the proposed top of rail is anticipated for construction of the Guideway. The following subsections provide preliminary recommendations to prepare the ground supported track subgrades between the north abutment of the Nine Mile Creek Bridge and West 70th Street. Additional borings will be required for final design recommendations.

B.6.a. Excavations

B.6.a.1. Track Construction

We recommend excavating the soils down to the proposed bottom of subgrade elevation. We expect a combination of fill and native soils will be encountered. If fill is encountered at the track subgrade, we recommend evaluating the condition of the fill during construction. Additional subcuts may be necessary and should be determined in the field at the time of construction.

We recommend removing all vegetation, topsoil, and any soft or wet soils encountered at the surface, including topsoil fill or fill containing organics. If soft or otherwise unsuitable soils are encountered at subgrade elevations, additional excavations may be necessary. This should be evaluated in the field on a case by case basis. Table 8 below provides our recommended excavation depths at the boring locations performed between STA 2035+00 and STA 2051+00.

Table 10. Recommended Guideway Subgrade Correction Depths

Boring	Boring Elevation (ft)	Guideway Subgrade Elevation (ft)	Recommended Excavation Depth Below Subgrade (ft)	Excavation Bottom Elevation (ft)
2032ST	876.0	867	3	864
2033ST	878.2	865	---	865
2034ST	880.1	863	0-2	861-863

Excavation depths will vary away from the boring locations and could be deeper. We recommend a geotechnical engineer or experienced technician working under the supervision of a geotechnical engineer observe the subgrade soils prior to the placement of fill. If pockets of unsuitable fill or soft native soils are encountered, the excavations may extend beyond the depths noted in the table above.

B.6.b. Selecting Excavation Backfill and Additional Required Fill

B.6.b.1. General Subgrade Fill

We initially recommend backfilling over wet or submerged excavation bottoms with at least 2 feet of coarse sand having less than 70 percent of the particles by weight passing a #40 sieve, and less than 10 percent of the particles passing a #200 sieve. We anticipate that this material will need to be imported.

On-site soils free of organic soil and debris can be considered for reuse as subgrade backfill and fill. The clays, however, being fine-grained, will be more difficult to compact if wet or allowed to become wet, or if spread and compacted over wet surfaces.

Imported material needed to replace excavation spoils or balance cut and fill quantities, may consist of sand, silty sand, clayey sand, sandy lean clay or lean clay. We recommend, however, that the plastic index of these materials not exceed 20.

B.6.b.2. Guideway Fill

Based on the proposed design sections, the Guideway will be composed of 40-inch thick layer of granular material, under a minimum of 12-inches of subballast material. We recommend specifying Guideway fill to meet the requirements of the Minnesota Department of Transportation (MnDOT) 3149.2B2 (Select Granular Borrow) for the granular material, and 3138 (Aggregate Base) for the subballast.

B.6.c. Placement and Compaction of Backfill and Fill

We recommend spreading backfill and fill in loose lifts of approximately 6 to 12 inches. We recommend compacting backfill and fill in accordance with the criteria presented below in Table 11. The relative compaction of utility backfill should be evaluated based on the structure below which it is installed, and vertical proximity to that structure.

Table 11. Material and Compaction Specification for Backfill and Fill

Material	Material Specification	Compaction Specification
Subgrade Fill	Onsite Material Free of Debris and Organic Material or Imported Soil	100% of standard Proctor Density (ASTM D698)
Retaining Wall Backfill	MnDOT 3149.2D2	MnDOT 2105.3F
Guideway Select Granular Layer	MnDOT 3149.2B2	100% of standard Proctor Density (ASTM D698)
Guideway Subballast	MnDOT 3138	MnDOT 2211.3C

B.7. Land Bridge

Land bridges will be used to support the tracks from STA 2245+16 to STA 2253+91, where the bridge over Prairie Center Drive begins. The land bridge will be supported by driven pile due to the deep fill and organic deposits and we are assuming spacing between pile caps is approximately 50 feet. Refer to section B.2 above for the anticipated pile lengths based on assumed loads.

B.8. General Civil/Roadway Construction

Surface feature improvements including parking lots, curb and gutter, sidewalk, utilities and light posts will be constructed at the Golden Triangle station platform.

The soil conditions in the area are extremely susceptible to consolidation and settlement from new loads and raises in grade. For the parking lot areas, lightweight fill in the form of tire chips or expanded polystyrene (EPS) foam blocks may be an option to raise grade with minimal stress increase, however, this may be an obstacle for the installation of utilities or light pole bases. Once final design parameters are known, additional measures such as surcharges can be explored to increase the rate of consolidation. Regardless of the methods mentioned above, long term consolidation and settlement of the soil will occur, and may vary in magnitude from one inch to upwards of several feet.

We recommend all structures, including light pole bases be supported on deep foundation systems.

We also recommend supporting all deep utilities (sanitary sewer, water main, and storm sewer) on driven piles.

It should be noted differential settlement will occur between the pile-supported platform that will not settle and surface features around the platform that will realize settlement roughly proportional to the amount of new fill placed. Lightweight fill or pile supported transition slabs could be used to accommodate the differential settlement.

C. Procedures

C.1. Penetration Test Borings

The penetration test borings were drilled with core and auger drill equipped with hollow-stem auger mounted on an off-road carrier. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 1/2- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

Penetration test boreholes that met the Minnesota Department of Health (MDH) Environmental Borehole criteria were sealed with an MDH-approved grout.

C.2. Material Classification and Testing

C.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

C.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures.

C.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or allowed to remain open for an extended period of observation as noted on the boring logs.

D. Qualifications

D.1. Variations in Subsurface Conditions

D.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

D.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

D.2. Continuity of Professional Responsibility

D.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

D.3. Use of Report

This preliminary report is for the exclusive use of the parties to which it has been addressed. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects. Upon completion of final design, we recommend a final boring program be completed to investigate those areas not observed during our preliminary work.

D.4. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these recommendations, please call Josh Kirk at 952.995.2222 jkirk@braunintertec.com or Ray Huber at 952.995.2260 rhuber@braunintertec.com at your convenience.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate-Project Engineer
License Number: 45005

Reviewed by:

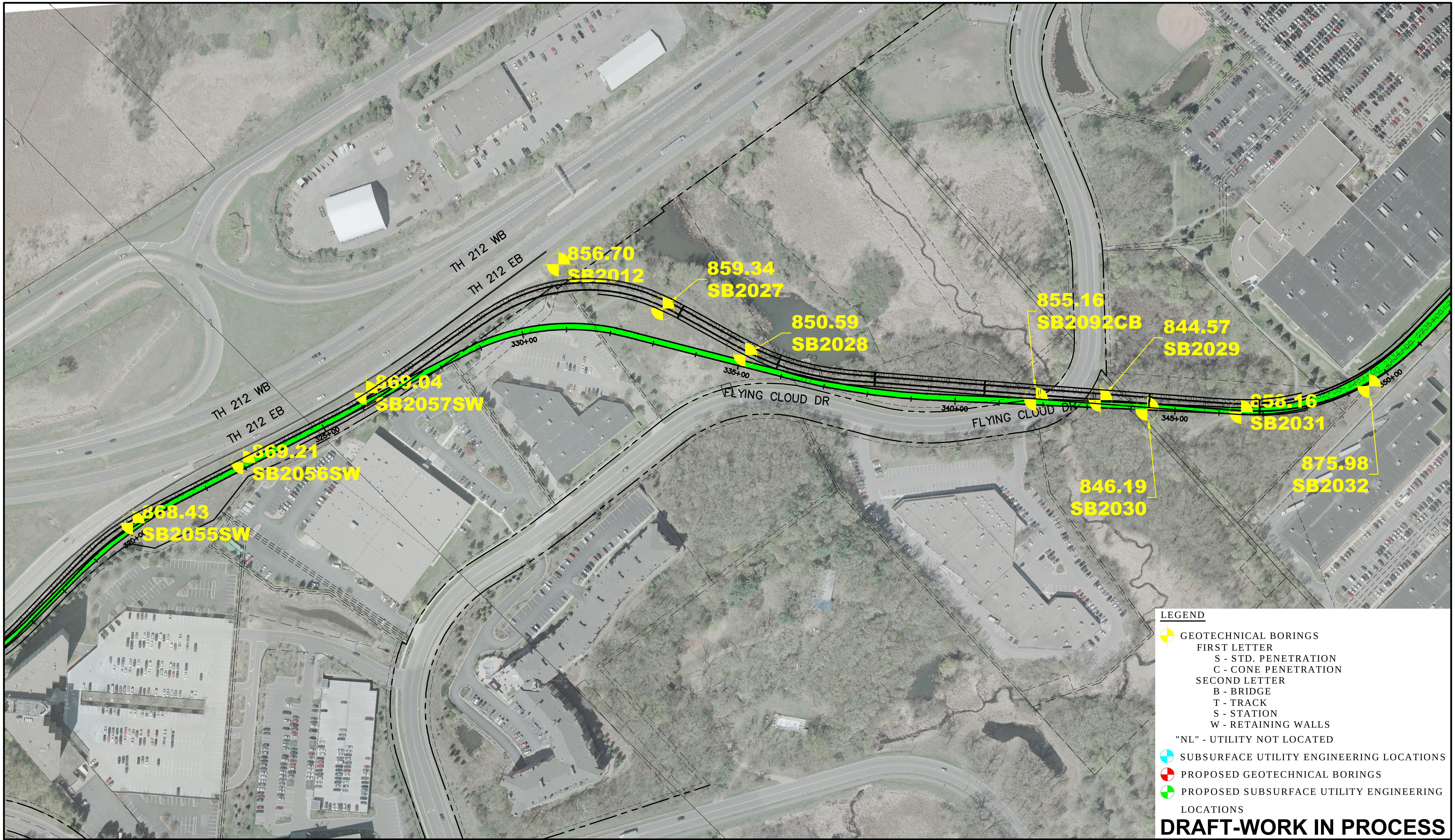
Ray A. Huber, PE
Vice President-Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Boring Location Sketch
Preliminary Plan and Profile Pages W2-STU-RTW-PPFL-004 and 005
Preliminary Plans and Profile Pages – Walls RTW-W205 and RTW-W215
Standard Penetration Borings (2032ST, 2033ST, 2034ST, 2035CSS, 2036SS, 2037SS, 2083ST, 2025SB, 2026SB)
Nominal Geotechnical Resistance Graphs
Lateral Pile Analysis Results
SPT Descriptive Terminology

APPENDIX



SOUTHWEST Green Line LRT Extention

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 6 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

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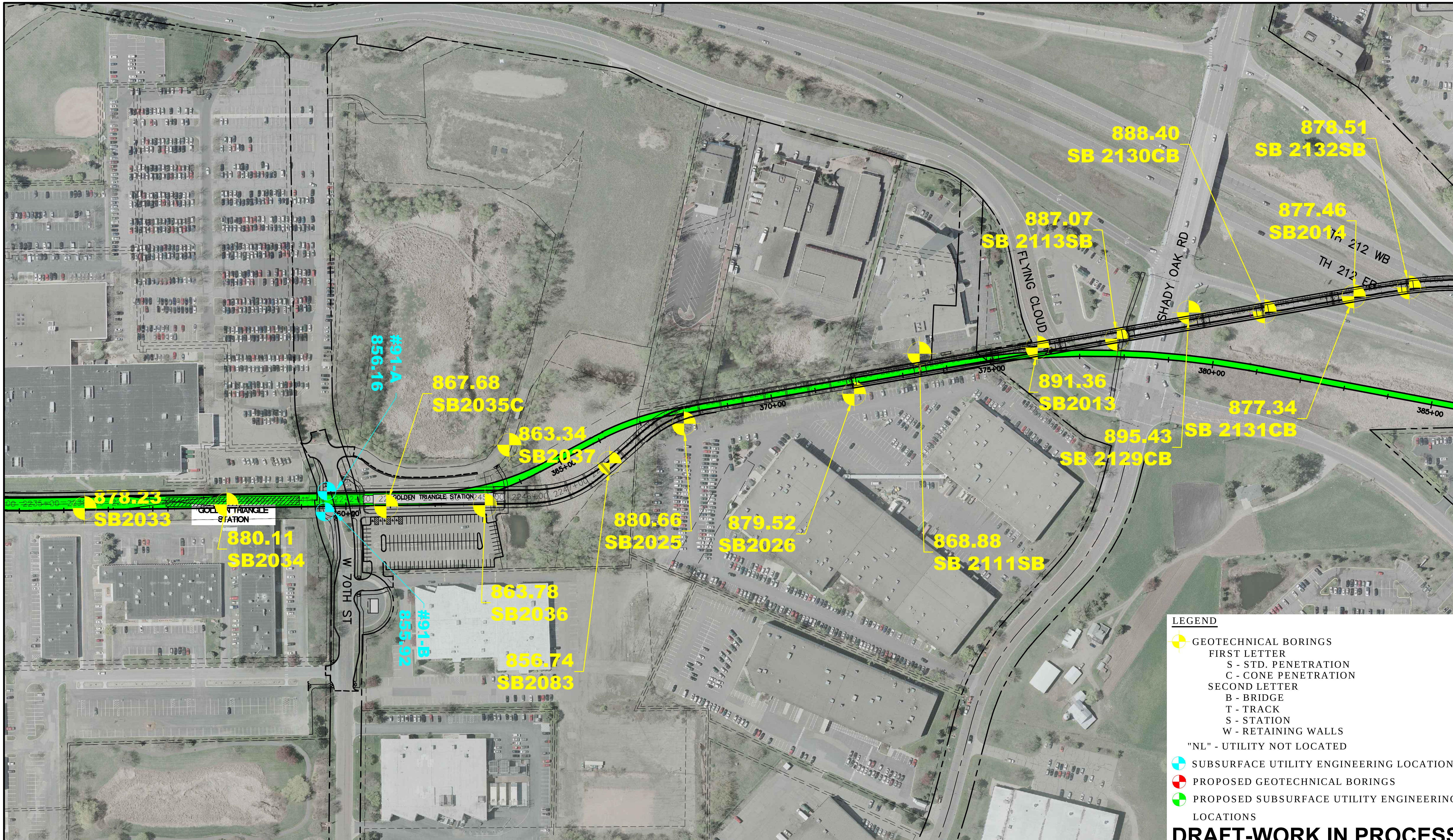
SRF Consulting Group, Inc.



SOUTHWEST Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 7 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

NORTH

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SRF Consulting Group, Inc.

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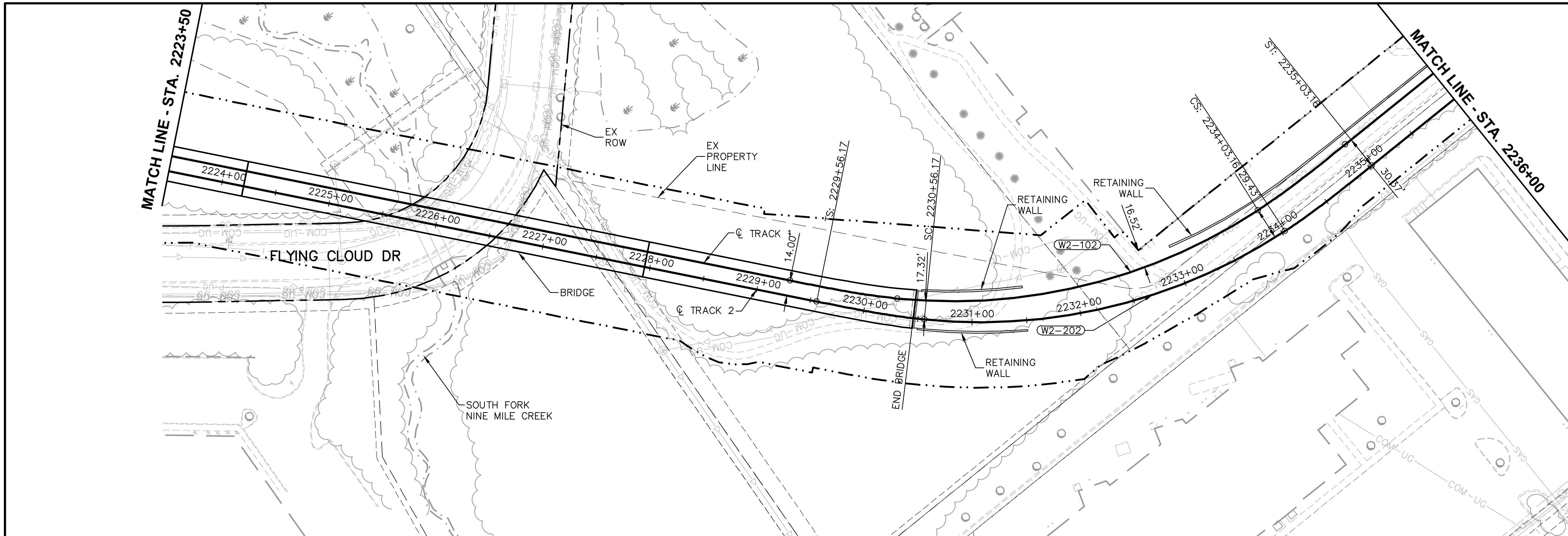

CURVE NO. W2-202
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Lc = 346.99'
Ls = 100.00'
Ea = 2.75"
Eu = 2.10"
V = 25 MPH

CURVE NO. W2-102
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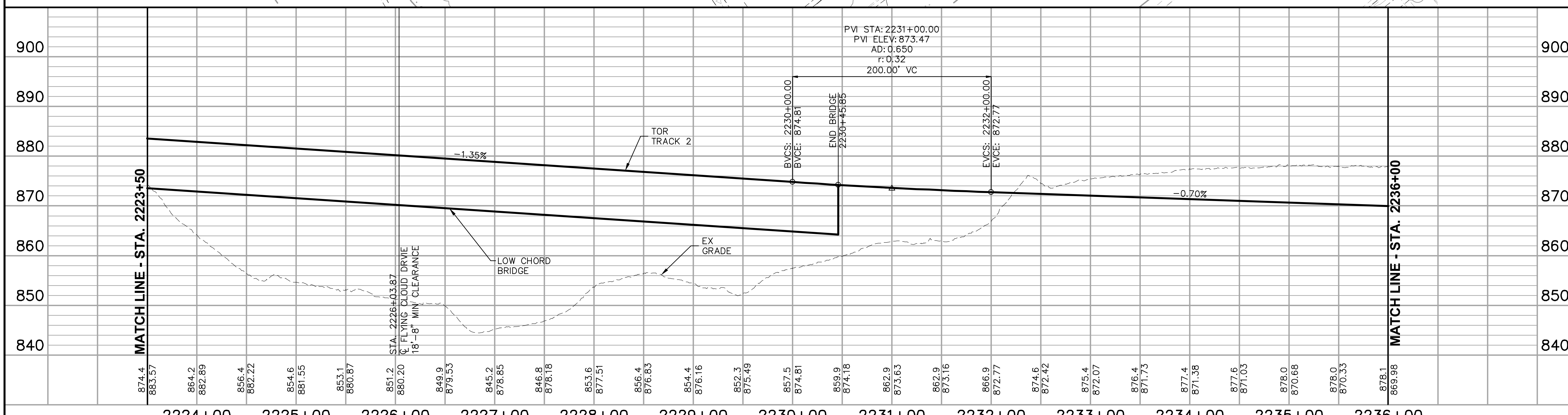
Lc = 346.99'
Ls = 100.00'
Ea = 2.75"
Eu = 2.10"
V = 25 MPH



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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST - VOLUME 1 (CIVIL) - SEGMENT 2
TRACK
PLAN AND PROFILE
STA. 2223+50 TO STA. 2236+00

DISCIPLINE: TRACK

SHEET NAME: W2-TRK-PPFL-002

SHEET 33 OF XX

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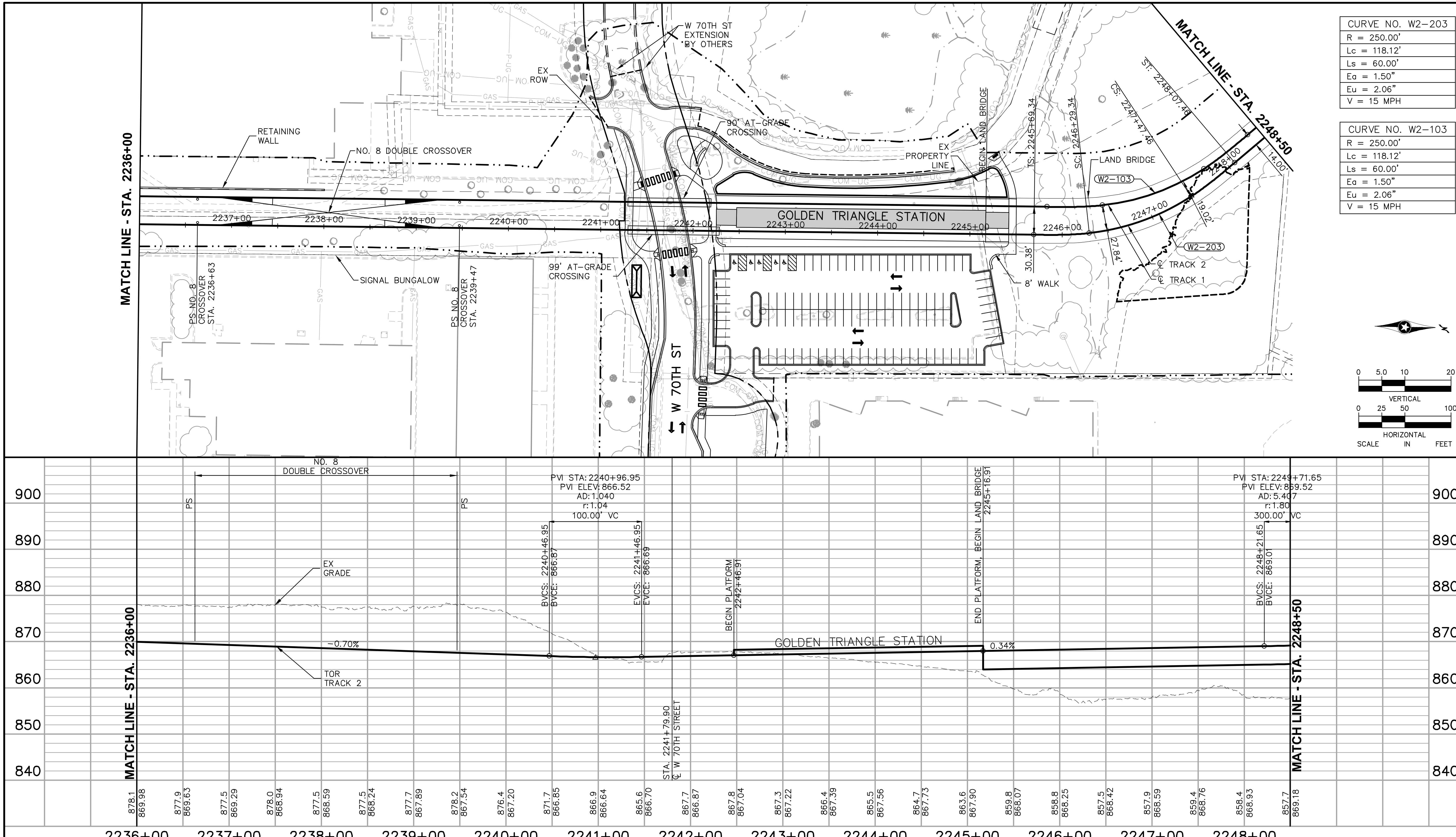

CURVE NO. W2-203
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Lc = 118.12'
Ls = 60.00'
Ea = 1.50"
Eu = 2.06"
V = 15 MPH

CURVE NO. W2-103
R = 250.00'
Lc = 118.12'
Ls = 60.00'
Ea = 1.50"
Eu = 2.06"
V = 15 MPH

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST - VOLUME 1 (CIVIL) - SEGMENT 2
TRACK
PLAN AND PROFILE
STA. 2236+00 TO STA. 2248+50

DISCIPLINE: TRACK

SHEET NAME: W2-TRK-PPFL-003

SHEET 34 OF XX

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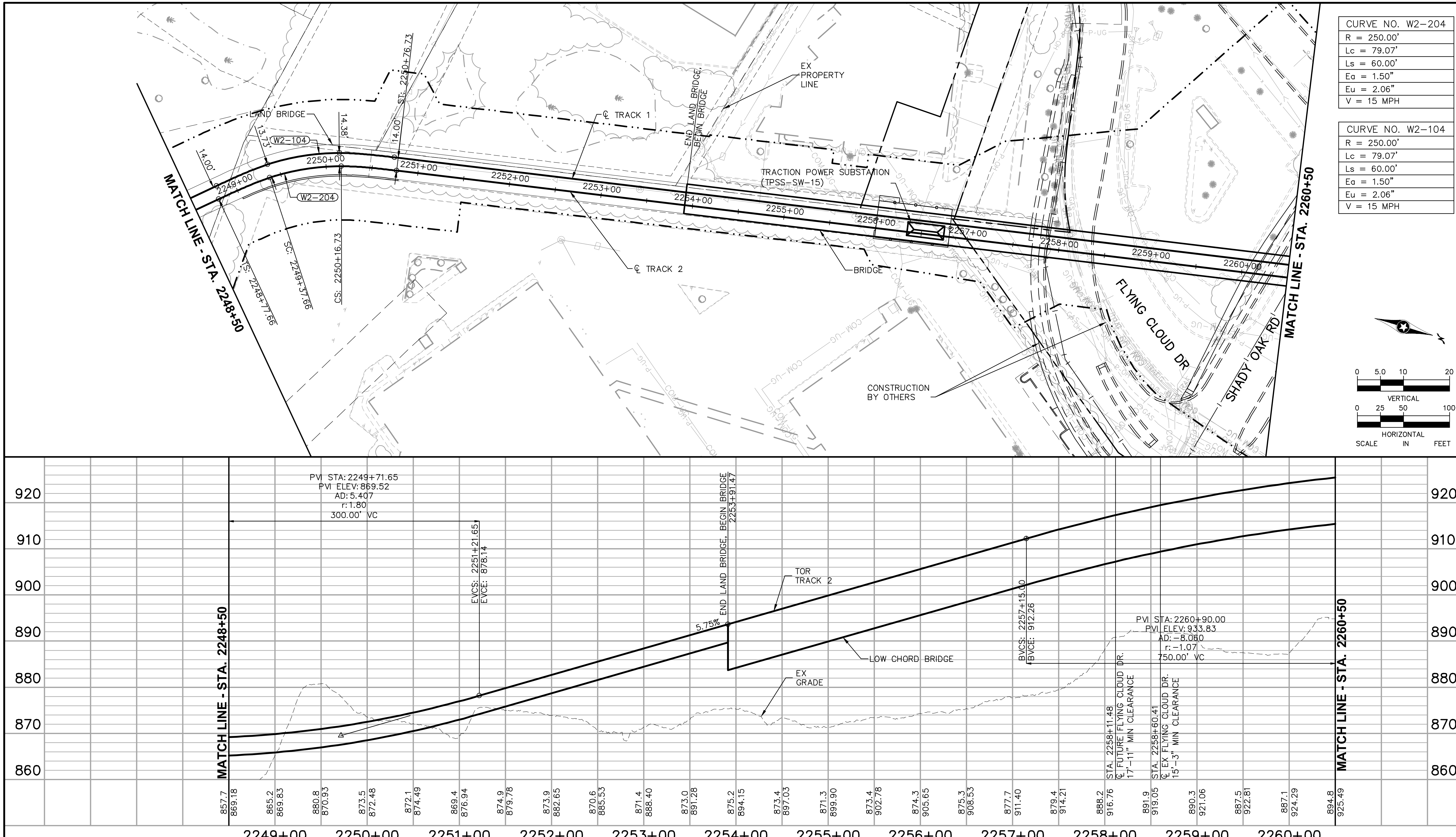

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SOUTHWEST Green Line LRT Extension

WEST - VOLUME 1 (CIVIL) - SEGMENT 2
TRACK
PLAN AND PROFILE
STA. 2248+50 TO STA. 2260+50

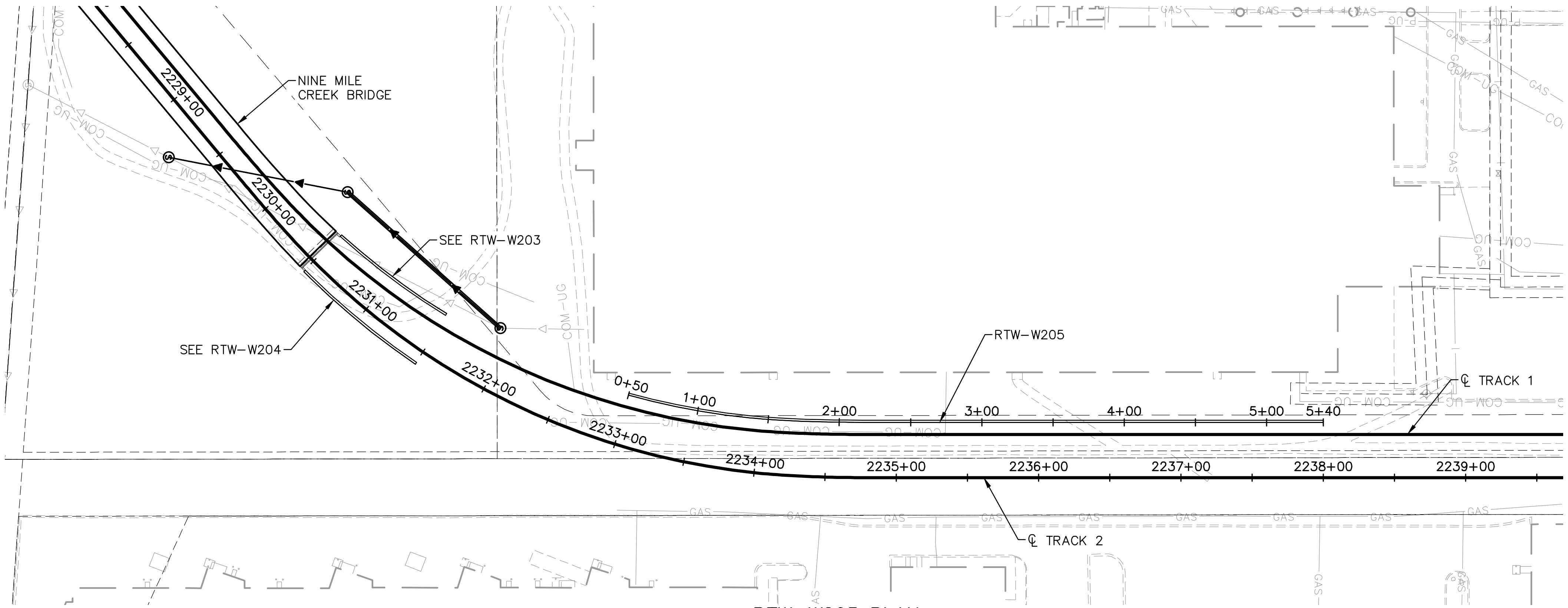
DISCIPLINE: TRACK

SHEET NAME: W2-TRK-PPFL-004

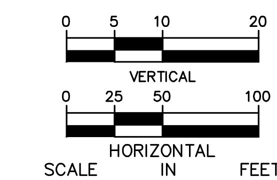
SHEET 35 OF XX

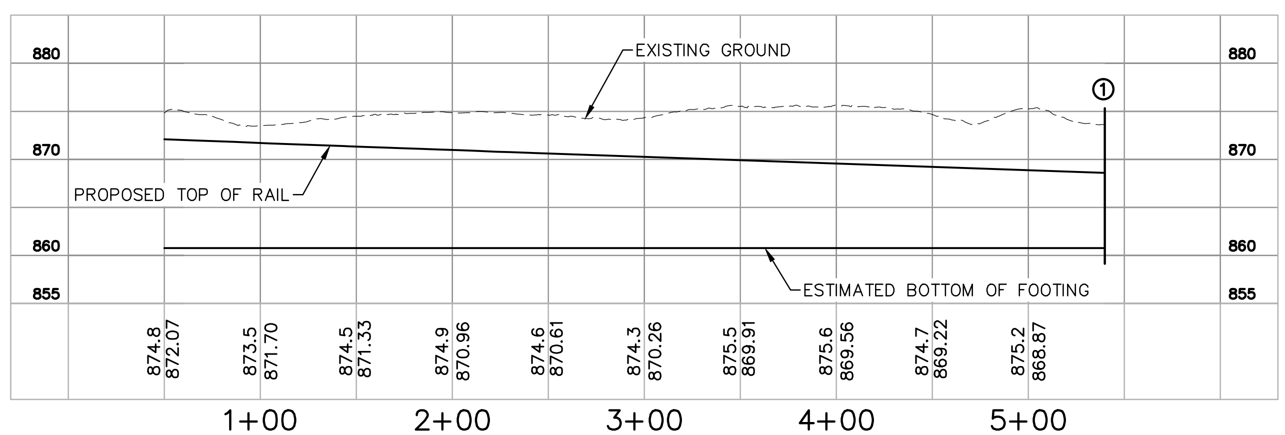
NOTE:
RTW-W205 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

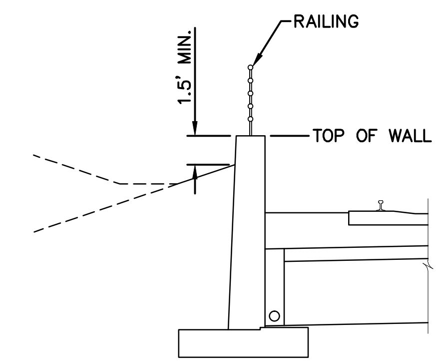


RTW-W205 PLAN





RTW-W205 PROFILE



RTW-W205 TYPICAL SECTION

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2
RTW-W205
PLAN AND PROFILE

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-RTW-PPFL-004

SHEET 183 OF 204

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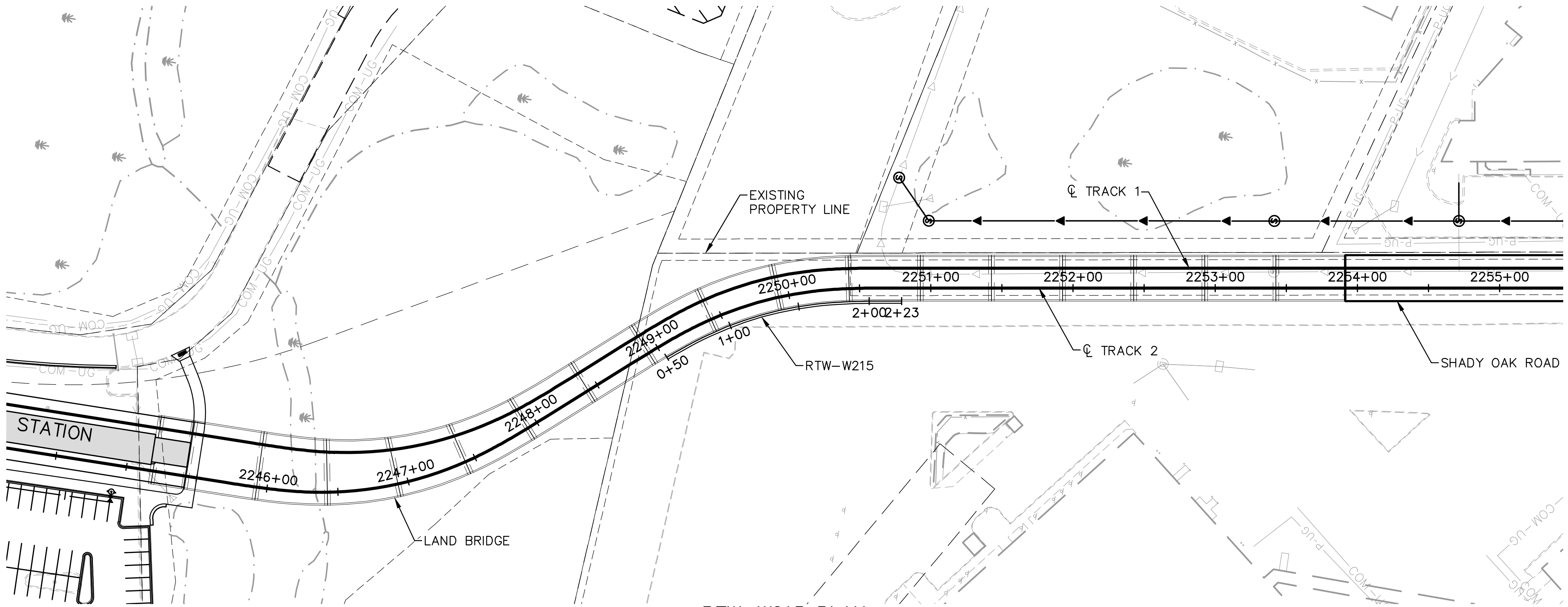
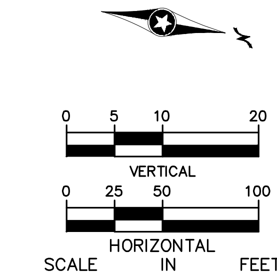
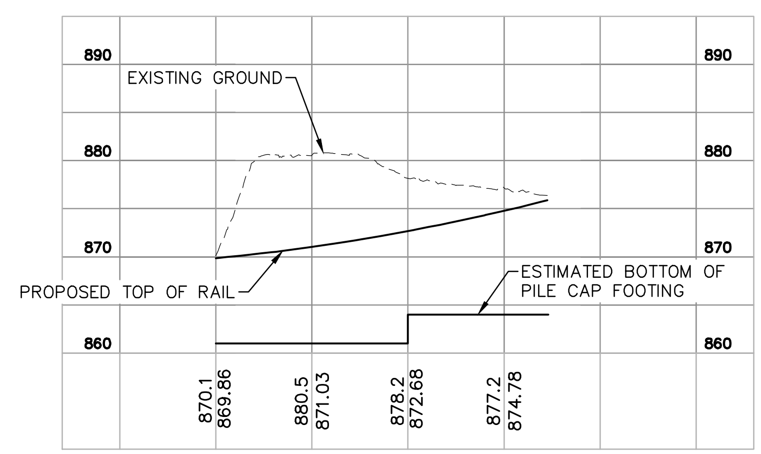
NOTE:
RTW-W215 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON A PILE SUPPORTED FOUNDATION.



RTW-W215 PLAN





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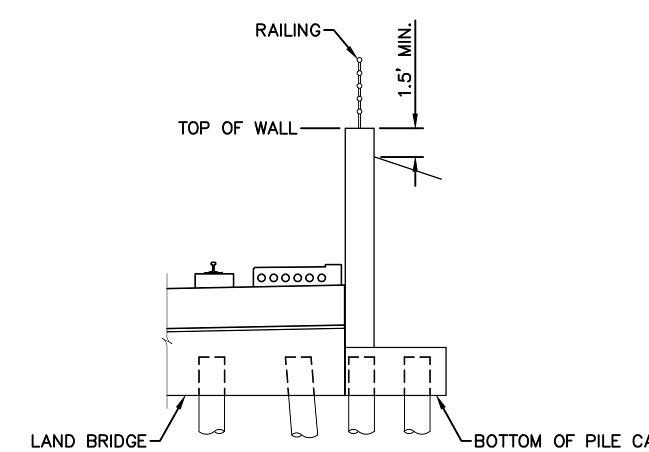

RTW-W215 PROFILE

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2
RTW-W215
PLAN AND PROFILE

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-RTW-PPFL-005

SHEET 184 OF 204

LOG OF BORING

BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2032ST**

LOCATION: N: 130310.4; E: 493145
See attached sketch.

DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: **8/30/13** | SCALE: **1" = 4'**

Elev. feet 876.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
873.0	3.0	CL	SANDY LEAN CLAY, black, moist to wet. (Topsoil)				
867.0	9.0	FILL	FILL: Clayey Sand, fine- to medium-grained, trace Gravel, gray, moist.	7 18 24		 9	
864.0	12.0	FILL	FILL: Clayey Sand, fine- to medium-grained, with Gravel, black and brown, moist.	23			
854.0	22.0	SC	CLAYEY SAND, fine- to medium-grained, trace Gravel, gray, moist, medium to hard. (Glacial Till)	10 7 32* 33*		10	P200=35% *Little recovery due to Gravel. *No recovery.
847.0	29.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, with Lean Clay lenses, brown, wet, medium dense. (Glacial Till) Silt and Sand layers from 26 to 28 feet.	18 25 19		10	P200=21%
		SC	CLAYEY SAND, fine- to medium-grained, with Gravel, brown to 30 feet then gray, moist, very stiff. (Glacial Till)	21			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2032ST (cont.)**

LOCATION: N: 130310.4; E: 493145
See attached sketch.

DRILLER: M. Takada	METHOD: 3 1/4" HSA, Autohammer	DATE: **8/30/13**	SCALE: **1" = 4'**

Elev. feet 844.0	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			CLAYEY SAND, fine- to medium-grained, with Gravel, brown to 30 feet then gray, moist, very stiff. (Glacial Till) *(continued)*	23			
840.0	36.0			27			
			END OF BORING.				
			Water not observed with 34 1/2 feet of hollow-stem auger in the ground.				
			Water not observed to cave-in depth of 22 feet immediately after withdrawal of auger.				
			Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2033ST**

LOCATION: N: 130606.8; E: 493151.9
See attached sketch.

DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: **8/30/13** | SCALE: **1" = 4'**

Elev. feet 878.2	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
		FILL	FILL: Poorly Graded Sand with Silt, fine- to coarse-grained, with Gravel, brown, moist.					
				10		2		P200=6%
				15				
871.2	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Gravel, reddish brown, moist.	21				
				50/6"				*No sample recovery. Pushed rock.
866.2	12.0	CL	LEAN CLAY with SAND, with Poorly Graded Sand lenses, brown to 17 feet then gray, wet, rather stiff to very stiff. (Glacial Till)	12		14		P200=67%
				23			3 1/2	
				9			2 1/2	
				9				
				11			2 1/2	
				12				
				14				*Water not observed with 19 1/2 feet of hollow-stem auger in the ground.
				17				Boring immediately backfilled.
847.2	31.0		END OF BORING.*					

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2034ST**

LOCATION: N 130925.5; E: 493143.8
See attached sketch.

DRILLER: M. Takada	METHOD: 3 1/4" HSA, Autohammer	DATE: **8/30/13**	SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 880.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
879.0	1.1	FILL	FILL: Silty Sand, fine-grained, black, moist. (Topsoil Fill)				
		FILL	FILL: Sandy Lean Clay, trace Gravel, brown and black, moist.	19			
				9		11	
				20			
				23			
866.1	14.0			9			
863.1	17.0	FILL	FILL: Slightly Organic Clayey Sand, fine- to medium-grained, black, moist. (Buried Topsoil)	8		18	OC=4%
861.1	19.0	FILL	FILL: Sandy Lean Clay, trace Gravel, gray, wet.	16			
		SM	SILTY SAND, fine- to medium-grained, with occasional Lean Clay lenses, brown, moist, medium dense to dense. (Glacial Till)	14			
				13		8	P200=19%
				21			
			Gravel from 25 to 30 feet.				
				40			
848.1	32.0			40	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.

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BRAUN[SM]
INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2034ST (cont.)**

LOCATION: N 130925.5; E: 493143.8
See attached sketch.

DRILLER: M. Takada	METHOD: 3 1/4" HSA, Autohammer	DATE: **8/30/13**	SCALE: **1" = 4'**

Elev. feet 848.1	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		SP-SM	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	12			
844.1	36.0			12			
			END OF BORING. Water observed at 32 feet with 32 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2035CSS**
LOCATION: N: 131284.5; E: 493147.9
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 9/5/13	SCALE: 1" = 4'

Elev. feet 867.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
866.7	1.0	AGG	12 inches of Aggregate Base.				
863.7	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, black, moist.	17			
860.7	7.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, with black Silty Sand lenses, brown, moist.	44			
855.7	12.0	FILL	FILL: Clayey Sand, fine- to medium-grained, trace Gravel, with Sand lenses, brown, moist.	14 18			An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
		SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, very loose to loose. (Glacial Outwash)	8	▽		
				7		15	Slogged augers with mud from 15 to 40 feet. P200=8%
			Lean Clay lenses at 20 feet.	6			
			Fine-grained at 25 feet.	2			
				7			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:17

Braun Project BL-13-00213 GEOTECHNICAL EVALUATION SWLRT Minnetonka, Minnesota	BORING: 2035CSS (cont.) LOCATION: N: 131284.5; E: 493147.9 See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 9/5/13	SCALE: 1" = 4'

Elev. feet 835.7	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
833.7	34.0						
		SM	SILTY SAND, fine- to medium-grained, with Lean Clay lenses at 35 feet, trace Gravel, brown, waterbearing, medium dense to dense. (Glacial Till)	12			
				15		9	P200=22%
			Coarse Sand layer at 45 feet.	39			
818.7	49.0						
		SM	SILTY SAND, fine- to medium-grained, with Gravel, with occasional layers of Sand, Silt and Clay, brown, waterbearing, medium dense. (Glacial Till)	24			
				21			
				26			
803.7	64.0						

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project BL-13-00213 GEOTECHNICAL EVALUATION SWLRT Minnetonka, Minnesota	BORING: 2035CSS (cont.) LOCATION: N: 131284.5; E: 493147.9 See attached sketch.
DRILLER: M. Belch / METHOD: 3 1/4" HSA, Autohammer	DATE: 9/5/13 / SCALE: 1" = 4'

Elev. feet 803.7	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, with occasional Lean Clay lenses, brown, Waterbearing, medium dense to dense. (Glacial Outwash)	23 24 45			
788.7	79.0		END OF BORING. Auger met refusal at the 79-foot depth. Water observed at 12 1/2 feet with 12 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2036SS**

LOCATION: N: 131506.5; E: 493146.1
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **9/4/13**	SCALE: **1" = 4'**

Elev. feet 863.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
		AGG	24 inches of Aggregate Base.					
861.8	2.0	FILL	FILL: Sandy Lean Clay, trace Gravel, gray and brown, wet.	9				
				TW				
			Sand lense at 7 feet.	6		18	1/4	
			Black Lean Clay lenses at 10 feet.	5			3/4	
851.8	12.0	PT	PEAT, fibrous, dark brown, moist. (Swamp Deposit)	8				OC=85%
844.8	19.0	CL	LEAN CLAY, slightly Organic, gray, wet. (Swamp Deposit)	4				OC=2% LL=34, PL=20, PI=14
839.8	24.0	SP	POORLY GRADED SAND, fine- to medium-grained, with Gravel, gray, waterbearing, loose to medium dense. (Glacial Outwash)	9	▽	17		P200=2% Switched to mud rotary drilling method after 25-foot sample. An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while
				8				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:17

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2036SS (cont.)**

LOCATION: N: 131506.5; E: 493146.1
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **9/4/13**	SCALE: **1" = 4'**

Elev. feet 831.8	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			POORLY GRADED SAND, fine- to medium-grained, with Gravel, gray, waterbearing, loose to medium dense. (Glacial Outwash) *(continued)*					drilling.
			Coarse-grained at 35 feet.	12				
824.8	39.0	SM	SILTY SAND, fine- to medium-grained, with Lean Clay lenses at 40 feet, brown, waterbearing, medium dense to dense. (Glacial Till)	42				
				24				
814.8	49.0	SC	CLAYEY SAND, trace Gravel, brown, wet, hard. (Glacial Till)	32				
809.8	54.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, dense. (Glacial Outwash)	39		13		P200=9%
804.8	59.0	SC	CLAYEY SAND, trace Gravel, brown, waterbearing, hard to very stiff. (Glacial Till)	36			3	

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:17

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2036SS (cont.)**
LOCATION: N: 131506.5; E: 493146.1
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/4/13** | SCALE: **1" = 4'**

Elev. feet 799.8	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			CLAYEY SAND, trace Gravel, brown, waterbearing, hard to very stiff. (Glacial Till) *(continued)*					
			Waterbearing Sand lense at 65 feet.	36				
			Sand layer at 70 feet.	30		12		P200=37%
789.8	74.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense. (Glacial Till)	33				
				45				
			Clayey Sand lenses at 85 feet.	20				
				22				
769.8	94.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff to hard. (Glacial Till)	15				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:17

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213 **GEOTECHNICAL EVALUATION** **SWLRT** **Minnetonka, Minnesota**	BORING: **2036SS (cont.)** LOCATION: N: 131506.5; E: 493146.1 See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **9/4/13**	SCALE: **1" = 4'**

Elev. feet 767.8	Depth feet 96.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			SANDY LEAN CLAY, trace Gravel, gray, wet, stiff to hard. (Glacial Till) *(continued)*	50			4 1/2	
762.8	101.0							
			END OF BORING. Water observed at 25 feet with 25 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:17

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2037SS**

LOCATION: N: 131561.2; E: 493009.7
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/6/13** | SCALE: **1" = 4'**

Elev. feet 863.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
862.6	0.8	PAV	3 inches of Bituminous over 6 inches of Aggregate Base.				
		FILL	FILL: Sandy Lean Clay, trace Gravel, brown, wet.	17			
			Organics and debris at 5 feet.	14			Apparent geotextile fabric at 5 feet.
856.3	7.0	FILL	FILL: Sandy Lean Clay, trace Gravel and roots, black, wet.	TW			DD=122 pcf MC=13% Su=1000 psf
				5			
851.3	12.0	PT	PEAT, fibrous, with shells, black, wet. (Swamp Deposit)	3		298	OC=59%
				TW			
846.3	17.0	OL	ORGANIC CLAY, trace fibers, gray, wet. (Swamp Deposit)	3		65	OC=9%
844.3	19.0	ML	SILT, gray, wet, very loose. (Alluvium)	3			
841.3	22.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, very loose to dense. (Glacial Outwash)	2	▽		An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling.
				6			
				10			
				10		14	P200=5%

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:18

Braun Project BL-13-00213 GEOTECHNICAL EVALUATION SWLRT Minnetonka, Minnesota	BORING: 2037SS (cont.) LOCATION: N: 131561.2; E: 493009.7 See attached sketch.		
DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 9/6/13	SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 831.3	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, very loose to dense. (Glacial Outwash) *(continued)*	9			
				9			
				19			
				15			
				7			
				15			
			Fine-grained at 47 feet.	40			
				20			
				15			Switched to mud rotary drilling method after 50-foot sample.
				13			
799.3	64.0						

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:18

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2037SS (cont.)**

LOCATION: N: 131561.2; E: 493009.7
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **9/6/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 799.3	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		CL	LEAN CLAY, brown to gray, wet, very stiff. (Glacial Till)	28			
794.3	69.0						
		SM	SILTY SAND, fine- to medium-grained, trace Gravel, with occasional Lean Clay lenses, brown, waterbearing, medium dense to dense. (Glacial Till)	30			
				32			
				36			
				19			
774.3	89.0						
		CL	SANDY LEAN CLAY, trace Gravel, gray and brown, wet, hard. (Glacial Till)	41			
				76			

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2037SS (cont.)**
LOCATION: N: 131561.2; E: 493009.7
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **9/6/13**	SCALE: **1" = 4'**

Elev. feet 767.3	Depth feet 96.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			SANDY LEAN CLAY, trace Gravel, gray and brown, wet, hard. (Glacial Till) *(continued)*				
				*			*95 blows for 10 inches.
762.3	101.0						
			END OF BORING.				
			Water observed at 22 1/2 feet with 22 1/2 feet of hollow-stem auger in the ground.				
			Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:18

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2083ST**

LOCATION: N: 131786.6; E: 493050.6;
See attached sketch.

DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: **3/27/14** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 856.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		PT	WELL DECOMPOSED PEAT, dark brown and black, wet. (Swamp Deposit)				
				WH			WH=Weight of hammer.
			Roots and shells at 5 feet.	WH			
849.7	7.0	OH	ORGANIC SILT, with roots and shells, black, wet. (Swamp Deposit)	WH		67%	OC=8%
				WH		102	LL=71 PL=36 PI=35
				WH			A solid triangle indicates the groundwater level in the boring on the date indicated. Groundwater levels fluctuate.
842.7	14.0	ML	SILT, gray, wet, loose. (Alluvium)				
				5	▼		Switched to mud rotary drilling at 15 feet, switched back to auger boring at 25 feet.
			Poorly Graded Sand layer at 16 feet.				
				7*			*No sample recovery.
837.7	19.0	GP	POORLY GRADED GRAVEL, gray, waterbearing, loose. (Glacial Outwash)				
				9			
834.7	22.0	SP	POORLY GRADED SAND, medium- to coarse-grained, with frequent Gravel layers, gray, waterbearing, loose to dense. (Glacial Outwash)	10			
				13			
				37*		14	P200=5% *Jetted auger from 27 to 30 feet.
				41			
825.7	31.0	SP-					

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:18

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2083ST (cont.)**

LOCATION: N: 131786.6; E: 493050.6; See attached sketch.

DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: **3/27/14** | SCALE: **1" = 4'**

Elev. feet 824.7	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
		SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, gray, waterbearing, medium dense. (Glacial Outwash) *(continued)*	23			
				20			
819.7	37.0	SC-SM	SILTY CLAYEY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to very dense. (Glacial Till)	51		9	
				53			
				17			
				13			
			Poorly Graded Sand layer at 47 feet.	15			
				16			
				23			
				12			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/13/14 15:18

Braun Project BL-13-00213 GEOTECHNICAL EVALUATION SWLRT Minnetonka, Minnesota	BORING: 2083ST (cont.) LOCATION: N: 131786.6; E: 493050.6; See attached sketch.

DRILLER: M. Takada	METHOD: 3 1/4" HSA, Autohammer	DATE: 3/27/14	SCALE: 1" = 4'

Elev. feet 792.7	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			SILTY CLAYEY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to very dense. (Glacial Till) *(continued)*	18		13	DD=126.5 pcf
787.7	69.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, stiff. (Glacial Till)	16			
782.7	74.0	SP	POORLY GRADED SAND, fine-grained, gray, waterbearing, medium dense to dense. (Glacial Outwash)	17			
				44			
772.7	84.0	SS	SANDSTONE, fine- to medium-grained, brown and light brown, waterbearing, very dense. (St. Peter Formation)	67/11"			
				50/5"			
				50/2"			
760.7	96.0		END OF BORING AT 96 FEET.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2025SB	880.7 (Surveyed)

Location: Hennepin Co. Coordinate: X=492962 Y=131954 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7507

Hammer CME Automatic Calibrated

Drilling Completed 8/26/13

Depth / Elev.	Classification	SPT N60	Other Tests Or Remarks
1.0 / 879.7	12 inches of Aggregate Base.		
7.0 / 873.7	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, with occasional Lean Clay lenses, brown, moist, (SP-SM), fill	13, 18	
19.0 / 861.7	SANDY LEAN CLAY, trace Gravel, brown to gray, wet, (CL), fill	6, 8*, 6, 6, 4	*No sample recovery.
22.0 / 858.7	CLAYEY SAND, trace Gravel, gray, waterbearing, (CS), fill	4	Switched to mud rotary drilling method after 20-foot sample.
27.0 / 853.7	SLIGHTLY ORGANIC SANDY LEAN CLAY, trace Gravel, black, wet, (CL), fill	8, 11	OC=2%
34.0 / 846.7	SANDY LEAN CLAY, trace Gravel, brown, wet, very stiff, (CL), till	20, 19*	*No sample recovery.
	SILTY SAND, fine- to medium-grained, with Gravel, with occasional Poorly Graded Sand lenses, brown, wet, medium dense to dense, (SM), till	21, 22, 26, 21	P200=23%

Columns also shown (empty): MC (%), COH (psf), γ (pcf), REC (%), RQD (%), ACL (ft), Core Breaks, Formation or Member. Drilling operation: PD.

Index Sheet Code 3.0

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2025SB**	**880.7** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SILTY SAND, fine- to medium-grained, with Gravel, with occasional Poorly Graded Sand lenses, brown, wet, medium dense to dense, (SM), till *(continued)*		21					
				PD	26					
50				PD	31					
				PD						
55					42					
				PD						
60					26					
				PD						
65					14					
	69.0 / 811.7			PD						
70			POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to very dense, (SP-SM), outwash		18					
				PD						
75					20					
				PD						
80					15					P200=6%
				PD						
85					18					
				PD						
90										

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2025SB**	**880.7** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
				PD						
95			POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to very dense, (SP-SM), outwash *(continued)*		*					*50 blows per 50-inch set.
				PD						
100	100.6 / 780.1				*					*50 blows per 6-inch set.

Bottom of Hole - 100.6 feet.
Water observed at 20 feet with 20 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2026SB	879.5 (Surveyed)

Location: Hennepin Co. Coordinate: X=492895 Y=132336 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7507

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 8/27/13

Depth / Elev.	Classification	Drilling Operation	SPT N60 (REC %)	MC (%) (RQD %)	COH (psf) (ACL ft)	γ (pcf) (Core Breaks)	Soil / Rock	Other Tests Or Remarks (Formation or Member)
1.0 / 878.5	12 inches of Aggregate Base.							
4.0 / 875.5	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, moist, (SP-SM), fill		8					
7.0 / 872.5	SILTY SAND, fine- to medium-grained, with bituminous pieces, black, moist, (SM), fill		20					
9.0 / 870.5	CLAYEY SAND, with Gravel, brown, moist, (SC), fill		14					
12.0 / 867.5	SILTY SAND, fine- to medium-grained, with Gravel, with bricks and bituminous, brown, moist, (SM), fill		8					
20.0 / 859.5	SANDY LEAN CLAY, trace Gravel, brown, wet, (CL), fill		4					
			9					Switched to mud rotary drilling method after 15-foot sample.
		PD	9					
22.0 / 857.5	SANDY LEAN CLAY, trace roots, black, wet, (CL), fill	PD	15					
24.0 / 855.5	ORGANIC CLAY, with roots and fibers, black, wet, (OL), swamp deposit.	PD	6					OC=7%
27.0 / 852.5	LEAN CLAY with SAND, slightly organic, with roots and fibers, gray, wet, (CL), swamp deposit	PD	7					OC=2%
34.0 / 845.5	WELL-GRADED GRAVEL with SILT, fine- to coarse-grained, gray, waterbearing, medium dense to dense, (GW-GM), outwash	PD	23					
		PD	25					
		PD	35					
	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense, (SP-SM), outwash	PD	30					
		PD	24*					*No sample recovery.
								P200=7%
		PD						No sampling from 42 to 50 feet due to cobbles.

Depth scale: 5, 10, 15 (water level), 20, 25, 30, 35, 40, 45

Index Sheet Code 3.0

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2026SB**	**879.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense, (SP-SM), outwash *(continued)*	PD						
	49.0 / 830.5									
50			SANDY LEAN CLAY, trace Gravel, brown, wet, hard, (CL), till	⊠	53					
				PD						
	54.0 / 825.5									
55			POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense to very dense, (SP), outwash	⊠	22					
				PD						
60				⊠	28					
				PD						
65				⊠	51					
				PD						
70				⊠	20*					*No sample recovery.
				PD						
75				⊠	25					
				PD						
80				⊠	33					
				PD						
85				⊠	22					
				PD						
	89.0 / 790.5									
90										

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

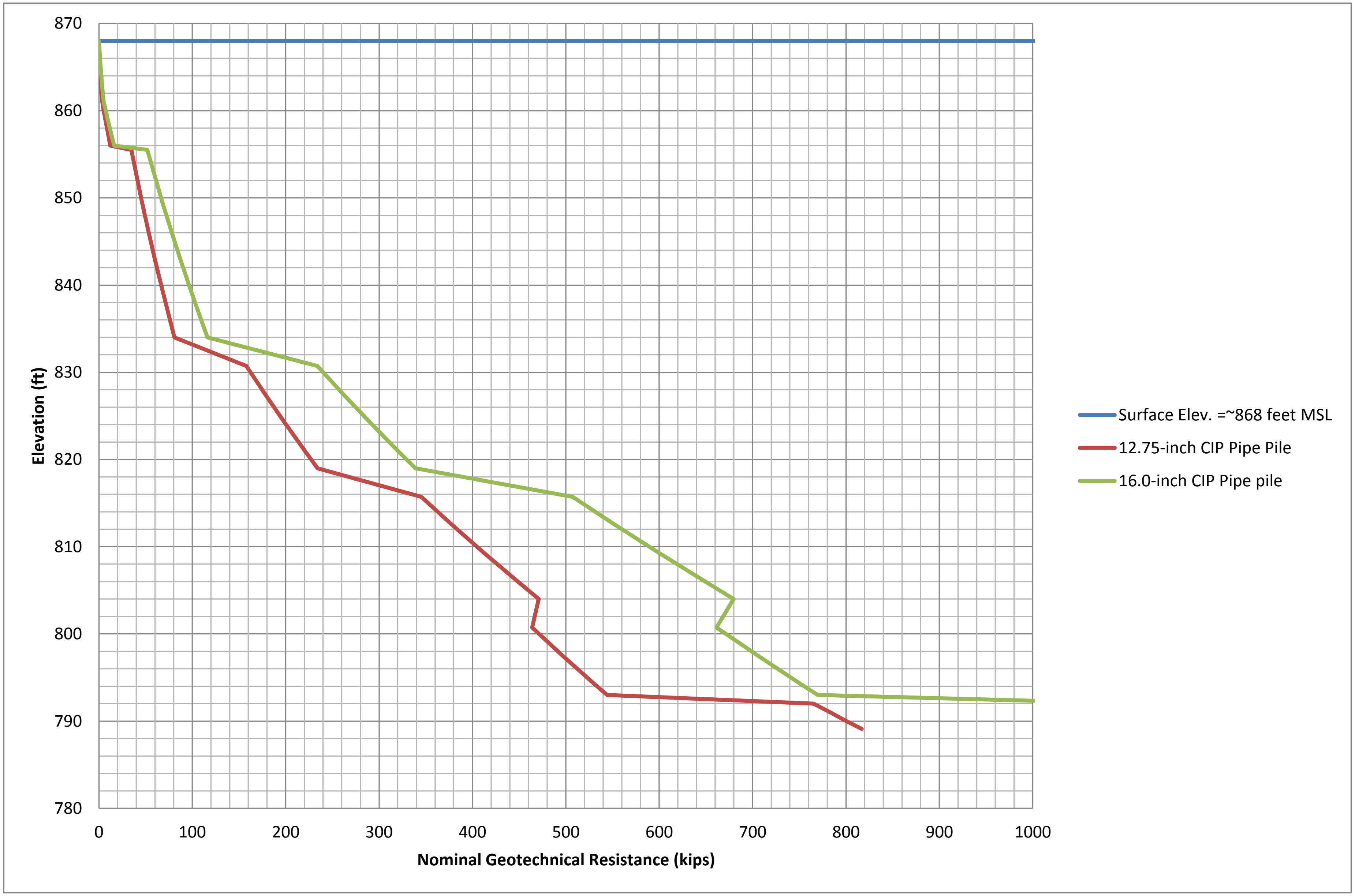
Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2026SB**	**879.5** *(Surveyed)*

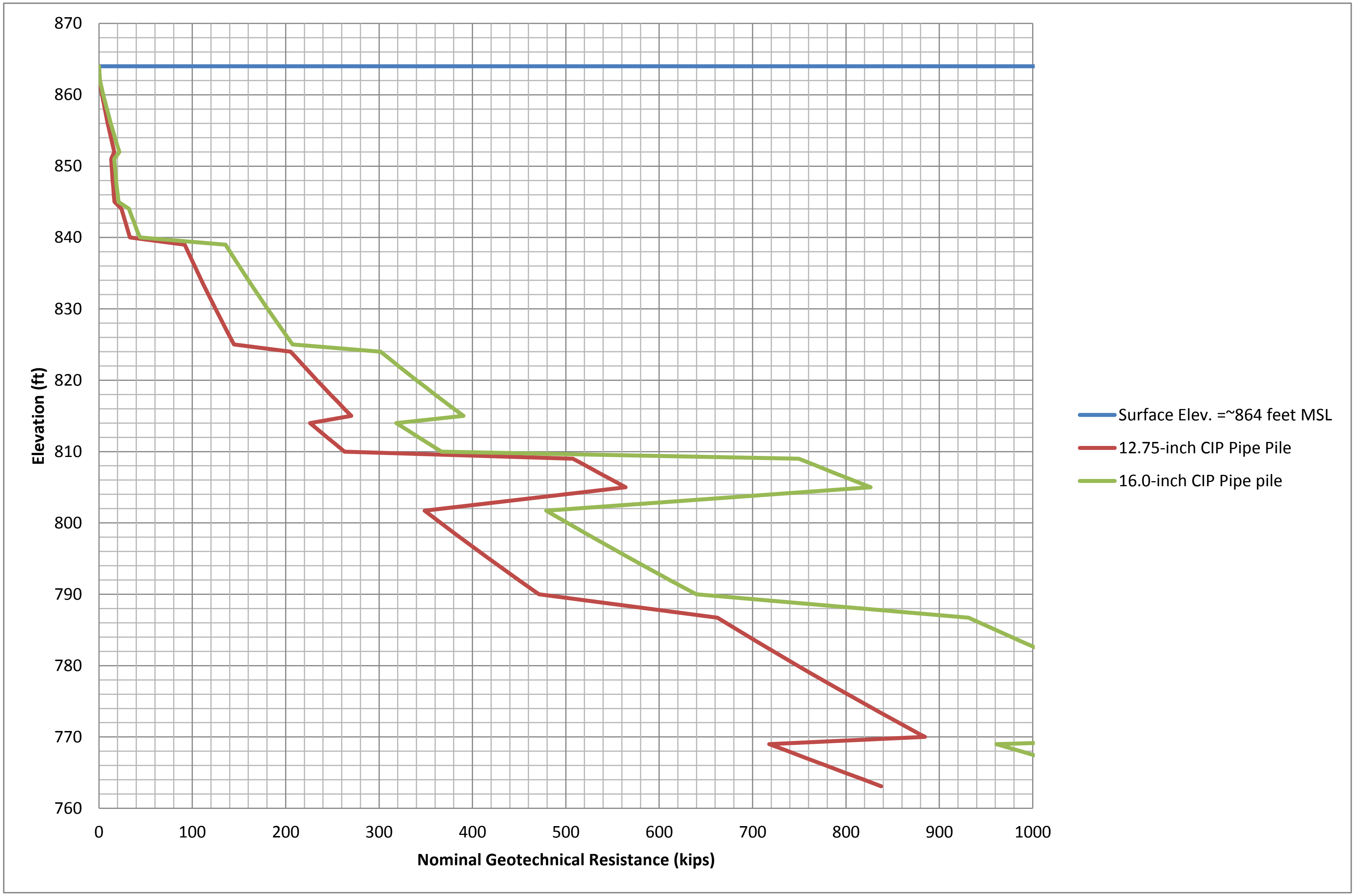
DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Other Tests Or Remarks / Formation or Member
				X	25				
				PD					
95			SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard, (CL), till *(continued)*	X	37				
				PD					
100	101.0 / 778.5			X	41				

Bottom of Hole - 101 feet.
Water observed at 15 feet with 15 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

Golden Triangle Station Area
Boring: 2035CSS
12.75-inch and 16.0-inch Closed Ended Pipe Pile



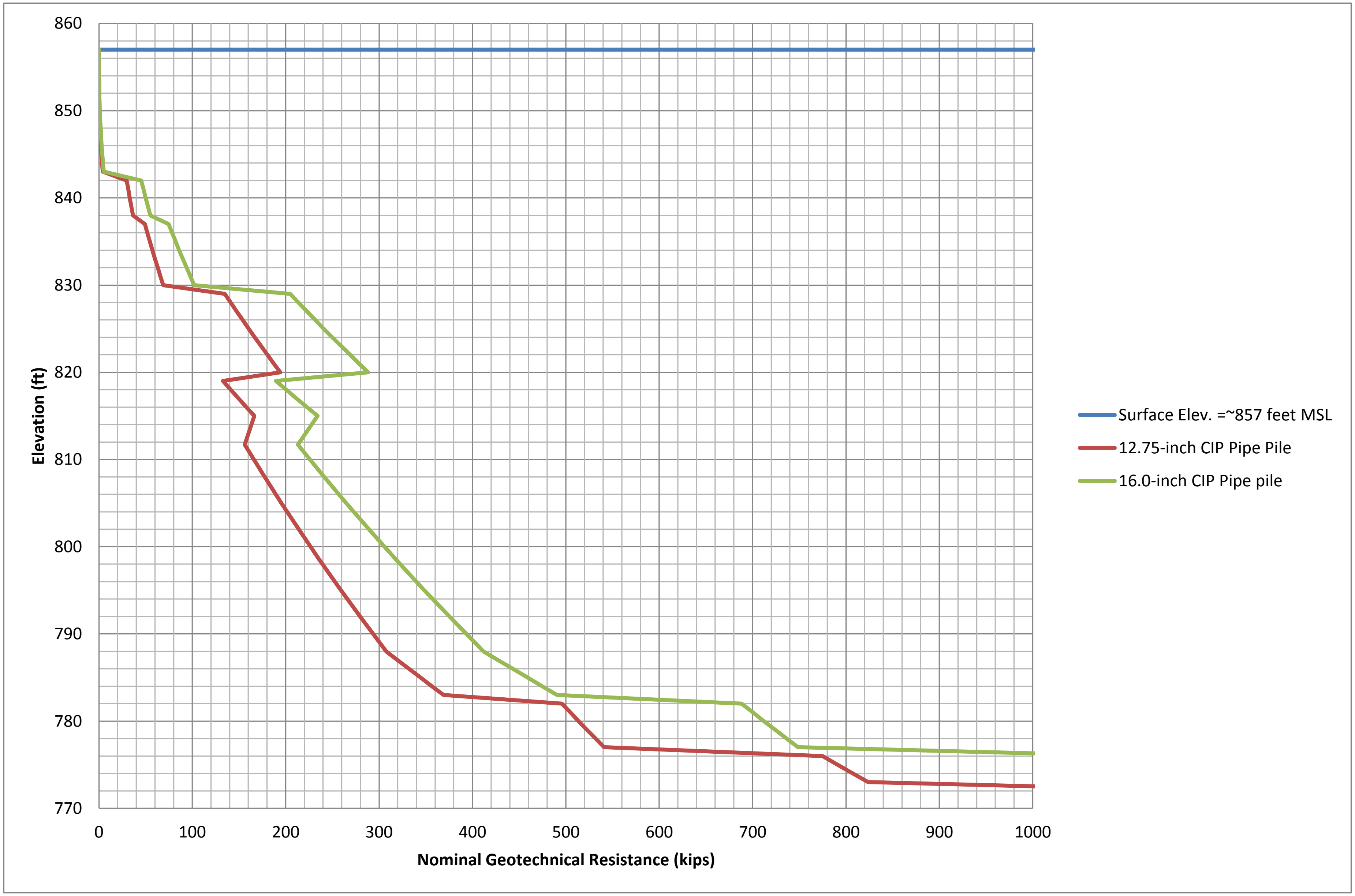
Golden Triangle Station Area
Borinig: 2036SS
12.75-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

BRAUN INTERTEC

Golden Triangle Station Area
Boring: 2083ST
12.75-inch and 16.0-inch Closed Ended Pipe Pile



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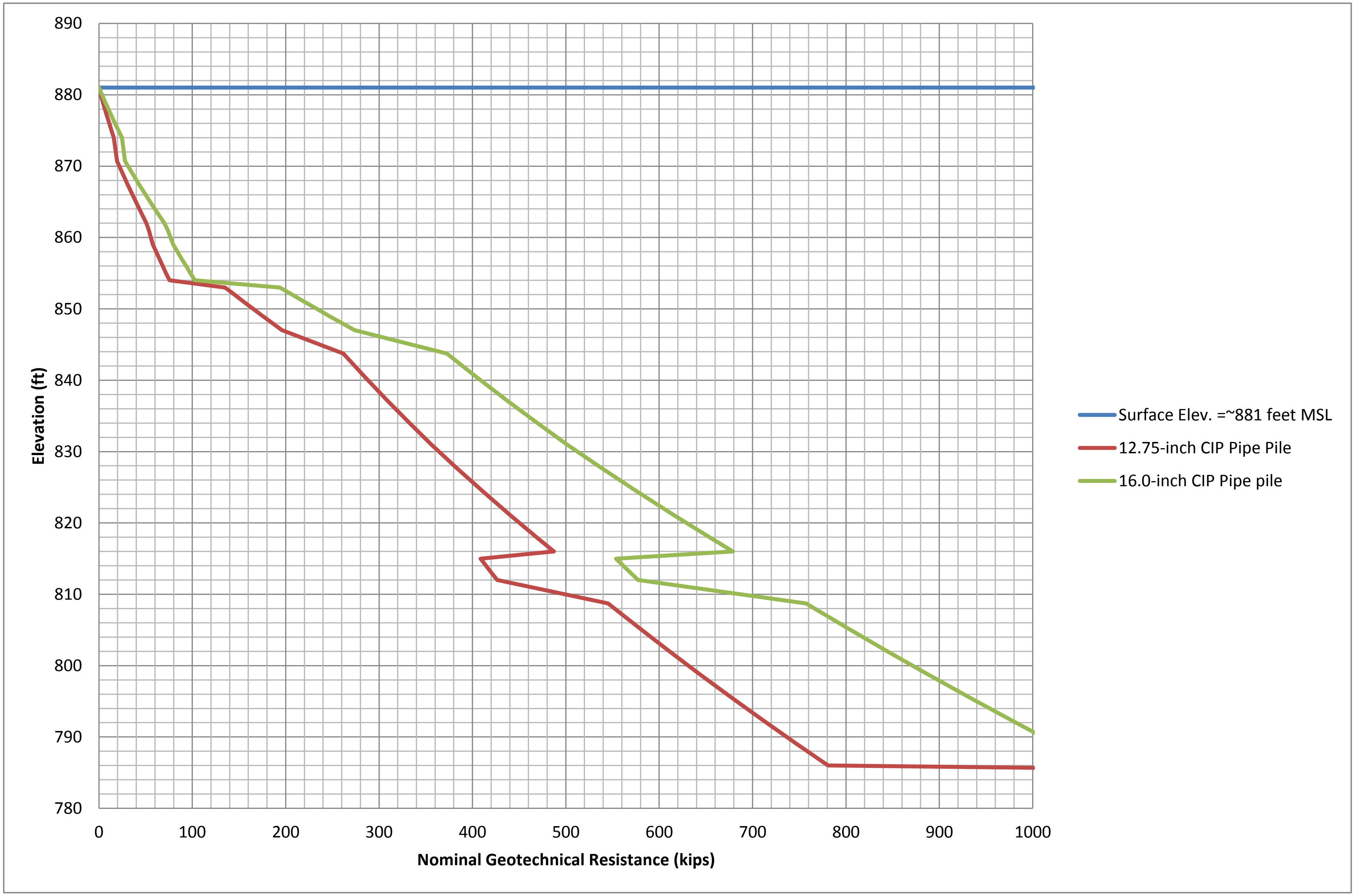
Golden Triangle Station Area
Boring: 2025SB
12.75-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

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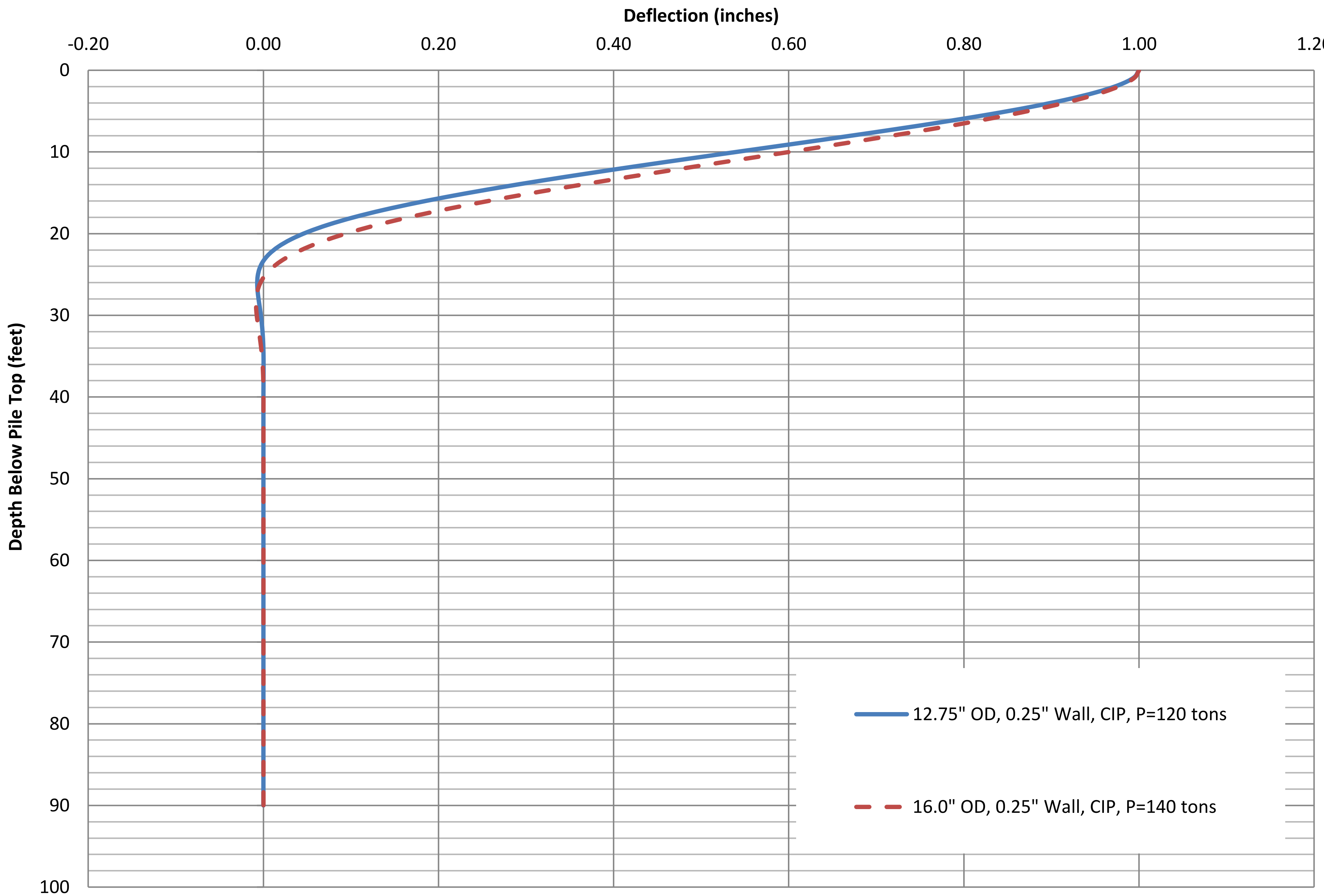
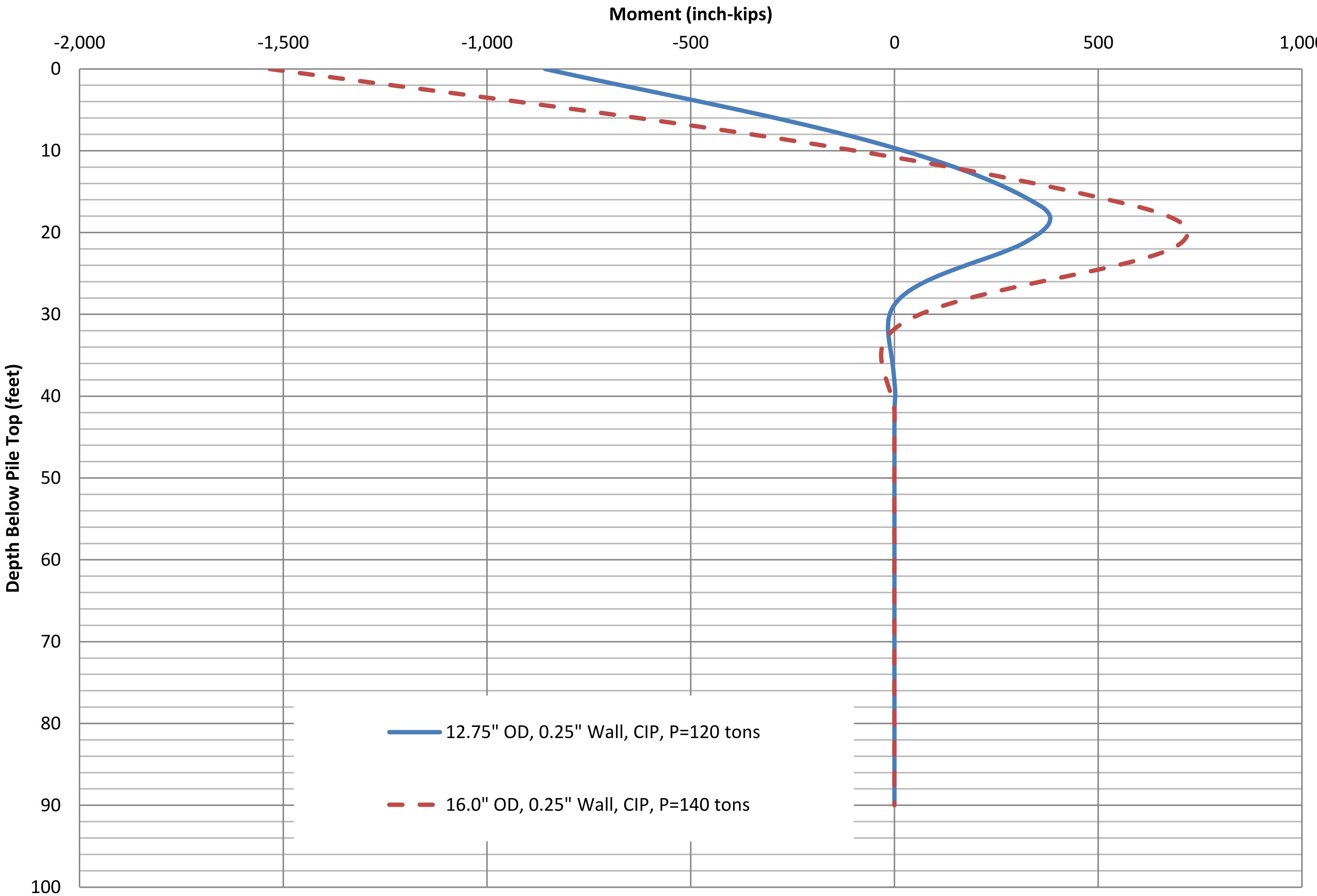
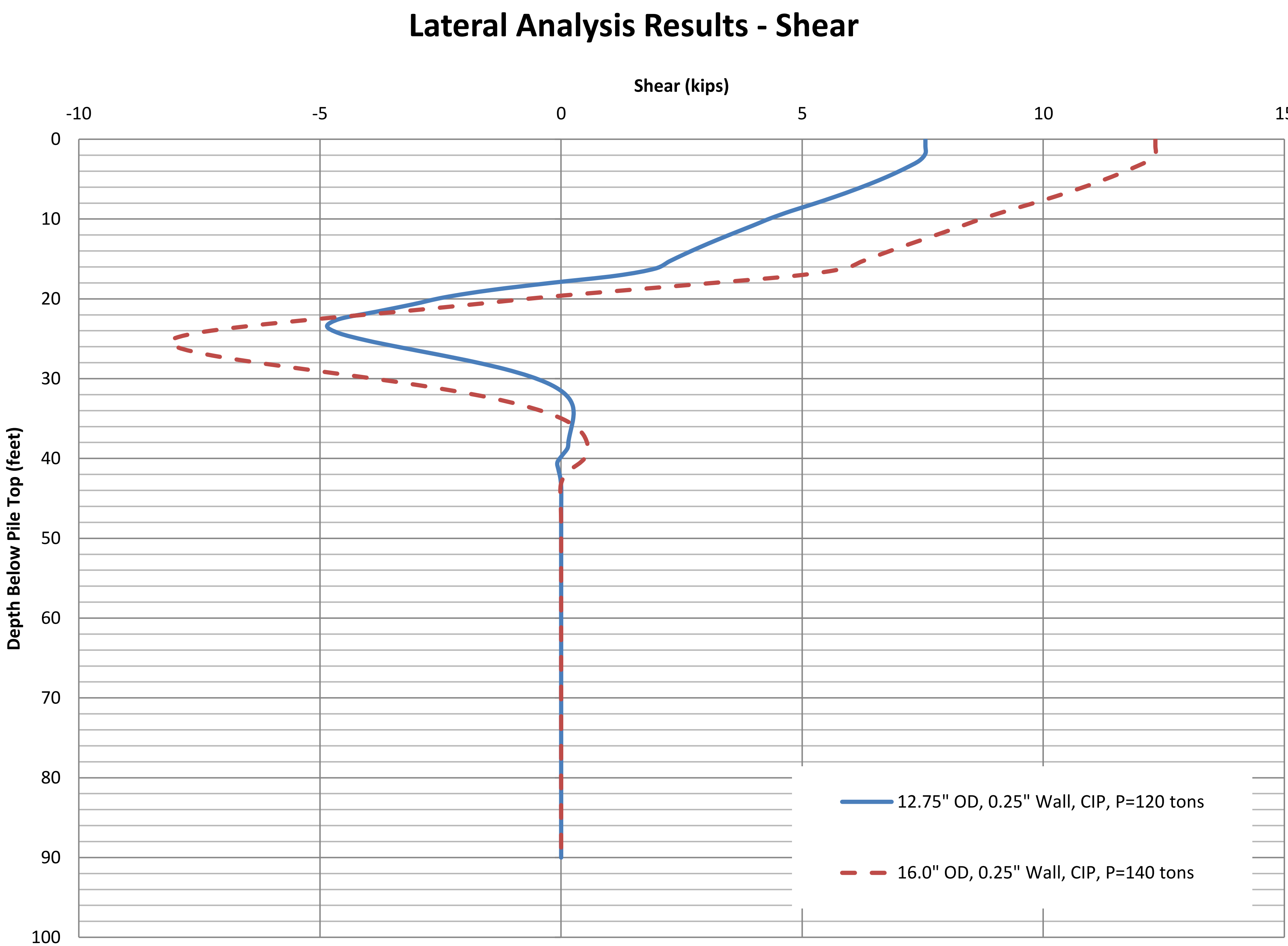
Lateral Analysis Results - Deflection



Lateral Analysis Results - Moment




Lateral Analysis Results - Shear
Shear (kips)
-10
-5
0
5
10
15
0
10
20
30
40
50
60
70
80
90
100
Depth Below Pile Top (feet)
12.75" OD, 0.25" Wall, CIP, P=120 tons
16.0" OD, 0.25" Wall, CIP, P=140 tons

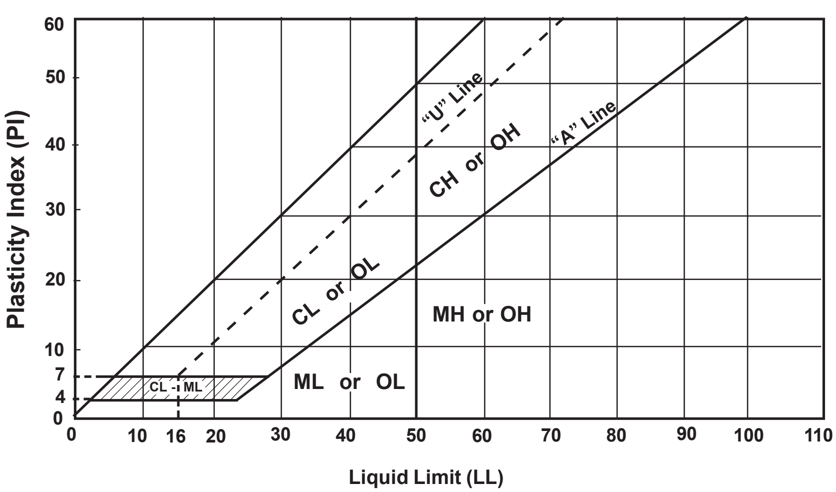
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	**GW**	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	**GP**	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	**GM**	Silty gravel [d f g]
			Fines classify as CL or CH	**GC**	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	**SW**	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	**SP**	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	**SM**	Silty sand [f g h]
			Fines classify as CL or CH	**SC**	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	**CL**	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	**ML**	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	**OL**	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	**CH**	Fat clay [k l m]
			PI plots below "A" line	**MH**	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	**OH**	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		**PT**	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $\quad C_c = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
  Coarse .... 3/4" to 3"
  Fine .... No. 4 to 3/4"
Sand
  Coarse .... No. 4 to No. 10
  Medium .... No. 10 to No. 40
  Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix C

Bridge over Shady Oak Road and TH 212

BRAUN INTERTEC

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August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Foundation Analysis Design Recommendation Report
Bridge over Shady Oak Road and TH 212 – 90% Design
STA 2253+91 to STA 2275+41
Southwest LRT, West Segment 2
Eden Prairie, Minnesota

Dear Mr. Demers:

Braun Intertec has completed the geotechnical evaluation for the proposed light rail bridge over Shady Oak Road and TH 212 in Eden Prairie, Minnesota. The following sections provide our recommendations for the design and construction of bridge foundations and associated embankments.

This report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for retaining walls (RTW-W206 and RTW-W207), land bridges, general track construction, and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project information

The west segment of the SWLRT project is proposing to construct a light rail transit line through Hopkins, Minnetonka, and Eden Prairie, Minnesota. This portion of the project considers the design and construction of a multiple span bridge carrying the SWLRT alignment over TH 212, Shady Oak Road, and Flying Cloud Drive in Eden Prairie, Minnesota. The light rail bridge will consist of two abutments and 13 piers. Prestressed concrete beams are proposed to support a cast-in-place concrete deck.

A.1. Type of Structures

This design report provides recommendations for bridge foundations and approach embankment support for the bridge carrying light rail vehicles over TH 212, Shady Oak Road, and Flying Cloud Drive. The abutments and piers are anticipated to be supported on cast-in-place concrete pipe piles. The north approach will consist of an earth embankment with sides supported by retaining walls RTW-W206 and RTW-W207. The south approach will consist of a land bridge that will be supported on cast-in-place concrete pipe piles. Design recommendations for the retaining walls and land bridge will be covered under separate reports.

A.2. Location of Bridge

The bridge is proposed to carry the LRT tracks over TH 212 near the junction of Shady Oak Road and TH 212 in Eden Prairie, Minnesota. The north bridge abutment will be located on the west side of TH 212 approximately 0.25 miles south of TH 62 and the south abutment on the east side of TH 212 approximately 0.1 miles south of Shady Oak Road. A series of 13 bridge piers will be located between the abutments, with span lengths ranging from approximately 135 to 171 feet. The overall length of the bridge is approximately 2,150 feet between the abutments.

A.3. Other Information

The design team discussed the use of spread footing foundations to support the new structure. While the soils at some boring locations appear suitable to support the anticipated vertical loads, the anticipated lateral loads and large footing size needed to resist the loads make spread footings a less viable option. Therefore, pile supported foundations are being considered for structure support.

To construct the bridge, embankment grade increases of 15 to 20 feet for the north bridge abutment will be necessary. Grade raises of this magnitude will influence the design and construction of the proposed bridge foundation types. The effects of the embankment stresses are accounted for in our foundation design recommendations.

B. Subsurface Investigation Summary

B.1. Summary of Borings Taken

Braun Intertec completed standard penetration test (SPT) borings and cone penetration test (CPT) soundings near the proposed bridge structures on the project. Further details of the structure location and corresponding SPT borings and CPT soundings performed are as follows:

Table 1. Structure Location and Corresponding SPT Boring and CPT Soundings

Structure	Approximate Track Stationing	Corresponding SPT Borings	Corresponding CPT Soundings
South Abutment	2253+91	2026SB	-
Pier 1	2255+48	2111SB	-
Pier 2	2257+13	2013SB	-
Pier 3	2258+68	2112SB	-
Pier 4	2260+23	2113SB	-
Pier 5	2261+94	2129SB	-
Pier 6	2263+29	-	2130CB
Pier 7	2264+89	2014SB	2131CB
Pier 8	2266+59	2132SB	-
Pier 9	2268+09	2133SB	2133CB
Pier 10	2269+59	2015SB	-
Pier 11	2271+09	-	2134CB
Pier 12	2272+59	-	2135CB
Pier 13	2273+99	-	2136CB
North Abutment	2275+41	2016SB	-

The Appendix includes copies of the SPT and CPT logs, a generalized soil profile and a boring layout sketch.

B.2. Description of Foundation Soil and Rock Conditions

The borings conducted for the bridge piers and abutments generally revealed a surficial layer of topsoil fill underlain by additional fill over mixed layers of glacial soils (outwash and tills). Swamp deposits were noted in Borings 2026SB (South Abutment), 2112SB (Pier 3), 2113SB (Pier 4), and 2133SB (Pier 9), between the fill and underlying glacial soils. The following paragraphs discuss the encountered soils in more detail at each substructure location.

B.2.a. Pavements

Borings 2026SB, 2111SB, and S113SB were located within or near existing parking lot areas. The borings encountered various amounts of bituminous pavement and/or aggregate base. A summary of the encountered pavement section is provided in the following table.

Table 2. Encountered Pavement Section

Boring	Approximate Track Stationing	Bituminous Thickness (inches)	Aggregate Base Thickness (inches)
2026SB	2253+91	-	12
2111SB	2255+48	4	8
2113SB	2260+23	4	-

B.2.b. Topsoil Fill

A surficial layer of topsoil fill was encountered at all boring locations, with the exception of Borings 2026SB, 2111SB, and 2113SB. The topsoil fill ranged in thickness from a few inches to 2 feet and consisted of silty sand (SM), clayey sand (SC), sandy lean clay (CL), and organic clay (OL).

B.2.c. Fill

Immediately below the topsoil fill or pavements, the borings encountered fill soils consisting of a mixture of poorly graded sand with silt (SP-SM), silty sand, clayey sand, sandy lean clay, lean clay with sand (CL), and organic clay to varying depths ranging from approximately 7 to 58 feet below existing grade, corresponding to elevations 887 to 823 feet.

B.2.d. Swamp Deposits

Swamp deposits were encountered directly beneath the fill near the intersection of Shady Oak Road and Flying Cloud Drive (Borings 2026SB, 2112SB, and 2113SB) and between the southbound TH 212 off-ramp to Shady Oak Road (Boring 2133SB). Swamp deposits consisted of peat (PT), organic clay, and slightly organic lean clay with sand. The swamp deposits extended to variable depths ranging from 19 to 63 feet below existing grade, corresponding to elevations 864 to 818.

B.2.e. Glacial Soils

Glacial soils were encountered below the fill and swamp deposits to boring termination depths, except where weathered bedrock was encountered below the glacial soils. The glacial soils consisted of till and outwash with classifications including sandy lean clay, lean clay, sandy silt, silt with sand, clayey sand, silty sand, poorly graded sand, poorly graded sand with silt, and well graded gravel with silt. Glacial soils have the potential to contain cobbles and boulders.

B.2.f. Weathered Bedrock

Weathered sandstone bedrock was encountered at Borings 2111SB and 2016SB below the glacial soils at depths of 96 and 109 feet below existing grade, respectively. The recovered sandstone samples classified as poorly graded sand.

B.2.g. Penetration Resistance Testing

The results of our penetration resistance testing from the borings are summarized below. Comments are provided to qualify the significance of the results.

Table 3. Penetration Resistance Data

Geologic Material	Classification	Range of Penetration Resistances*	Comments
Fill	SP-SM, SM, SC, CL	3 to 34 BPF	Variable compaction
Swamp Deposits	OL, OH, CL, PT	4 to 18 BPF	Slightly to moderately consolidated
Glacial Soils	GW-GM, SP-SM, SP, SM, ML	5 to 50+ BPF	Locally loose to very dense, generally medium dense to dense
	CL, SC	4 to 53 BPF	Locally rather soft to hard, generally stiff to hard

*BPF-Blows per Foot

B.2.h. CPT Sounding Results

Where the retaining wall CPT soundings penetrated into the underlying glacial soils, we recorded tip resistances generally ranging from less than 100 to over 5,000 psi. These tip resistances also indicate soils are generally loose to very dense and appear consistent to the SPT borings performed concurrently on the project

B.3. Summary of Water Level Measurements

Groundwater elevations were noted on the boring logs between elevations of about 851 1/2 and 876 1/2 feet above Mean Sea Level (MSL). Seasonal and annual fluctuations of groundwater, however, should be anticipated.

B.4. Interpretation of Water Level

The water level measurements in the borings indicated groundwater elevations between 851 1/2 and 876 1/2 feet, however, the boreholes were only open for a short period of time and it is likely that insufficient time was available for groundwater rise to its hydrostatic level. Based on the anticipated bottom-of-footing/pile-cap elevations for the bridge substructures and the recorded water levels, groundwater may influence foundation construction of the pile caps. The estimated water level and anticipated design may require the placement of 1 to 2 feet of crushed rock to aid in controlling groundwater seepage with sumps and pumps and provision of a working platform for construction of the pile caps.

C. Foundation Analysis

Based on the soil conditions encountered in the borings and soundings, and the loads anticipated on the bridge, we recommend the proposed bridge abutments and piers be supported on pile foundations.

C.1. Embankments and Slopes

The proposed bridge will require the construction of an approach embankment at the north abutment. The south abutment will transition to a land bridge, thus no embankment construction is anticipated on the south end of the proposed bridge. The northern approach embankment will be approximately 15 to 20 feet tall and will utilize two walls, RTW-W206 and RTW-W207, to retain embankment backfill material (walls covered under separate report).

Foundation preparation will include removal of topsoil and topsoil fill. After removals, the foundation preparation will consist of surface compacting the underlying subsurface soils and the placement of engineered fill to provide competent foundation soils, as needed.

C.1.a. Settlement

Based on the anticipated fill heights of up to 15 to 20 feet for the north embankment, total settlement magnitudes up to 1 to 1 1/2 inches are estimated using imported granular fill.

C.1.b. Time Rate of Settlement

Due to the embankment raise in grade at the north bridge approach, we recommend a waiting period to allow settlement of the underling soils to occur prior to foundation construction. Details of the preload waiting period are discussed in Section D.5.

C.2. Pile Foundations

C.2.a. Nominal Resistance at Given Tip Elevations (Compression)

For bridge support, we calculated the nominal resistance of the piles in compression. Please refer to the Nominal Resistance Graphs and Section C.3.c.1 for the calculation method.

C.2.b. Calculate and Consider Downdrag and Lateral Squeeze

The new fill being placed for the north approach embankment will result in settlement of the existing soils. Therefore, we recommend constructing the embankment to the proposed finished grade elevation, waiting for a period of 2 to 6 weeks to allow the underlying foundation soils to consolidate, then excavate the embankment material to the bottom of foundation elevation and install the bridge and retaining wall foundations. This waiting period will allow the foundation design of the bridge to utilize battered pile.

Based on the recommended preloading of the north approach embankment and no raise in grade anticipated in the area of the south abutment and bridge piers, we do not anticipate downdrag forces will contribute additional load to the piles.

Lateral squeeze can occur if the unit weight of the fill multiplied by the fill height is greater than three times the undrained shear strength of the subgrade soils. Due to the general granular nature of the soil encountered at the north embankment, we do not anticipate that lateral squeeze will be an issue.

C.2.c. Lateral Earth Pressure Calculations for P-Y Curves and Lateral Earth Forces

The following tables provide the soil parameters used for the lateral pile analyses and p-y curve generation, which was performed using the computer program LPILE (2013). Based on the soils encountered in the borings, we used the default lateral modulus of subgrade reaction values included in LPILE. For the purposes of our analyses, we used the soil parameters from Borings 2014SB and 2133SB.

Table 4. Soil Parameters for p-y Curve Generation – Boring 2014SB (Pier 7)

Layer Top Depth Below BOPC Elevation (feet)	Layer Bottom Depth Below BOPC Elevation (feet)	Effective Unit Weight (pounds per cubic foot)	Internal Angle of Friction (degrees)	Undrained Shear Strength (pounds per square foot)	Material Type
0	9	125	28	NA	Sand (Reese)
9	17	130	33	NA	Sand (Reese)
17	34	63	32	NA	Sand (Reese)
34	47	63	NA	2,500	Stiff Clay w/out Freewater
47	64	68	NA	1,200	Stiff Clay w/out Freewater
64	69	63	33	NA	Sand (Reese)
69	74	68	NA	4,000	Stiff Clay w/out Freewater
74	100	68	34	NA	Sand (Reese)

Table 5. Soil Parameters for p-y Curve Generation – Boring 2133SB (Pier 9)

Layer Top Depth Below BOPC Elevation (feet)	Layer Bottom Depth Below BOPC Elevation (feet)	Effective Unit Weight (pounds per cubic foot)	Internal Angle of Friction (degrees)	Undrained Shear Strength (pounds per square foot)	Material Type
0	13	120	NA	900	Stiff Clay w/out Freewater
13	30	58	NA	900	Stiff Clay w/out Freewater
30	37	23	NA	250	Soft Clay
37	50	63	NA	2375	Stiff Clay w/out Freewater
50	55	43	NA	350	Soft Clay
55	70	68	NA	2750	Stiff Clay w/out Freewater
70	85	58	36	NA	Sand (Reese)
85	95	60	38	NA	Sand (Reese)

C.2.d. Tip Elevation

We recommend driving the proposed pipe pile sections to the elevations shown in Section D.4 and the attached resistance graphs for driven pile. The table below shows approximate bottom-of-pile-cap elevations based on plans provided by SPO.

Table 6. Approximate Bottom-of-pile-cap Elevations

Substructure	Anticipated Bottom-of-Pile-Cap Elevation (feet)
South Abutment	857.75
Pier 1	859.00
Pier 2	864.25
Pier 3	883.75
Pier 4	880.50
Pier 5	876.50
Pier 6	876.75
Pier 7	870.50
Pier 8	870.25
Pier 9	872.75
Pier 10	866.00
Pier 11	865.50
Pier 12	867.75
Pier 13	870.75
North Abutment	873.50

C.3. Summarize Design Assumptions

C.3.a. Embankment Heights, Unit Weights, and Walls

Based on the preliminary design information, finished grade at the north bridge abutment will be about 15 to 20 feet above existing grades. We have assumed the anticipated fill soils will have a moist unit weight of 120 pounds per cubic foot (pcf) and will meet MnDOT Specification 3149.2B2 for Granular Borrow. The earth embankment will have sides supported by walls, RTW-W206 and RTW-W207, and the end of the embankment will be supported by the bridge abutment.

C.3.b. Bridge Loading Information (Axial and Horizontal)

Please refer to Section D.1 and D.4 for anticipated pile loads and resistances.

C.3.c. Design Methodologies – Pile-Supported Structures

C.3.c.1. Pile Capacity – LRFD (212 Bridge)

We used the computer program UniPile, version 5.0.0.33, to estimate the static nominal geotechnical resistance (R_n) of the 12- and 16-inch outside-diameter, 1/4-inch thick wall, closed-ended pipe piles for support of the bridge abutments and piers. UniPile software was developed by UniSoft Geotechnical Solutions Ltd. and can calculate pile resistance using a variety of methods.

For our analysis, we utilized the Beta-method, an effective stress method, to estimate the static geotechnical resistance for these piles. This method determines shaft resistance using Bjerrum-Burland beta coefficients (β), which are based on soil type and effective friction angle. We estimated the β values for each layer using Figure 9.20 from the Federal Highway Administration (FHWA) Publication No. NHI-05-042, Design and Construction of Driven Pile Foundations, April 2006. The Beta-method determines end bearing resistance using toe bearing capacity factors (N_t), which are also based on soil type and effective friction angle. We estimated the N_t values from Table 9-6 of the April 2006 FHWA publication identified previously.

C.3.c.2. Downdrag

We do not expect downdrag will act on the piling based on the anticipated north embankment construction method and the anticipated lack of grade raise in the areas of the south abutment and the proposed piers.

C.4. Construction Considerations

C.4.a. Design of Temporary and Permanent Slopes

The existing foundation/embankment soils consist of a mixture of cohesive soils and sand with angles of internal friction of 28 degrees or greater. The permanent slopes can match the existing slopes, except they must be not steeper than 1V:2H. The granular borrow is anticipated have an angle of internal friction of approximately 30 degrees. This soil could be temporarily placed at a slope of 1V:1.5H, but must be limited to 1V:2H or flatter for the permanent condition.

C.4.b. Subcut Recommendations and Backfill Requirements

C.4.b.1. Bridge over Shady Oak Road

We recommend removing the topsoil fill along the north approach embankment. The excavations to remove these soils are anticipated to be limited and are estimated to be about 1 to 2 feet below grade at the north embankment. The extent of the excavation should extend horizontally beyond the embankment limits a distance equal to the depth of the subcut, or 1 foot, whichever is greater. As the bridge piers are to be constructed within a cut, we do not anticipate a need for subcutting below the substructure since a driven-pile foundation system will support the structure.

Based on the anticipated bottom-of-pile-cap substructure elevations, groundwater may be encountered within the bottom excavations. If encountered, temporary dewatering may be needed along with the placement of crushed rock to help control groundwater seepage with sumps and allow for the provision of a stable working platform during construction.

We recommend backfilling below the substructures and constructing embankment fills with Granular Borrow or Select Granular borrow. We also recommend compacting the soils to meet the requirements from MnDOT Specifications 2451 or 2105, as appropriate for backfill and fill, respectively. The compaction should be evaluated using the Specified Density Method defined in MnDOT Specification 2105.3 F1. Soils placed as backfill may not be saturated or frozen at time of placement. Do not place new backfill material on frozen soil.

We recommend using Select Granular Modified 10 percent for Structure Backfill. Select Granular Modified 10% shall comply with Specification 3149.2B2, modified to 10 percent or less passing the 0.075 mm (#200) sieve.

C.4.b.2. Construction Staging Requirements

Based on the soil borings and estimated settlements of up to 1 1/2 inches at the north abutment, we recommend a construction delay at this location to allow settlement in the underlying soils to occur prior to foundation construction. Further, a waiting period of 2 to 6 weeks will allow the designing of abutments to utilize battered pile to resist lateral loads. Details of the preload waiting period are discussed in Section D.5.

Due to the anticipated cuts at the pier substructure locations, a waiting period is not necessary at these substructure locations.

C.4.c. Demolition

All existing pavement, structures, and associated deleterious material where proposed structures and oversize areas are to be located should be fully removed and replaced with suitable engineered fill.

E. Foundation Recommendations – Deep Foundations

E.1. Bearing Resistances and Associated Resistance/Safety Factors

Please refer to the Appendix for nominal bearing resistances for driven pile for bridge abutment and pier support. For situations where subsurface exploration and static calculations have been completed, we recommend that the following φ_{dyn} factors be used for LRFD Design.

Table 7. Recommended Pile Driving Resistance Factors (ϕ_{dyn})

Specified Construction Control	ϕ dyn
MnDOT Pile Formula 2012 (MPF12) for Pipe Pile Sections	0.50
Wave Equation and Pile Driving Analyzer (PDA)	0.65

We also recommend evaluating the factored resistance against the structural capacity of the pile per the AASHTO LRFD Bridge Design Specifications, Third Addition.

E.2. Uplift Capacity/Resistance

Currently, a tension resistance line is not provided on the Nominal Bearing Resistance Graphs attached to this report. If piles will experience tension loads, we will revise our recommendations accordingly.

E.3. Recommended Design Soil Parameters (e.g., Coefficient of Friction, Lateral Earth Pressure Coefficients, etc.)

We recommend soil parameters to be used for design are as follows:

Table 8. Soil Parameter for Design

Soil Type	Angle of Internal Friction (degrees)	Effective unit Weight (pcf)	Coefficient of Sliding Friction Rough Concrete	Active Earth Pressure Coefficient	At-Rest Earth Pressure Coefficient
Select Granular Borrow	35	120	0.6	0.27	0.43
Granular Borrow	30	120	0.5	0.33	0.50
Existing Non-organic Granular Fill	30	125	0.5	0.33	0.50
Existing Clay Fill	28	130	0.4	0.36	0.53

E.4. Recommended Pile Size, Length, and Tip Elevation

E.4.a. Bridge Abutments and Piers

We have constructed two tables , located in the Appendix, which summarize the anticipated pile depths based on the factored load ($\Sigma\gamma Q_n$) for 12.0- and 16.0-inch, outside-diameter pipe pile with a wall thickness of 1/4 inch. The tables provide a PDA length (i.e., φ_{dyn} of 0.65) and a MPF12 formula length (i.e., φ_{dyn} of 0.50) for each location. We assumed a cutoff elevation of about 1 foot above the anticipated bottom-of-pile-cap elevation. Please refer to the nominal bearing resistance graphs and the anticipated pile length tables using PDA Analysis and the MPF 12 for a detailed profile of pile resistances and anticipated pile lengths.

As you review the anticipated pile length tables, you will notice the anticipated pile lengths for Boring 2030CB are relatively shallow in comparison to the adjacent structure locations. While the CPT Sounding results show favorable soil conditions, we recommend either performing additional analysis at this location to confirm the soil conditions or be prepared to drive the piles to elevations similar to the adjacent piers.

For our lateral analyses, we assumed a pile top located 5 feet below the ground surface. The maximum lateral loads in our analyses are for a loading condition assuming 1-inch of deflection at the pile top with a fixed-head condition. We assumed a pile wall thickness of 1/4-inch, a steel yield strength of 45 ksi, and concrete infill with a compressive strength of 3 ksi for our analyses. Please refer to the attachments for the shear force and bending moments within the pile at service loads of 120 tons for the 12.0-inch closed-end pipe pile and 140 tons for the 16.0-inch closed-end pipe pile.

E.5. Waiting Periods for Embankments

Since the north abutment will require fill up to a height of 15 to 20 feet, we recommend incorporating a preload into the design to reduce the overall estimated settlement to allow the pile design to utilize battered pile to resist lateral loads.

Foundation soils supporting the north embankment are generally granular and consolidation of these soils should occur rather quickly. However, some layers of cohesive soils encountered near the north abutment may require a longer period of time to consolidate. The embankment preload should be constructed with, at a minimum, the dimensions identified on MnDOT plan sheet 5-297.233. We are including a copy of this sheet in Appendix C. Preload material should be compacted in accordance with the Quality Density Method. Soils placed for the preload shall not be saturated or frozen at the time of placement. Do not place new preload material on frozen soil.

At the north abutment, we recommend placing the preload to the proposed finished grade of the guideway (approximate elevation 900 feet) and allowing the preload to sit for a period of 2 to 6 weeks or until settlement has essentially ceased. A minimum of three settlement plates shall be installed near the abutment within the preload embankment and monitored to evaluate the rate and amount of settlement. The geotechnical engineer will review the monitoring data and make the determination of when the end of the waiting period will be. The settlement plates should be surveyed (at a minimum) as shown in the table below. This approach will allow the north abutment pile to be designed with a batter for lateral load support.

Table 9. Recommended Settlement Plate Monitoring Schedule

Preload Area	First Week	Second Week	Beyond Second Week
North Abutment	Every other day	Twice weekly	Once per week

If the material is to be used within the final constructed embankment, the preload should consist of a material meeting the specification for granular borrow; unless it is in the zone of structural backfill required for the bridge abutment and/or retaining walls. Preload material that will remain as permanent material within the zone of structural backfill should consist of structural backfill as specified in section 3149.2D2.

E.6. Surcharge Systems Recommendations

Based on the soil borings, the soils supporting the north embankment primarily contain granular soils, with some layers of cohesive soils. We anticipate settlement in these soils will occur within a short period of time following construction of the preload and final bridge embankments. Therefore, we do not anticipate a surcharge is necessary.

E.7. Temporary Slopes and Shoring Limits

Temporary slopes in the Granular Borrow or Select Granular Borrow backfill are recommended to be constructed at 1V:1.5H or shallower. Temporary slopes constructed in natural material are recommended to be constructed at 1V:2H or shallower. In a temporary condition; these slopes have a Factor of Safety against global failure in excess of 1.3.

F. Material Classification and Testing

F.1. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

F.2. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures and follow MnDOT guidelines.

F.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced. The boreholes were then backfilled or sealed with bentonite grout.

G. Qualifications

G.1. Variations in Subsurface Conditions

G.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore, strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

G.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

G.2. Continuity of Professional Responsibility

G.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

G.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

G.3. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

H. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these bridge foundation recommendations, please call Josh Kirk at 952.995.2222 or jkirk@braunintertec.com or Ray Huber at 952.995.2260 or rhuber@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal - Project Engineer
License Number: 45005

Reviewed by:

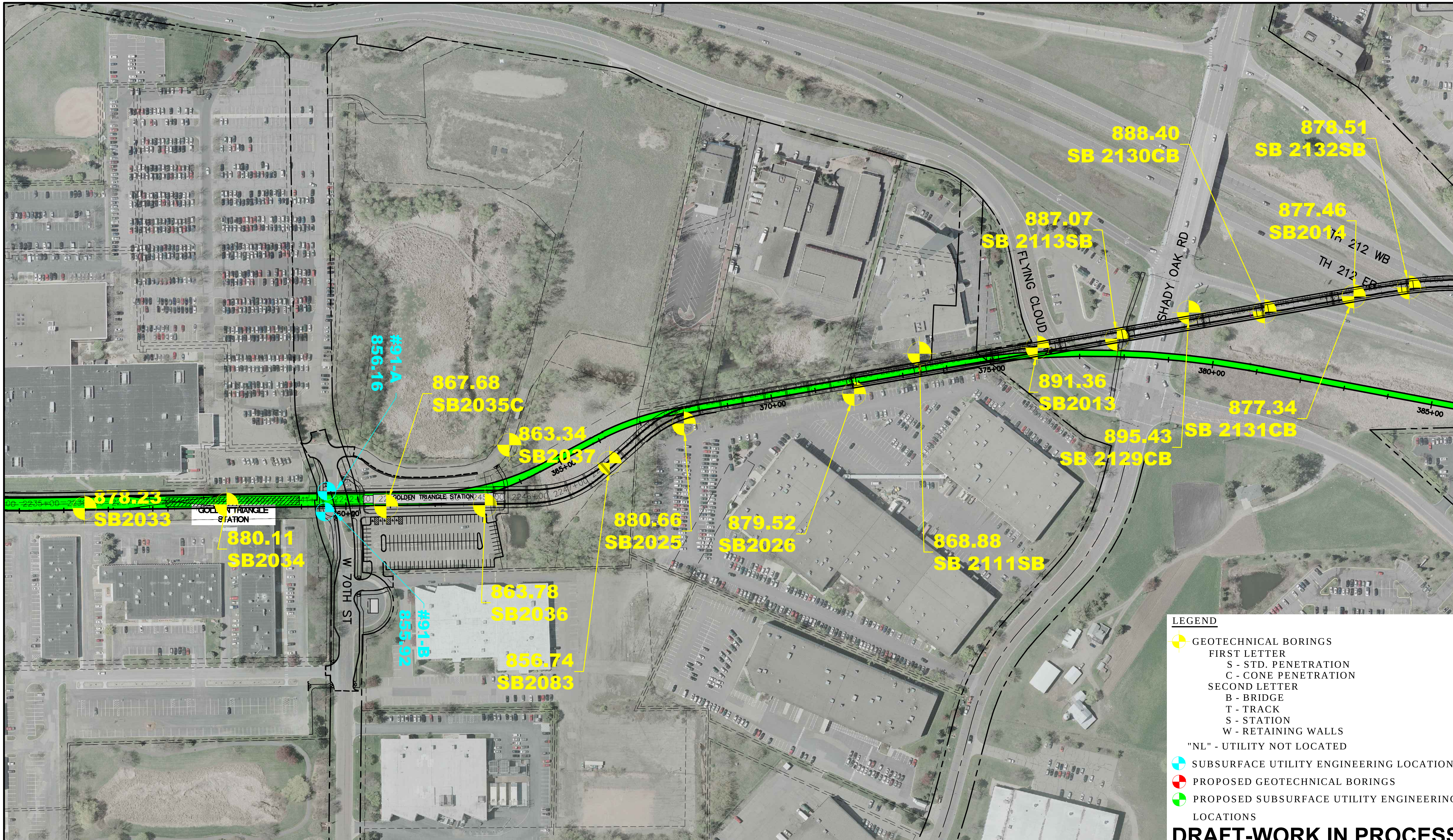
Ray A. Huber, PE
Vice President-Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Boring Location Sketch
Preliminary Engineering Plan and Profile Sheets – Bridge over Shady Oak Road
SPT Logs 2026SB, 2111SB, 2013SB, 2112SB, 2113SB, 2129SB, 2014SB, 2132SB, 2133SB, 2015SB, 2016SB
CPT Logs 2130CB, 2131CB, 2133CB, 2134CB, 2135CB, 2136CB
Summary of Anticipated Pile Lengths – PDA Analysis
Summary of anticipated Pile Lengths – MPF12 Analysis
Nominal Bearing Graphs
Lateral Pile Analysis Results - Borings 2014SB and 2033SB
SPT Descriptive Terminology
CPT Descriptive Terminology

APPENDIX



SOUTHWEST Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 7 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

NORTH
0 50 100 200

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SRF Consulting Group, Inc.

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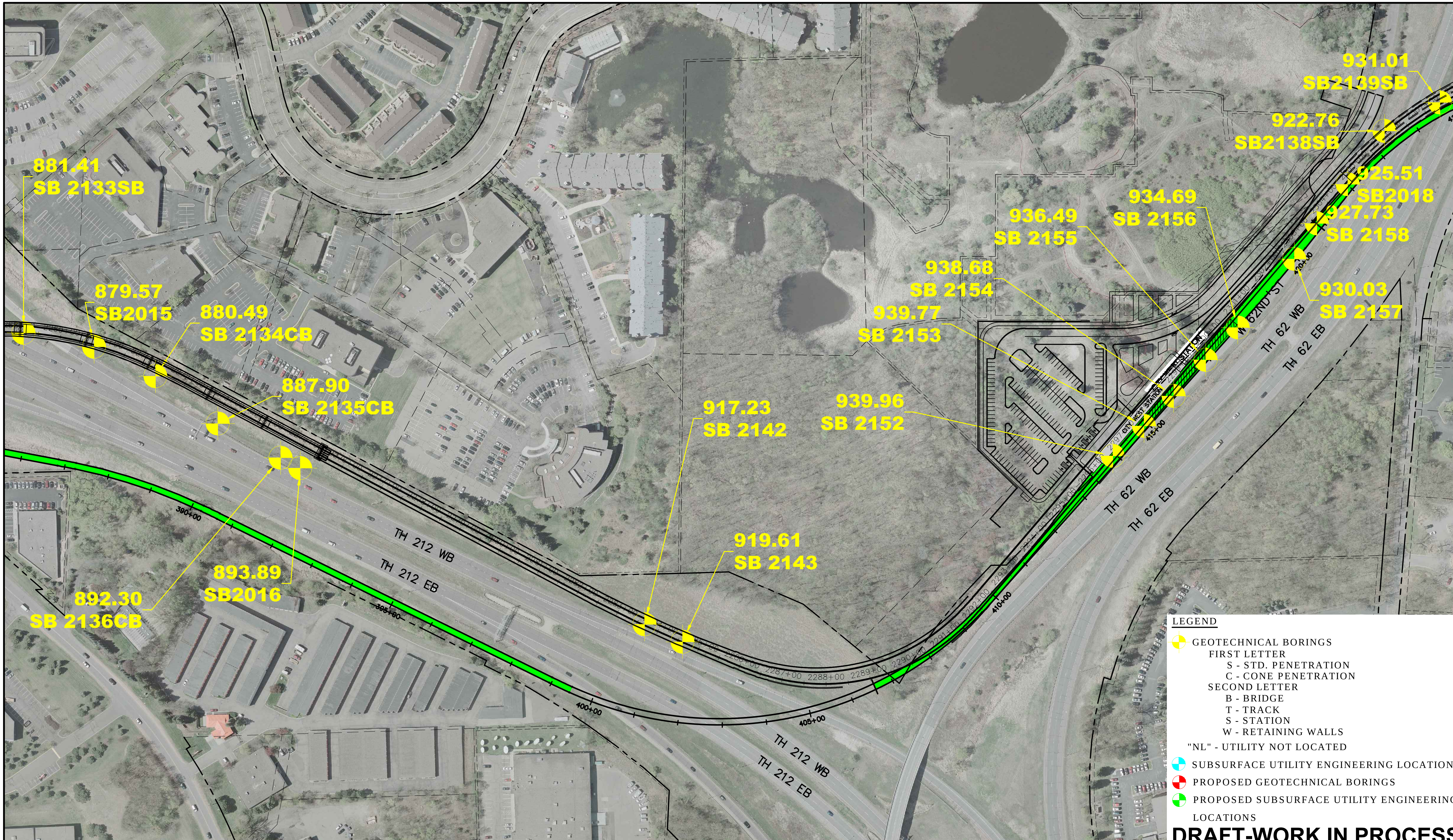

SOUTHWEST
Green Line LRT Extention

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 8 OF 12

IRT: N/A

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NORTH

0 50 100 200

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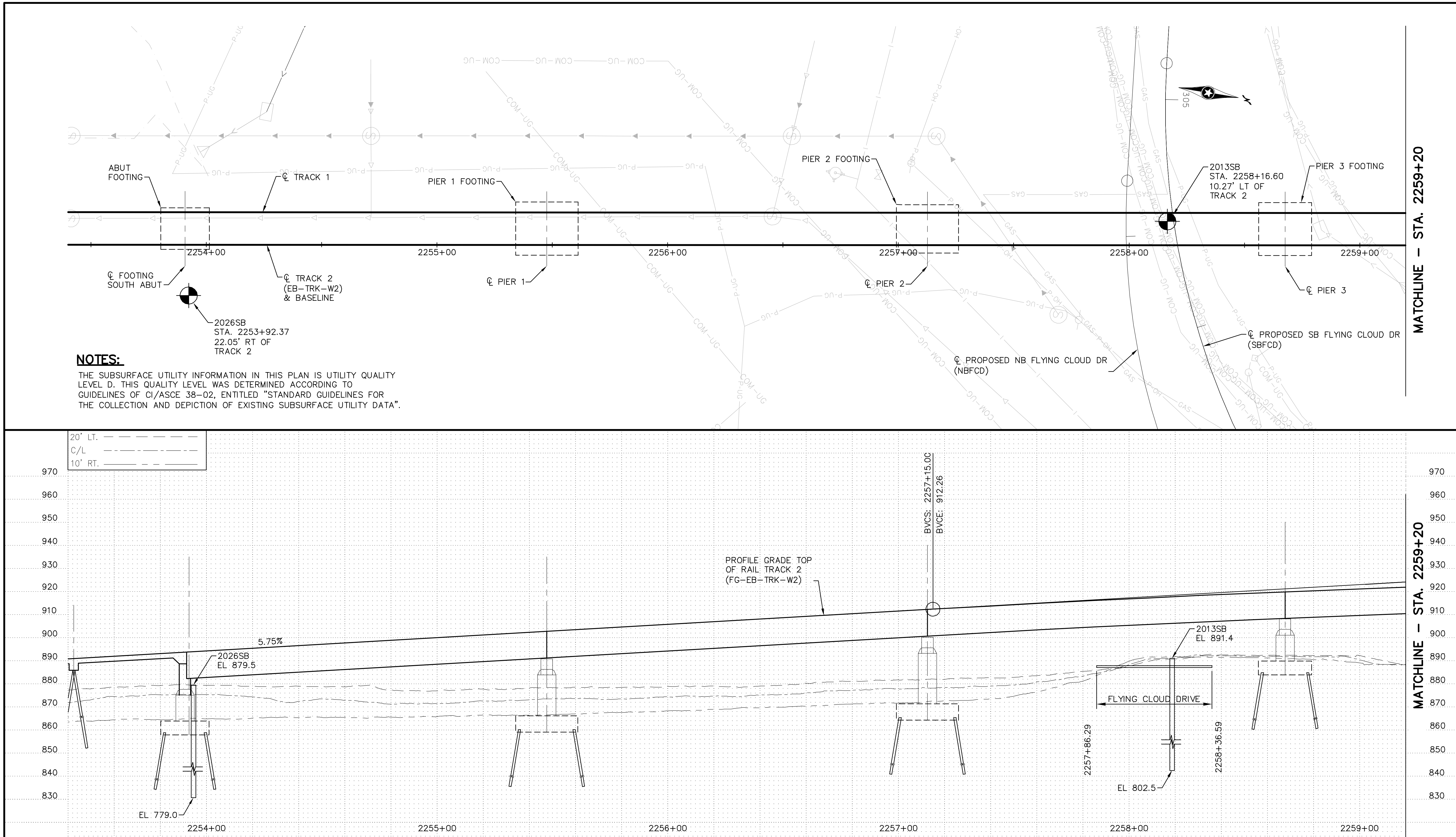

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PRELIMINARY ENGINEERINING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST SEGMENT 2
SHADY OAK ROAD
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

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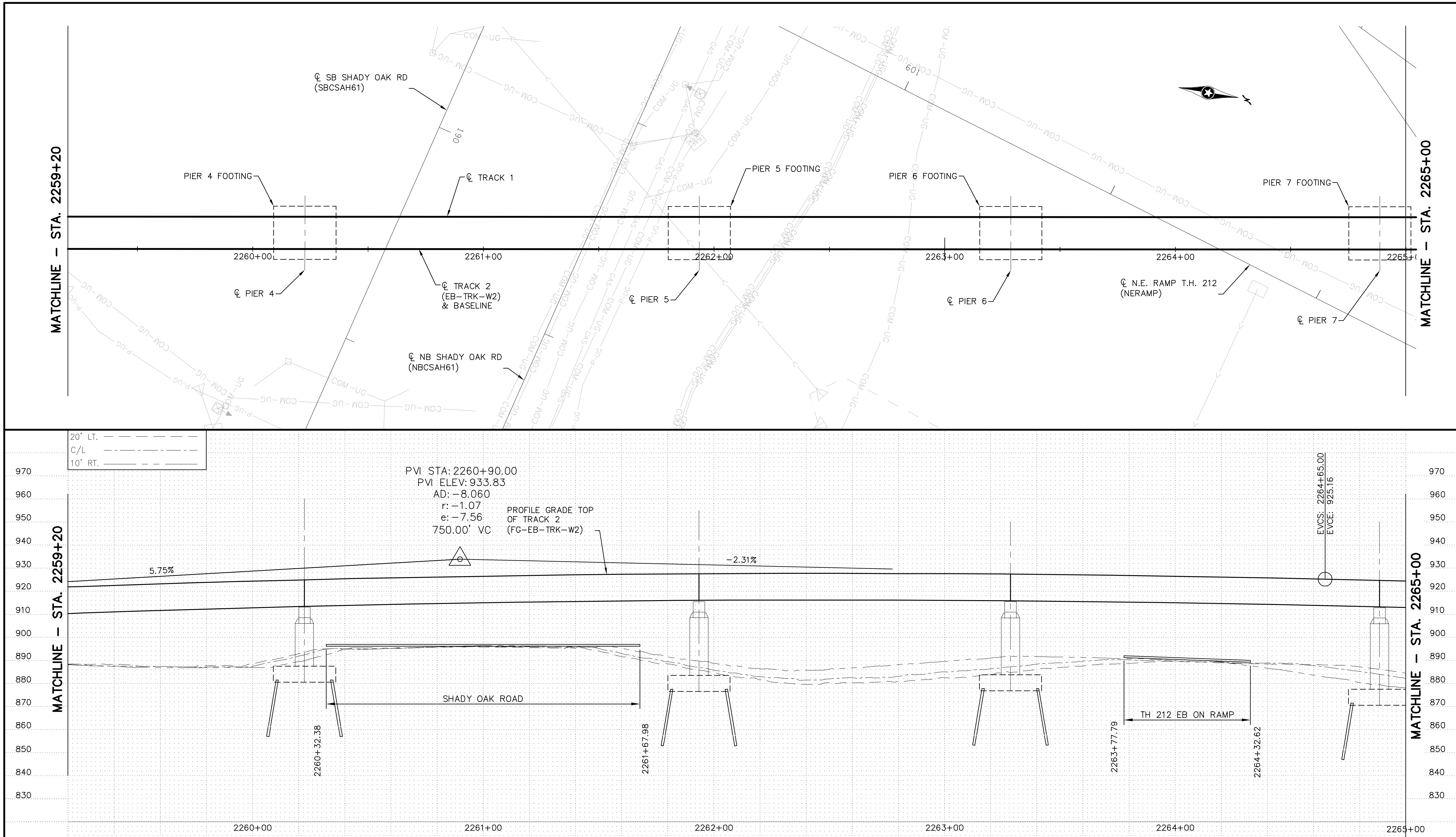
SHEET 68 OF 197



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SOUTHWEST Green Line LRT Extension

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SHADY OAK ROAD
BRIDGE XXXXX (LRT)
BORINGS

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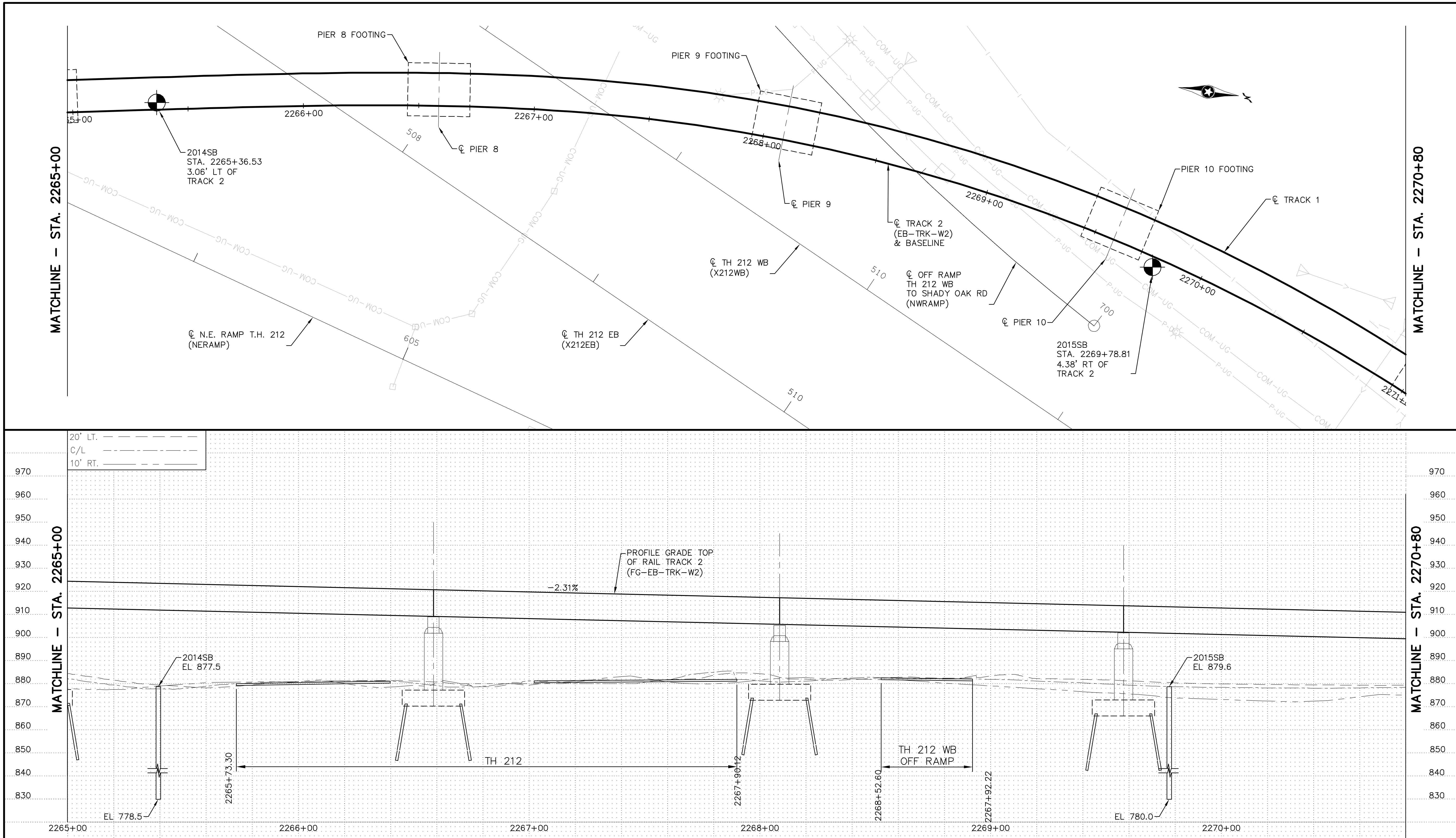

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SOUTHWEST Green Line LRT Extension

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SHADY OAK ROAD
BRIDGE XXXXX (LRT)
BORINGS

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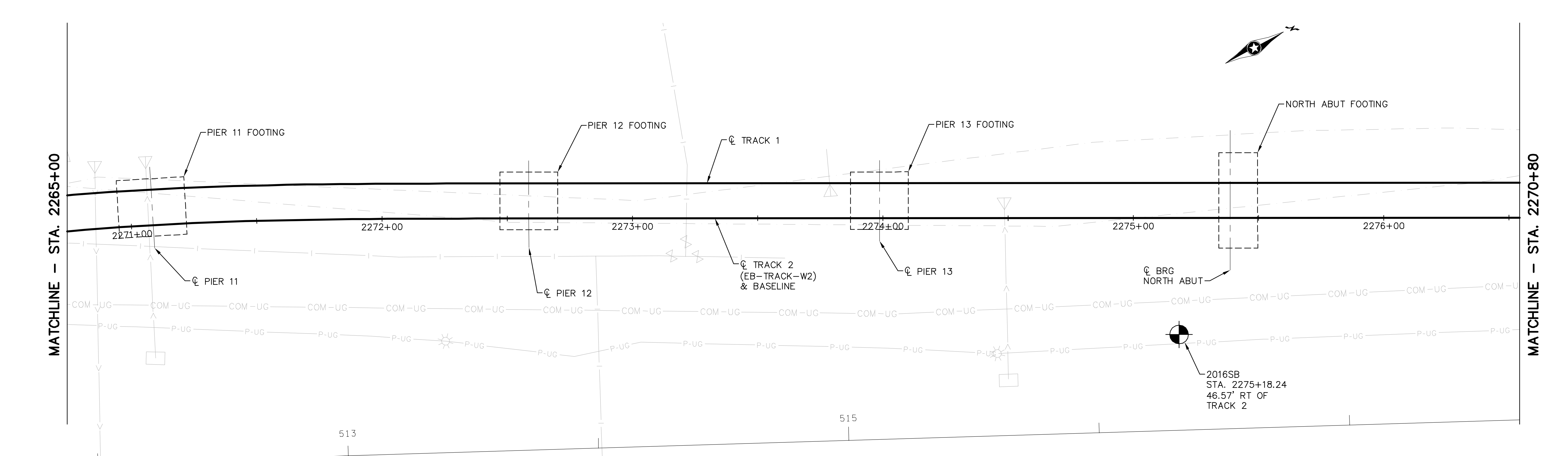

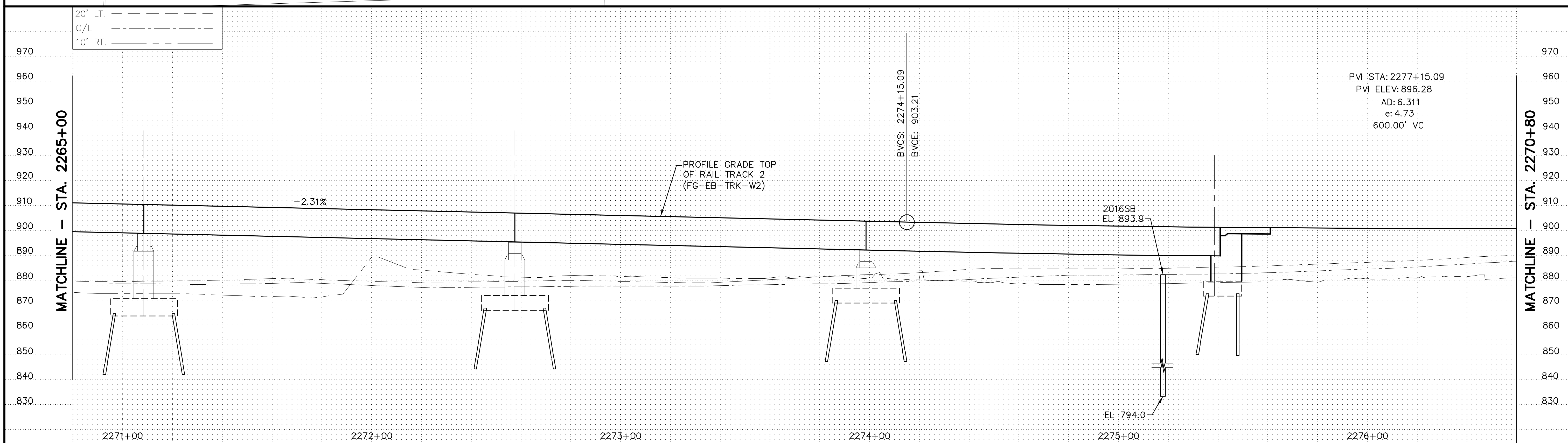

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WEST SEGMENT 2
SHADY OAK ROAD
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-BRG-T212-SUR6

SHEET 71 OF 197

2026SB
Elevation 879.5

Coh N60: 8, 20, 14, 8, 4, 9, 9, 15, 6, 7, 23, 25, 35, 30, 24, 34, 53, 22, 28, 51, 20, 25, 33, 22, 25, 37, 41

- SILTY SAND, fine- to medium-grained, with Gravel, dark brown, moist.
- FILL: Poorly Graded Sand with Silt, fine- to medium-grained, with Gravel, brown, moist.
- FILL: Silty Sand, fine- to medium-grained, with bituminous pieces, black, moist.
- FILL: Clayey Sand, fine- to medium-grained, with Gravel, brown, moist.
- FILL: Silty Sand, fine- to medium-grained, with Gravel, with bricks and bituminous, brown, moist.
- FILL: Sandy Lean Clay, trace Gravel, brown, wet.
- FILL: Sandy Lean Clay, trace roots, black, wet.
- ORGANIC CLAY, with roots and fibers, black, wet.
- LEAN CLAY with SAND, slightly organic, with roots and fibers, gray, wet.
- WELL-GRADED GRAVEL with SILT, fine- to coarse-grained, gray, waterbearing, medium dense to dense.
- POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense.
- SANDY LEAN CLAY, trace Gravel, brown, wet, hard.
- POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense to very dense. -With Silty Sand layer at 65 feet. -Coarse Sand at 85 feet.
- SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard.

END OF BORING.

Water observed at 15 feet with 15 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.
Bottom of Borehole at 101 ft

2013SB
Elevation 891.4

Coh N60: 15, 10, 29, *, 28, 37, 42, *, *, 52, 10, 20, 18, 23, 18, 32, 17, *, 94, 49, 28, 21, 15, 16, 32, 46, 32, *

- FILL: Silty Sand, fine- to medium-grained, trace Gravel, dark brown, moist.
- FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.
- FILL: Clayey Sand, trace Gravel, dark brown and black, moist.
- POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, moist, medium dense.
- SILTY SAND, fine- to medium-grained, with Gravel, brown, moist, medium dense to very dense.
- SILTY SAND, fine- to medium-grained, with Clayey Sand layers and seams at 18 feet, trace Gravel, brown, moist, dense.
- SILTY SAND, fine- to medium-grained, with Gravel and Cobbles, brown, moist, very dense.
- SILTY SAND, fine- to medium-grained, with occasional Clay lenses and seams, trace Gravel, brown, moist, loose to very dense.
- POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, moist, medium dense.
- POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, moist to 40 feet then waterbearing, medium dense to dense.
- SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard. Gravel layer encountered at 46 feet.
- SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense to very dense.
- POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, waterbearing, medium dense.
- CLAYEY SAND, trace Gravel, brown, wet, medium dense to dense.
- POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, waterbearing, dense.
- SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, very dense.

END OF BORING. Water observed at 40 feet with 39 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with

2014SB
Elevation 877.5

Coh N60: 17, 18, 79, 58, 57, 12, 9, 5, 22, 12, 22, 15, 23, 21, 17, 17, 12, 6, 5, 4, 6, 18, 26, 28, 31, 41, 43, 58, 50/6"

- FILL: Clayey Sand, trace Gravel, dark brown, wet.
- FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist. With Gravel and Cobbles at 7 1/2 feet.
- POORLY GRADED SAND with SILT, fine- to medium-grained, with some Gravel, brown, moist, medium dense to very dense.
- POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, waterbearing, loose.
- POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel and Cobbles, gray, waterbearing, medium dense.
- SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff.
- POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, gray, waterbearing, medium dense.
- SANDY LEAN CLAY, trace Gravel, gray, wet, medium to very stiff.
- CLAYEY SAND, trace Gravel, gray, wet, very loose to medium dense.
- POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, medium dense.
- CLAYEY SAND, trace Gravel, gray, wet, medium dense.
- POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, dense to very dense.

END OF BORING.

Water observed at 17 1/2 feet with 17 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.
Bottom of Borehole at 99.8 ft

Elevation scale: 900, 890, 880, 870, 860, 850, 840, 830, 820, 810, 800, 790, 780, 770, 760, 750, 740, 730

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM: D2488.

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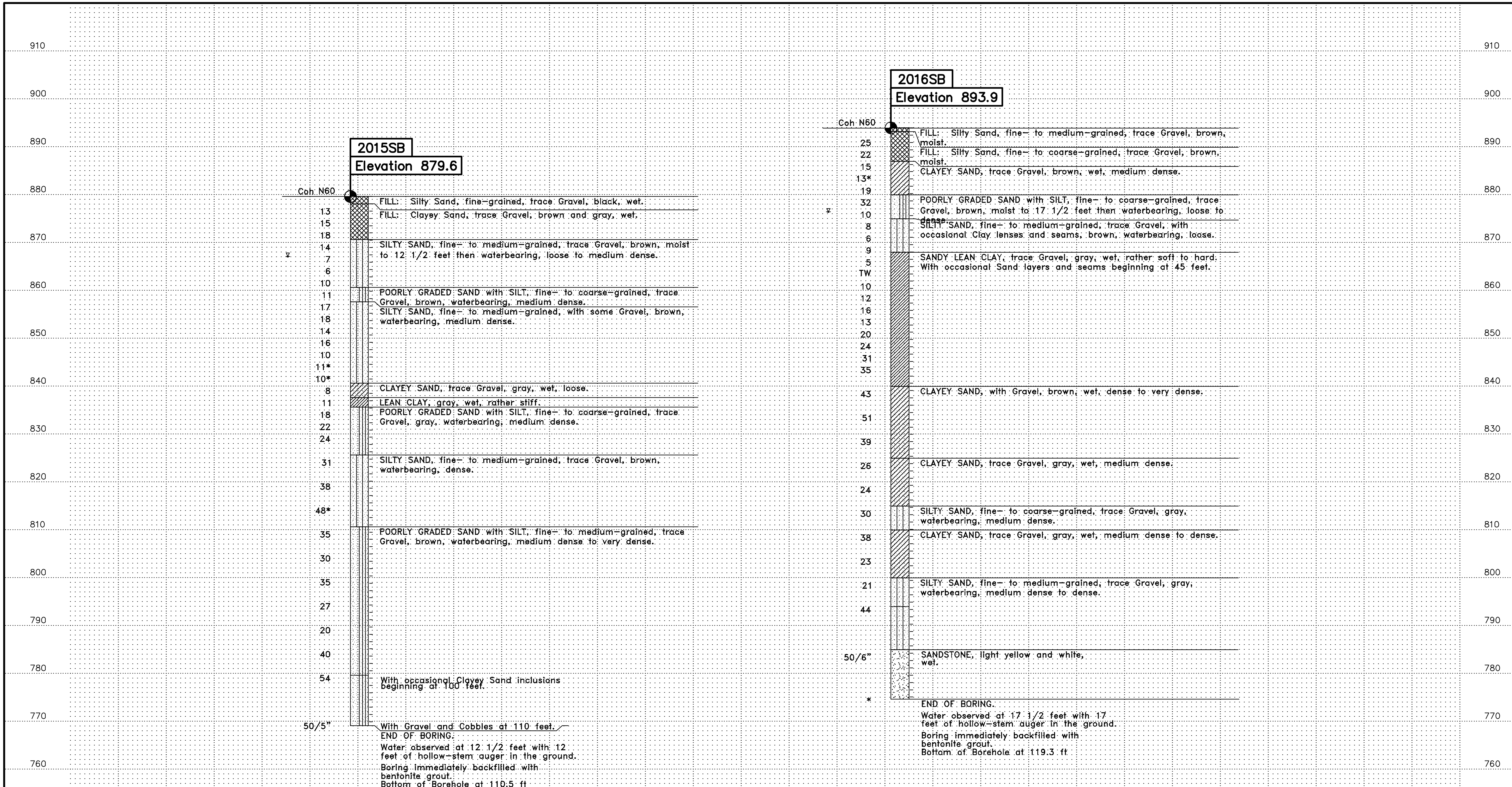
PRELIMINARY ENGINEERINING

WEST SEGMENT 2
SHADY OAK ROAD
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-BRG-T212-SUR7-BOR1

SHEET 72 OF 197



NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM: D2488.

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PRELIMINARY ENGINEERINING

METROPOLITAN COUNCIL SOUTHWEST Green Line LRT Extension

WEST SEGMENT 2
SHADY OAK ROAD
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: **STRUCTURES**

SHEET NAME: W2-STU-BRG-T212-SUR7-BOR2

SHEET 73 OF 197

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2026SB	879.5 (Surveyed)

Location: Hennepin Co. Coordinate: X=492895 Y=132336 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7507

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 8/27/13

Depth / Elev.	Classification	SPT N60	Other Tests Or Remarks
1.0 / 878.5	12 inches of Aggregate Base.		
4.0 / 875.5	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, moist, (SP-SM), fill	8	
7.0 / 872.5	SILTY SAND, fine- to medium-grained, with bituminous pieces, black, moist, (SM), fill	20	
9.0 / 870.5	CLAYEY SAND, with Gravel, brown, moist, (SC), fill	14	
12.0 / 867.5	SILTY SAND, fine- to medium-grained, with Gravel, with bricks and bituminous, brown, moist, (SM), fill	8	
20.0 / 859.5	SANDY LEAN CLAY, trace Gravel, brown, wet, (CL), fill	4 9 9	Switched to mud rotary drilling method after 15-foot sample.
22.0 / 857.5	SANDY LEAN CLAY, trace roots, black, wet, (CL), fill	15	
24.0 / 855.5	ORGANIC CLAY, with roots and fibers, black, wet, (OL), swamp deposit.	6	OC=7%
27.0 / 852.5	LEAN CLAY with SAND, slightly organic, with roots and fibers, gray, wet, (CL), swamp deposit	7	OC=2%
34.0 / 845.5	WELL-GRADED GRAVEL with SILT, fine- to coarse-grained, gray, waterbearing, medium dense to dense, (GW-GM), outwash	23 25 35	
	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense, (SP-SM), outwash	30 24* 34	*No sample recovery. P200=7% No sampling from 42 to 50 feet.

Index Sheet Code 3.0

(Continued Next Page)

Soil Class: Rock Class: Edit: Date: 7/15/14

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2026SB**	**879.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	49.0 / 830.5		POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense, (SP-SM), outwash *(continued)*	PD						
50	54.0 / 825.5		SANDY LEAN CLAY, trace Gravel, brown, wet, hard, (CL), till	PD	53					
55				PD	22					
60				PD	28					
65				PD	51					
70			POORLY GRADED SAND, fine- to coarse-grained, with Gravel, brown, waterbearing, medium dense to very dense, (SP), outwash	PD	20*					*No sample recovery.
75				PD	25					
80				PD	33					
85				PD	22					
90	89.0 / 790.5			PD						

(Continued Next Page)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2026SB**	**879.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
				X	25					
				PD						
95			SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard, (CL), till *(continued)*	X	37					
				PD						
100	101.0 / 778.5			X	41					

Bottom of Hole - 101 feet.
Water observed at 15 feet with 15 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2111SB	868.9 (Surveyed)

Location: Hennepin Co. Coordinate: X=492805 Y=132483 (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7519
Hammer CME Automatic Calibrated
SHEET 1 of 3
Drilling Completed 6/28/14

DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	1.0 / 867.9	4 inches of Bituminous over 8 inches of Aggregate Base.					
	4.0 / 864.9	SILTY SAND, fine- to medium-grained, trace Gravel, dark brown, moist, (SM), fill	34	7			
5	7.0 / 861.9	SANDY LEAN CLAY, slightly organic, black, moist, (CL), fill	8	16			
10	12.0 / 856.9	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, with occasional layers of Sandy Lean Clay, brown and dark brown, moist to 10 feet then waterbearing, (SP-SM), fill	7	8			
			17	14			
15	17.0 / 851.9	SANDY LEAN CLAY, trace Gravel, bluish gray, moist to wet, very stiff, (CL), till	17	18			
			24	13			Sand layer encountered at 15 feet.
20	20.0 / 848.9	POORLY GRADED SAND, fine- to medium-grained, with Lean Clay lenses, brown, waterbearing, medium dense, (SP), outwash	23	12			Switched to mud rotary drilling method after 17 1/2-foot sample.
	22.0 / 846.9	SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense, (SM), till	23	11			
25		POORLY GRADED SAND, fine- to coarse-grained, trace to with Gravel, gray, waterbearing, medium dense, (SP), outwash	22	17			
			24	16			*No sample recovery.
30			23	15			
			25	22			
35			26	18			
			24	24			
40			24	16			
			24	22			
45			27	22			

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2111SB**	**868.9** *(Surveyed)*

DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
		POORLY GRADED SAND, fine- to coarse-grained, trace to with Gravel, gray, waterbearing, medium dense, (SP), outwash *(continued)*	24	23			
			24	21			
50	50.0 / 818.9	SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense, (SM), till	22	11			
55	55.0 / 813.9	SANDY LEAN CLAY, trace Gravel, brown, wet, very stiff, (CL), till	20	15			DD=124 pcf
60	60.0 / 808.9	SILTY SAND, trace Gravel, brown, wet, medium dense to dense, (SM), till	18	13			
65			40	14			Rock fragments encountered at 65 feet.
70	70.0 / 798.9	CLAYEY SAND, trace Gravel, gray, wet, stiff to rather stiff, (SC), till	15	12			DD=129 pcf
75			11*				*No sample recovery.
80			11	14			
85	85.0 / 783.9	CLAYEY SAND, trace Gravel, gray, wet, stiff to rather stiff, (SC), till	15	22			
90							

Drilling Operation: PD (between samples)

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2111SB**	**868.9** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			CLAYEY SAND, trace Gravel, gray, wet, stiff to rather stiff, (SC), till *(continued)*	X	15	23				
				PD						
95	96.0 / 772.9			X	5	20				
			SANDSTONE, yellow to light brown, waterbearing, (SS), weathered bedrock	PD						
100	100.9 / 768.0			X	6*	18				60 blows per 11-inch set.

Bottom of Hole - 100.9 feet.
Water observed at 10 feet while drilling.
Water observed at 12 1/2 feet with 14 1/2 feet of hollow-stem auger.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2013SB	891.4 (Surveyed)

Location: Hennepin Co. Coordinate: X=492791 Y=132749 (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7507
Hammer CME Automatic Calibrated

Drilling Completed 7/11/13

Depth / Elev.	Classification	SPT N60	MC (%)	Other Tests Or Remarks
0.2 / 891.2	SILTY SAND, fine- to medium-grained, trace Gravel, dark brown, moist, (SM), topsoil fill		5	
4.0 / 887.4	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, (SM), fill	15	3	
7.0 / 884.4	CLAYEY SAND, trace Gravel, dark brown and black, moist, (SC), fill	10	10	
9.0 / 882.4	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, moist, medium dense, (SP), outwash	29	3	
17.0 / 874.4	SILTY SAND, fine- to medium-grained, with Gravel, brown, moist, medium dense to very dense, (SM), till	*		*40 blows per 6-inch set. Pushed rock, minimal sample recovery.
		28	8	
		37	5	
19.0 / 872.4	SILTY SAND, fine- to medum-grained, with Clayey Sand layers and seams at 18 feet, trace Gravel, brown, moist, dense, (SM), till	42	5	
24.0 / 867.4	SILTY SAND, fine- to medium-grained, with Gravel and Cobbles, brown, moist, very dense, (SM), till	*		*50 blows per 5-inch set. No sample recovery.
		*		*50 blows per 5-inch set.
34.0 / 857.4	SILTY SAND, fine- to medium-grained, with occasional Clay lenses and seams, trace Gravel, brown, moist, loose to very dense, (SM), till	52	4	
		10	14	
		20	8	
		18	10	
37.0 / 854.4	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, moist, medium dense, (SP-SM), outwash	23	11	
42.0 / 849.4	POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, moist to 40 feet then waterbearing, medium dense to dense, (SP-SM), outwash	18	9	
		32	12	Switched to mud rotary drilling method after 40-foot sample.
	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard, (CL), till	17	15	qp=1 1/2 tsf

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Soil Class: Rock Class: Edit: Date: 7/15/14
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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2013SB**	**891.4** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	47.0 / 844.4		SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard, (CL), till *(continued)*		*	9				*72 blows for 11-inch set. Gravel encountered at 46 feet.
				PD						
					94	9				
50				PD						
	54.0 / 837.4		SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense to very dense, (SM), till		49	11				
				PD						
55					28	13				
				PD	21	15				
60										
				PD						
65	69.0 / 822.4		POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, waterbearing, medium dense, (SP-SM), outwash		15	16				
				PD						
70					16	10				
				PD						
75	79.0 / 812.4		CLAYEY SAND, trace Gravel, brown, wet, rather stiff to hard, (CS), till		32	10				
				PD						
80					46	12				
				PD						
85	88.0 / 803.4		POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, waterbearing, dense, (SP-SM), outwash		32	16				
				PD						
90	90.0		SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, very dense, (SM), till		*	10				*50 blows per 6-inch set.

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2013SB**	**891.4** *(Surveyed)*

DEPTH Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
801.4		Bottom of Hole - 90 feet. Water observed at 40 feet with 39 1/2 feet of hollow-stem auger in the ground. Boring then sealed with bentonite grout.							

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2112SB	(Surveyed)

Location: Hennepin Co. Coordinate: X= Y= (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7514
Hammer CME Automatic Calibrated

Drilling Completed 5/20/14

DEPTH	Depth / Elev.	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	2.0	SILTY SAND, fine- to medium-grained, trace roots and Gravel, black, moist. (SM), topsoil fill			21			
	4.0	SILTY SAND, fine- to medium-grained, with Gravel, brown, moist. (SM), fill		27	8			
5	12.0	LEAN CLAY with SAND, slightly organic, gray and black, moist. (CL), fill		8	24			
				9	29			DD=93 pcf OC=3%
10				4	23			
	19.0	ORGANIC CLAY, decomposed, trace fibers, black, moist. (OL), swamp deposit		7	48			DD=68 pcf OC=13%
15				4	32			
				10	32			DD=89 pcf OC=4%
20	34.0	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist to 30 feet then waterbearing, very dense to loose. (SM), till		11	8			Drillers Note: Switched to mud rotary drilling method after 20-foot sample.
			PD	26	8			
25			PD	63	7			
			PD	48	9			
▼30			PD	6	9			
			PD	5	13			
35	37.0	LEAN CLAY, with lenses of Silt, gray, wet, loose. (CL), till	PD	6	30			LL=31, PL=22, PI=9
	45.0	POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, gray, waterbearing, medium dense. (SP-SM), outwash	PD	16	9			
40			PD	19	10			
			PD	16	22			A layer of Lean Clay was encountered at 43 feet.
45			PD					

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2112SB	(Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, gray to brown, waterbearing, dense to medium dense. (SP-SM), outwash		33*					*No sample recovery.
				PD	38	18				
50				PD	22	18				P200=10%
	53.0									
			SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to dense. (SM), till	PD						
55					25	15				
				PD						
60					38	9				
				PD						
65					40	14				
				PD						
70					26	12				
				PD						
75					20	16				
				PD						
80					20	11				
	83.0									
			SANDY LEAN CLAY, trace Gravel, brown and gray, wet, very stiff. (CL), till	PD						
85					19	16				
	88.0									
			POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing,	PD						
90										

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2112SB**	(Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	93.0		medium dense, (SP-SM), outwash POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense, (SP-SM), outwash *(continued)*	X	19	20				
				PD						
95			CLAYEY SAND, trace Gravel, brown, wet, stiff to rather stiff. (SC), till	X	13	11				DD=136 pcf
				PD						
100				X	12	11				
	103.0			PD						
105			POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense. (SP), outwash	X	14	14				
				PD						
110	111.0			X	17	18				P200=4%
			POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, loose. (SP-SM), outwash	PD						
115				X	12	22				
				PD						
120	121.0			X	9	24				

Bottom of Hole - 121 feet.
Water observed at a depth of 30 feet while drilling.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2113SB	887.1 (Surveyed)

Location: Hennepin Co. Coordinate: X=492771 Y=132927 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7506

Hammer CME Automatic Calibrated

Drilling Completed 5/19/14

Depth	Elev.	Classification	Other Tests Or Remarks
0.3	886.8	4 inches of bituminous.	
6.0	881.1	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, moist to 5 feet then wet. (SP-SM), fill	
12.0	875.1	ORGANIC CLAY, with Sand seams, black, wet. (OL), fill	DD=94 pcf OC=4% Drillers Note: Switched to mud rotary drilling method after 10-foot sample.
14.0	873.1	SANDY LEAN CLAY, trace Gravel, brownish gray, wet. (CL), fill	DD=127 pcf qu=1 1/4 tsf
19.0	868.1	ORGANIC CLAY and SANDY LEAN CLAY, trace Gravel, brown, gray and black, wet. (OL/CL), fill	Pulled out of hole at 17 1/2 feet. Blind drilled to 20 feet, then sample, then switched to mud rotary drilling method after 20-foot sample.
22.0	865.1	SANDY LEAN CLAY, trace Gravel, brown and dark gray, wet. (CL), fill	DD=109 pcf
24.0	863.1	ORGANIC SILT, black, wet. (OH), swamp deposit	OC=10%
27.0	860.1	SANDY LEAN CLAY, trace Gravel, light gray and brown, wet, very stiff, (CL), till	
32.0	855.1	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense. (SM), till	
34.0	853.1	LEAN CLAY, trace Gravel, gray and brown, wet, very stiff. (CL), till	DD=105 pcf LL=16 PL=11 PI=5
37.0	850.1	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brownish gray, waterbearing, medium dense. (SP-SM), outwash	
40.0	847.1	SILT with SAND, brown, wet, medium dense. (ML), till	DD=124 pcf
		POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel and layers of Lean Clay, brown, waterbearing, medium dense to dense. (SP-SM), outwash	P200=11%

Depth (approx.)	SPT N60	MC (%)
1.5		5
4	11	7
6.5	6	11
9	4	29
11.5	3	14
14	14	14
16.5	7	11
19	8	18
21.5	15	18
24	18	52
26.5	20	
29	29	15
31.5	21	22
34	22	23
36.5	19	15
39	24	18
41.5	27	13
44	31	17

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2113SB	887.1 (Surveyed)

Depth / Elev.	Classification	SPT N60	MC (%)	Other Tests Or Remarks
		33	15	
47.0 / 840.1	LEAN CLAY, with frequent layers of Silt and Fat Clay, brown, wet, hard. (CL), till	48	25	
		31	26	DD=100 pcf LL=24 PL=17 PI=12
53.0 / 834.1	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, medium dense to dense. (SM), till	29	16	
		36*		*No sample recovery. Rock in tip of sampler.
		19	14	P200=15%
70.0 / 817.1	SANDY SILT, with lenses of Lean Clay, gray, wet, medium dense. (ML), till	15*		*No sample recovery.
		25	19	
78.0 / 809.1	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to stiff. (CL), till	20	14	qp=1/2 tsf
		16	11	DD=139 pcf
88.0 / 799.1	CLAYEY SAND, with Gravel, gray, wet, stiff. (SC), till			

Drilling Operation: PD

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2113SB**	**887.1** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			CLAYEY SAND, with Gravel, gray, wet, stiff. (SC), till *(continued)*	X	15					
	93.0 / 794.1			PD						
95				X	25	12				
				PD						
100			POORLY GRADED SAND, fine- to medium-grained, with frequent layers of Lean Clay, gray, waterbearing, medium dense to very dense. (SP), outwash	X	35	17				
105				PD						
110	111.0 / 776.1			X	63	21				

Bottom of Hole - 111 feet.
Water observed at a depth of 12 feet while drilling.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2129SB	895.4 (Surveyed)

Location: Hennepin Co. Coordinate: X=492712 Y=133089 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7506

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 6/25/14

Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
0.2 / 895.2	SILTY SAND, fine- to medium-grained, black, moist, (SM), topsoil fill					
4.0 / 891.4	SILTY SAND, fine- to medium-grained, with Gravel, dark brown and black, moist, (SM), fill	16				
7.0 / 888.4	SANDY LEAN CLAY, trace Gravel, brown, wet, (CL), fill	9				
9.0 / 886.4	LEAN CLAY, black and gray, wet, (CL), fill	12				
19.0 / 876.4	CLAYEY SAND, trace Gravel, with layers of Silty Sand and Lean Clay, brown and dark brown, wet, (SC), fill	12, 28, 16, 9				Dark brown Lean Clay layer at 17 feet.
22.0 / 873.4	SANDY LEAN CLAY, trace Gravel, brown, wet, medium, (CL), till	6				
29.0 / 866.4	SILTY SAND, fine- to medium-grained, with Gravel, brown, moist, medium dense, (SM), till	12, *, 20				*100+ blows for 9 inches. Rock encountered.. No recovery sample.
39.0 / 856.4	POORY GRADED SAND, fine - to medium-grained, trace Gravel, with occasional Silt lenses, brown, wet to 30 feet then waterbearing, loose to medium dense, (SP), outwash	5, 20, 28, 21				Switched to mud rotary drill method after 30-foot sample.
42.0 / 853.4	SILTY SAND, fine- to medium-grained, with frequent Silt and Lean Clay lenses, brown and gray, waterbearing, medium dense, (SM), till	22				
44.0 / 851.4	POORLY GRADED SAND, fine-grained, brown and gray, waterbearing, medium dense, (SP), outwash	28				
	SANDY SILT, brown, waterbearing, dense, (ML), till					

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Soil Class: Rock Class: Edit: Date: 7/15/14

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2129SB**	**895.4** *(Surveyed)*

Depth / Elev.	Classification	SPT N60
	SANDY SILT, brown, waterbearing, dense, (ML), till *(continued)*	34
47.0 / 848.4	SANDY LEAN CLAY, trace Gravel, with Silty Sand layer at 48 feet, gray, wet, very stiff to hard, (CL), till	27, 22, 33
59.0 / 836.4	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, dense, (SM), till	40
64.0 / 831.4	POORLY GRADED SAND, fine- to medium-grained, with Gravel, gray, waterbearing, dense, (SP), outwash	32
69.0 / 826.4	CLAYEY SAND, trace Gravel, with occasional Silty Sand layers, gray, wet, very stiff, (SC), till	29, 26, 19
84.0 / 811.4	POORLY GRADED SAND, fine- to medium-grained, gray, waterbearing, medium dense to very dense, (SP), outwash	27

Column headings: DEPTH; Depth/Elev.; Lithology; Classification; Drilling Operation; SPT N60 / REC (%); MC (%) / RQD (%); COH (psf) / ACL (ft); γ (pcf) / Core Breaks; Soil / Rock; Other Tests Or Remarks / Formation or Member. Drilling Operation: PD between sampling intervals. Depth scale: 50, 55, 60, 65, 70, 75, 80, 85, 90.

(Continued Next Page)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2129SB**	**895.4** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
				X	28					
				PD						
95				X	30					
				PD						
100			POORLY GRADED SAND, fine- to medium-grained, gray, waterbearing, medium dense to very dense, (SP), outwash *(continued)*	X	55					
105				PD						
110	111.0 / 784.4			X	48					

Bottom of Hole - 111 feet.
Water observed at 30 feet with 30 feet of hollow-stem auger.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2014SB	877.5 (Surveyed)

Location: Hennepin Co. Coordinate: X=492676 Y=133459 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine: 7507

Hammer: CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed: 7/15/13

Depth / Elev.	Classification
0.3 / 877.2	CLAYEY SAND, trace Gravel, dark brown, wet, (SC), topsoil fill
9.0 / 868.5	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, (SM), fill
17.5 / 860.0	POORLY GRADED SAND with SILT, fine- to medium-grained, with some Gravel, brown, moist, medium dense to very dense, (SP-SM), outwash
22.0 / 855.5	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, waterbearing, loose, (SP-SM), outwash
27.0 / 850.5	POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel and Cobbles, gray, waterbearing, medium dense, (SP-SM), outwash
29.0 / 848.5	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff, (CL), till
34.0 / 843.5	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, gray, waterbearing, medium dense, (SP), outwash
(continues)	SANDY LEAN CLAY, trace Gravel, gray, wet, medium to very stiff, (CL), till

SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	41			
17	9			
18	10			
79	6			
58	7			
57	6			
12	6			
9	20			
5	18			Switched to mud rotary drilling after 20-foot sample.
22	12			
12*				*No sample recovery.
22	21			
15	26			
23	18			
21	19			
17	22			
17	21			
12	19			

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2014SB**	**877.5** *(Surveyed)*

Depth / Elev.	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Soil	Other Tests Or Remarks
47.0 / 830.5	SANDY LEAN CLAY, trace Gravel, gray, wet, medium to very stiff, (CL), till *(continued)*	X	6	19				
		PD						
		X	5	12				
		PD						
		X	4	10				
		PD						
	CLAYEY SAND, trace Gravel, gray, wet, rather soft to very stiff, (CS), till	X	6	11				
		PD						
		X	18	14				
64.0 / 813.5		PD						
	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, medium dense, (SP), outwash	X	26	14				
69.0 / 808.5		PD						
	CLAYEY SAND, trace Gravel, gray, wet, very stiff, (SC), till	X	28	12				
74.0 / 803.5		PD						
	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, dense to very dense, (SP), outwash	X	31	17				
		PD						
		X	41	21				
		PD						
		X	43	19				
		PD						

Second header row: REC (%) | RQD (%) | ACL (ft) | Core Breaks | Rock | Formation or Member

DEPTH scale: 50, 55, 60, 65, 70, 75, 80, 85, 90

(Continued Next Page)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2014SB**	**877.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
					58	12				
				PD						
95			POORLY GRADED SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, dense to very dense, (SP), outwash *(continued)*		*	15				*50 blows per 6-inch set.
				PD						
	99.8 / 777.7				*					*50 blows per 4-inch set.

Bottom of Hole - 99.8 feet.
Water observed at 17 1/2 feet with 17 1/2 feet of hollow-stem auger in the ground.
Boring then sealed with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2132SB	878.5 (Surveyed)

Location: Hennepin Co. Coordinate: X=492656 Y=133584 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7506

Hammer CME Automatic Calibrated

SHEET 1 of 2

Drilling Completed 5/20/14

DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	0.5 / 878.0	SANDY LEAN CLAY, trace roots and Gravel, black, moist, (CLS), topsoil fill					
5			4				
	13.0 / 865.5	CLAYEY SAND, trace Gravel, gray and brown, moist to wet, (SC), fill					
10 (water level ▼)			12				Switched to mud rotary drilling method after 10-foot sample.
15			7				
	20.0 / 858.5	CLAYEY SAND, trace Gravel, brown, wet, medium, (SC), outwash					
20			7				
25			5				
	28.0 / 850.5	SILTY SAND, fine- to medium-grained, with Gravel, brown, waterbearing, loose, (SM), outwash					
30			8				
35			5				
40		CLAYEY SAND, with Gravel, brown, waterbearing, rather soft to stiff, (SC), outwash	8				
45							

Drilling Operation: PD (between samples from about 11 ft to 44 ft)

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2132SB**	**878.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			CLAYEY SAND, with Gravel, brown, waterbearing, rather soft to stiff, (SC), outwash *(continued)*	PD	8					
50				PD	20					
	53.0 / 825.5		POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, gray, waterbearing, medium dense, (SP-SM), outwash	PD						
55				PD	34					
60	61.0 / 817.5				34					

Bottom of Hole - 61 feet.
Water observed a a depth of 10 feet while drilling.
Boring immediately backfilled with bentonite grout.

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2133SB	881.2 (Surveyed)

Location: Hennepin Co. Coordinate: X=492655 Y=133738 (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7506
Hammer CME Automatic Calibrated

Drilling Completed 5/21/14

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.5 / 880.7		ORGANIC CLAY, trace roots, black, moist, (OL), topsoil fill							
			CLAYEY SAND, trace Gravel, gray and brown, moist, (SC), fill		19					
5										
10					20					Switched to mud rotary drilling method after 10-foot sample.
	13.0 / 868.2		CLAYEY SAND, with Gravel, brown, wet to waterbearing, (SC), fill	PD						
15				PD	24					
20				PD	4					
25				PD	6					
30				PD	7					
35				PD	12					
	38.0 / 843.2		PEAT, trace fibers, black, wet, (PT), swamp deposit	PD						
40				PD	6					
45	45.0			PD						

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Soil Class:J. Kirk Rock Class: Edit: Date: 7/15/14

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2133SB**	**881.2** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	836.2		CLAYEY SAND, with Gravel, brown, wet, (SC), fill		19					
				PD						
				PD						
50					32					
				PD						
55					19					
	58.0 / 823.2		ORGANIC CLAY, trace fibers, black, wet, (OL), swamp deposit	PD						
60					5					
	63.0 / 818.2		CLAYEY SAND, with Gravel, brown, wet, stiff, (SC), outwash	PD						
65	66.0 / 815.2				16					

Bottom of Hole - 66 feet.

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2015SB	879.6 (Surveyed)

Location: Hennepin Co. Coordinate: X=492687 Y=133897 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7507

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 7/16/13

DEPTH	Depth / Elev.	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	1.5 / 878.1	SILTY SAND, fine-grained, trace Gravel, black, wet, (SM), fill			40			
5	9.0 / 870.6	CLAYEY SAND, trace Gravel, brown and gray, wet, (SC), fill		13	10			
				15	11			
				18	9			
10		SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist to 12 1/2 feet then waterbearing, loose to medium dense, (SM), till		14	7			
				7	10			
15				6	9			Switched to mud rotary drilling method after 15-foot sample.
	19.0 / 860.6		PD	10	9			
20	22.0 / 857.6	POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, waterbearing, medium dense, (SP), outwash	PD	11	22			
			PD	17	10			
25			PD	18	6			
			PD	14	9			
30		SILTY SAND, fine- to medium-grained, with some Gravel, brown, waterbearing, medium dense, (SM), till	PD	16	9			
			PD	10	11			
35			PD	11*				*No sample recovery.
	39.0 / 840.6		PD	10*				*No sample recovery.
40	42.0 / 837.6	CLAYEY SAND, trace Gravel, gray, wet, medium, (SC), till	PD	8	18			
	44.0 / 835.6	LEAN CLAY, gray, wet, rather stiff, (CL), till	PD	11	27			LL=25, PL=17, PI=8
45			PD					

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2015SB**	**879.6** *(Surveyed)*

DEPTH	Depth / Elev.	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
		POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, gray, waterbearing, medium dense, (SP-SM), outwash *(continued)*		18	12				
			PD						
				22	12				
50			PD						
				24	14				
	54.0 / 825.6		PD						
55		SILTY SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, dense, (SM), till		31	12				
			PD						
60				38	19				
			PD						
65				48*					*No sample recovery.
	69.0 / 810.6		PD						
70		POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to very dense, (SP-SM), outwash		35	16				
			PD						
75				30	18				
			PD						
80				35	14				
			PD						
85				27	16				
			PD						
90									

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS *SHEET 3 of 3*

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2015SB**	**879.6** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
				X	20	18				
				PD						
95				X	40	19				
				PD						
100			POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to very dense, (SP-SM), outwash *(continued)*	X	54	16				Occasional Clayey Sand inclusions beginning at 100 feet.
105				PD						
110	110.5 / 769.1			X		5				Gravel and Cobbles at 110 feet. *50 blows per 5-inch set.

Bottom of Hole - 100.5 feet.
Water observed at 12 1/2 feet with 12 feet of hollow-stem auger in the ground.
Boring then sealed with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2016SB	893.9 (Surveyed)

Location: Hennepin Co. Coordinate: X=49259 Y=134360 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7507

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 7/18/13

DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	0.8 / 893.1	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, (SM), topsoil fill		8			
		SILTY SAND, fine- to coarse-grained, trace Gravel, brown, moist, (SM), fill	25	6			
5	7.0 / 886.9		22	12			
		CLAYEY SAND, trace Gravel, brown, wet, stiff to very stiff, (CS), till	15	12			
10			13*	11			*No sample recovery.
	14.0 / 879.9		19	11			
15		POORLY GRADED SAND with SILT, fine- to coarse-grained, trace Gravel, brown, moist to 17 1/2 feet then waterbearing, loose to dense, (SP-SM), outwash	32	8			
	19.0 / 874.9		10	10			
20		SILTY SAND, fine- to medium-grained, trace Gravel, with occasional Clay lenses and seams, brown, waterbearing, loose, (SM), till	8	10			
			6	15			
25	26.0 / 867.9		9	11			
		SANDY LEAN CLAY, trace Gravel, gray, wet, rather soft to hard, (CL), till	5	18			
30			TW	17			qu=1480 psf DD=115 pcf
			10	16			
35			12	16			qp=1 1/2 tsf
			16	16			qp=2 tsf
40			13	11			qp=1 3/4 tsf
			20	10			qp=2 1/2 tsf Occasional Sand layers and seams beginning at 45 feet.
45							

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2016SB**	**893.9** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SANDY LEAN CLAY, trace Gravel, gray, wet, rather soft to hard, (CL), till *(continued)*		24	11				qp=2 1/4 tsf
					31	13				qp=2 tsf
50					35	10				qp=3 tsf Switched to mud rotary drilling method after 50-foot sample.
				PD						
	54.0 839.9		CLAYEY SAND, with Gravel, brown, wet, hard, (SC), till							
55					43	10				
				PD						
60					51	10				
				PD						
65					39	13				
				PD						
	69.0 824.9		CLAYEY SAND, trace Gravel, gray, wet, very stiff, (SC), till							
70					26	11				
				PD						
75					24					
				PD						
	79.0 814.9		SILTY SAND, fine- to coarse-grained, trace Gravel, gray, waterbearing, medium dense, (SM), till							
80					30	13				
				PD						
	84.0 809.9		CLAYEY SAND, trace Gravel, gray, wet, hard to very stiff, (SC), till							
85					38	13				
				PD						
90										

(Continued Next Page)

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2016SB**	**893.9** (Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			CLAYEY SAND, trace Gravel, gray, wet, hard to very stiff, (SC), till *(continued)*		23	12				
				PD						
95	94.0 / 799.9		SILTY SAND, fine- to medium-grained, trace Gravel, gray, waterbearing, medium dense to dense, (SM), till		21	10				
				PD						
100					44					
105				PD						
110	109.0 / 784.9		SANDSTONE, light yellow and white, wet, (SS), weathered bedrock		*	16				ST. PETER FORMATION *50 blows per 6-inch set
115				PD						
	119.3 / 774.6									*50 blows per 4-inch set

Bottom of Hole - 119.3 feet.
Water observed at 17 1/2 feet with 17 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

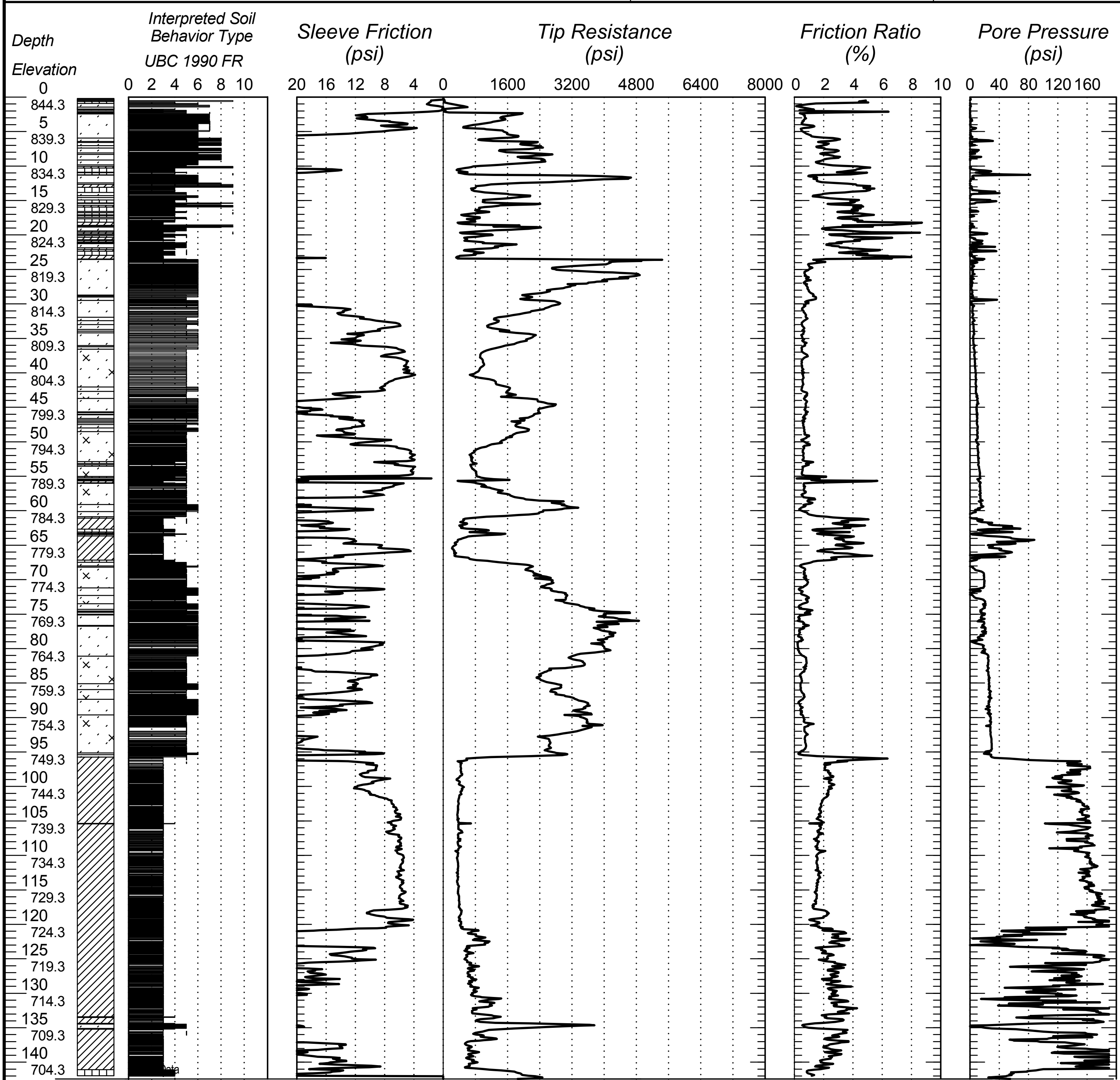
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
		SWLRT	**2105CW**	**844.3** (Surveyed)

Location **Co. Coordinate: X=484480 Y=125283** (ft.)	CPT Machine **CPT-1**	SHEET 1 of 2
Latitude (North)= Longitude (West)=	CPT Operator	Date Completed
No Station-Offset Information Available	Hole Type **CPT-STD/PWP-DISS**	**5/12/14**



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Soil Class: Rock Class: Edit: Date: 7/28/14
N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213-MNDOT-CPT-DXF.GPJ

CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
		SWLRT	2105CW	844.3 (Surveyed)

Mn/DOT GEOTECHNICAL SECTION - CONE PENETRATION TEST RESULTS	SHEET 2 of 2

Depth / Elevation	Interpreted Soil Behavior Type UBC 1990 FR	Sleeve Friction (psi)	Tip Resistance (psi)	Friction Ratio (%)	Pore Pressure (psi)
	0 2 4 6 8 10	20 16 12 8 4 0	1600 3200 4800 6400 8000	0 2 4 6 8 10	0 40 80 120 160

Bottom of Hole 142.41

Soil Class: Rock Class: Edit: Date: 7/28/14
N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213-MNDOT-CPT-DXF.GPJ

METROPOLITAN COUNCIL

BRAUN℠ INTERTEC

CONE PENETRATION TEST RESULTS

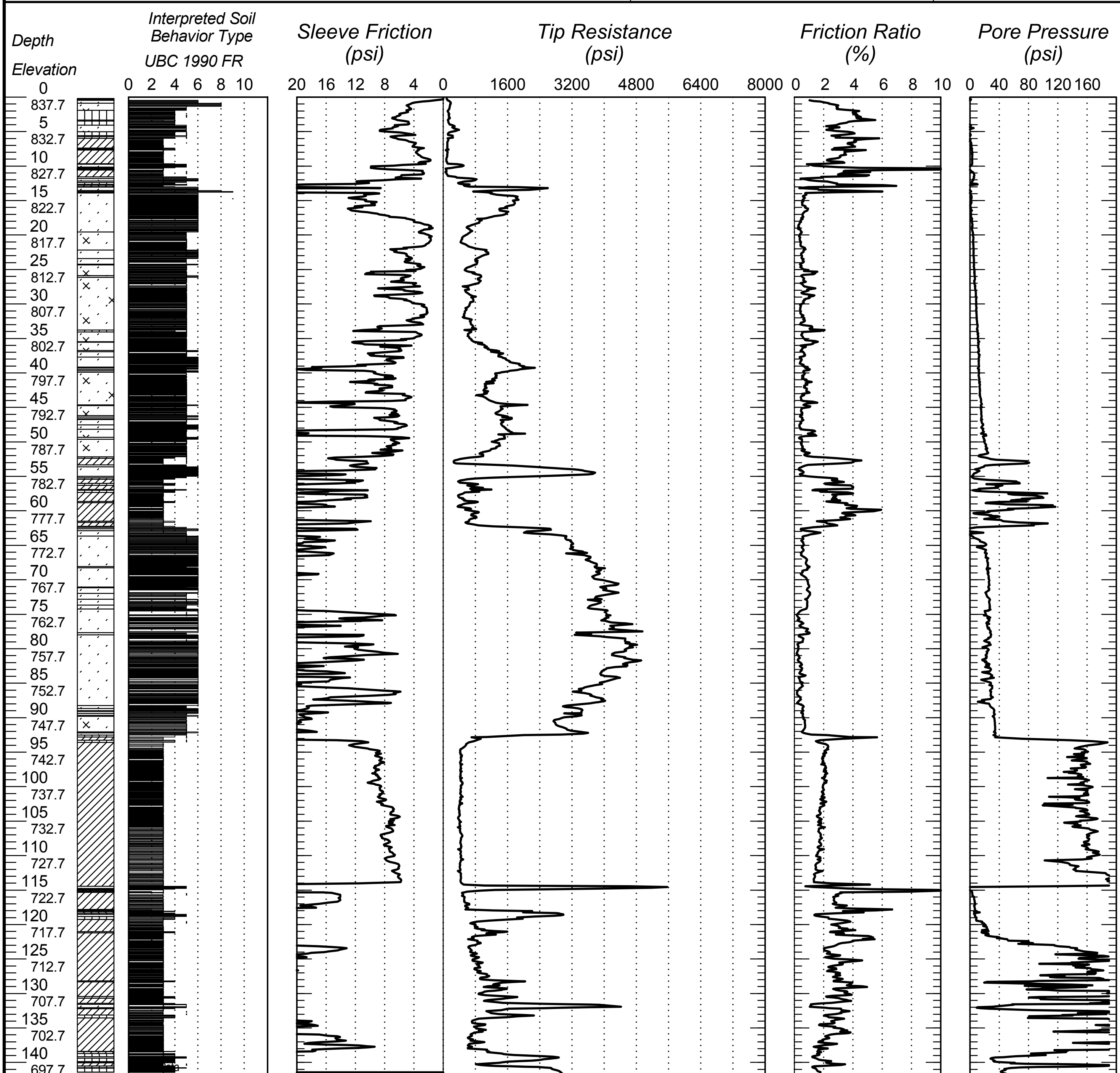
UNIQUE NUMBER

U.S. Customary Units

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
		SWLRT	**2106CW**	**837.7** (Surveyed)

Location **Co. Coordinate: X=484537 Y=125277** (ft.)	CPT Machine **CPT-1**	SHEET 1 of 2
Latitude (North)= Longitude (West)=	CPT Operator	Date Completed
No Station-Offset Information Available	Hole Type **CPT-STD/PWP-DISS**	**5/12/14**



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(Continued Next Page)

Soil Class: Rock Class: Edit: Date: 7/28/14
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CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
		SWLRT	2106CW	837.7 (Surveyed)

Mn/DOT GEOTECHNICAL SECTION - CONE PENETRATION TEST RESULTS

Depth / Elevation	Interpreted Soil Behavior Type UBC 1990 FR	Sleeve Friction (psi)	Tip Resistance (psi)	Friction Ratio (%)	Pore Pressure (psi)
	0 2 4 6 8 10	20 16 12 8 4 0	1600 3200 4800 6400 8000	0 2 4 6 8 10	0 40 80 120 160

Bottom of Hole 142.08

METROPOLITAN COUNCIL

BRAUN℠ INTERTEC

CONE PENETRATION TEST RESULTS

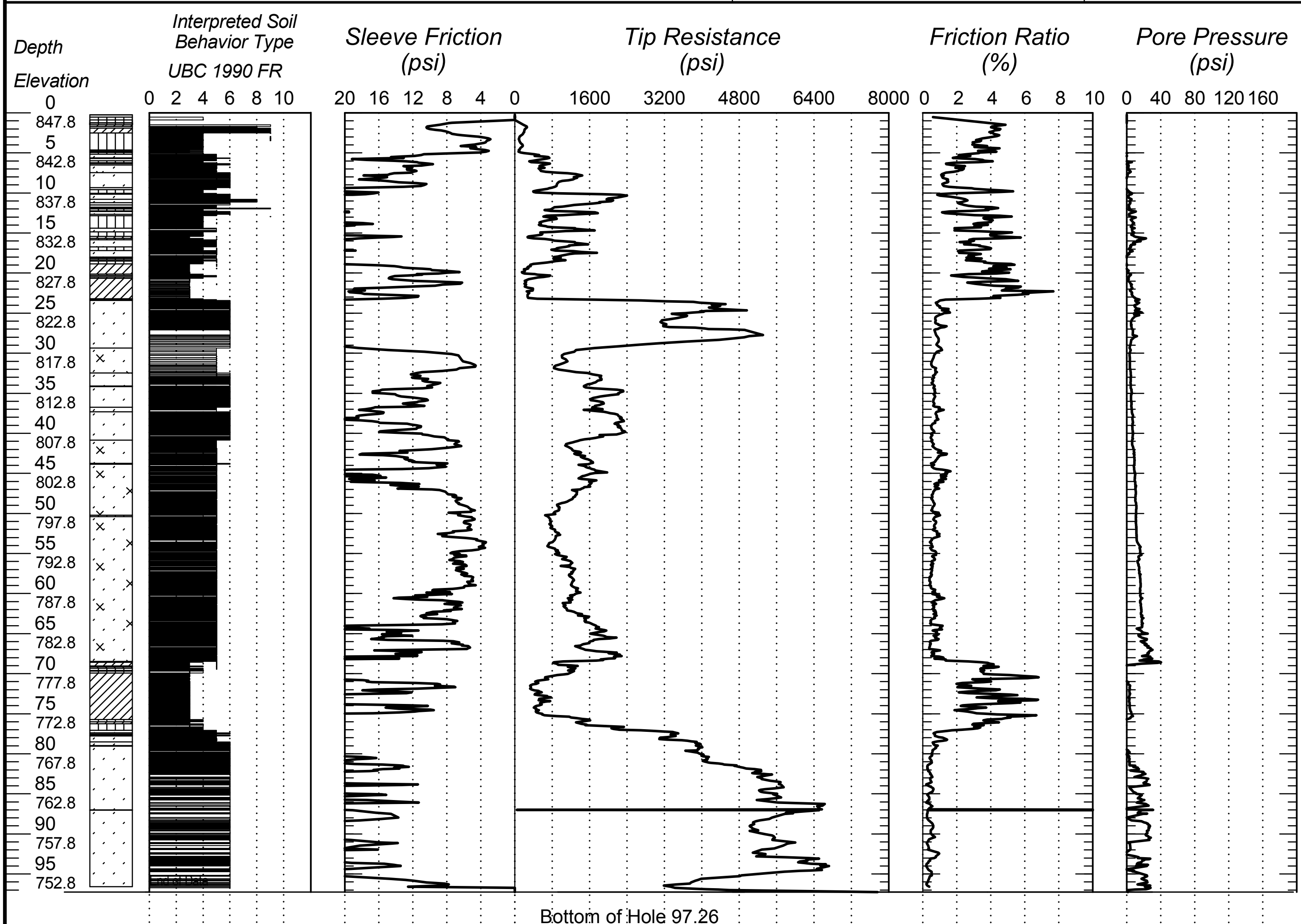
UNIQUE NUMBER

U.S. Customary Units

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location SWLRT	Sounding No. 2107CB	Ground Elevation 847.8 (Surveyed)

Location Co. Coordinate: X=484566 Y=125333 (ft.)	CPT Machine CPT-1	SHEET 1 of 1
Latitude (North)= Longitude (West)=	CPT Operator	Date Completed
No Station-Offset Information Available	Hole Type CPT-STD/PWP-DISS	5/12/14



Index Sheet Code

Soil Class: Rock Class: Edit: Date: 7/28/14
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METROPOLITAN COUNCIL

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CONE PENETRATION TEST RESULTS

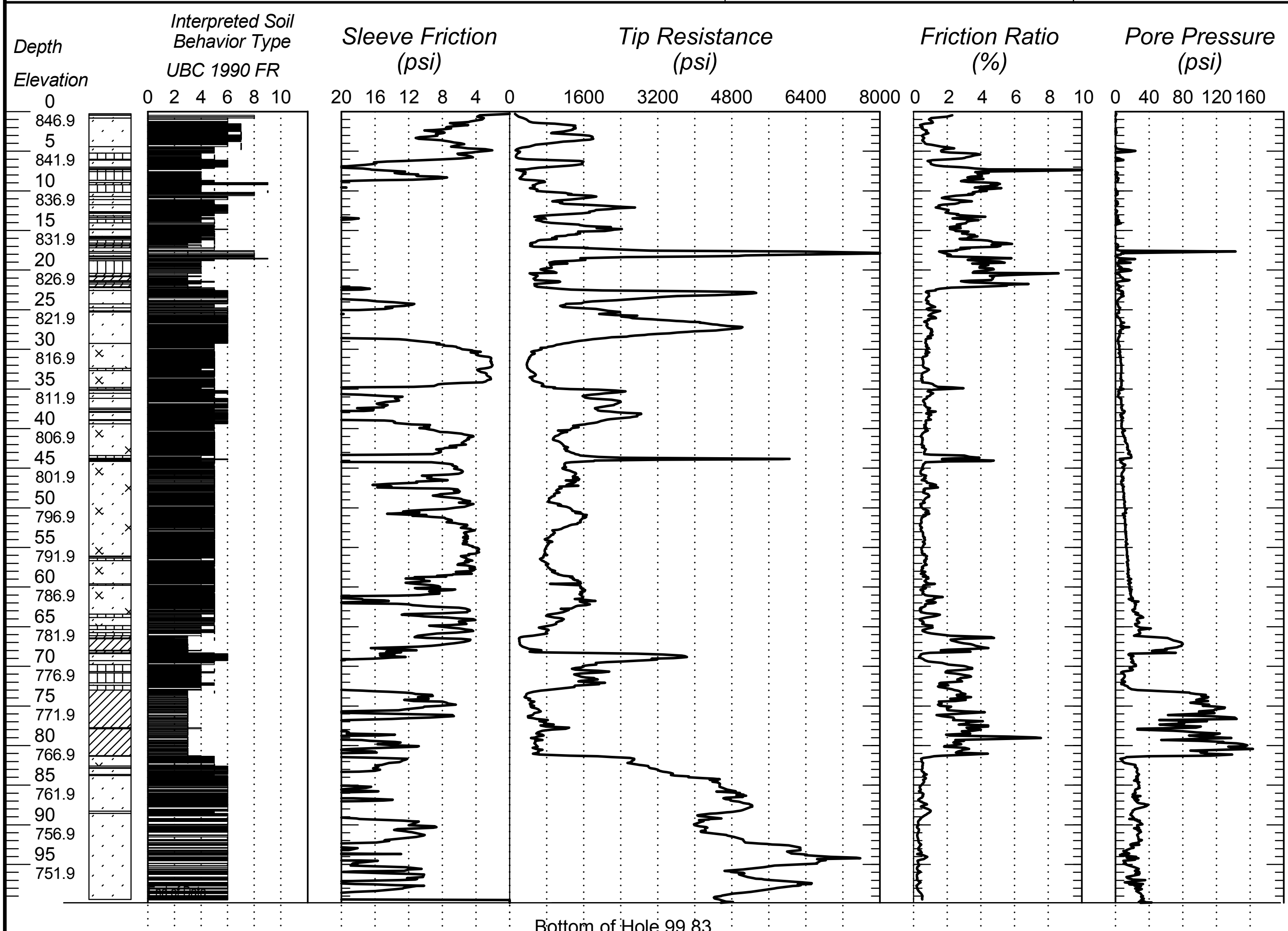
UNIQUE NUMBER

U.S. Customary Units

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
		SWLRT	**2108CB**	**846.9** *(Surveyed)*

Location **Co. Coordinate: X=484692 Y=125400** (ft.)	*CPT Machine* **CPT-1**	*SHEET 1 of 1*
Latitude (North)= *Longitude (West)=*	*CPT Operator*	*Date Completed*
No Station-Offset Information Available	*Hole Type* **CPT-STD/PWP-DISS**	**5/12/14**



Index Sheet Code

Soil Class: Rock Class: Edit: Date: 7/28/14
N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213-MNDOT-CPT-DXF.GPJ

METROPOLITAN COUNCIL

BRAUN INTERTEC

CONE PENETRATION TEST RESULTS

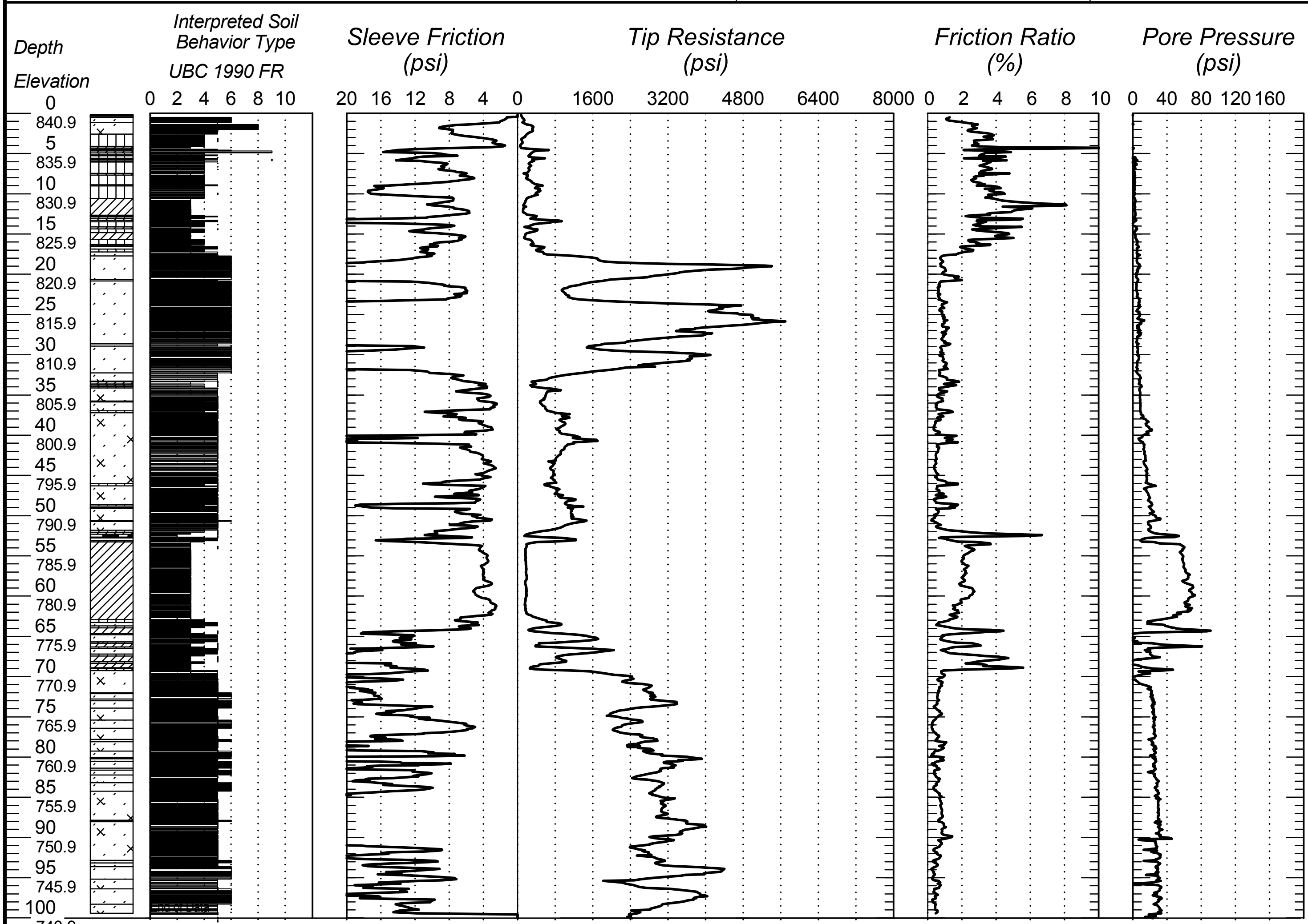
UNIQUE NUMBER

U.S. Customary Units

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
		SWLRT	2109CB	840.9 (Surveyed)

Location **Co. Coordinate: X=484758 Y=125406** (ft.)	CPT Machine **CPT-1**	SHEET 1 of 1
Latitude (North)= Longitude (West)=	CPT Operator	Date Completed
No Station-Offset Information Available	Hole Type **CPT-STD/PWP-DISS**	**5/12/14**



Bottom of Hole 100.02

Index Sheet Code

Soil Class: Rock Class: Edit: Date: 7/28/14

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METROPOLITAN COUNCIL

BRAUN INTERTEC

MINNESOTA DEPARTMENT OF TRANSPORTATION

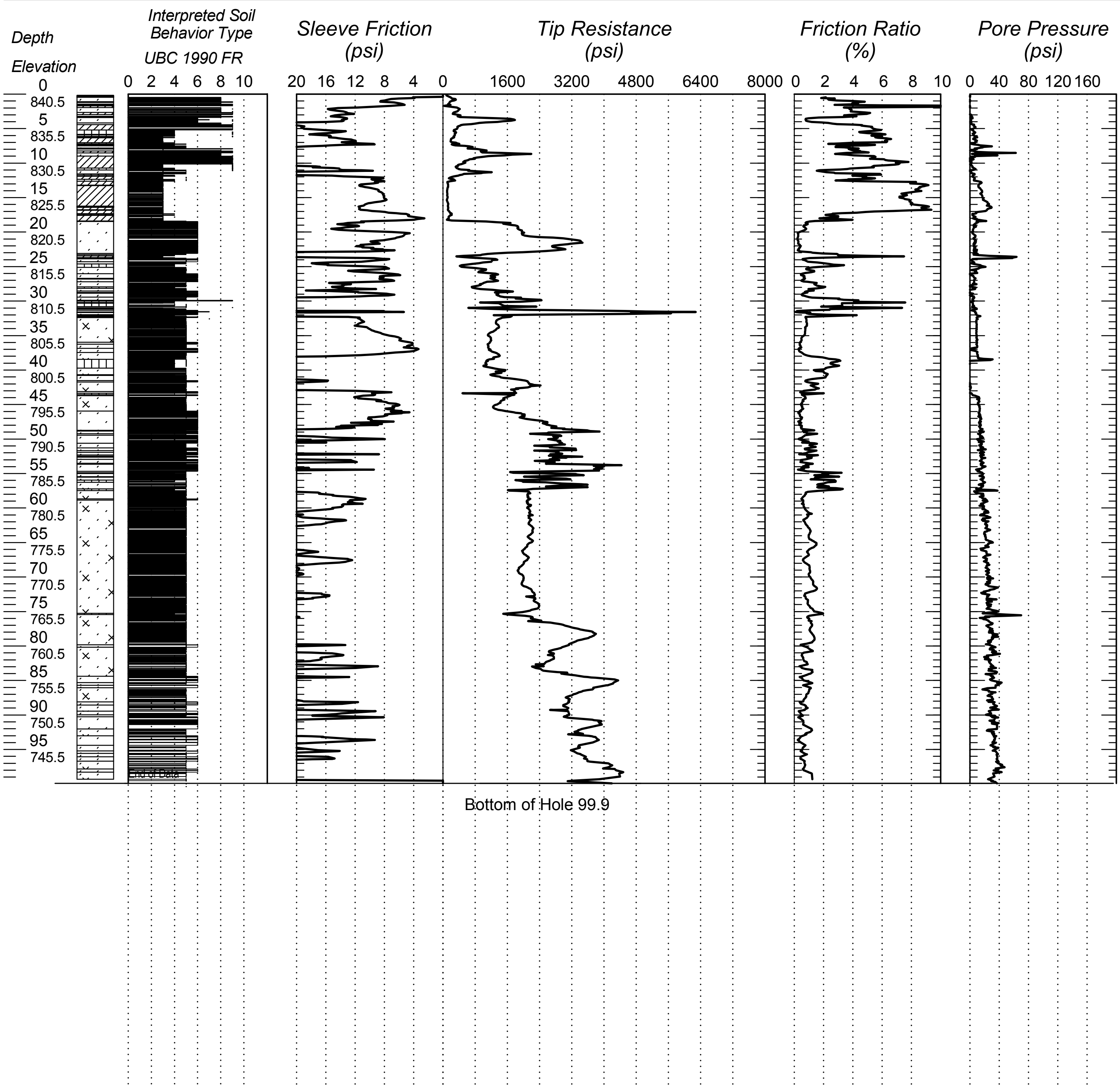
CONE PENETRATION TEST RESULTS

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Sounding No.	Ground Elevation
		SWLRT	2110CB	840.5 (Surveyed)

Location		CPT Machine CPT-1	SHEET 1 of 1
Co. Coordinate: X=484958 Y=125289 (ft.)			
Latitude (North)=	Longitude (West)=	CPT Operator	Date Completed
No Station-Offset Information Available		Hole Type CPT-STD/PWP-DISS	5/12/14



Index Sheet Code

Soil Class: Rock Class: Edit: Date: 7/28/14
N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213-MNDOT-CPT-DXF.GPJ

Summary of Anticipated Pile Lengths - PDA Analysis

Boring/Substructure	Anticipated Cutoff Elevation (feet)	Factored Load $\Sigma\gamma Q_n$ (tons)	Nominal Resistance R_n (tons)	O.D. of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2026SB (South Abutment)	859	120	185 [370 kips]	12.0	796	63
				16.0	815	44
		140	215 [430 kips]	12.0	789	70
				16.0	809	50
2111SB (Pier 1)	860	120	185 [370 kips]	12.0	792	68
				16.0	809	51
		140	215 [430 kips]	12.0	785	75
				16.0	806	54
2013SB (Pier 2)	865	120	185 [370 kips]	12.0	811	54
				16.0	830-815*	35-50*
		140	215 [430 kips]	12.0	810	55
				16.0	812	53
2112SB (Pier 3)	885	120	185 [370 kips]	12.0	823	62
				16.0	843	42
		140	215 [430 kips]	12.0	815-803*	70-82*
				16.0	836	49
2113SB (Pier 4)	883	120	185 [370 kips]	12.0	831-812*	52-71*
				16.0	833	50
		140	215 [430 kips]	12.0	827-804*	56-79*
				16.0	833	50
2129 SB (Pier 5)	879	120	185 [370 kips]	12.0	834-822*	45-57*
				16.0	837	42
		140	215 [430 kips]	12.0	815	64
				16.0	836	43
2130 CB (Pier 6)	878	120	185 [370 kips]	12.0	841	37
				16.0	850	28
		140	215 [430 kips]	12.0	831	47
				16.0	847	31
2014SB (Pier 7)	872	120	185 [370 kips]	12.0	813-807	59-65
				16.0	815	57
		140	215 [430 kips]	12.0	803	69
				16.0	813*	59
2132SB (Pier 8)	871	120	185 [370 kips]	12.0	813**	58**
				16.0	828	43
		140	215 [430 kips]	12.0	806**	65**
				16.0	825	46

Summary of Anticipated Pile Lengths – PDA Analysis

Boring/Substructure	Anticipated Cutoff Elevation (feet)	Factored Load $\Sigma\gamma Q_n$ (tons)	Nominal Resistance R_n (tons)	O.D. of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2133CB (Pier 9)	874	120	185 [370 kips]	12.0	804	70
				16.0	807	67
		140	215 [430 kips]	12.0	802	72
				16.0	805	69
2015SB (Pier 10)	867	120	185 [370 kips]	12.0	808	59
				16.0	821	46
		140	215 [430 kips]	12.0	803	64
				16.0	816	51
2134CB (Pier 11)	867	120	185 [370 kips]	12.0	809	58
				16.0	833	34
		140	215 [430 kips]	12.0	807	60
				16.0	811	56
2135CB (Pier 12)	869	120	185 [370 kips]	12.0	815	54
				16.0	819	50
		140	215 [430 kips]	12.0	812	57
				16.0	816	53
2136CB (Pier 13)	872	120	185 [370 kips]	12.0	827	45
				16.0	832	40
		140	215 [430 kips]	12.0	800	72
				16.0	829	43
2016SB (North Abutment)	875	120	185 [370 kips]	12.0	826	49
				16.0	841	34
		140	215 [430 kips]	12.0	815	60
				16.0	837	38

*Capacity may be achieved at shallower elevation. Recommend confirming with PDA.
**Interpolated from Nominal Resistance Graph

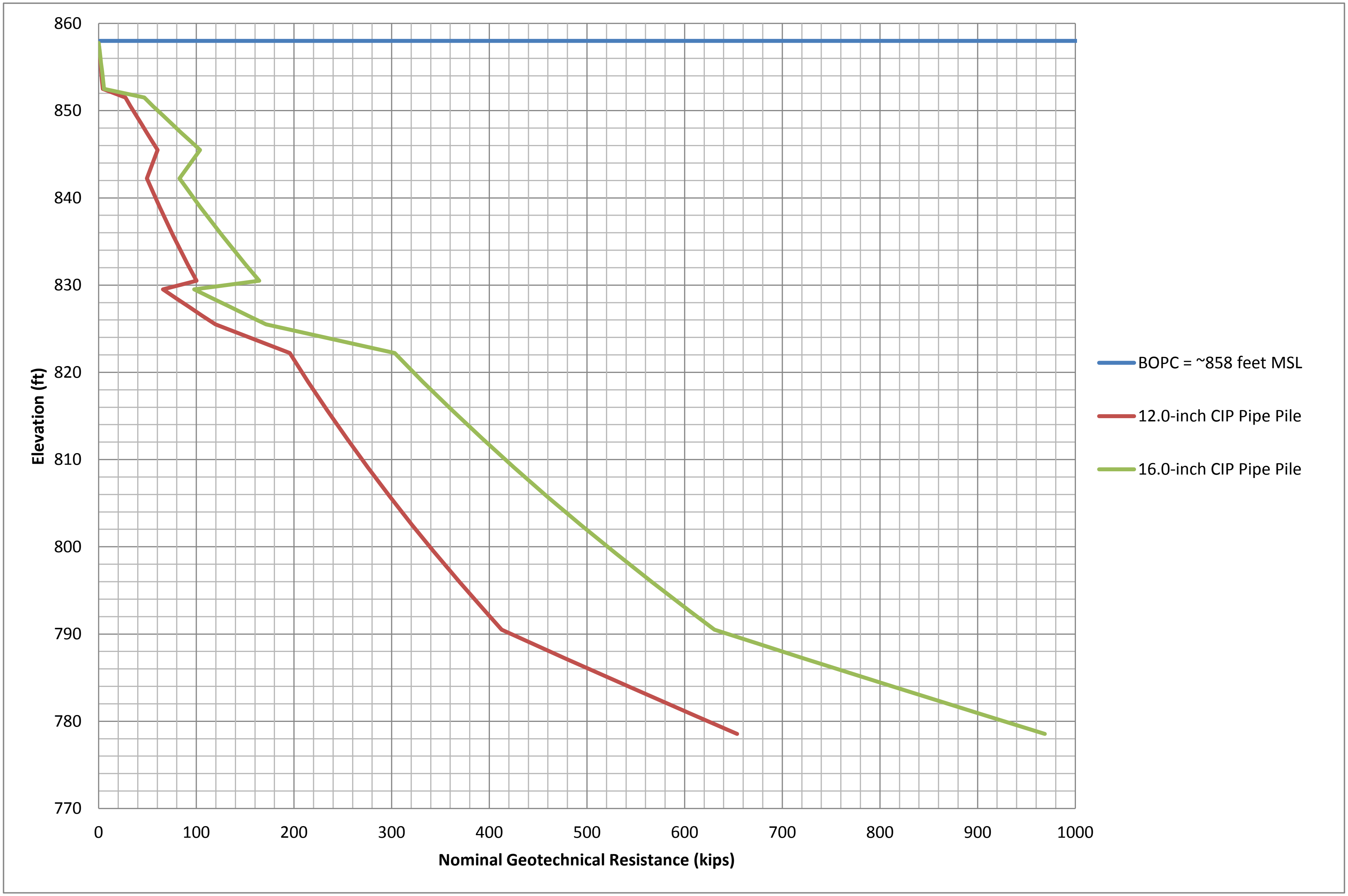
Summary of Anticipated Pile Lengths – MPF12 Analysis

Boring/Substructure	Anticipated Cutoff Elevation (feet)	Factored Load $\Sigma\gamma Q_n$ (tons	Nominal Resistance R_n (tons)	O.D. of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2026SB (South Abutment)	859	120	240 [480 kips]	12.0	786	73
				16.0	804	55
		140	280 [560 kips]	12.0	783	76
				16.0	796	63
2111SB (Pier 1)	860	120	240 [480 kips]	12.0	783	77
				16.0	807	53
		140	280 [560 kips]	12.0	775	85
				16.0	790	70
2013SB (Pier 2)	865	120	240 [480 kips]	12.0	809	56
				16.0	812	53
		140	280 [560 kips]	12.0	804	61
				16.0	811	54
2112SB (Pier 3)	885	120	240 [480 kips]	12.0	810-801*	75-84*
				16.0	831	54
		140	280 [560 kips]	12.0	800	85
				16.0	824	61
2113SB (Pier 4)	883	120	240 [480 kips]	12.0	799	84
				16.0	832	51
		140	280 [560 kips]	12.0	794	89
				16.0	831-806*	52-77*
2129 SB (Pier 5)	879	120	240 [480 kips]	12.0	811	68
				16.0	835	44
		140	280 [560 kips]	12.0	810	69
				16.0	834-820*	45-59*
2130 CB (Pier 6)	878	120	240 [480 kips]	12.0	828	50
				16.0	841	37
		140	280 [560 kips]	12.0	803	75
				16.0	832	46
2014SB (Pier 7)	872	120	240 [480 kips]	12.0	803	69
				16.0	813	59
		140	280 [560 kips]	12.0	803	69
				16.0	813-805	59-67
2132SB (Pier 8)	871	120	240 [480 kips]	12.0	800**	71**
				16.0	821	50
		140	280 [560 kips]	12.0	792**	79**
				16.0	816	55

Summary of Anticipated Pile Lengths – MPF12 Analysis

Boring/Substructure	Anticipated Cutoff Elevation (feet)	Factored Load $\Sigma\gamma Q_n$ (tons	Nominal Resistance R_n (tons)	O.D. of Pipe Pile (inches)	Approximate Tip Elevation (feet)	Approximate Pile Length (feet)
2133CB (Pier 9)	874	120	240 [480 kips]	12.0	801	73
				16.0	803	71
		140	280 [560 kips]	12.0	797*	77*
				16.0	801	73
2015SB (Pier 10)	867	120	240 [480 kips]	12.0	797	70
				16.0	811	56
		140	280 [560 kips]	12.0	791	76
				16.0	809	58
2134CB (Pier 11)	867	120	240 [480 kips]	12.0	805	62
				16.0	808	59
		140	280 [560 kips]	12.0	802**	65**
				16.0	806	61
2135CB (Pier 12)	869	120	240 [480 kips]	12.0	809-790*	60-79*
				16.0	815	54
		140	280 [560 kips]	12.0	783**	86*
				16.0	812	57
2136CB (Pier 13)	872	120	240 [480 kips]	12.0	796	76
				16.0	825	47
		140	280 [560 kips]	12.0	790**	82**
				16.0	807	65
2016SB (North Abutment)	875	120	240 [480 kips]	12.0	807	68
				16.0	831	44
		140	280 [560 kips]	12.0	799	76
				16.0	820	55

Bridge Over Shady Oak Road - South Abutment
Boring: 2026SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

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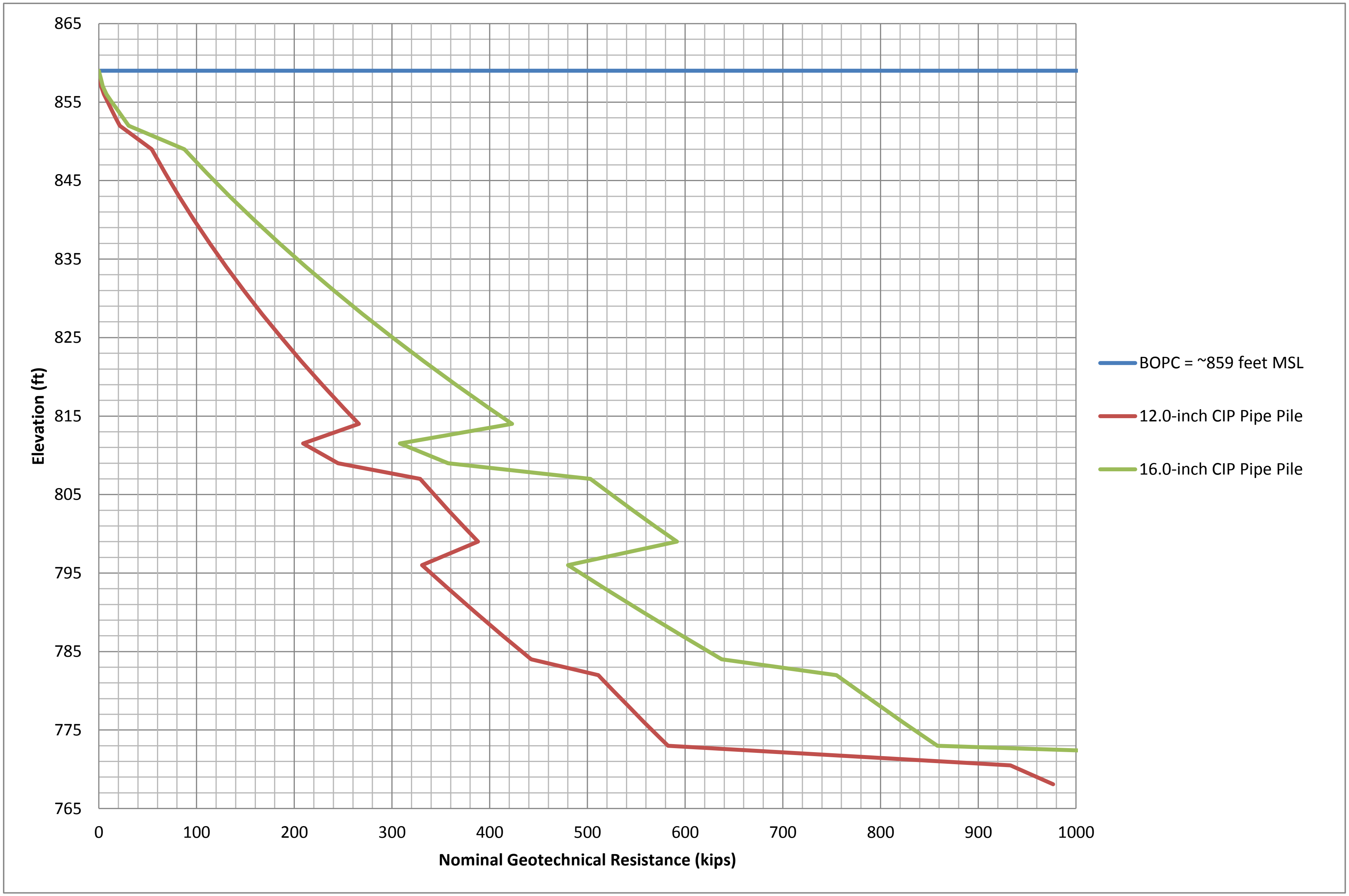
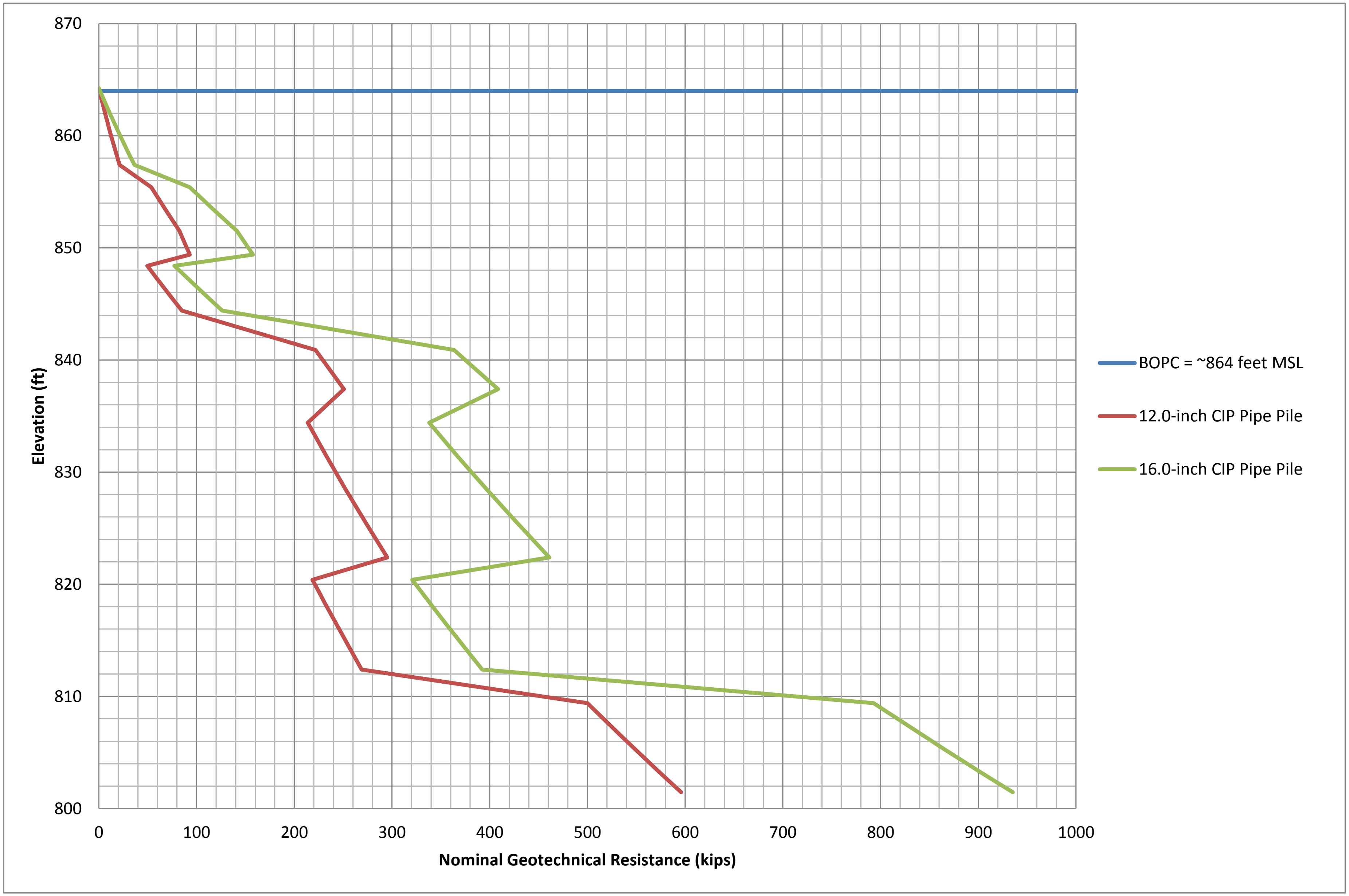
Bridge Over Shady Oak Road - Pier 1
Boring: 2111SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

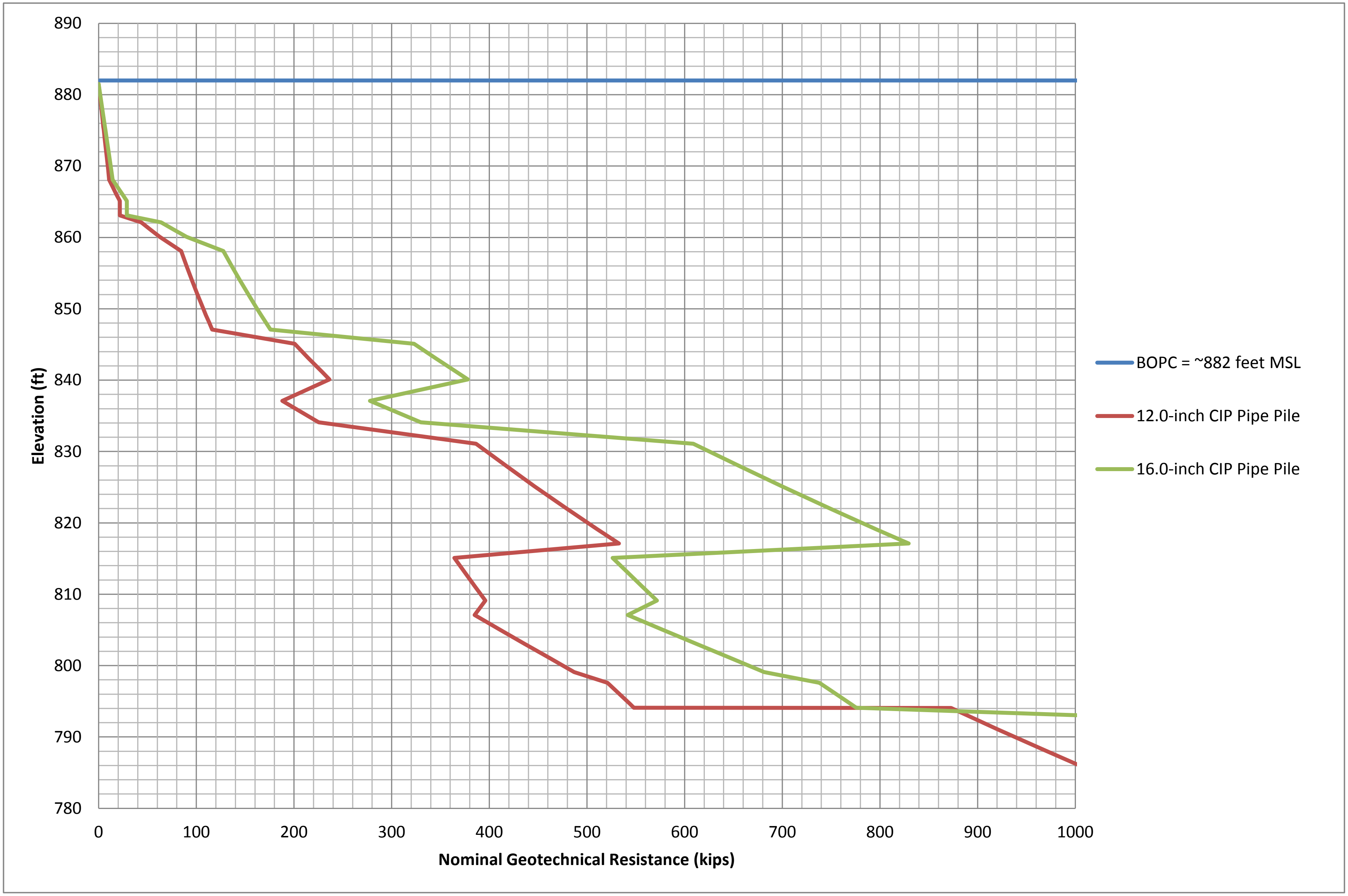
BRAUN INTERTEC

Bridge Over Shady Oak Road - Pier 2
Boring: 2013SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



BRAUN INTERTEC

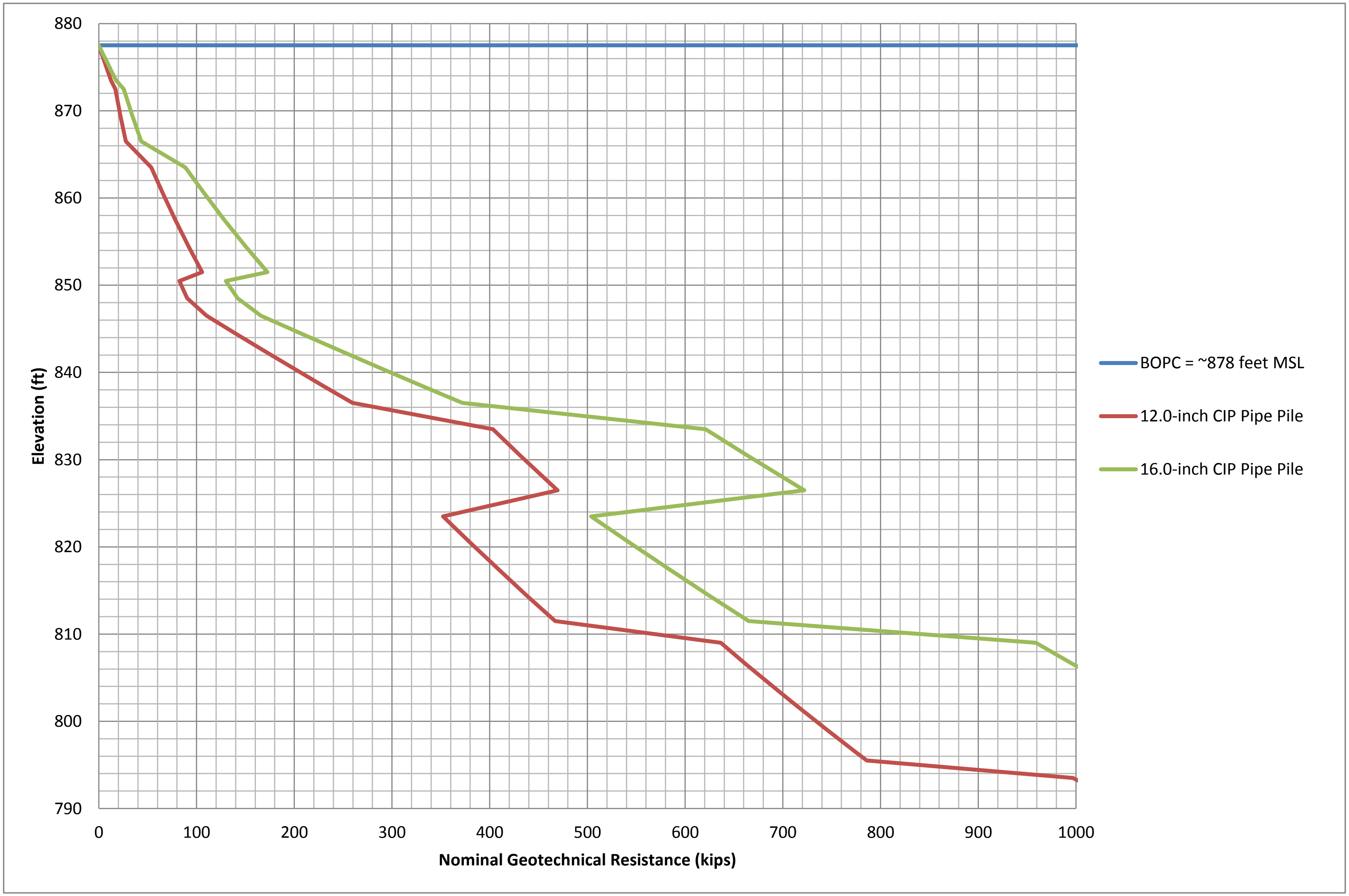
Bridge Over Shady Oak Road - Pier 4
Boring: 2113SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

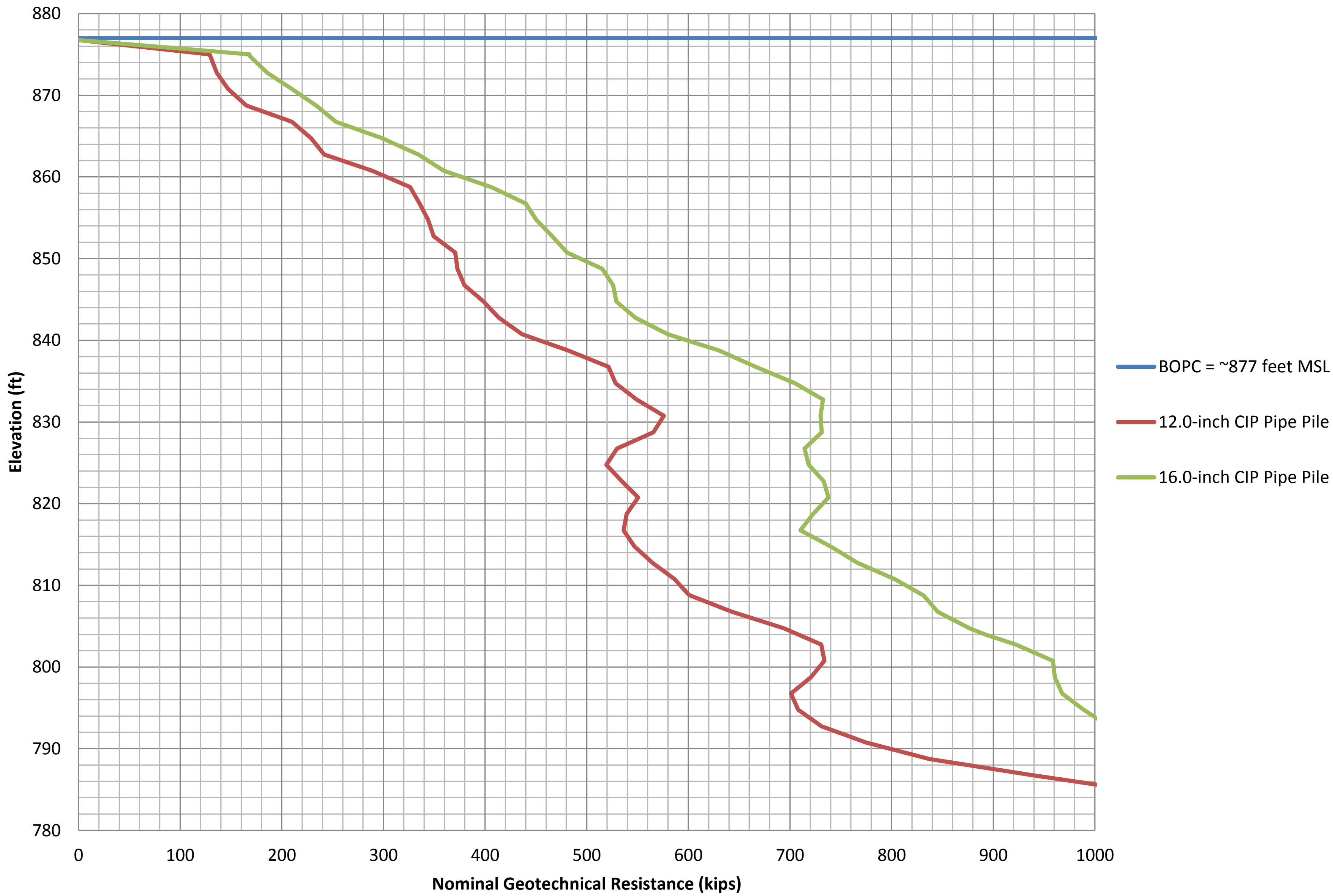
BRAUN INTERTEC

Bridge Over Shady Oak Road - Pier 5
Boring: 2129SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



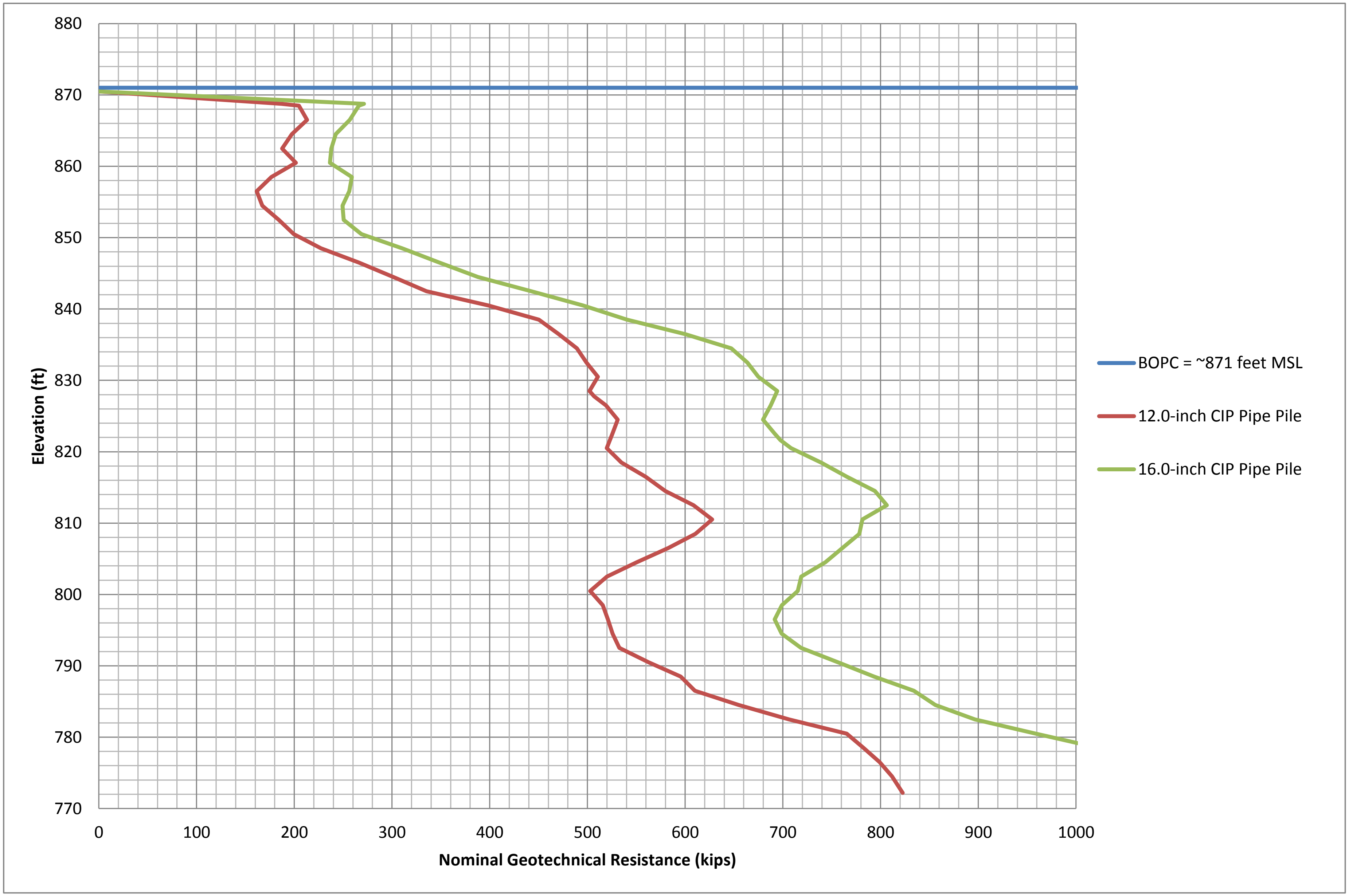
BRAUN INTERTEC

Bridge Over Shady Oak Road - Pier 6
Sounding: 2130CB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



BRAUN INTERTEC

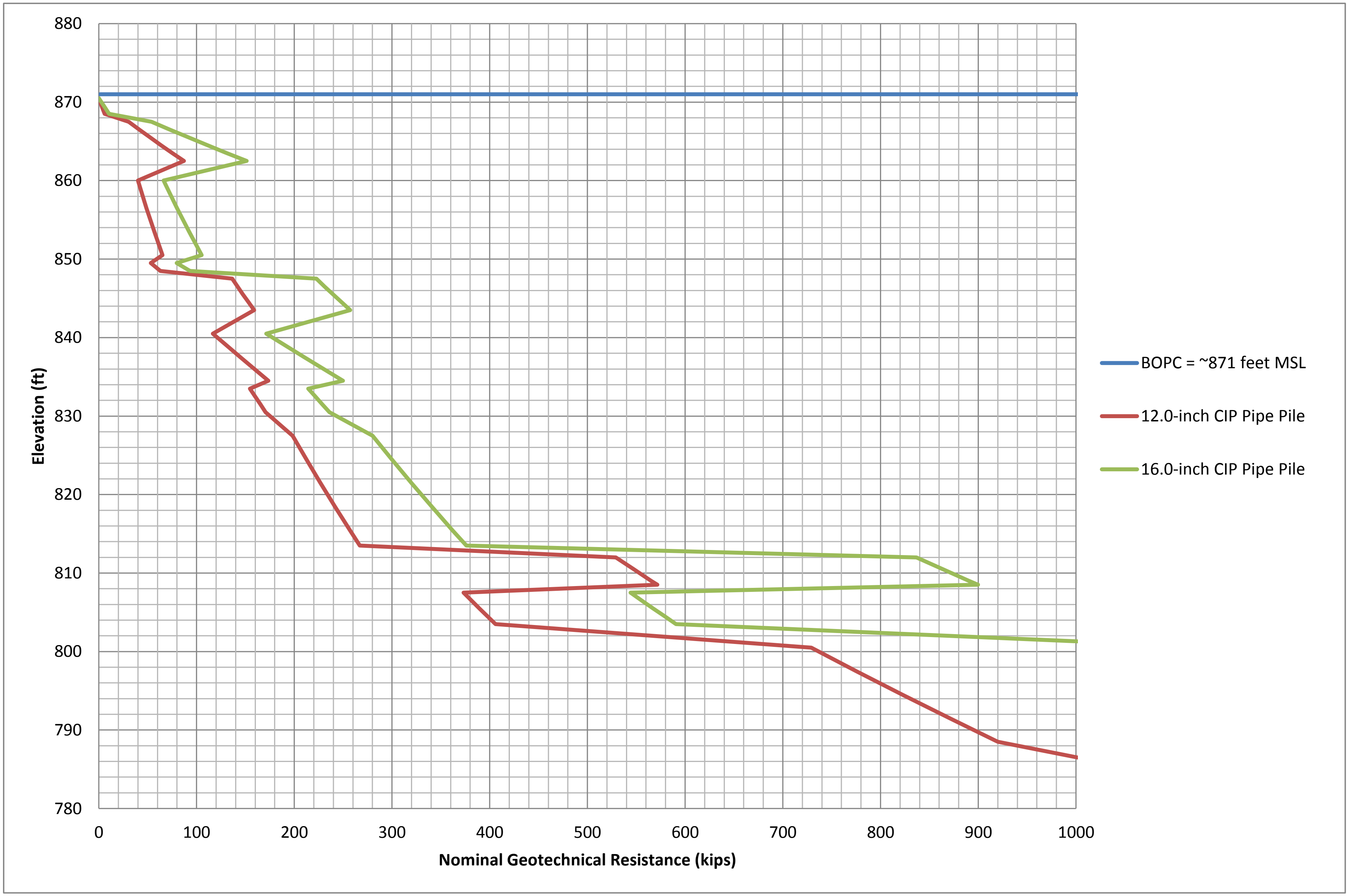
Bridge Over Shady Oak Road - Pier 7
Sounding: 2131CB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



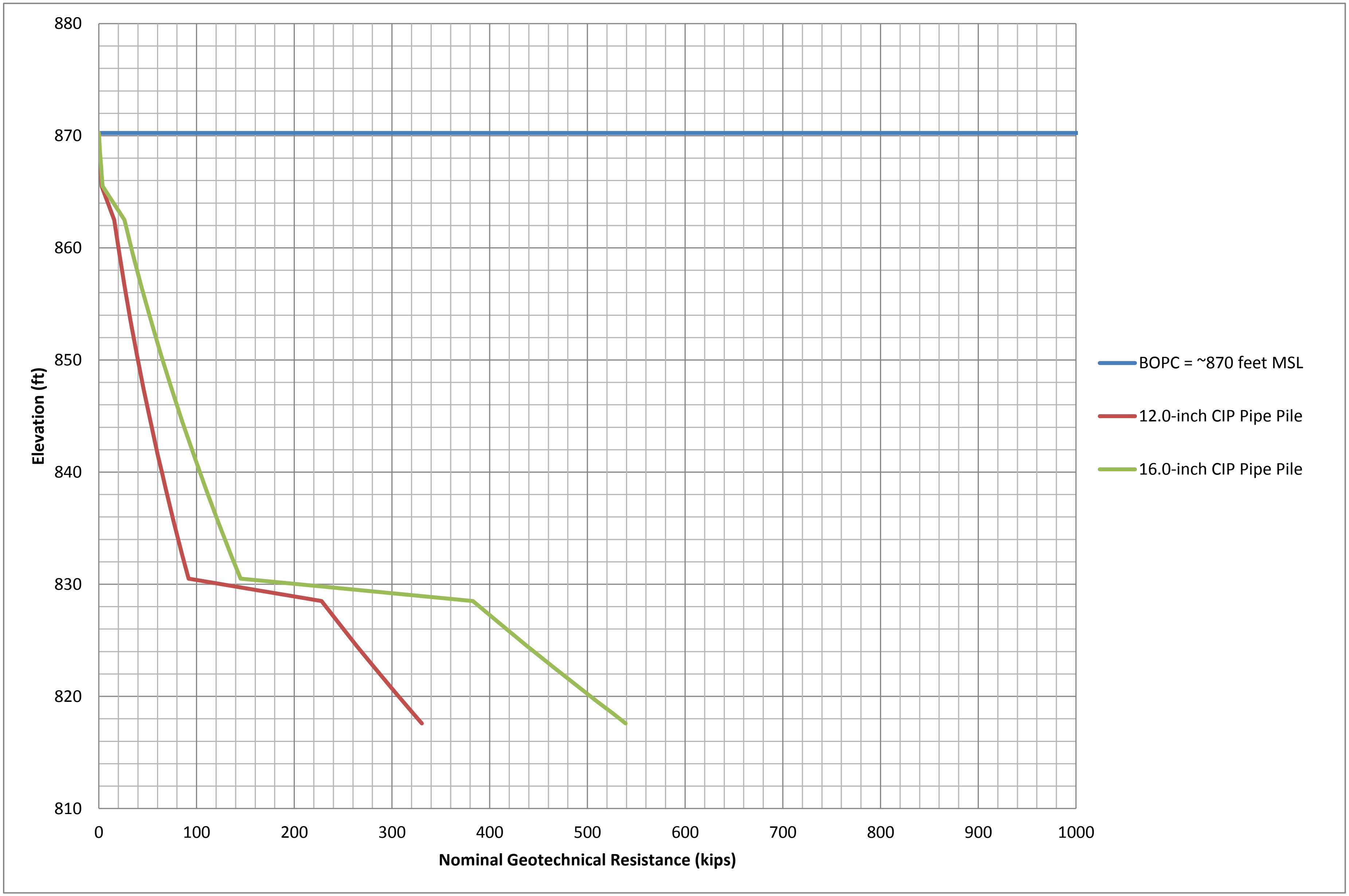
BRAUN INTERTEC

Braun Project No. BL-13-00213

Bridge Over Shady Oak Road - Pier 7
Boriing: 2014SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile

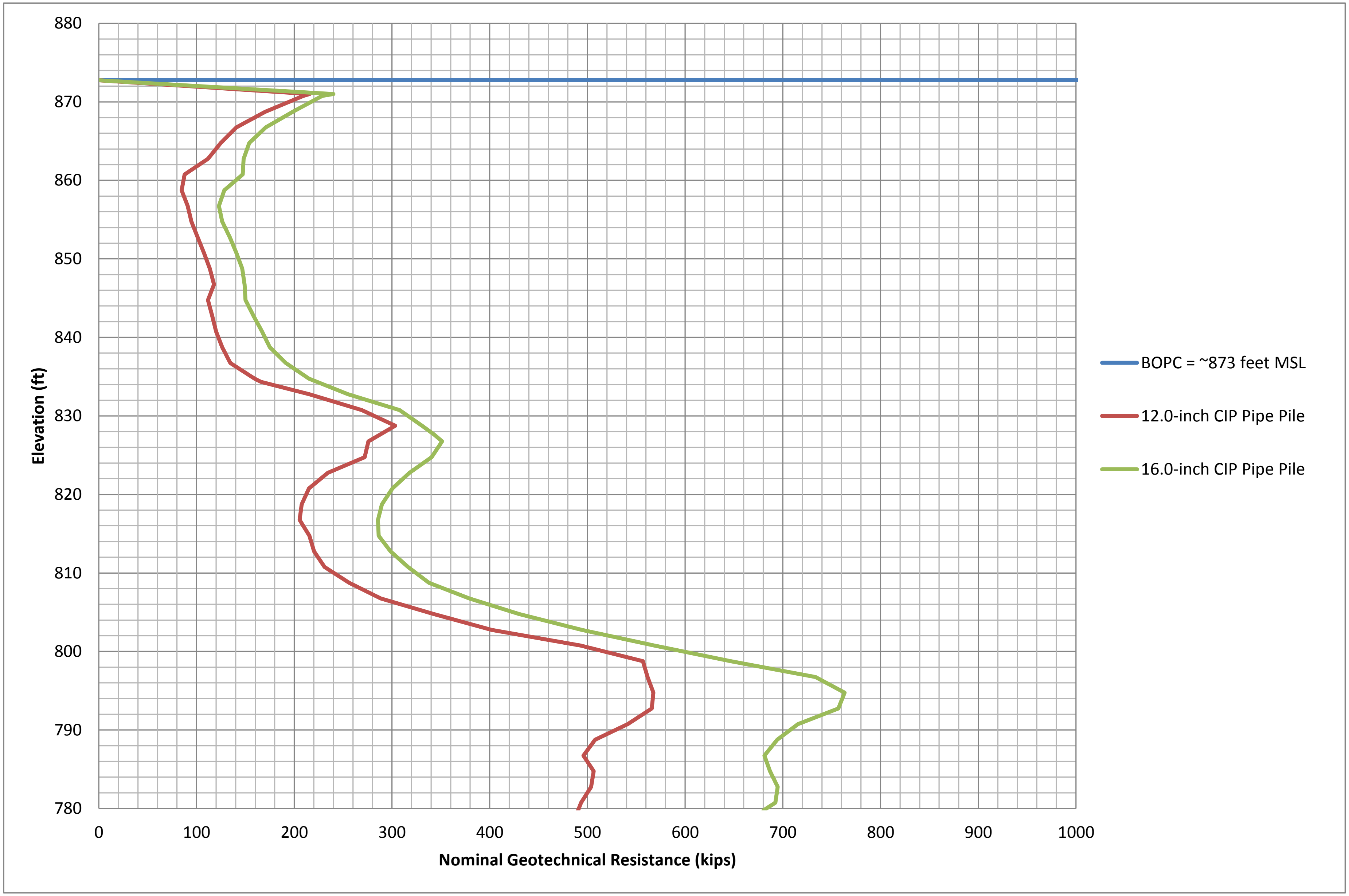


Bridge Over Shady Oak Road - Pier 8
Boring: 2132SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



BRAUN INTERTEC

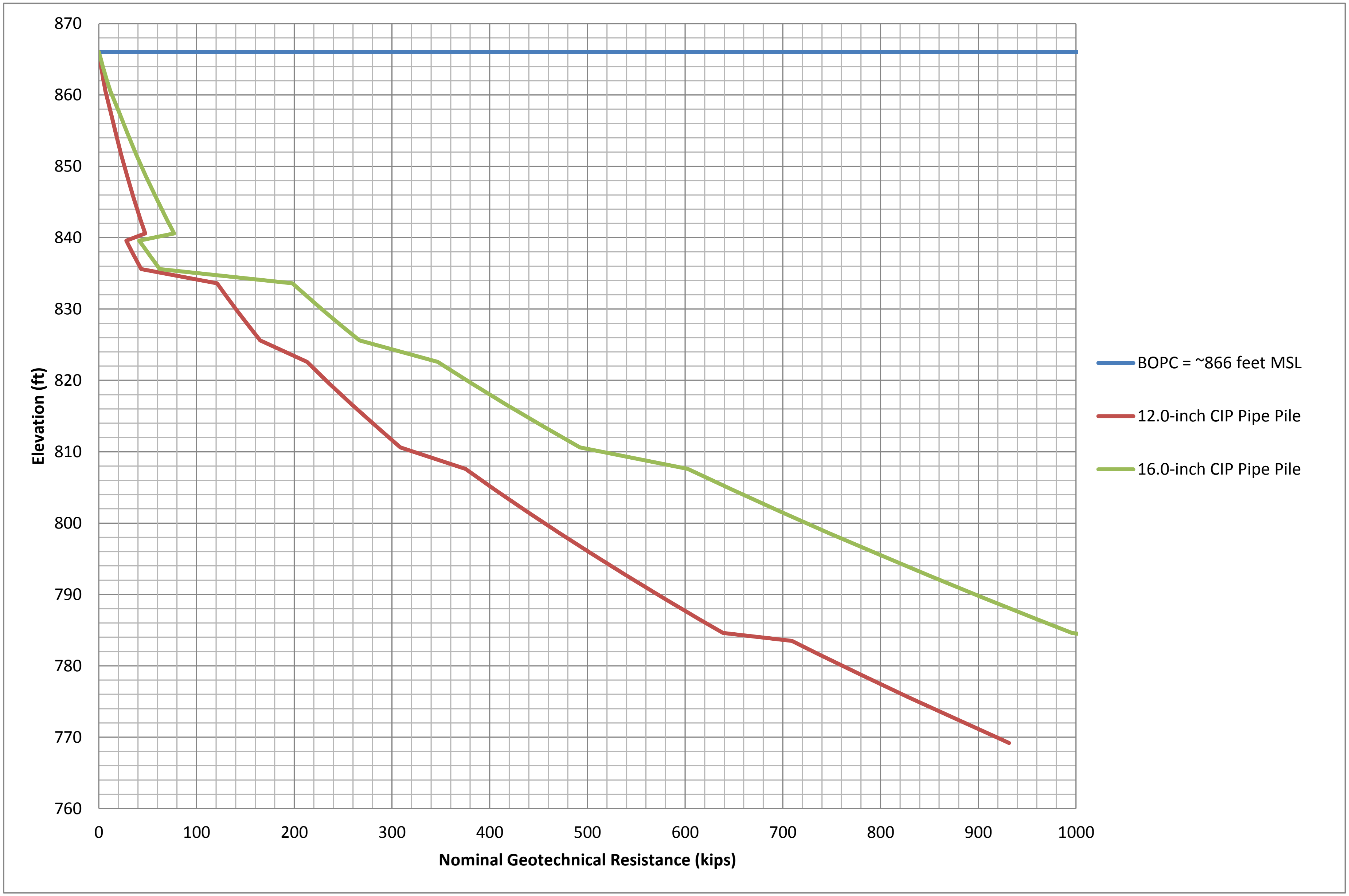
Bridge Over Shady Oak Road - Pier 9
Sounding: 2133CB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

BRAUN INTERTEC

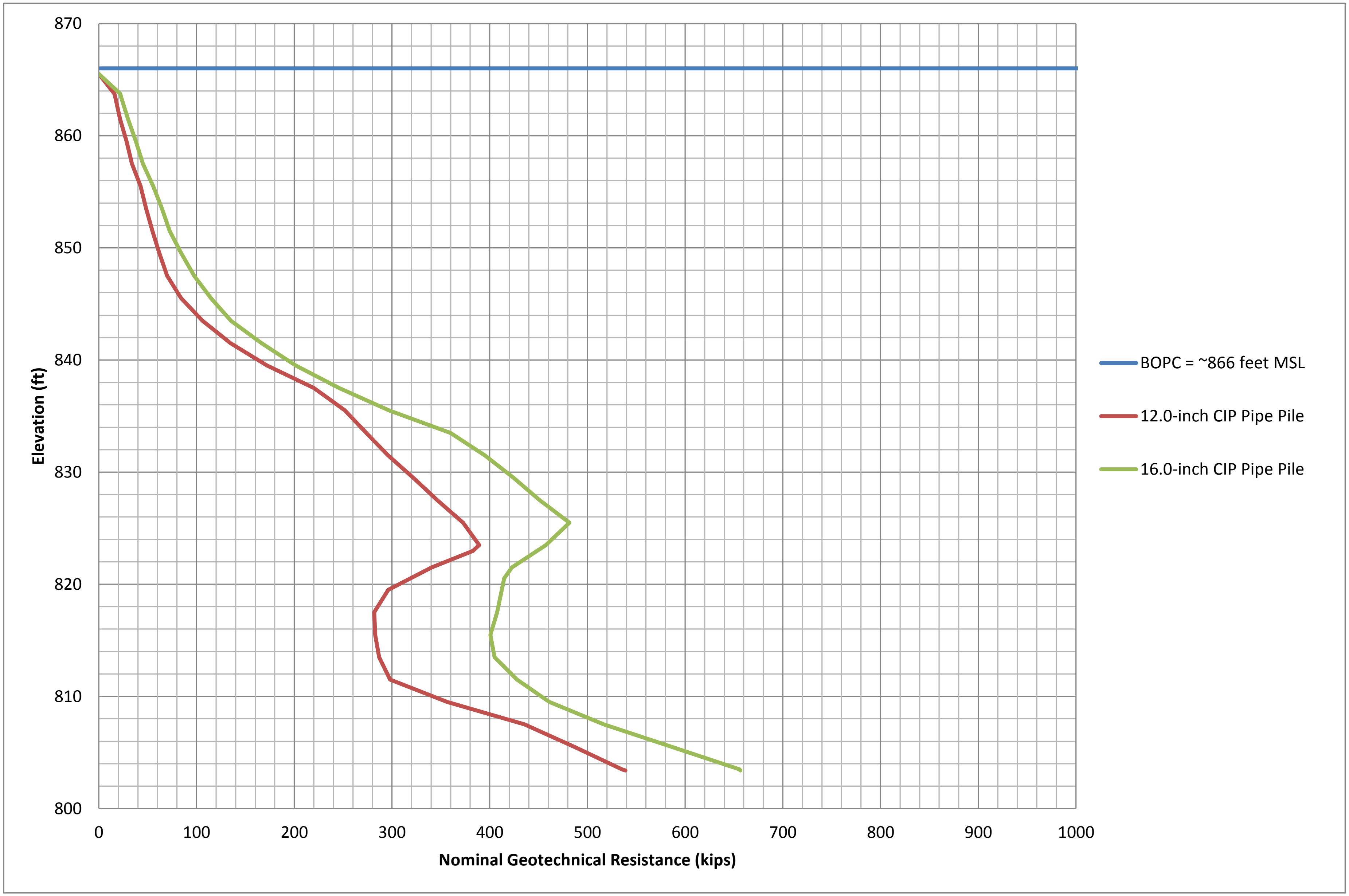
Bridge Over Shady Oak Road - Pier 10
Boring: 2015SB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

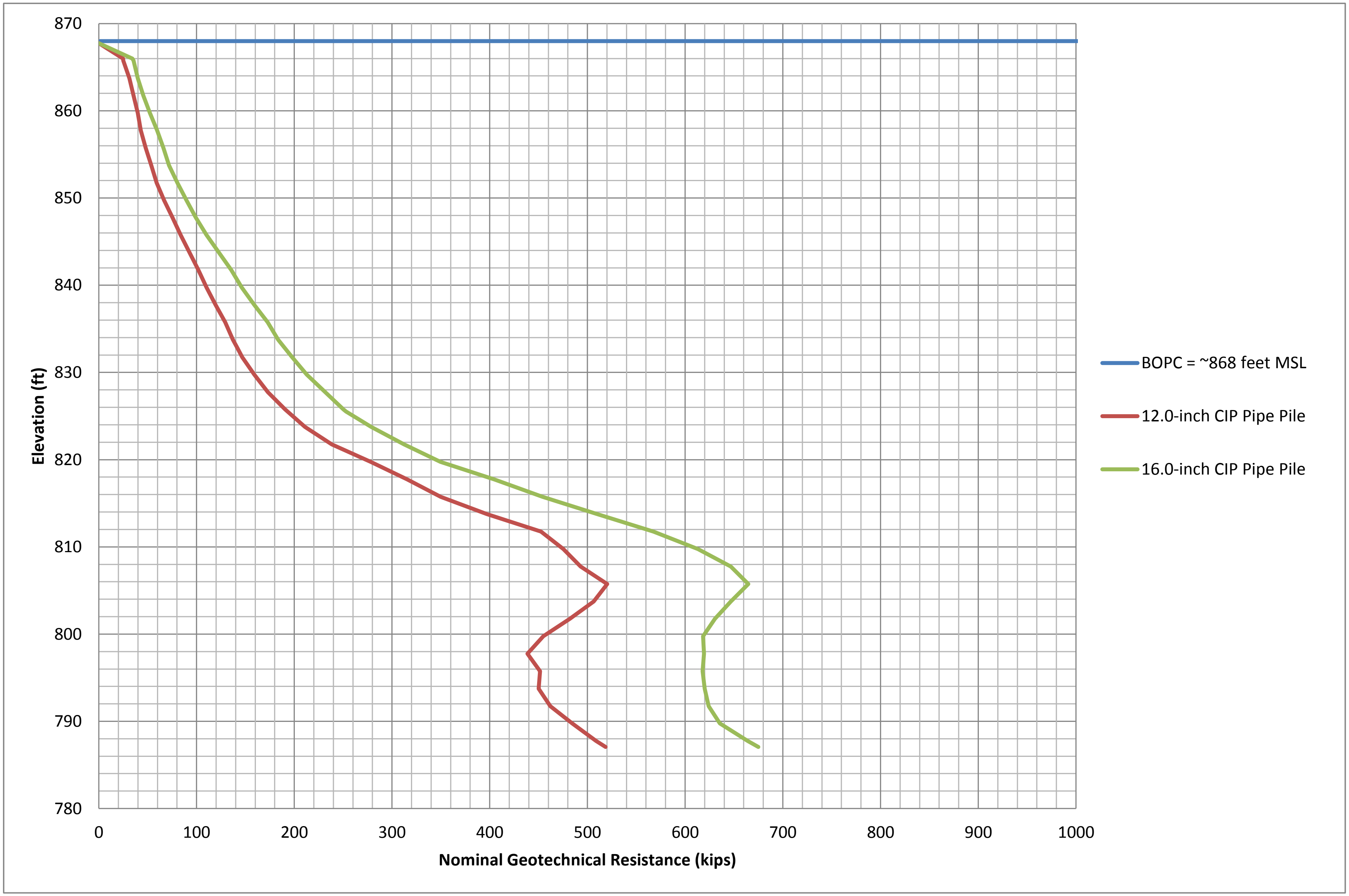
BRAUN INTERTEC

Bridge Over Shady Oak Road - Pier 11
Sounding: 2134CB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



Braun Project No. BL-13-00213

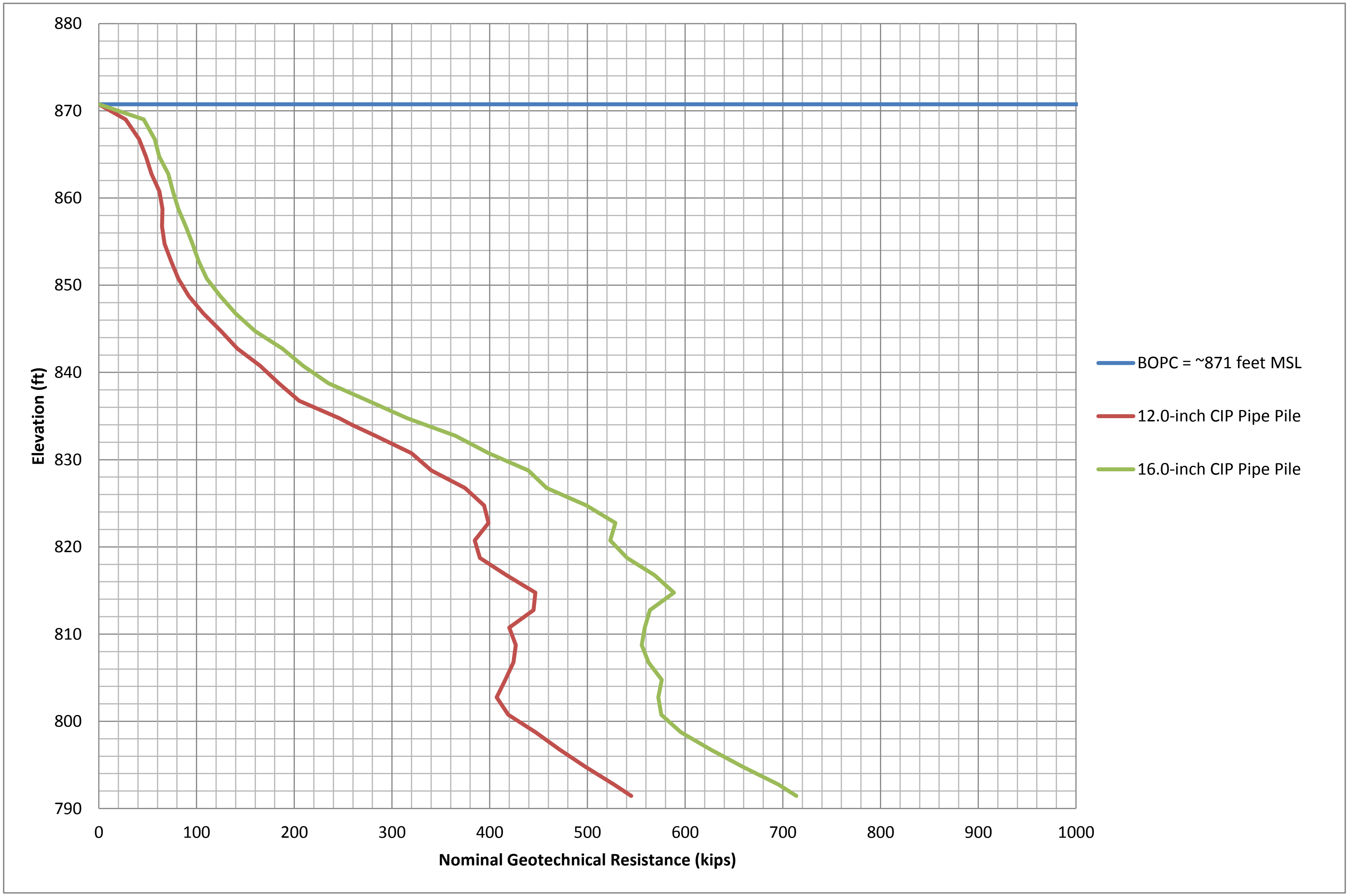
Bridge Over Shady Oak Road - Pier 12
Sounding: 2135CB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



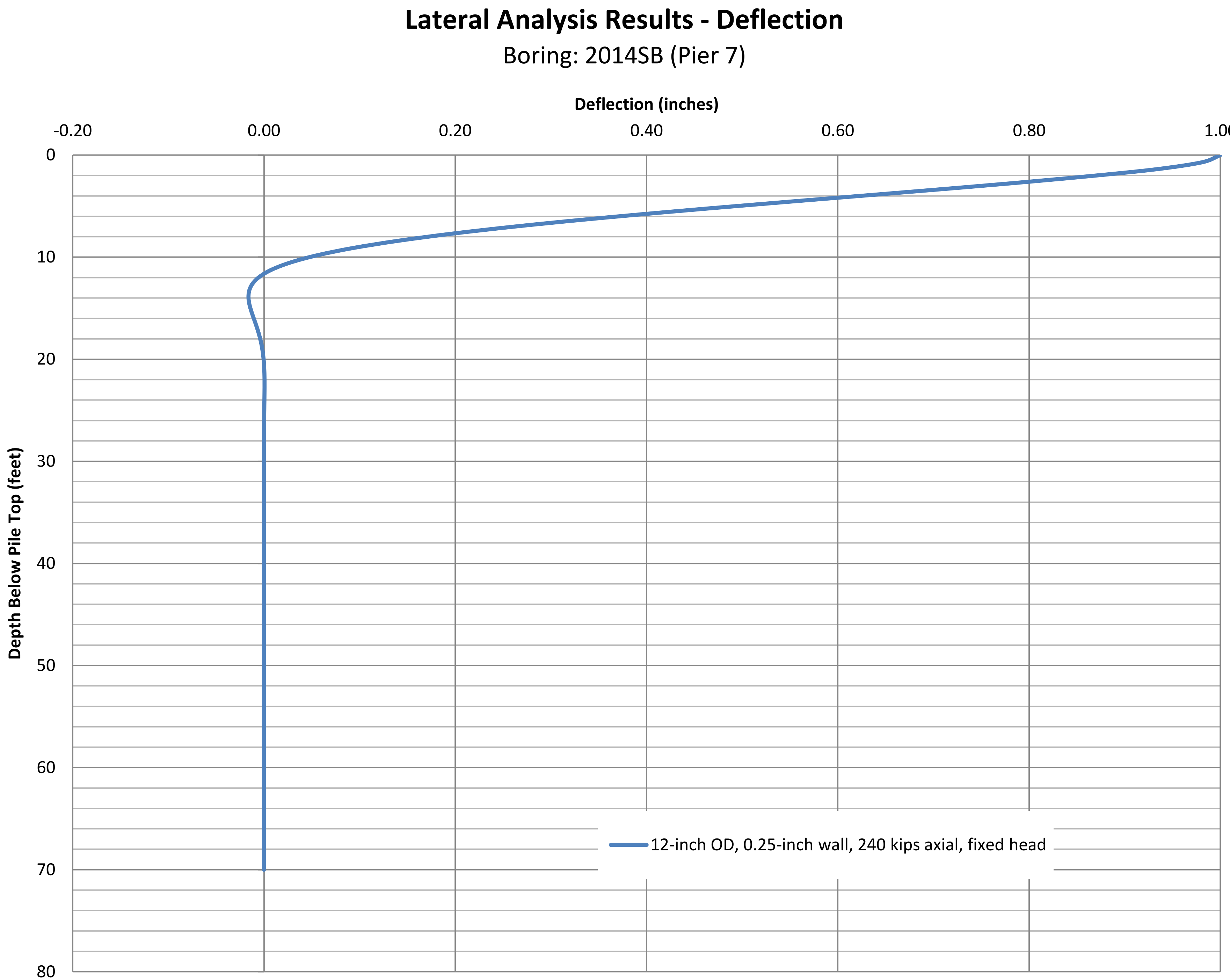
Braun Project No. BL-13-00213

BRAUN INTERTEC

Bridge Over Shady Oak Road - Pier 13
Sounding: 2136CB
12.0-inch and 16.0-inch Closed Ended Pipe Pile



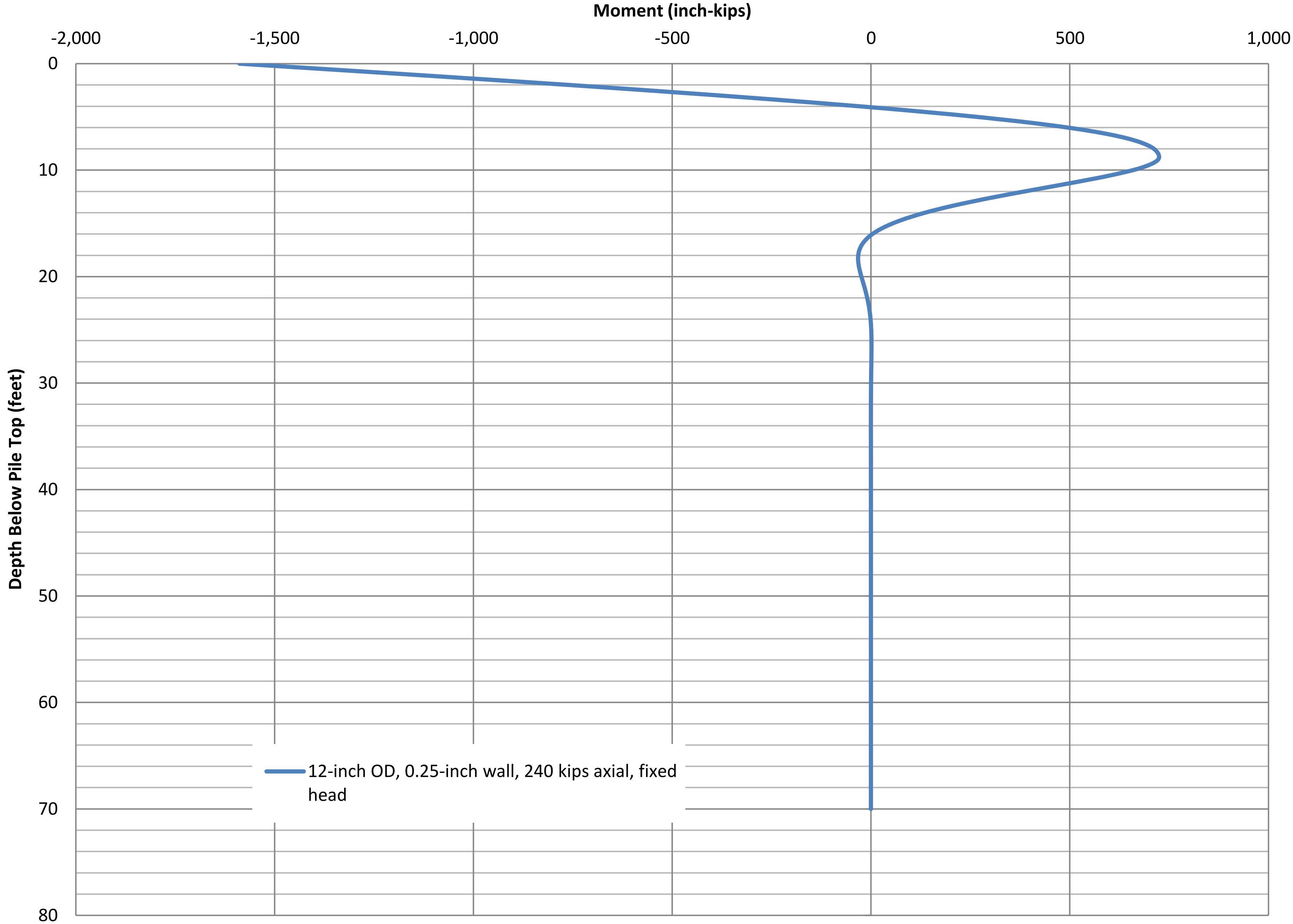
BRAUN INTERTEC



Braun Project No. BL-13-00213

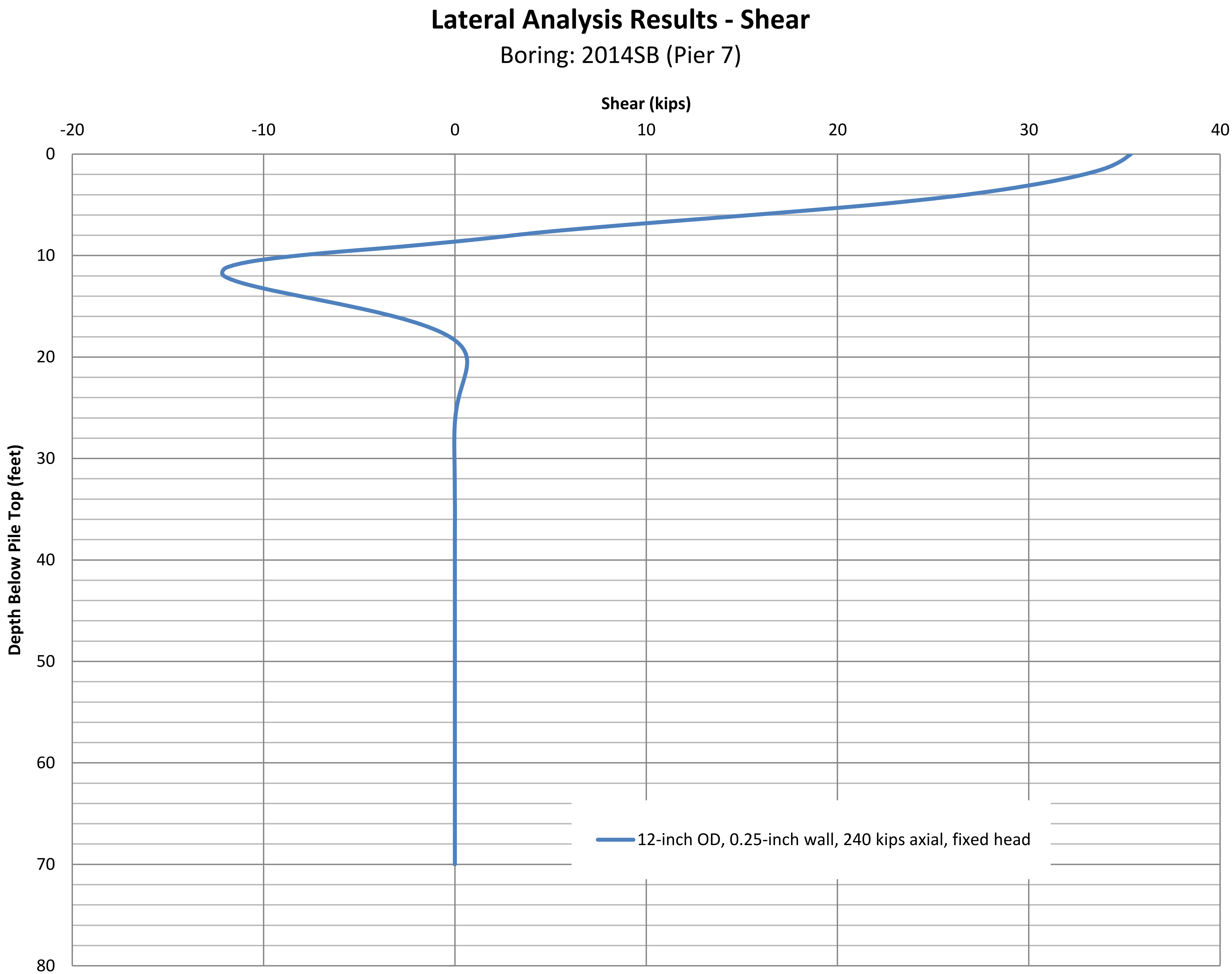
Lateral Analysis Results - Moment

Boring: 2014SB (Pier 7)



Braun Project No. BL-13-00213

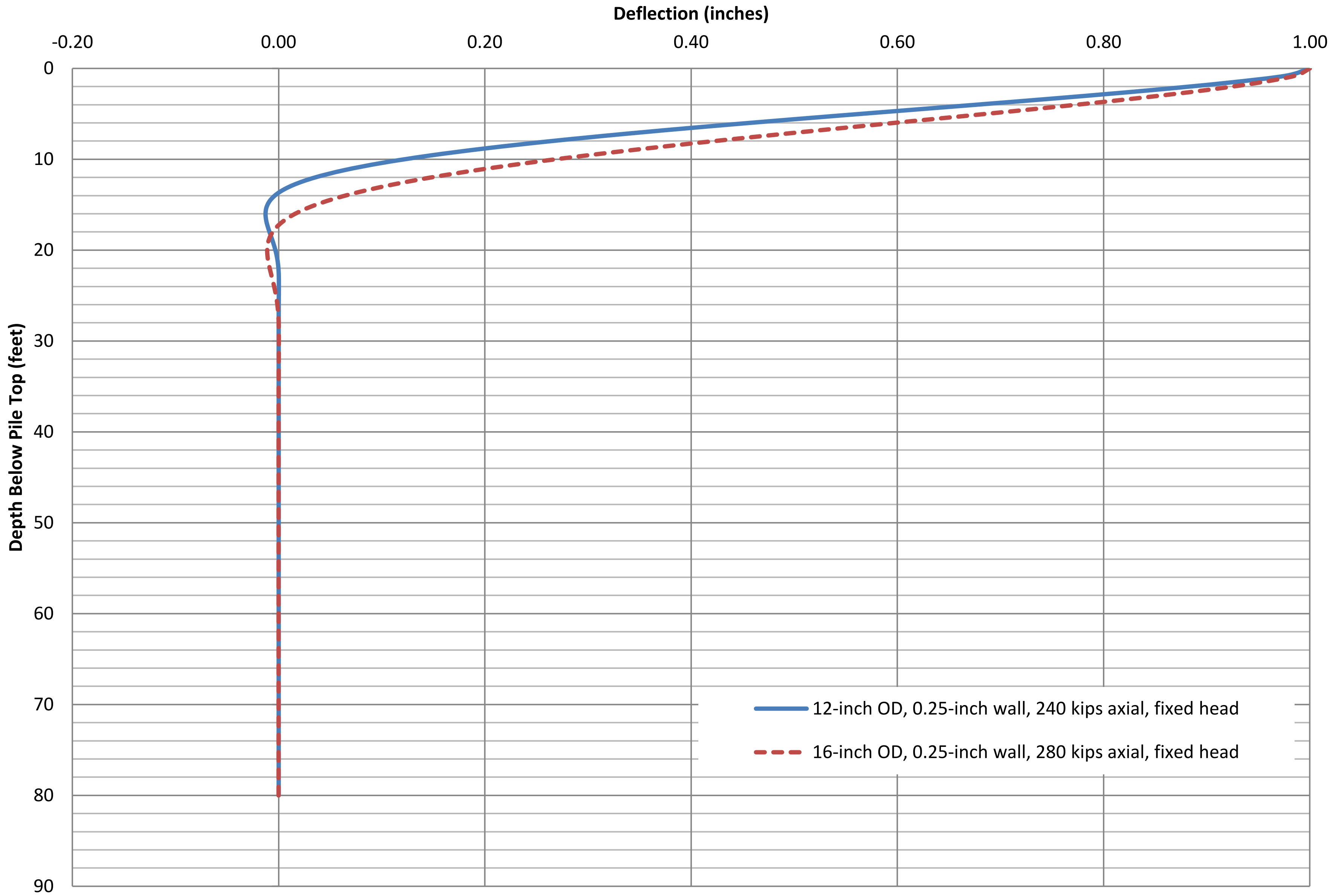
BRAUN INTERTEC



BRAUN INTERTEC

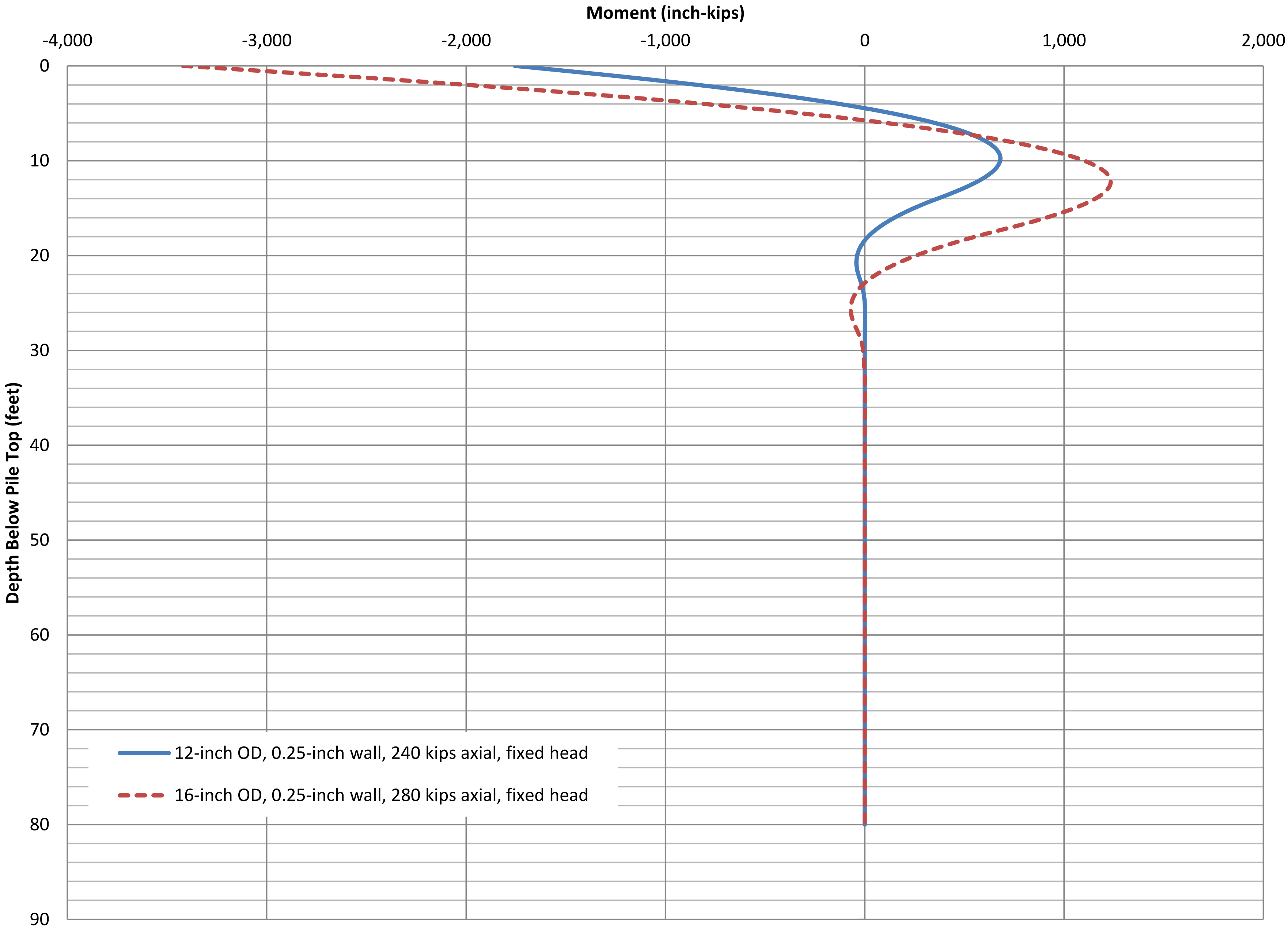
Lateral Analysis Results - Deflection

Boring: 2133SB (Pier 9)



Lateral Analysis Results - Moment

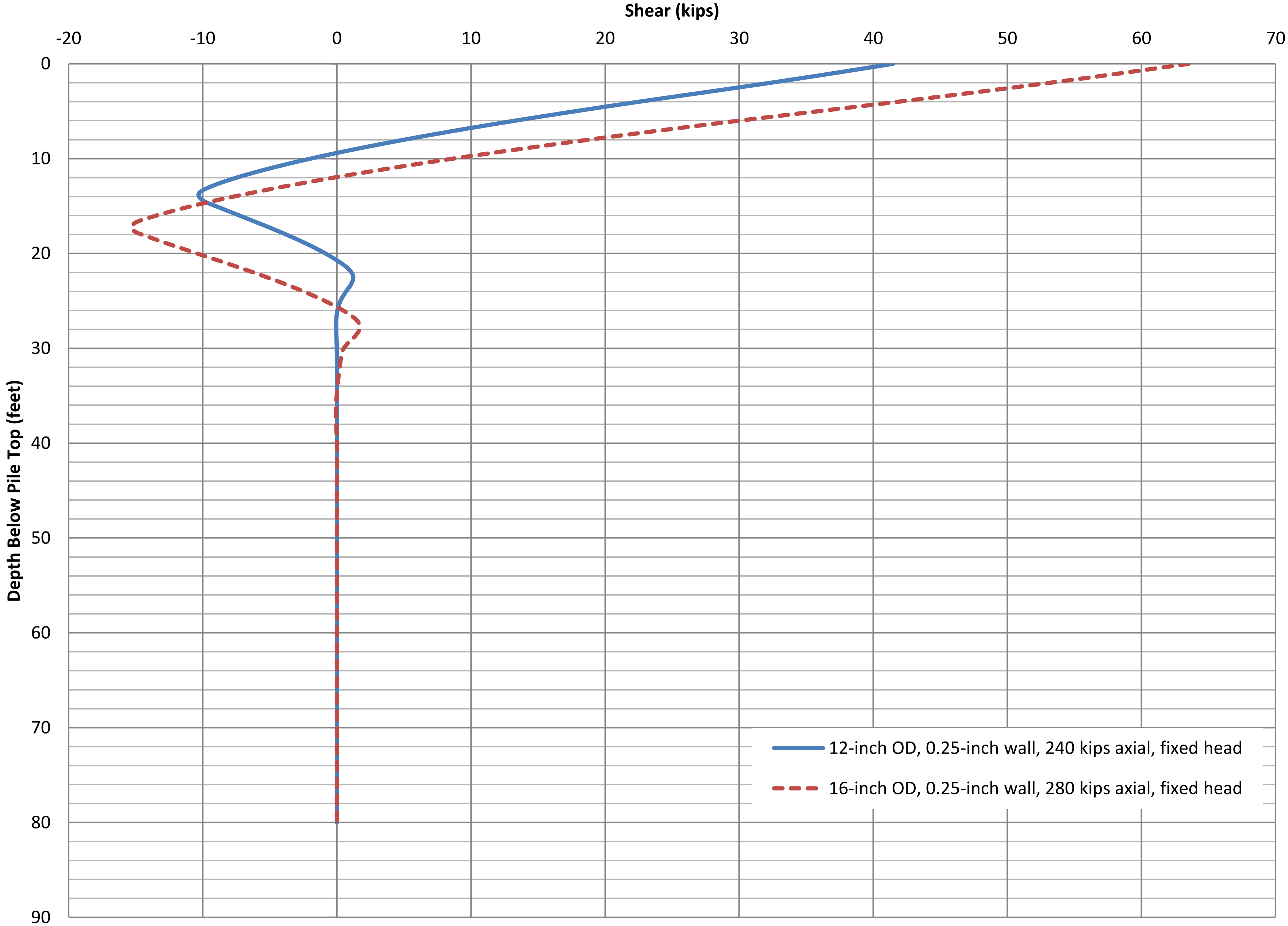
Boring: 2133SB (Pier 9)



BRAUN INTERTEC

Lateral Analysis Results - Shear

Boring: 2133SB (Pier 9)



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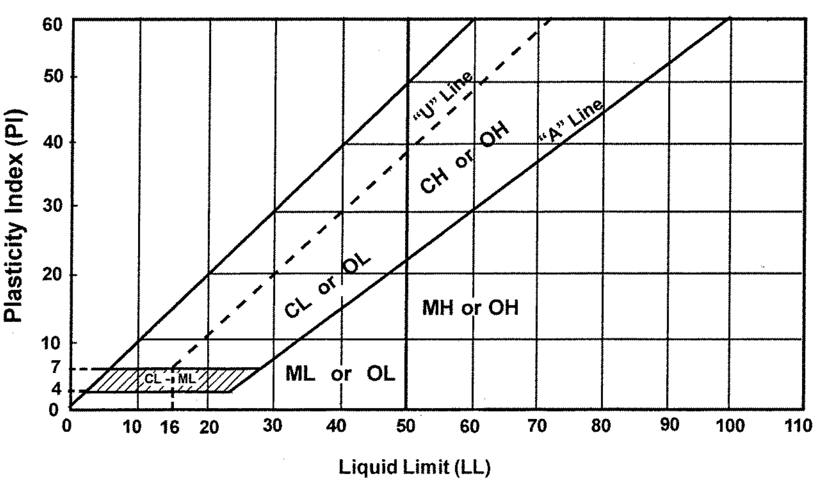
Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	**∅**	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

BRAUN INTERTEC

Descriptive Terminology
Cone Penetration Test

This document accompanies Cone Penetration Test Data. Please refer to the Boring Log Descriptive Terminology Sheet for information relevant to conventional v. Cone Penetration Test (CPT) boring logs.

Cone Penetration Test (CPT) sounding was performed in general accordance with ASTM D 5778 and consistent with the ordinary degree of care and skill used by reputable practitioners of the same discipline currently practicing under similar circumstances and in the same locality. No warranty, express or implied, is made.

Since subsurface conditions outside each CPT sounding are unknown, and soil, rock and pore water conditions cannot be relied upon to be consistent or uniform, no warranty is made that conditions adjacent to each sounding will necessarily be the same as or similar to those shown on this log. Braun Intertec is not responsible for any interpretations, assumptions, projections or interpolations of the data made by others.

Pore water pressure measurements and subsequently interpreted water levels shown on CPT logs should be used with discretion as they represent dynamic conditions. Dynamic pore water pressure measurements may deviate substantially from hydrostatic conditions, especially in cohesive soils. In cohesive soils, pore water pressures often take an extended time to reach equilibrium and thus reflect their true field level. Groundwater levels can be expected to vary both seasonally and yearly. The absence of notations on this log regarding water does not necessarily mean that groundwater is not present to the depth explored, or that a contractor will not encounter groundwater during excavation or construction.

CPT Terminology

CPT............Cone Penetration Test
CPTU.........Cone Penetration Test with Pore Pressure measurements
SCPTU.......Cone Penetration Test with Pore Pressure and Seismic measurements
Piezocone...Common name for CPTU test
Q_T........................normalized cone resistance
B_q........................pore pressure ratio
F_r..........................normalized friction ratio
σ_{vo}........................overburden pressure
σ'_{vo}.......................effective overburden pressure

q_T TIP RESISTANCE

The resistance at the cone corrected for water pressure. Data is from cone with a 60 degree apex angle and a 15 cm^2 end area.

f_s SLEEVE FRICTION RESISTANCE

The resistance along the sleeve of the penetrometer.

F_r Friction Ratio

Ratio of sleeve friction over corrected tip resistance.
$F_r = f_s/q_t$

V_s Shear Wave Velocity

A measure of the speed at which a seismic wave travels through soil/rock.

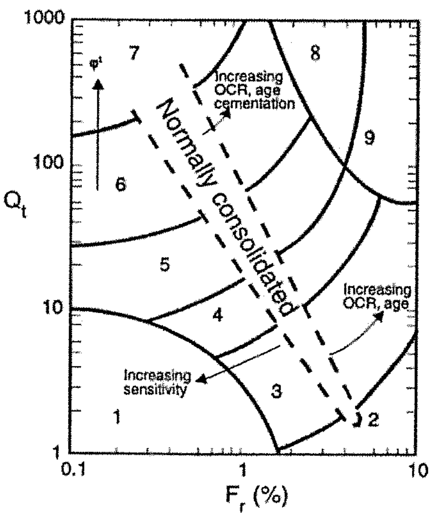
SBT SOIL BEHAVIOR TYPE

Soil Identification methods for the Cone Penetration Test are based on correlation charts developed from observations of CPT data and conventional borings. Please note that these identification charts are provided as a guide to Soil Behavior Type and should not be used to infer a soil classification based on grain size distribution.

Engineering judgment and comparison with augered borings is especially important in the proper interpretation of CPT data in certain geo-materials.

The following charts provide a Soil Behavior Type for the CPT Data. The numbers corresponding to different regions on the charts represent the following soil behavior types:

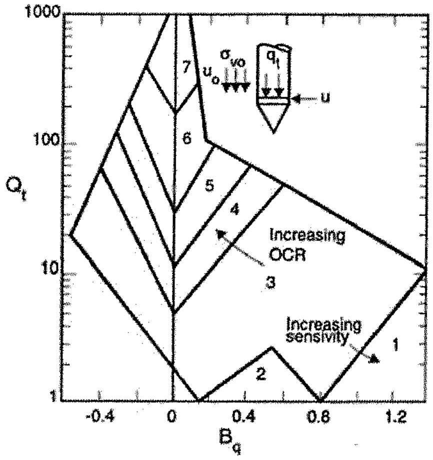
Soil Behavior Type based on friction ratio



$$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \qquad F_r = \frac{f_s}{q_t - \sigma_{vo}} \times 100\%$$

Robertson CPT 1990

Soil Behavior Type based on pore pressure



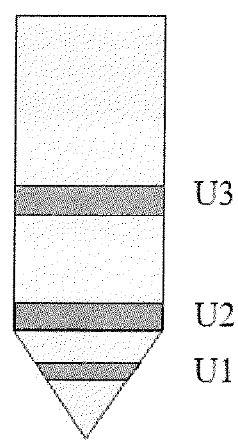
$$Q_t = \frac{q_t - \sigma_{vo}}{\sigma'_{vo}} \qquad B_q = \frac{u_2 - u_o}{q_t - \sigma_{vo}}$$

Robertson CPT 1990

1 Sensitive, Fine Grained
2 Organic Soils - Peat
3 Clays - Clay to Silty Clay
4 Silt Mixtures - Clayey Silt to Silty Clay
5 Sand Mixtures - Silty Sand to Sandy Silt
6 Sands - Clean Sand to Silty Sand
7 Gravelly Sand to Sand
8 Very Stiff Sand to Clayey Sand
9 Very Stiff, Fine Grained

U2 PORE WATER MEASUREMENTS

Pore water measurements reported on CPT logs are representative of pore water pressures measured at the U2 location, just behind the cone tip, prior to the sleeve, as shown in the figure below. These measurements are considered to represent dynamic pore water pressures due to the local disturbance caused by the cone tip. Dynamic pore water pressure decay and static pore water pressure measurements are reported on a Pore Water Pressure Dissipation Graph.



Appendix D

Retaining Walls W206, W207 and W209

BRAUN INTERTEC

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6545 Wayzata Boulevard, Suite 500
Wayzata, MN 55426

Re: Summary of Historical Boring Information and Preliminary Retaining Wall Recommendations
Retaining Walls RTW-W206, RTW-W207, and RTW-W209 – 30% Design
STA 2275+32 to STA 2304+71
Eden Prairie and Minnetonka, Minnesota

Dear Mr. Demers:

This purpose of this letter is to provide you and the design team with a summary of our gathered historical soil boring information in the area of retaining walls RTW-W206, RTW-W207, and RTW-W209 and to provide preliminary retaining wall closing design information. A final geotechnical report should be prepared after final geotechnical design borings are completed.

A. Subsurface Investigation Summary

A.1. Summary of Historical Boring Information

Due to site terrain and vegetation, preliminary design soil borings have not been completed. We referenced previously completed SWLRT soil borings and historical borings performed near the site to obtain general soil conditions typical of the area. Three (3) standard penetration soil borings for SWLRT were performed in the general area. The table below provides information on the borings including numbering, track stationing, and the ground surface elevation at the boring location:

Table 1. Soil Boring Information near the Proposed Retaining Walls

Boring	Approximate Track Station	Surface Elevation at Boring Location (ft)
2016SB	2275+30	893.9
2018SB	2304+70	925.5
2019SB	2309+25	934.4

Included in the Appendix are four historical borings (ST-121, ST-210, ST-211, ST-213) from an adjacent site which provide generalized soil information for the area. A boring location sketch is also provided in the Appendix.

A.2. Description of Foundation Soil Conditions

A.2.a. General Soil Profile

As mentioned previously, borings were not performed at the proposed wall locations. The following soil conditions are based on existing SWLRT borings and available historical boring information near the proposed walls. We recommended additional borings be performed prior to final design to evaluate the subsurface conditions at the wall locations.

In general, the area where the proposed walls are to be constructed consist of Des Moines lobe sands and clays.

The general soil profile consists of a mixture of sands and clays, with some surficial fill associated with the construction of TH 212 and TH 62.

Table 2 below provides some general guidelines regarding the consistency of the soils that are anticipated to be encountered.

Table 2. Anticipated Soil Consistencies based on Historical Soil Boring Information

Soil Type	Average Blows Per Foot (BPF)	Typical Soil Consistency
SP (poorly graded sand)	17 - 30	Medium Dense
SP-SM (poorly graded sand w/ silt)	10 - 16	Loose to Medium Dense
SM (silty sand)	18 - 30	Medium Dense
SC (clayey sand	20 - 35	Medium Dense to Dense
CL (lean clay)	6 - 15	Medium to Stiff
CLS (sandy lean clay)	10 - 15	Rather Stiff to Stiff

A.2.b. Groundwater

Based on the historical information and the borings near the proposed walls, we anticipate groundwater is deeper than the planned excavation depths for the proposed walls. However, perched groundwater may be encountered in sandy layers. In the area, perched groundwater was noted in sand layers up to an elevation of 910, but may vary away from the boring locations.

Seasonal and annual fluctuations in groundwater levels should also be expected. Two piezometers were installed as part of the investigation for the proposed TH 62 tunnel and can be referenced for groundwater information. At last measurement on May 17, 2013, groundwater was encountered at elevation 880.

B. Design and Construction Considerations

Limited design information was known at the time of this report. Based on the draft municipal consent plans, it appears retaining walls RTW-W206, RTW-W207, and RTW-W209 will be constructed from STA 2275+50 to STA 2304+71. The table below shows the wall segment, length, track stationing, and the anticipated minimum, maximum, and average cut and fill depths as reported to us by the design team.

Table 3. Preliminary Wall Design Information

Retaining Wall	Length (ft)	Beg. Track STA	End Track STA	Min. Cut (ft)	Max. Cut (ft)	Ave. Cut (ft)	Min. Fill (ft)	Max. Fill (ft)	Ave. Fill (ft)
RTW-206A	508	2275+49	2280+57	---	---	---	0	23	16
RTW-206B	285	2280+57	2283+43	0	9	6	---	---	---
RTW-206C	345	2283+43	2286+93	---	---	---	0	6	5
RTW-206D	308	2286+93	2290+29	0	32	17	---	---	---
RTW-206E	158	2290+20	2292+00	---	---	---	0	12	10
RTW-207A	1291	2275+49	2288+35	---	---	---	0	16	8
RTW-207C	51	2291+00	2291+50	---	---	---	0	4	2
RTW-207D	1340	2291+50	2304+71	0	16	10	---	---	---
RTW-209	482	2299+90	2304+71	4	17	11	---	---	---

The following design and construction criteria were considered and will be addressed in our preliminary evaluation. We recommend a final geotechnical program be established and performed upon final design of the retaining walls:

- Based on the cross sections we were provided, we anticipate that wall heights will range from 8 to 36 feet in height.
- While this report will discuss spread footing foundation with an allowable bearing capacity, we will also discuss the embedment depth for soldier piling and lagging along segments of the proposed retaining walls.
- For the preliminary solider pile wall design of the retaining wall, we assumed a uniform sandy soil with slightly increasing density below the excavation. We assume a surcharge from the light-rail train of 34 kips per axle spreading 5 feet along the length of rail and across the width of the tie.

B.1.a. Precautions Regarding Changed Information

We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C. Preliminary Recommendations

The following preliminary recommendations are based on the results of past and current soil borings in the vicinity of the proposed walls.

C.1. Cast-In-Place Concrete Retaining Walls

We based our preliminary design and construction recommendations on the MnDOT retaining wall design criteria for cast-in-place (CIP) concrete retaining walls, dated May 31, 2006.

C.1.a. Excavations

In general, we recommend removing the topsoil and fill from beneath the base of the new retaining walls. Based on the borings and historical information, the fill soils range from 1 to 7 feet below the ground surface. From there, the footings can either be placed on the native soils, or engineered fill can be placed and compacted to achieve design elevations. However, since the borings were offset along the proposed alignment and in the area of the proposed walls, it is possible that the fill soils do not extend to the same depth under the current alignment.

To provide lateral support to replacement backfill, additional required fill, and the structural loads they will support, we recommend oversizing (widening) the excavations 1 foot horizontally beyond the outer edges of the retaining wall foundations for each foot the excavations extend below bottom-of-footing subgrade elevations.

Excavation depths will vary between the borings and the actual wall location. Portions of the excavations may also be deeper than indicated by the borings. Contractors should also be prepared to extend excavations in wet or fine-grained soils to remove disturbed bottom soils.

C.1.b. Selection, Placement, and Compaction of Backfill.

We recommend referencing the following specification sections in Table 4 below from the 2014 MnDOT Standard Specifications for Construction when considering the material and compaction specifications for the embankment material beneath the wall, level pad material, and retaining wall backfill material.

Table 4. Material and Compaction Specifications for Retaining Walls.

Material	Material Specification	Compaction Specification
Embankment Fill	2105.A6	2105.3F
Leveling Pad Beneath Footings	3149.2G	2211.2D or 2211.3C
Retaining Wall Backfill	3149.2D2	2105.3F

C.1.c. Net Allowable Bearing Pressure

Based on MnDOT's cast-in place concrete retaining wall criteria, the above recommendations, and the assumed soils encountered at the wall locations, we anticipate the soils will be suitable for support of walls with a stem height of up to 20 feet. Because several feet of the stem wall height is buried for frost protection, the maximum exposed wall height will range from 16 to 23 feet. Regardless of wall height, we recommend further analysis and borings at the proposed wall locations to confirm soil conditions.

In areas where a cast-in-place wall may not be feasible, we have provided preliminary estimates for soldier pile and lagging installation using assumed soil conditions.

C.2. Preliminary Soldier Pile Wall Design

We performed a preliminary soldier pile and lagging design analysis based on preliminary information provided to us and assumed soil conditions provided in Table 5 below.

Table 5. Assumed Soil Conditions

Geologic Material	Saturated Unit Weight (pcf)	Friction Angle (degrees)
Above Grade Soils and/or Retained Soils	120	30
Below Grade Soils	125	30

Our preliminary analysis used the assumed soil conditions noted above to evaluate piles at various track stationing for various wall heights, grades, and slopes that were provided to us on preliminary track cross sections. Table 6 below provides preliminary sizing for use in preliminary cost estimation.

Table 6. Preliminary Soldier Pile Design Information

Track Stationing	Retaining Wall	Exposure Height (ft)	Pile Spacing (ft)	Pile Length (ft)	Number of Vertical Tiebacks	Horizontal Tieback Spacing (ft)
2275+50 to 2280+50	RTW-W206 & RTW-W207	25	8	40	1	8
		20	8	35	1	8
		15	8	25	1	8
		10	5	30	N/A	N/A
2281+00	RTW-W206	12	5	31	N/A	N/A
2281+50	RTW-W206	17	8	25	1	8
2282+00 to 2287+50	RTW-W206	15	8	30	1	8
		10	8	25	1	8
		8	8	23	1	8
2284+00 to 2288+00	RTW-W207	25	8	40	1	8
		20	8	35	1	8
		15	8	25	1	8
		10	5	30	N/A	N/A
2288+00 to	206	32	8	51	3	8

Track Stationing	Retaining Wall	Exposure Height (ft)	Pile Spacing (ft)	Pile Length (ft)	Number of Vertical Tiebacks	Horizontal Tieback Spacing (ft)
2289+50		30	8	45	2	8
		22	8	37	1	8
2289+00 to 2289+50	207	25	8	37	1	8
		15	8	23	1	8
2290+00 to 2292+00	206 & 207	20	8	35	1	8
		15	8	25	1	8
2292+50 to 2296+00	206 & 207	13	8	31	N/A	N/A
2299+00 to 2304+50	207 & 209	20	8	30	1	8
		15	8	23	1	8
		10	8	25	N/A	N/A

D. General

This report should be considered preliminary in nature and will be revised upon final design parameters and the completion of the full geotechnical program. In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If you have any questions about this report, please contact Josh Kirk at 952.995.2222.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal - Project Engineer
License Number: 45005

Ray A. Huber, PE
Vice President – Principal Engineer

Appendix:
Preliminary Engineering Plan and Profile Pages RTW-W206, RTW-W207, RTW-W209
Soil Boring Location Sketch of Adjacent Site
Historical Standard Penetration Borings - ST-121, ST-210, ST-211, ST-213

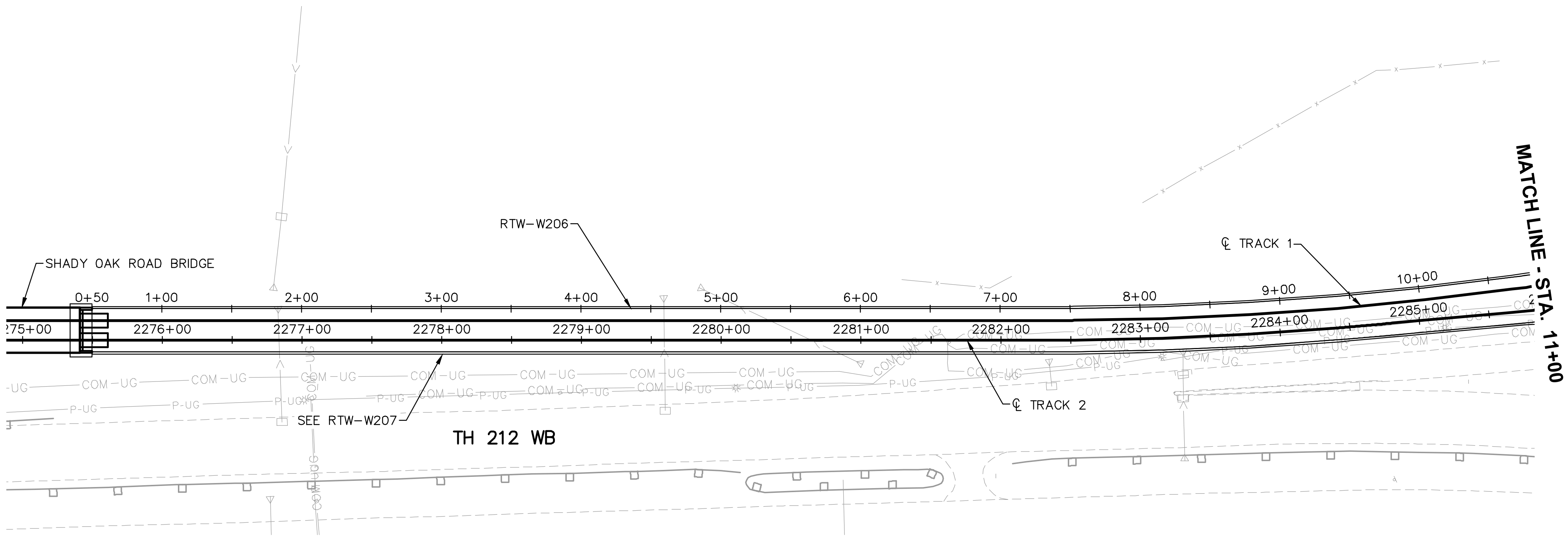
c: Mr. Jeff Stewart, SPO
Ms. Laura Amundson, Parsons Brinkerhoff

APPENDIX

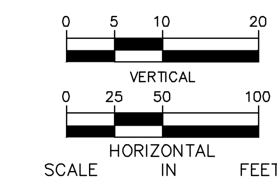
NOTE:
RTW-W206 IS ANTICIPATED TO BE A SOLDIER PILE AND LAGGING RETAINING WALL FROM STA. 2286+94 TO STA. 2290+30 TO PRESERVE THE ADJACENT FOREST ON THE HILL.

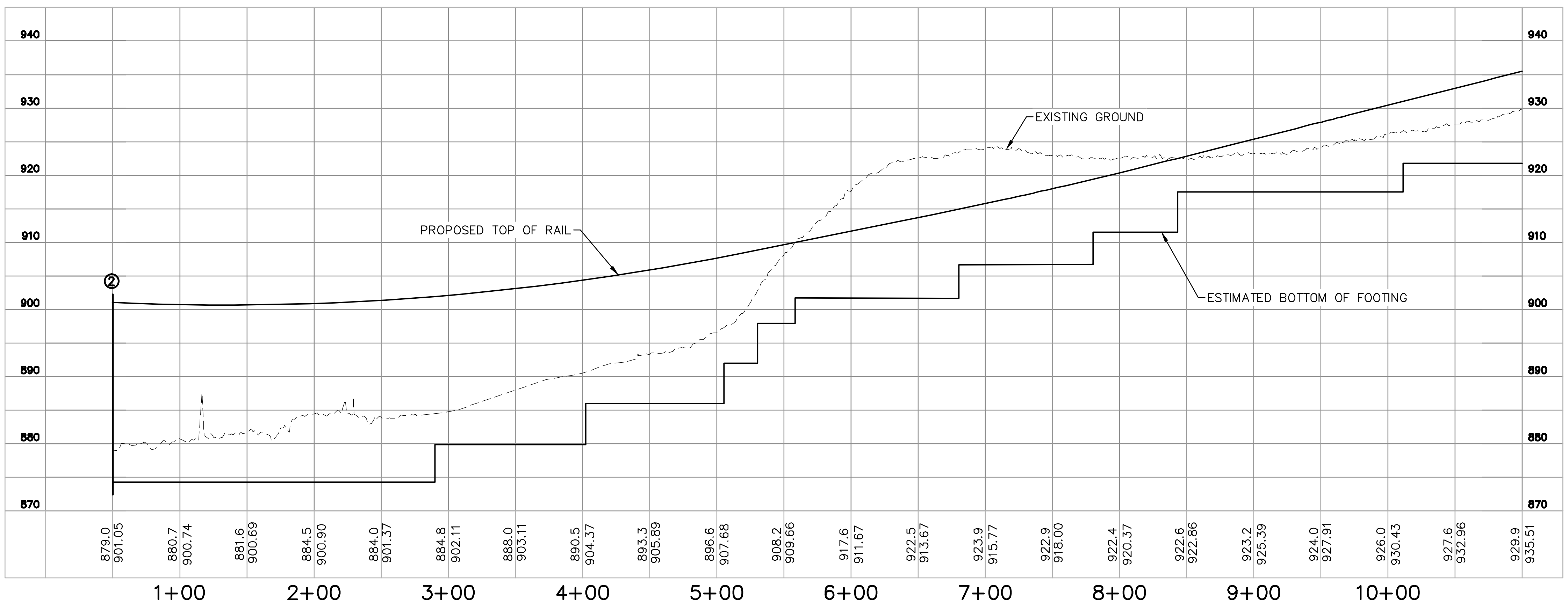
THE REMAINDER OF RTW-W206 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.

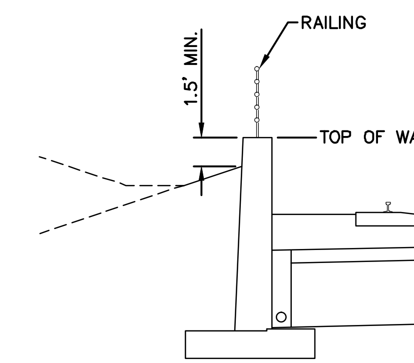


RTW-W206 PLAN

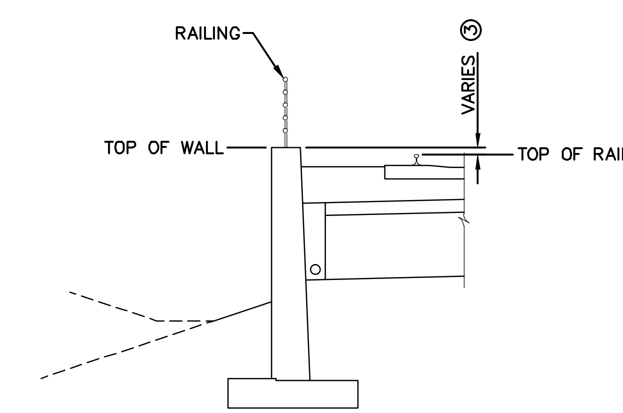




RTW-W206 PROFILE



RTW-W206 TYPICAL SECTION
STA. 5+58 TO STA. 8+43



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W206 TYPICAL SECTION
STA. 0+50 TO STA. 5+58
STA. 8+43 TO STA. 11+00

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AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2 - RTW-W206
PLAN AND PROFILE
STA. 00+50 TO STA. 11+00

DISCIPLINE: STRUCTURES

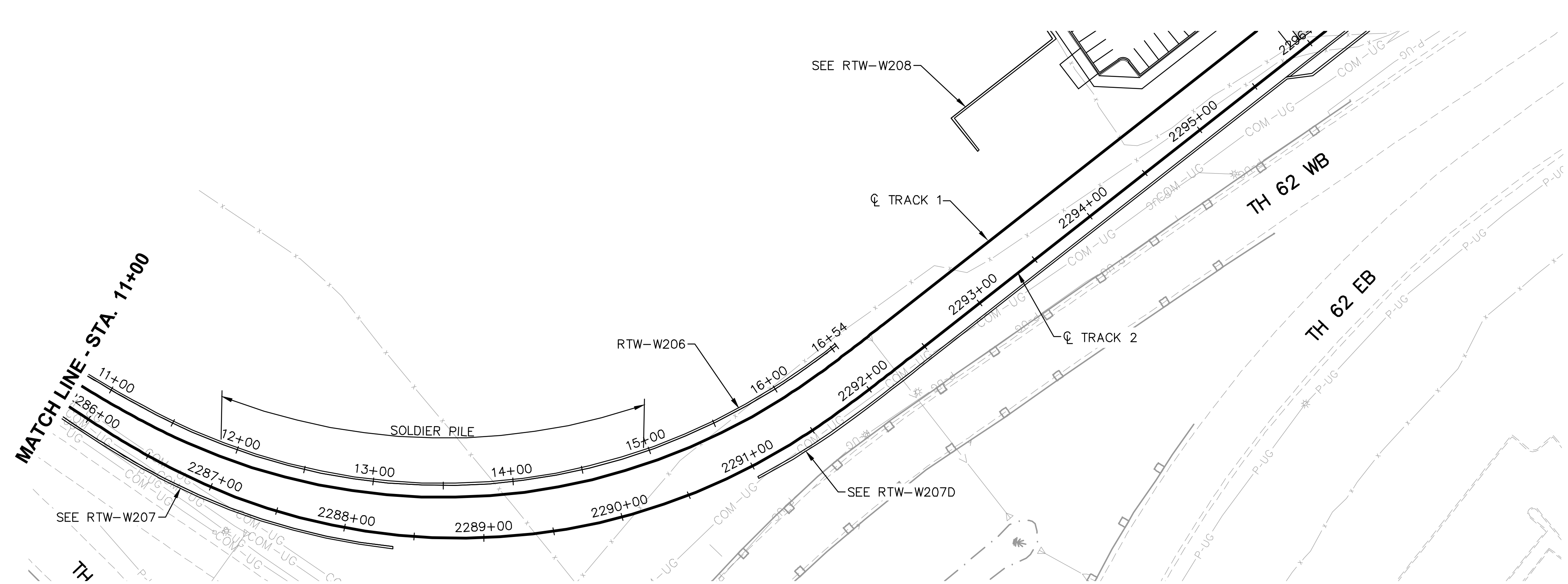
SHEET NAME: W2-STU-RTW-PPFL-006

SHEET 178 OF 197

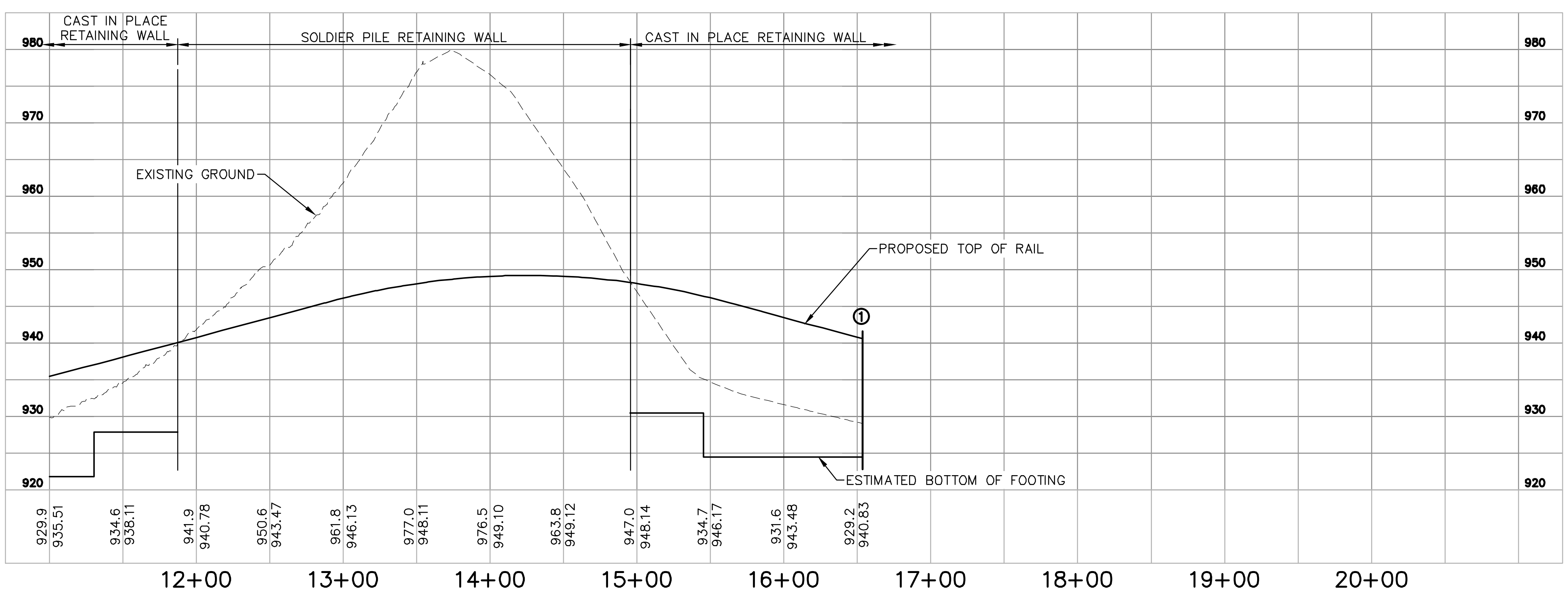
NOTE:
RTW-W206 IS ANTICIPATED TO BE A SOLDIER PILE AND LAGGING RETAINING WALL FROM STA. 2286+94 TO STA. 2290+30 TO PRESERVE THE ADJACENT FOREST ON THE HILL.

THE REMAINDER OF RTW-W206 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

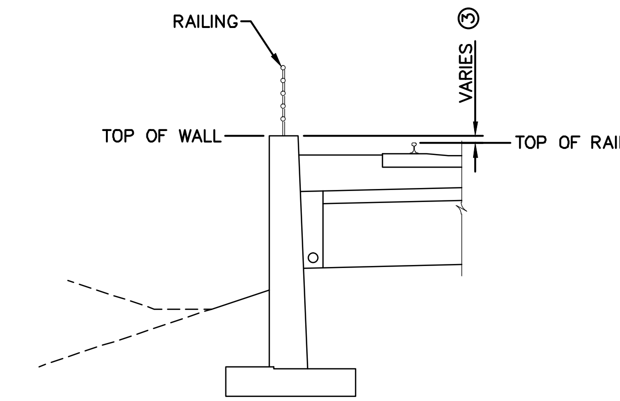
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.



RTW-W206 PLAN

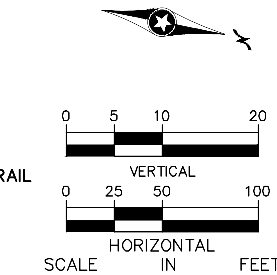


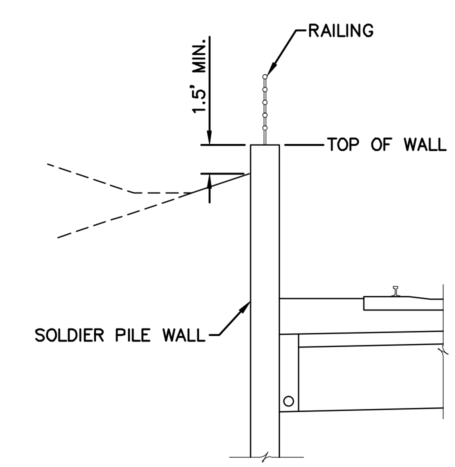
RTW-W206 PROFILE



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W206 TYPICAL SECTION
STA. 11+00 TO STA. 11+87
STA. 14+96 TO STA. 16+54





RTW-W206 TYPICAL SECTION
STA. 11+87 TO STA. 14+96

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AECOM

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2 - RTW-W206
PLAN AND PROFILESEGMENT 2
STA. 11+00 TO STA. 16+54

DISCIPLINE: STRUCTURES

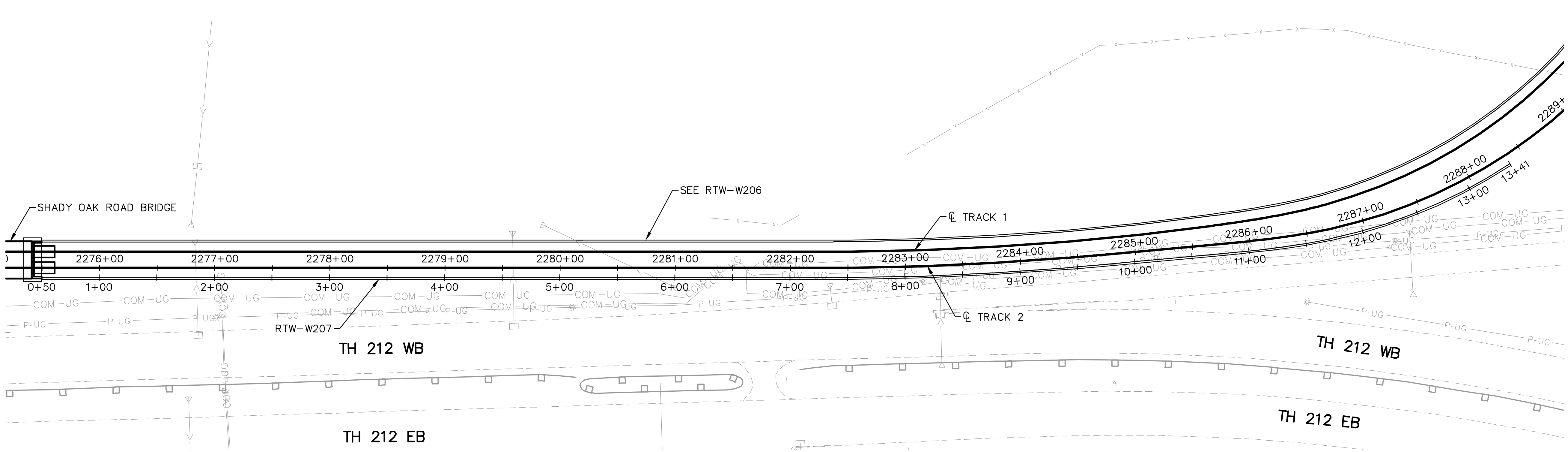
SHEET NAME: W2-STU-RTW-PPFL-007

SHEET 179 OF 197

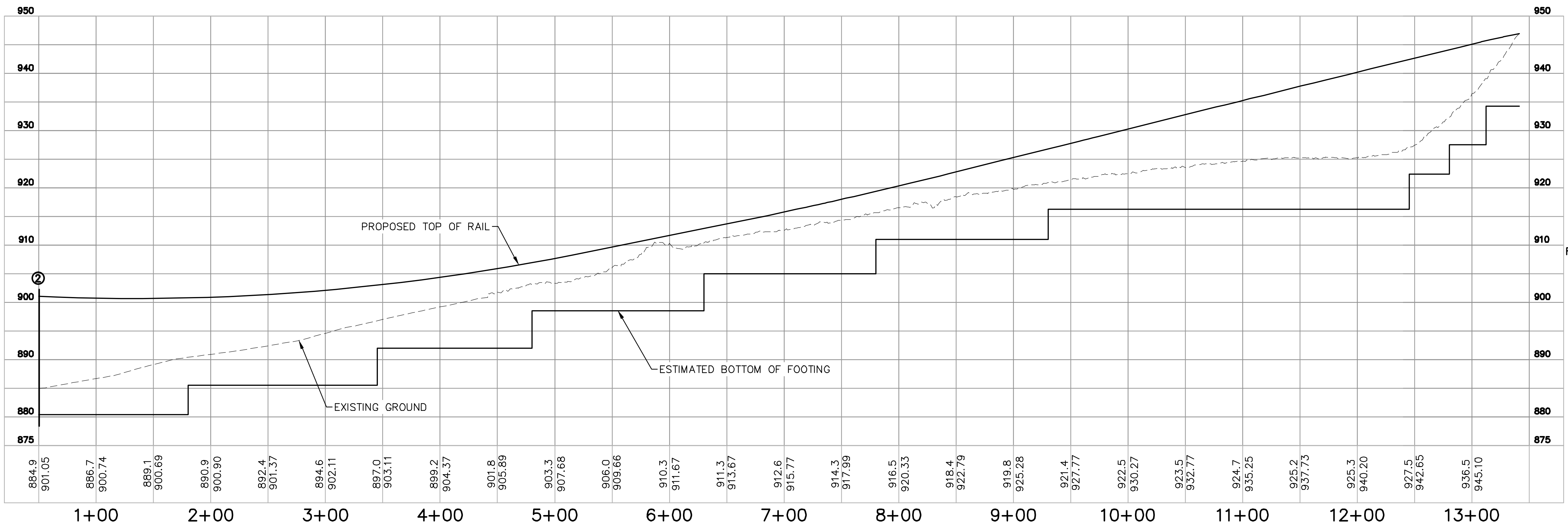
Jun, 13 2014 11:07 am V:\3200_PEC-W\CAD\SEGMENT-W2\SHEET\STRUCTURES\W2-STU-RETW.dwg By: NutzmaML

NOTE:
RTW-W207 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

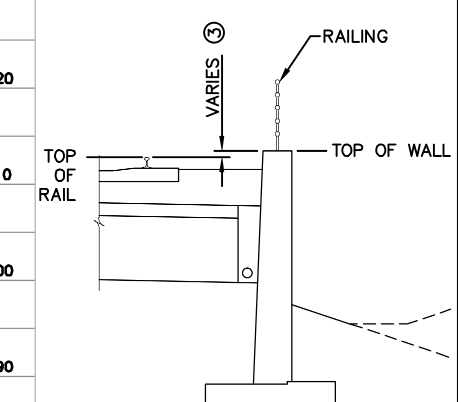
② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.



RTW-W207 PLAN



RTW-W207 PROFILE



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W207 TYPICAL SECTION

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2
RTW-W207
PLAN AND PROFILE

DISCIPLINE: STRUCTURES
SHEET NAME: W2-STU-RTW-PPFL-008

SHEET 180 OF 197

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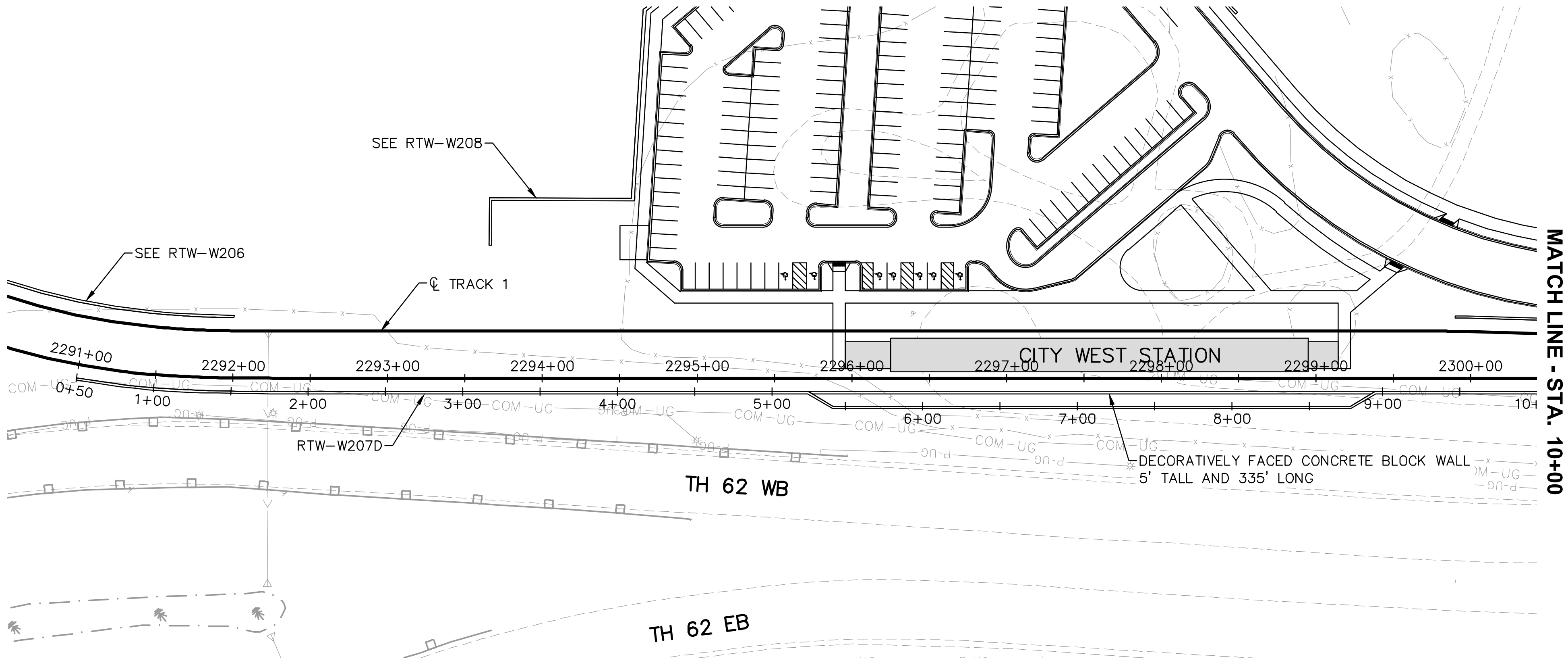
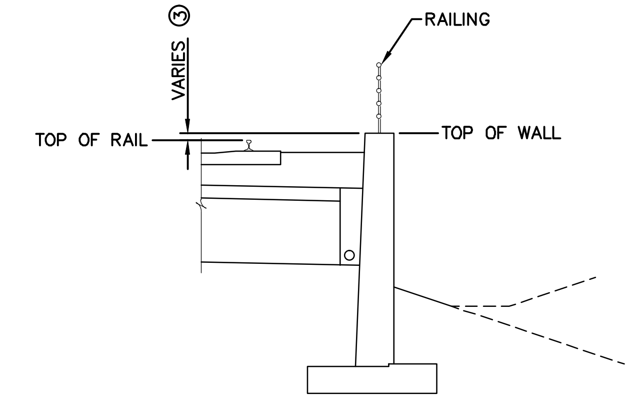
NOTE:
RTW-W207D IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

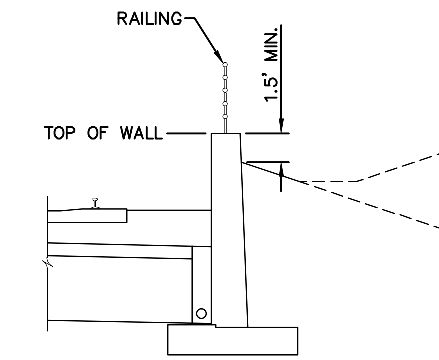


RTW-W207D PLAN



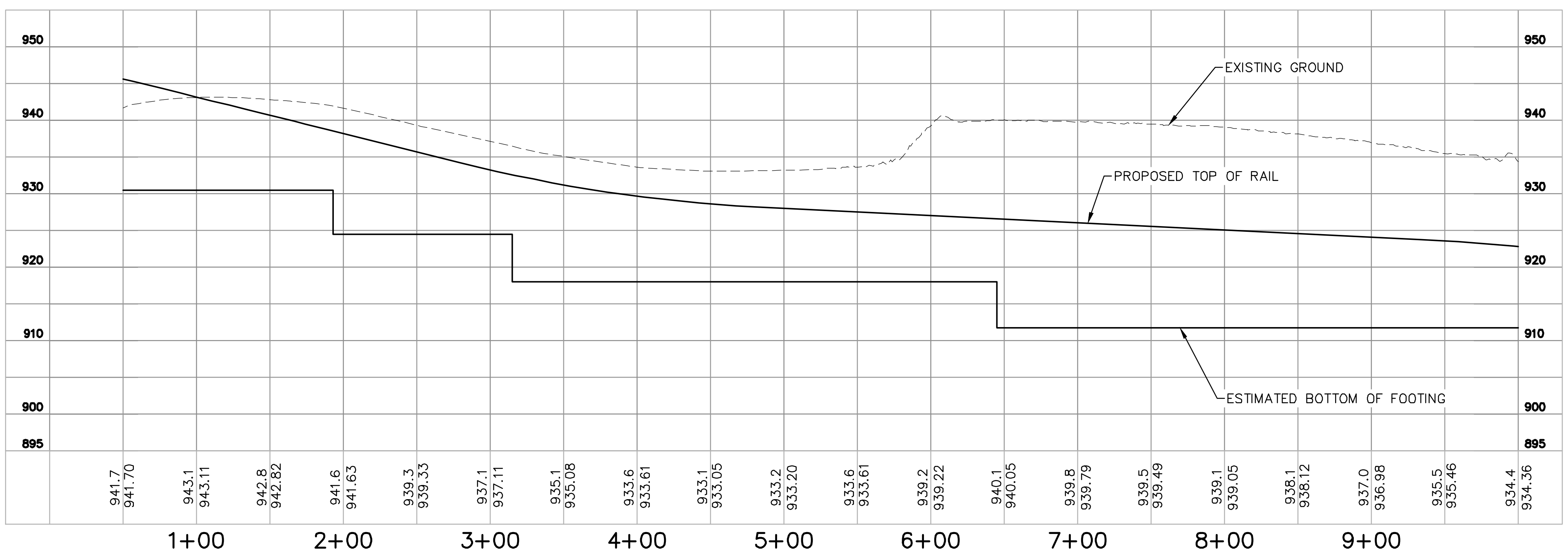
③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W207D TYPICAL SECTION
STA. 0+50 TO STA. 1+01

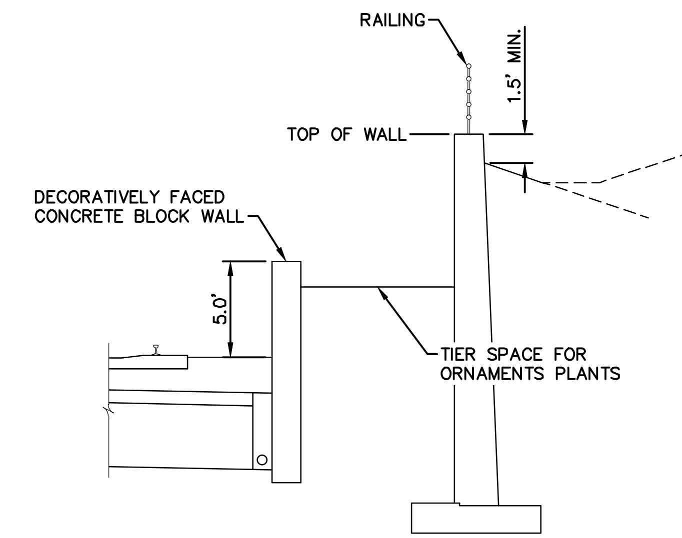


RTW-W207D TYPICAL SECTION
STA. 1+01 TO STA. 5+23
STA. 8+95 TO STA. 10+00

SCALE IN FEET: VERTICAL 0 5 10 20; HORIZONTAL 0 25 50 100



RTW-W207D PROFILE



RTW-W207D TYPICAL SECTION
STA. 5+23 TO STA. 8+95

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METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extention

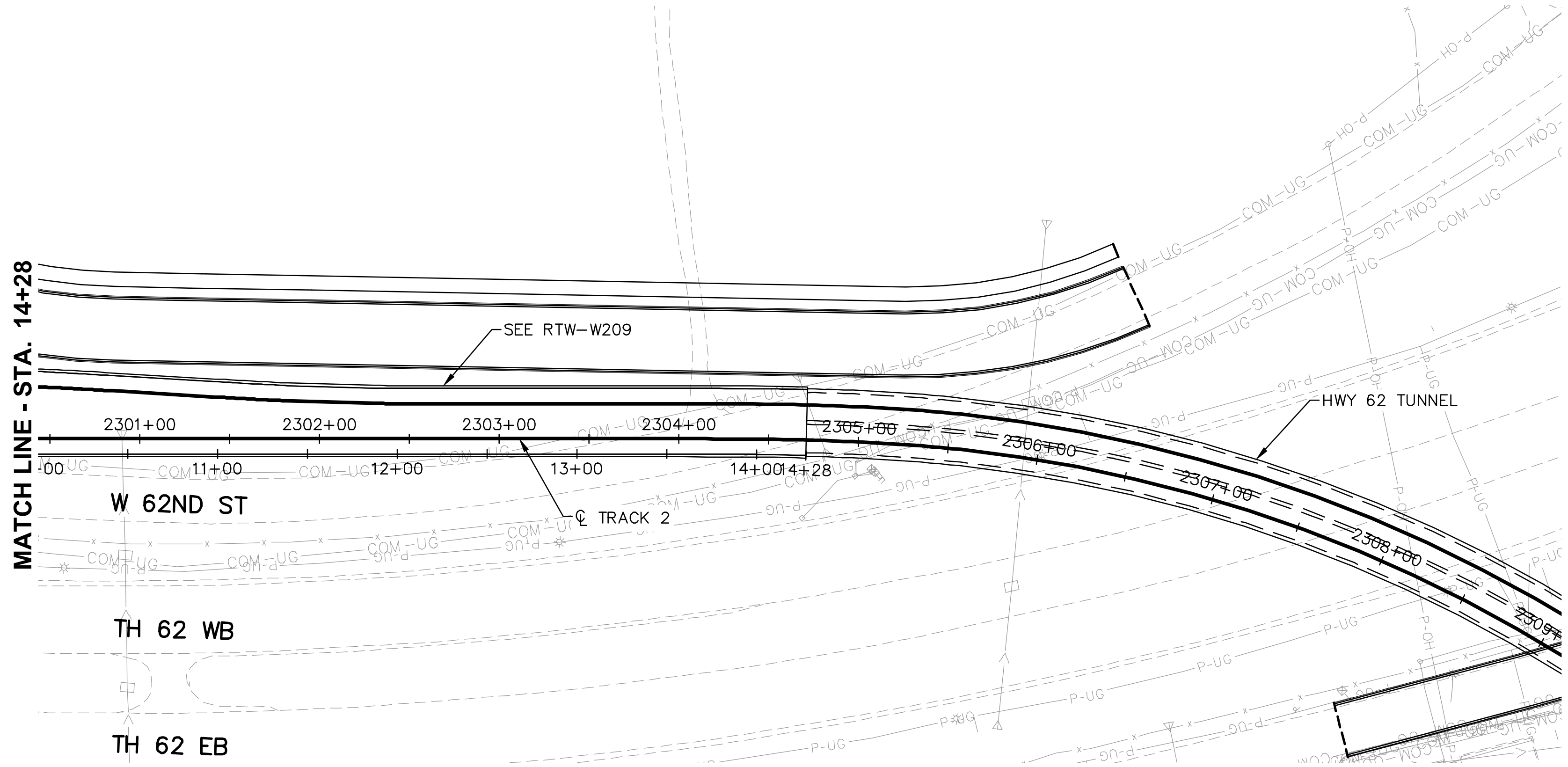
WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2 - RTW-W207D
PLAN AND PROFILE
STA. 0+50 TO STA. 10+00

DISCIPLINE: STRUCTURES
SHEET NAME: W2-STU-RTW-PPFL-009

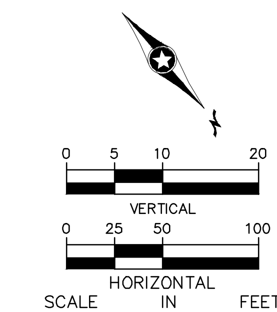
SHEET 181 OF 197

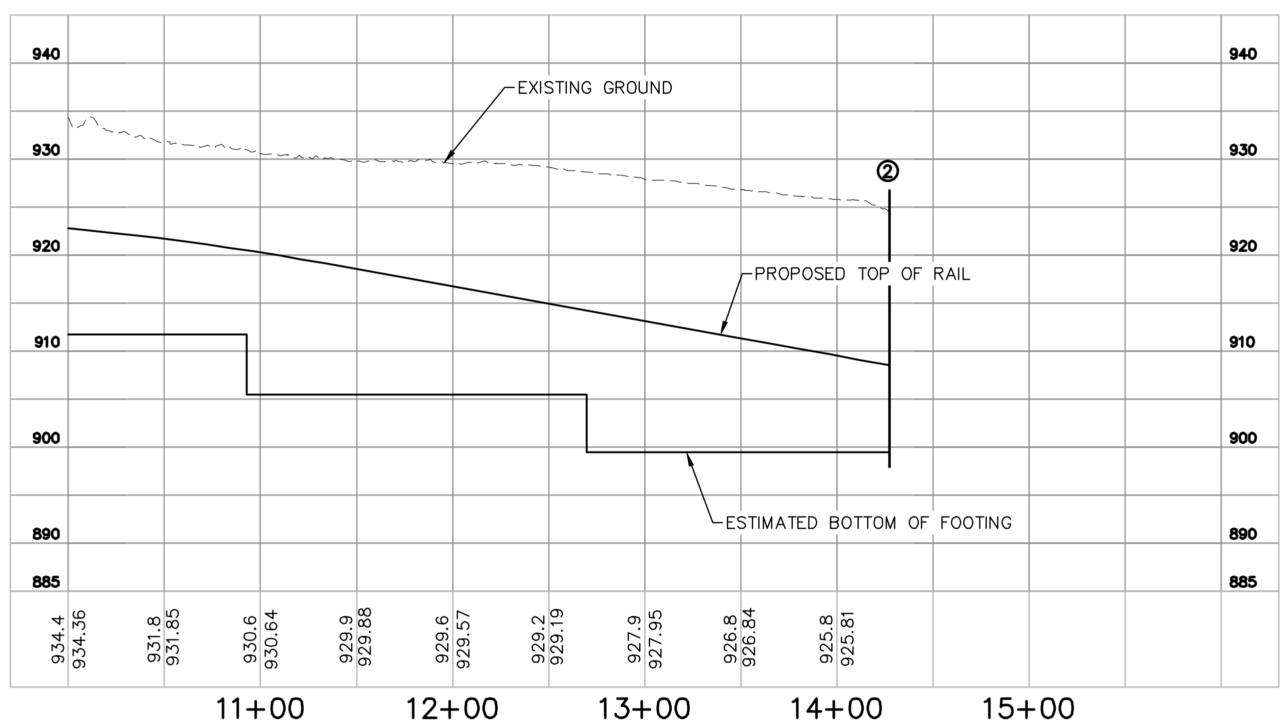
NOTE:
RTW-W207D IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

② JOINT LOCATION BETWEEN RETAINING WALL AND TUNNEL.

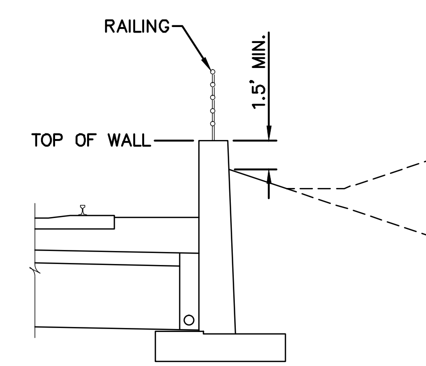


RTW-W207D PLAN





RTW-W207D PROFILE



RTW-W207D TYPICAL SECTION

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2 - RTW-W207D
PLAN AND PROFILE
STA. 10+00 TO STA. 14+28

DISCIPLINE: STRUCTURES

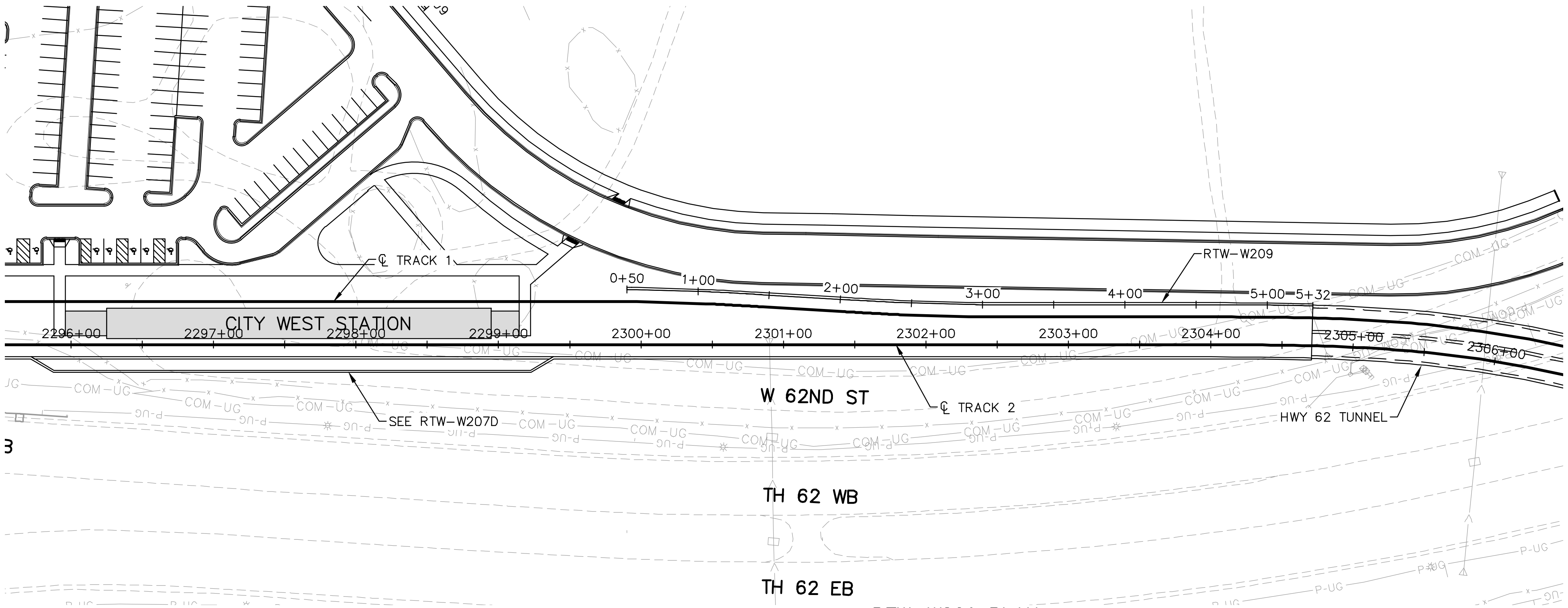
SHEET NAME: W2-STU-RTW-PPFL-010

SHEET 182 OF 197

NOTE:
RTW-W209 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

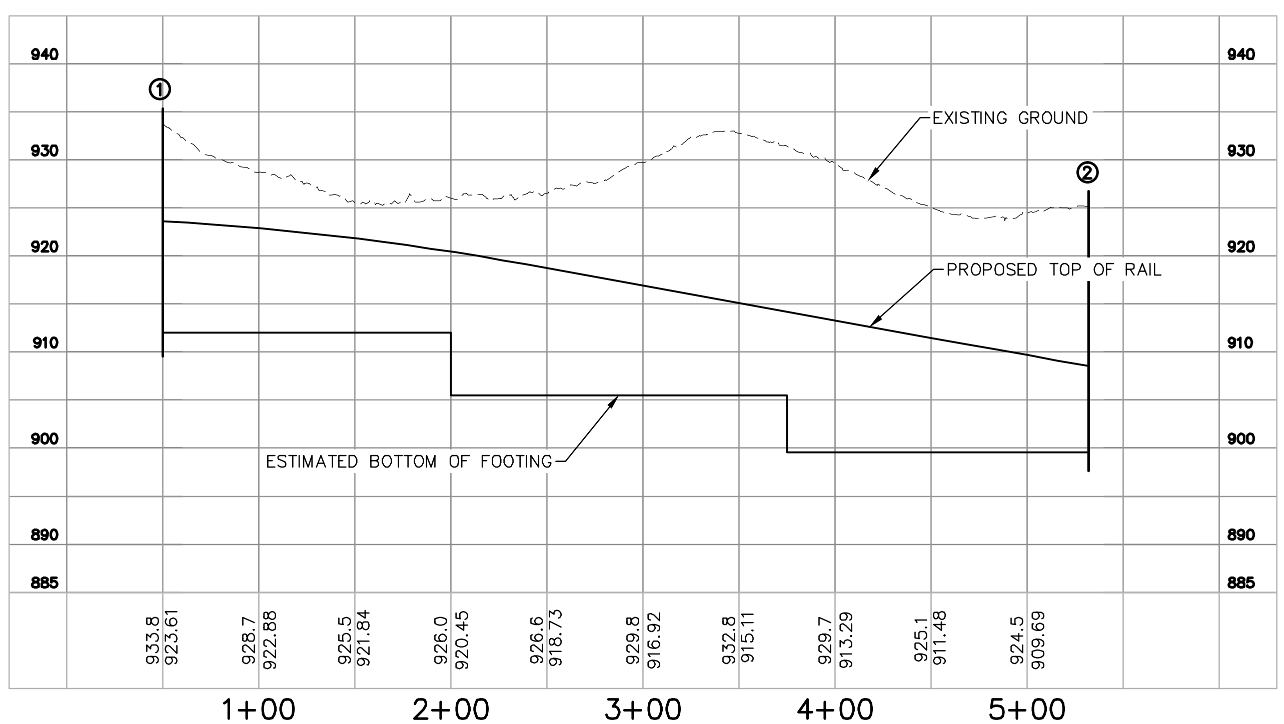
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

② JOINT LOCATION BETWEEN RETAINING WALL AND TUNNEL.

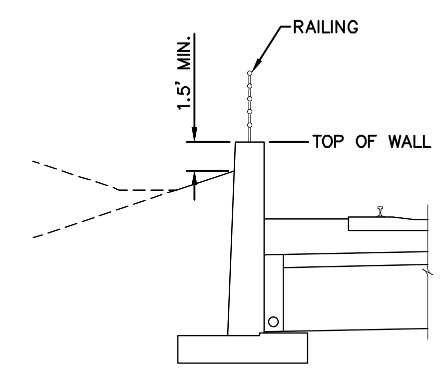


RTW-W209 PLAN

0 5 10 20
VERTICAL
0 25 50 100
HORIZONTAL
SCALE IN FEET



RTW-W209 PROFILE



RTW-W209 TYPICAL SECTION

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

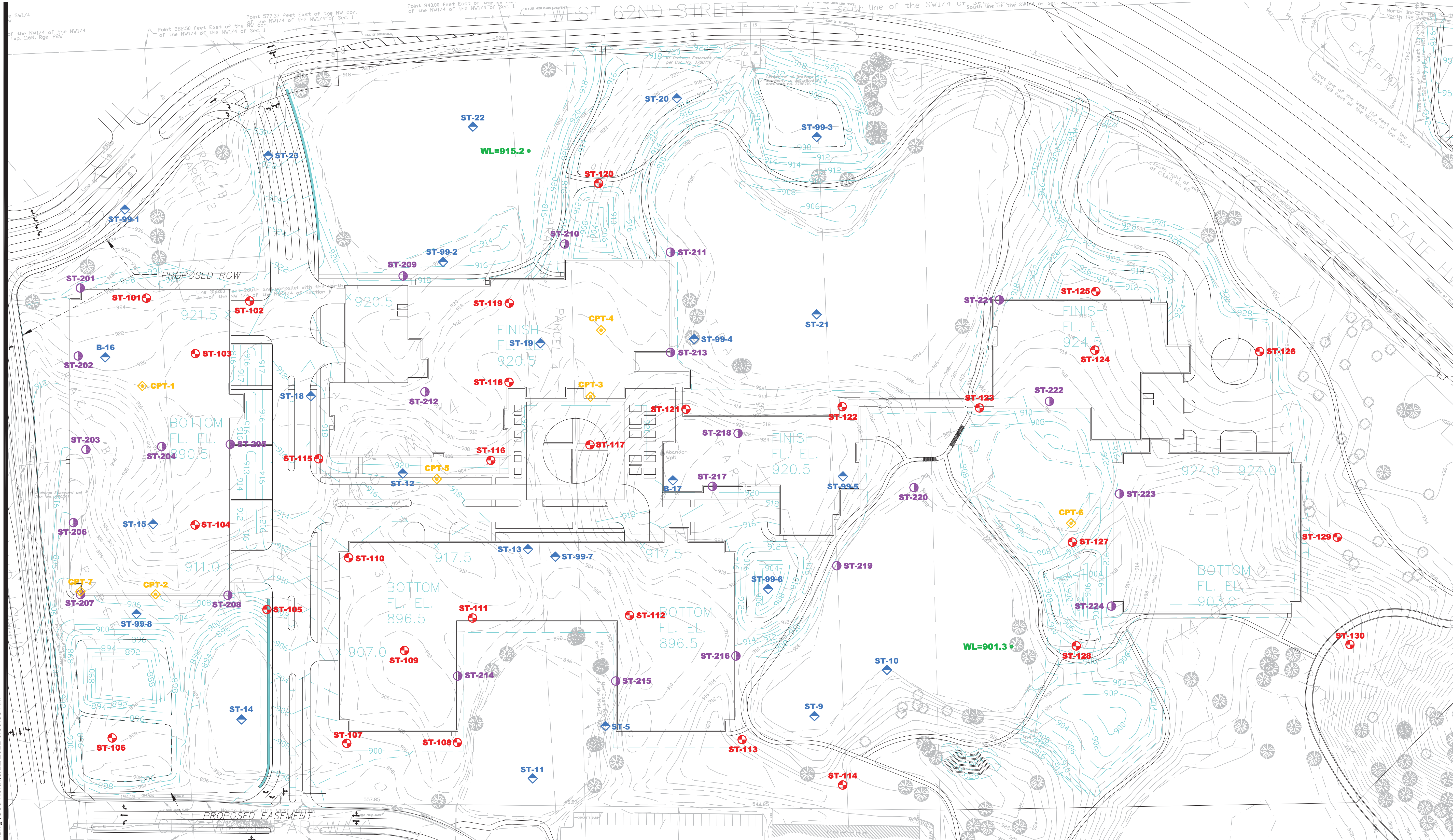
SOUTHWEST Green Line LRT Extension

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2
RTW-W209
PLAN AND PROFILE

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-RTW-PPFL-011

SHEET 183 OF 197



- WATER LEVELS ON NOVEMBER 26, 2010
- DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING
- DENOTES APPROXIMATE LOCATION OF CPT SOIL BORING
- DENOTES APPROXIMATE LOCATION OF PREVIOUSLY PERFORMED SOIL BORING
- DENOTES APPROXIMATE LOCATION OF PREVIOUSLY PERFORMED SOIL BORING

75' 0 150'

SCALE: 1"= 150'

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BRAUN INTERTEC
11001 Hampshire Avenue So.
Minneapolis, MN 55438
PH. (952) 995-2000
FAX (952) 995-2020

Base Dwg Provided By:
WESTWOOD PROF. SERVICES

SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
PROJECT RED
EDEN PRAIRIE, MINNESOTA

Project No:	BL1010023
Drawing No:	BL1010023D
Scale:	1"= 150'
Drawn By:	JAG
Date Drawn:	
Checked By:	CRK
Last Modified:	8/11/11
Sheet: of	Fig:

LOG OF BORING

BRAUN INTERTEC

BORING:	ST-121
LOCATION:	See attached sketch.

DRILLER: S. Briggs	METHOD: 3 1/4" HSA, Autohammer	DATE: 12/20/10	SCALE: 1" = 4'

Elev. feet 921.2	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
920.3	0.9	SC	CLAYEY SAND, dark brown, frozen. (Topsoil)				
917.2	4.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel, brown, moist, loose. (Glacial Outwash)	6			
914.2	7.0	CL	SANDY LEAN CLAY, with Gravel, brown, wet, very stiff. (Glacial Till)	17			
912.2	9.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, brown, moist, medium dense. (Glacial Outwash)	14			
909.2	12.0	CL	SANDY LEAN CLAY, trace Gravel, brown, wet, very stiff. (Glacial Till)	24		18	
904.2	17.0	SC	CLAYEY SAND, brown, wet, very stiff to hard. (Glacial Till)	51			
			With layer of Poorly Graded Sand with Silt at 15 feet.	28	▽		
		SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, with layers of Clayey Sand, brown, moist to waterbearing at 24 feet, medium dense. (Glacial Outwash)	*			*50/5" of set
				26			
				15			
				12			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:05

BORING:	ST-121 (cont.)
LOCATION:	See attached sketch.

DRILLER: S. Briggs	METHOD: 3 1/4" HSA, Autohammer	DATE: 12/20/10	SCALE: 1" = 4'

Elev. feet 889.2	Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
888.2	33.0						
		CL	SANDY LEAN CLAY, gray, wet, rather stiff to very stiff. (Glacial Till)	11			
				19			
880.2	41.0						
			END OF BORING. Water observed at 24 feet while drilling. Water observed at 34 1/2 feet with 39 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 20 feet immediately after withdrawal of auger. Boring then grouted.				

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

LOG OF BORING

BORING: ST-210	
LOCATION: See attached sketch.	

DRILLER: M. Rowland	METHOD: 3 1/4" HSA, Autohammer	DATE: 7/28/11	SCALE: 1" = 4'

Elev. feet 915.5	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	MC %	Tests or Notes
914.0	1.5	CL	SANDY LEAN CLAY, dark brown, wet. (Topsoil)					
911.5	4.0	SM	SILTY SAND, fine- to medium-grained, with layers of Poorly Graded Sand with Silt, brown, moist, very loose. (Alluvium)	4				
903.5	12.0	SP	POORLY GRADED SAND, fine- to medium-grained, with layers of Silty Sand, brown, moist, loose to medium dense. (Alluvium)	5				
				6				/////////////// Building 2 Lowest Level 907
				11				
		CL	SANDY LEAN CLAY, with Silty Sand layers at 13 feet, brown to gray, wet, rather stiff to hard. (Glacial Till)	18				
				20			15	
				17		4	15	DD=119
				18			16	
				10			16	
				11				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023A.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:44

BRAUN INTERTEC

LOG OF BORING

BORING:	ST-210 (cont.)
LOCATION:	See attached sketch.

DRILLER: M. Rowland	METHOD: 3 1/4" HSA, Autohammer	DATE: 7/28/11	SCALE: 1" = 4'

Elev. feet 883.5	Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	MC %	Tests or Notes
			SANDY LEAN CLAY, with Silty Sand layers at 13 feet, brown to gray, wet, rather stiff to hard. (Glacial Till) *(continued)*					
			With Gravel at 35 feet.	45				
877.5	38.0	SC	CLAYEY SAND, brown, wet, very stiff.					
				24				
874.5	41.0		END OF BORING.					
			Water not observed while drilling.					
			Boring then backfilled.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023A.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:44

LOG OF BORING

BORING:	ST-211
LOCATION:	See attached sketch.

DRILLER: K. Keck	METHOD: 3 1/4" HSA, Autohammer	DATE: 8/2/11	SCALE: 1" = 4'

Elev. feet 909.6	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	Tests or Notes
907.6	2.0	SC	CLAYEY SAND, dark brown, wet. (Topsoil)				
905.6	4.0	CL	LEAN CLAY with SAND, brown, wet, medium. (Glacial Till)	6			Building 2 Lowest Level 907
899.1	10.5	CL	SANDY LEAN CLAY, brown, wet, stiff to very stiff. (Glacial Till)	15 21 24		4	
895.6	14.0	SC-SM	SILTY CLAYEY SAND, fine- to medium-grained, reddish brown, moist, medium dense. (Glacial Till)	25			
893.6	16.0	CL	SANDY LEAN CLAY, light brown, wet, very stiff. (Glacial Till)	21			
881.6	28.0	SC-SM	SILTY CLAYEY SAND, with Gravel, brown, moist, medium dense. (Glacial Till)	28 50/6" 25	▽		
		SP-SM	POORLY GRADED SAND with SILT, fine-grained, reddish brown, waterbearing. (Glacial Outwash)	16			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023A.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:44

BORING:	**ST-211 (cont.)**
LOCATION:	See attached sketch.

DRILLER: K. Keck	METHOD: 3 1/4" HSA, Autohammer	DATE: **8/2/11**	SCALE: **1" = 4'**

Elev. feet 877.6	Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	Tests or Notes
876.6	33.0						
		SC	CLAYEY SAND, gray, wet, rather stiff to very stiff. (Glacial Till)	20			
868.6	41.0			9		2 1/2	
			END OF BORING. Water observed at 23 feet with 24 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 25 feet immediately after withdrawal of auger. Boring then grouted.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023A.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:44

BORING:	ST-212
LOCATION:	See attached sketch.

DRILLER: M. Rowland	METHOD: 3 1/4" HSA, Autohammer	DATE: 7/27/11	SCALE: 1" = 4'

Elev. feet 915.1	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
913.6	1.5	SC	CLAYEY SAND, black, wet. (Topsoil)				///////////// Building 1, Fill 5 feet to slab elevation 920.5
908.1	7.0	SC	CLAYEY SAND, brown, wet, medium. (Glacial Till)	8		14	
				8		19	
901.1	14.0	CL	SANDY LEAN CLAY, with Gravel, brown, wet, medium to stiff. (Glacial Till)	34			Cobble at 7 1/2 feet.
				8		18	
				16			
887.1	28.0	SC	CLAYEY SAND, with layers of Silty Sand, brown, wet, stiff to very stiff. (Glacial Till)	17	▽		
				16			
				13		17	
				27			
		SM	SILTY SAND, fine- to medium-grained, with layers of Clayey Sand, brown, wet, medium dense to dense. (Glacial Till)	29			

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

LOG OF BORING

BORING:	ST-212 (cont.)
LOCATION:	See attached sketch.

DRILLER: M. Rowland	METHOD: 3 1/4" HSA, Autohammer	DATE: 7/27/11	SCALE: 1" = 4'

Elev. feet 883.1	Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
881.1	34.0		SILTY SAND, fine- to medium-grained, with layers of Clayey Sand, brown, wet, medium dense to dense. (Glacial Till) *(continued)*				
		SC-SM	SILTY CLAYEY SAND, fine- to medium-grained, reddish brown, wet to waterbearing at 41 feet, dense. (Glacial Till)	33			
874.1	41.0			31			
			END OF BORING. Water observed at 30 feet with 40 feet of hollow-stem auger in the ground. Water observed at 16 feet immediately after withdrawal of auger. Boring then grouted.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023A.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:44

BRAUN INTERTEC

LOG OF BORING

BORING:	**ST-213**
LOCATION:	See attached sketch.

DRILLER: K. Keck	METHOD: 3 1/4" HSA, Autohammer	DATE: **8/1/11**	SCALE: **1" = 4'**

Elev. feet 909.2	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	MC %	Tests or Notes
907.7	1.5	SM	SILTY SAND, fine-grained, dark brown, moist. (Topsoil)					///////////// Building 2 Slab 920.5, Fill 11 feet
905.2	4.0	SC-SM	SILTY CLAYEY SAND, fine-grained, brown, moist, loose. (Alluvium)	6				
		CL	LEAN CLAY, gray, wet, medium. (Alluvium)	6	▼	1		
900.2	9.0		With Sand seam at 7 1/2 feet.	7	▽			Water observed at elevation 903.4 on 8/3/11 and 903.3 on 8/8/11.
897.2	12.0	CL-ML	SILTY CLAY, light gray, wet, rather stiff. (Alluvium)	9		1	23	
		ML	SANDY SILT, dark brown, waterbearing, medium dense. (Alluvium)	22				
892.2	17.0			15				
		CL	SANDY LEAN CLAY, with Gravel, dark gray, wet, rather stiff to stiff. (Glacial Till)	9		2	16	
				9				
				15				
				12		2 1/2		

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023A.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:44

BRAUN INTERTEC

LOG OF BORING

BORING:	ST-213 (cont.)
LOCATION:	See attached sketch.

DRILLER: K. Keck	METHOD: 3 1/4" HSA, Autohammer	DATE: 8/1/11	SCALE: 1" = 4'

Elev. feet 877.2	Depth feet 32.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	MC %	Tests or Notes
			SANDY LEAN CLAY, with Gravel, dark gray, wet, rather stiff to stiff. (Glacial Till) *(continued)*					
				12				
				7		1	17	
868.2	41.0							
			END OF BORING. Water observed at 8 feet with 9 feet of hollow-stem auger in the ground. Piezometer installed.					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2010\10023A.GPJ BRAUN_V8_CURRENT.GDT 8/18/11 11:44

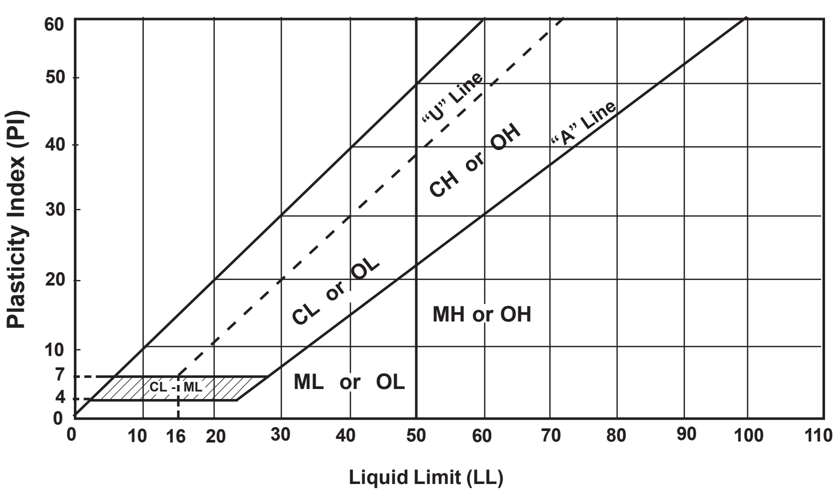
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
  Coarse .... 3/4" to 3"
  Fine .... No. 4 to 3/4"
Sand
  Coarse .... No. 4 to No. 10
  Medium .... No. 10 to No. 40
  Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix E

Retaining Walls W207D, W209, W210 and W211

BRAUN INTERTEC

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August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Foundation Analysis Design Recommendation Report
Retaining Walls RTW-W207D, RTW-W209, RTW-W210, and RTW-W211 – 75% Design
STA 2291+00 to STA2313+00
Southwest LRT, West Segment 2
Eden Prairie and Minnetonka, Minnesota

Dear Mr. Demers:

Braun Intertec Corporation has completed the geotechnical evaluation for the retaining walls RTW-W207D, RTW-W209, RTW-W210, and RTW-W211, adjacent to the Trunk Highway 62 Tunnel in Eden Prairie and Minnetonka, Minnesota. The following sections provide information regarding our opinions, methods and recommendations for the retaining wall foundations and backfill.

This report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for general track construction, the TH 62 tunnel crossing, City West Station Platform, and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project information

The west segment of the SWLRT project is proposing to construct a light rail transit line through the cities of Hopkins, Minnetonka, and Eden Prairie, Minnesota. This design report addresses the design and construction of four retaining walls that will support the track embankment near the 62 Tunnel segment in Eden Prairie and Minnetonka.

A.1. Type of Structure

Cast-in-place (CIP) concrete will be used to construct the retaining walls. The proposed CIP concrete walls will be supported by spread footing foundations founded at least 5 feet below the lowest finished grade along the toe of the wall. The walls will be designed and constructed by others.

A.2. Location of Walls

We were provided with drawings showing the plan and profile for each of the four walls. The rails will be lowered along the alignment relative to the adjacent grade in order to provide access to the tunnel. The locations and additional information for the walls are provided below.

A.2.a. Wall RTW-W207D

Wall RTW-207D is located along the south side of the proposed SWLRT alignment, extending between STA 2291+00 to STA 2304+71 for a length of about 1391 feet and connects to the West Tunnel entrance. The wall height (from top of footing to existing ground surface) will vary from 10 to 27 feet. The top of the wall will slope down from west to east with six steps in the foundation to accommodate the decreasing grade. Required grading changes due to the construction of the rail will consist of a 5 feet of fill at the western edge of the wall and 5 feet a cut along most of the alignment up to the western edge of the proposed station. About 15 feet of cut will be required east of the station to the termination point of the wall at the tunnel.

A.2.b. Wall RTW-W209

Wall RTW-W209 is located along the north side of the proposed SWLRT alignment, extending from about STA 2299+90 to STA 2304+71, for a length of 482 feet. The wall height (from top of footing to existing ground surface) will vary from 12 to 27 feet. The top of the wall will slope down from east to west with three steps in the foundation to accommodate the decreasing grade. Required grading changes due to construction of the rail will consist of about 4 to 7 feet of cut varying along the alignment of the wall.

A.2.c. Wall RTW-W210

Wall RTW-W210 is located along the north side of the proposed SWLRT alignment, extending from the west terminus of the 62 tunnel. It will extend from approximately STA 2311+69 to STA 2312+83, for a length of 116 feet. The wall will be parallel to and across the tracks from Wall RTW-W211. The wall height (from top of footing to existing ground surface) will vary from 15 to 22 feet with a decrease in height from south to north. Required grading changes due to construction of the rail will consist of 13 feet of cut at the western edge of the wall to 4 feet of cut at the eastern edge of the wall.

A.2.d. Wall RTW-W211

Wall RTW-W211 is located along the south side of the proposed SWLRT alignment, extending from the west terminus of the 62 tunnel. It will extend from approximately STA 2311+69 to STA 2313+00, for a length of about 130 feet. The wall will be parallel to and across the tracks from Wall RTW-W210. The wall height (from top of footing to existing ground) will vary from 15 to 20 feet with a decrease in height from south to north. Required grading changes due to construction of the rail will be similar to Wall RTW-W210.

B. Subsurface Investigation Summary

B.1. Summary of Borings Taken

Braun Intertec performed nine SPT (standard penetration test) borings (2152SW, 2153SW, 2154SW, 2155SW, 2156SW, 2157SW, 2158SW, 2018SB, and 2017SB) in the vicinity of the proposed wall alignments. Logs of the wall borings are included in the Appendix. A Boring Location Sketch is also included, showing the locations of the wall borings.

B.2. Description of Foundation Soil and Conditions

The proposed retaining walls are generally underlain with sandy lean clay till, followed by glacially deposited sands and silts to the termination depth of the borings. A more detailed description is provided below.

B.2.a. Topsoil

Four of the five borings initially encountered about 1/4 to 1 foot of topsoil or topsoil fill. The topsoil and topsoil fill consisted of sandy lean clay or silty sand that was brown to black and moist.

B.2.b. Pavement

Boring 2017SW initially encountered a pavement section consisting of 3 inches of bituminous over 3 1/2 inches of aggregate base.

B.2.c. Fill

Fill was encountered beneath the topsoil fill in Borings 2017SW, 2018SB, and 2019SB and extended to depths varying from 4 to 7 feet. The fill consisted of sandy lean clay (CL), clayey sand (SC), and silty sand (SM). Table 1 below illustrates the depth and type of fill material encountered.

Table 1. Fill Depths beneath Retaining Walls RTW-207D, RTW-W209, RTW-W210, RTW-W-211

Boring Number	Boring Elevation (ft)	Approximate Depth of Fill (ft)	Elevation at Bottom of Fill (ft)	Fill Composition
2152SW	940.0	8	932	Poorly Graded Sand with Silt, Sandy Lean Clay
2153SW	939.8	7	933	Sandy Lean Clay
2154SW	938.7	4	935	Clayey Sand
2155SW	936.5	6	930 1/2	Sandy Lean Clay
2156SW	934.7	3	931 1/2	Sandy Lean Clay
2157SW	930.0	6	924	Sandy Lean Clay
2158SW	927.7	6	922	Silty Sand, Clayey Sand
2018SB	925.5	8	917 1/2	Clayey Sand
2017SW	922.0	7	915	Lean Clay, Clayey Sand

Penetration resistances varied from 5 to 20 blows per foot (BPF).

B.2.d. Glacial Till

Glacial till soils were encountered throughout the soil profile across the lengths of the walls. The till consisted of sandy lean clay, clayey sand, and silty sand. The till soils typically contained varying amounts of gravel, were moist to wet and were brown. Penetration resistances varied from 9 to 81 BPF indicating the cohesive soils were rather stiff to hard and the granular soils were medium dense to very dense.

B.2.e. Glacial Outwash

Glacial outwash soils were also frequently encountered throughout the soil profile and were encountered beneath glacial till soils. The glacial outwash soils consisted of poorly graded sand and poorly graded sand with silt. The sands generally contained varying amounts of gravel. Penetration resistances varied from 10 BPF to 50 blows per 6 inches of penetration, indicating the soil was loose to very dense.

B.3. Summary of Water Level Measurements

SPT boring logs note water levels during drilling ranging from approximate 879 to 908 feet above mean sea level (MSL). This large range in elevation indicates the groundwater encountered was likely in a perched condition. Two temporary water level indicators were installed on either side of the tunnel and encountered a static water level at elevation 880. Depending on seasonal and annual precipitation rates, groundwater could be encountered near proposed footing elevations in a perched condition. Seasonal and annual fluctuations of groundwater should be anticipated.

C. Foundation Analysis

Based on the soil conditions encountered in the borings, foundations for the proposed retaining walls will bear on competent glacial till and glacial outwash soils. We recommend the use of spread footing foundations for support of the CIP walls.

To reduce the potential for settlement, we recommend surface compacting the exposed soils at the base of proposed foundations. Compaction should be completed with a large vibratory sheepsfoot compactor to densify any soils loosened by the excavation process.

The wall suitability will be controlled by the service limit state (settlement). A maximum total settlement of 1 inch is specified for the CIP retaining wall structures. Total settlement is defined as the sum of primary consolidation and secondary consolidation.

C.1. Excavations and Slopes

The tracks will be in a cut due to their lower elevation than existing grade. Retaining walls will be constructed separating the tracks from the adjacent higher grade. The retaining walls will consist of vertical CIP concrete walls. Preparation will include excavation to proposed grade, surface compaction beneath the footings, and backfilling behind the walls once the walls have been constructed to support the Guideway.

C.1.a. Settlement

We assume that any utilities along the proposed alignment will be relocated such that the walls will not be constructed over any existing utilities. Since grades are anticipated to be lowered, we anticipate that settlement along all of the retaining walls will be less than 1 inch, and more typically less than 1/2 inch.

C.1.b. Global Stability

Based on the proposed wall heights, slope angles, and the competent native soils encountered in the borings and soundings, the factor of safety is anticipated to exceed the required minimum value of 1.5. Local stability of the walls and associated reinforced embankments, which is separate from the global stability, will be determined by the retaining wall engineer.

C.2. Spread Footing Foundations

Settlements were calculated based on two methods. The first is the Hough method with Boussinesq and Westergaard stress distributions, which utilizes the standard penetration test (SPT) values from the soil borings. The second is the Menard method, which is based on pressuremeter determinations of soil parameters that were collected in the field or modified from the SPT values from the soil borings. For the Menard Method, where pressuremeter testing was not performed, conservative correlations were used to estimate pressuremeter values based on N_{60} factors provided in Federal Highway Administration (FHWA) Publication No. FHWA-IP-89-008. Tables 5 and 6 from this publication are in the Appendix for reference. After these two methods were evaluated, the results were averaged.

Terzhagi's strength limit state is also included on the nominal bearing graphs in the Appendix, for reference. The strength limit state (bearing) will not control design.

The service limit state (settlement) will control the design and the average service limit state should be used for design of the retaining walls. A maximum settlement of 1 inch is specified for this project.

C.3. Summary of Design Assumptions

C.3.a. Embankment Heights, Unit Weights, Side Slopes, and End slopes

The wet unit weight of the anticipated compacted fill soils has been assumed as 120 pounds per cubic foot (pcf). The top surface behind all walls will be the associated tracks for the SWLRT and will be relatively flat. The slope in front of all walls will be 1:4 (V:H) or flatter. Information regarding the walls is provided in Table 2.

Table 2. Design Information for Walls

Retaining Wall Location	Existing Grade Elevations (ft)	Corresponding Proposed Wall Heights (ft)	Approximate Footing Elevation (ft)
RTW-W207D	930-950	8 to 15	905-936
RTW-W209	909-924	8 to 15	900-911
RTW-W210	914-918	9 to 13	905
RTW-W211	914-918	9 to 13	905

C.3.b. Retaining Wall Loading Information

It is assumed a 2-foot live load surcharge will be used for the design of the retaining walls. We recommend the design loads and footing widths follow the MnDOT standard plans included in the Appendix.

C.3.c. Design Methodologies

The LRFD (Load and Resistance Factor Design Method) was used for design of the retaining wall foundations supported on shallow foundations. Resistance factors were obtained from the Sixth Edition of the AASHTO (American Association of State Highway and Transportation Officials) LRFD Bridge Design Specifications (6th edition with 2013 interim revisions).

The ASD (Allowable Strength Design Method) was referenced for design of the retaining wall footings supported on shallow foundations. Strength design and safety factors were taken from the MnDOT design criteria for retaining walls with a 2-foot live load surcharge.

C.4. Construction Considerations

C.4.a. Design of Temporary Slopes and Shoring Limits

We recommend that permanent slopes match the existing slopes, except they should not be steeper than 1V:2H. Select Granular Borrow is anticipated to have an angle of internal friction greater than 30 degrees. This soil could be temporarily placed at a slope of 1V:1 1/2 H, but if not retained by a CIP embankment, must be limited to 1V:2H or flatter for the permanent condition.

C.4.b. Backfill Requirements

Exposed excavation bottoms, deemed suitable by a Geotechnical Engineer, should be surface compacted by a large vibratory sheepsfoot compactor.

Please refer to Table 3 below for material and compaction specifications based on the 2014 MnDOT Standard Specification for Construction.

Table 3. Recommended Fill and Compaction Specifications

Material	Material Specification	Compaction Specification
Fill Placed Beneath Footings	2105.1A7	2105.3F
Leveling Pad Beneath Footings	3138.2B	2211.3C
Retaining Wall Backfill	3149.2D2	2105.3F

Backfill placed for all wall embankments should consist of Select Granular Modified 10 percent and compacted to meet the requirements of 2105.3F1. Select Granular Modified 10 percent shall comply with Specification 3149.2B2, modified to having 10 percent or less passing the 0.075 mm (#200) sieve. We recommend backfill material be placed in uniform layers approximately parallel to the profile, extending the full width of the retaining structures. We recommend backfill material be placed in lift thicknesses not exceeding 12 inches.

D. Foundation Recommendations

D.1. Bearing Capacities and Associated Resistance Factors/Factors of Safety

Based on the soil conditions and recommended soil corrections the service limit bearing pressure exceeds the anticipated soil loading based on the MnDOT Standard Plan for CIP Retaining Walls Associated factors of safety are also provided on the attached plan.

D.2. Recommended Lateral Design Soil Parameters

The recommended lateral soil parameters to be used for design are provided in Table 4.

Table 4. Lateral Soil Parameters

Soil Type	Angle of Internal Friction (degrees)	Effective unit Weight (pcf)	Coefficient of Sliding Friction Rough Concrete	Active Earth Pressure Coefficient	At-Rest Earth Pressure Coefficient
Select Granular Modified 10%	35	120	0.6	0.27	0.43
Granular Borrow	30	120	0.5	0.33	0.50
On-Site Granular Soils	32	120	0.5	0.3	0.46
On-Site Sandy Lean Clay	28	125	0.4	0.36	0.53
On-site Clayey Sand	28	135	0.4	0.36	0.53

D.3. Recommended Foundation Types, Sizes and Embedment Depths

We recommend that the walls be supported on spread footings, following the MnDOT standard plans included in the *Cast-in-Place Retaining Wall Details* section of the Appendix. The size of these footings shall be determined based upon the stem wall height by the wall designer. If stem wall heights/footing sizes change during retaining wall design, we should be notified to confirm that bearing capacity and settlement criteria are within the recommended tolerances. We recommend that the footings be embedded at least 4 1/2 feet below grade (bottom of footing) for frost protection.

D.4. Temporary Slopes and Shoring Limits

Temporary slopes in Select Granular Borrow can be constructed at 1V:1 1/2 H or shallower. Temporary slopes constructed in granular borrow or natural granular material encountered at the site are recommended to be constructed at 1V:1.5H or shallower. In a temporary condition, these slopes have a Factor of Safety against global failure in excess of 1.3.

E. Material Classification and Testing

E.1. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM International Standard Practice D 2488. A chart explaining the classification system is attached. Samples were sealed in jars or bags and returned to our facility for review and storage

E.2. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or sealed with bentonite grout.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore, strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

G. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

H. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these bridge foundation recommendations, please call Josh Kirk at 952.995.2222 or jkirk@braunintertec.com or Ray Huber at 952.995.2260 or rhuber@braunintertec.com at your convenience.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Joshua L. Kirk, PE
Associate Principal-Project Engineer
License Number: 45005

Reviewed by:

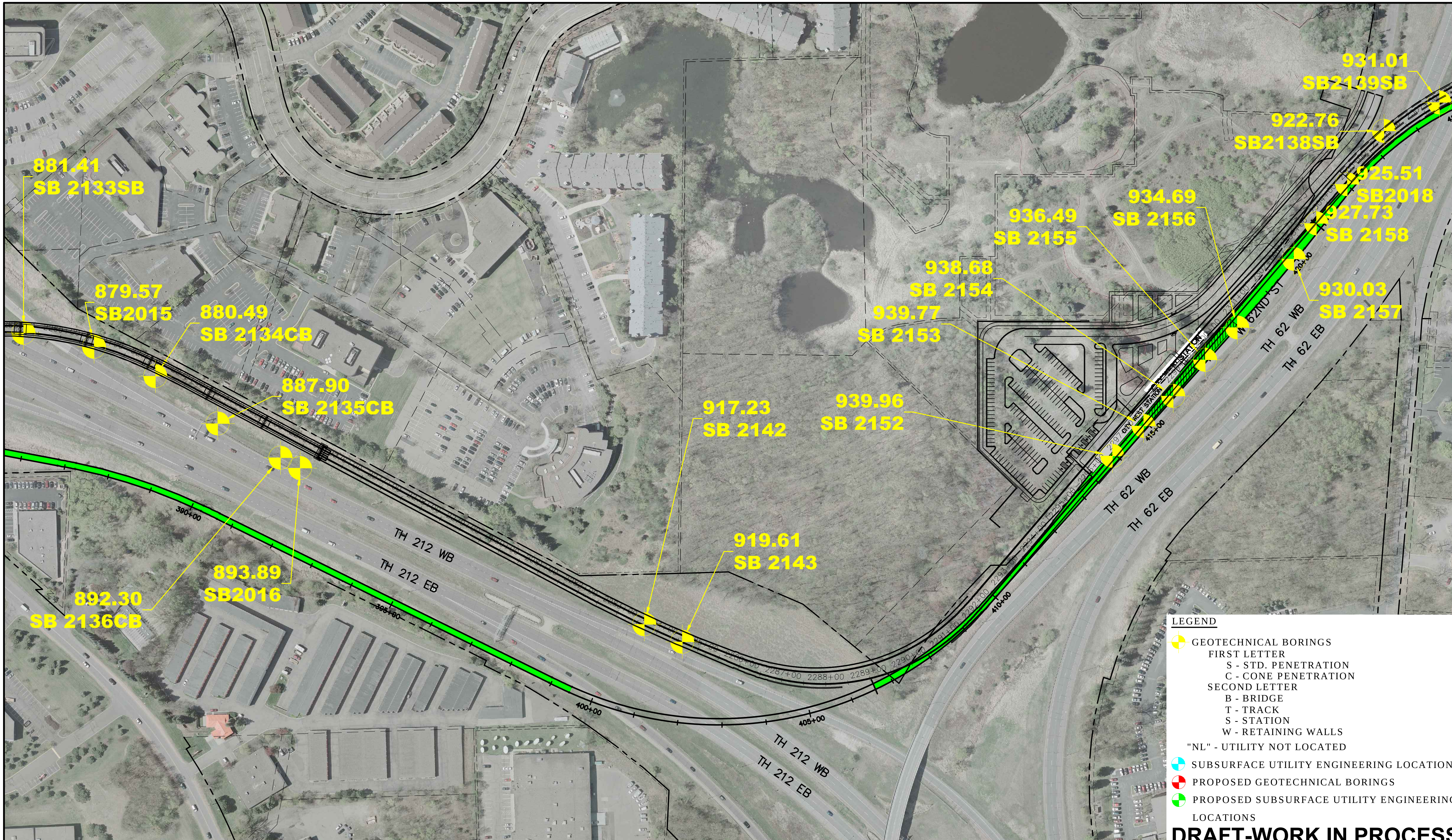
Ray A. Huber, PE
Vice President-Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Boring Location Sketch
Preliminary Engineering Plan and Profile Sheets for Retaining Wall RTW-W207D, RTW-W209, RTW-W210, and RTW-W211
Standard Penetration Boring Logs (2152SW, 2153SW, 2154SW, 2155SW, 2156SW, 2157SW, 2158SW, 2018SB and 2017SW)
Limit State Graphs for Walls RTW-W207D, RTW-W209 and RTW-W210/W211
MnDOT Standard Sheet No. 5-297.632, 1 of 4 (2' LL Surcharge, Spread Footing Supported Retaining Walls)
Publication No. FHWA-IP-89-008 N60 Correlation Tables
SPT Descriptive Terminology

APPENDIX



SOUTHWEST Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS

SHEET 8 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

NORTH

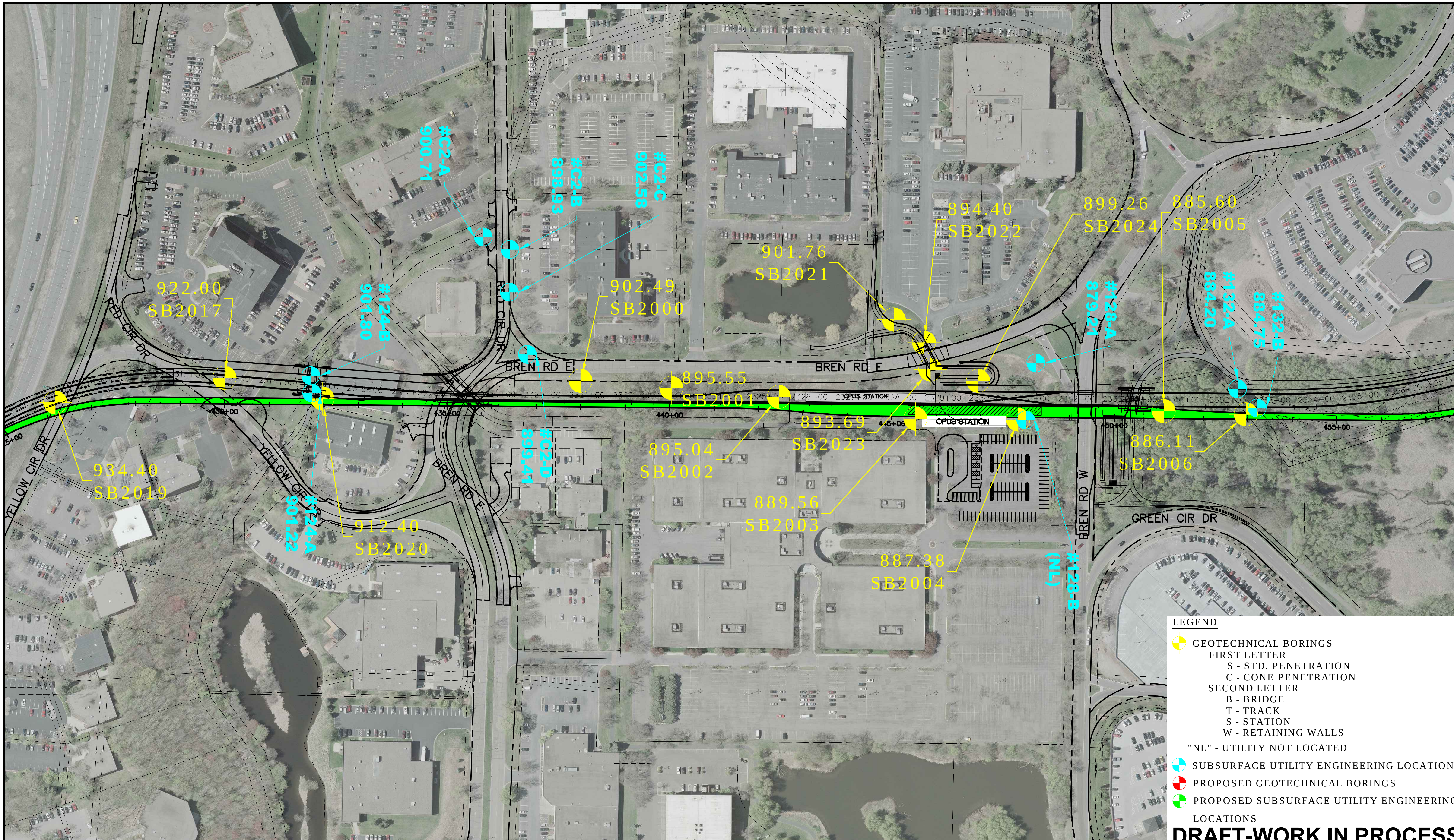
0 50 100 200

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.

Aug. 28 2014 11:32 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



SOUTHWEST Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 9 OF 12

IRT: N/A

REV: 0

DATE: 06/30/2014

NORTH
0 50 100 200

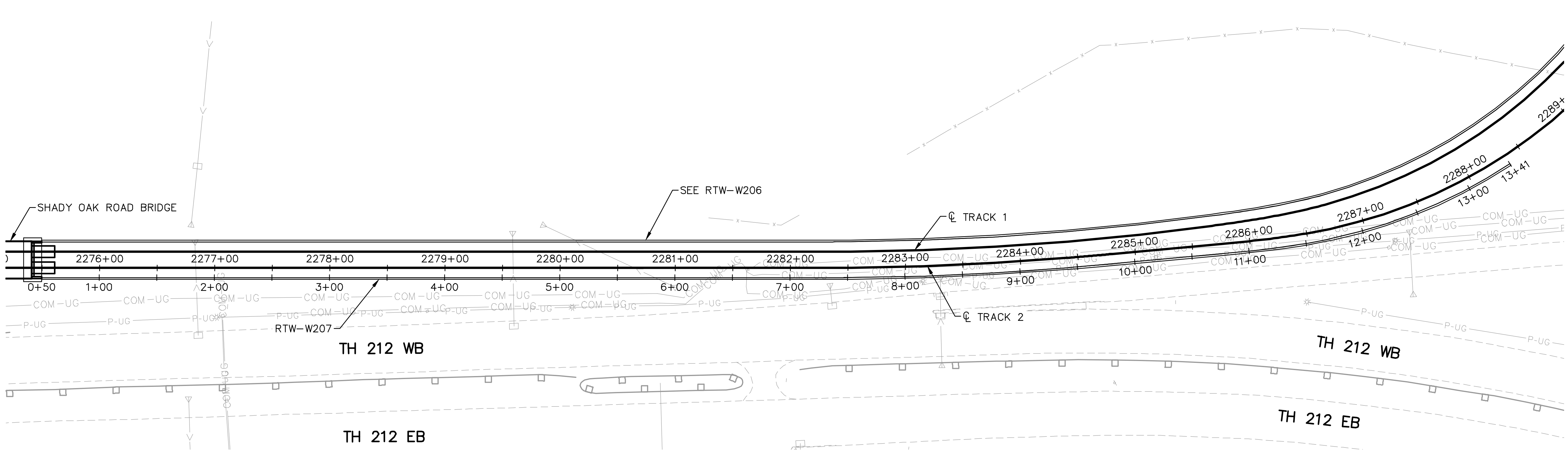
METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.

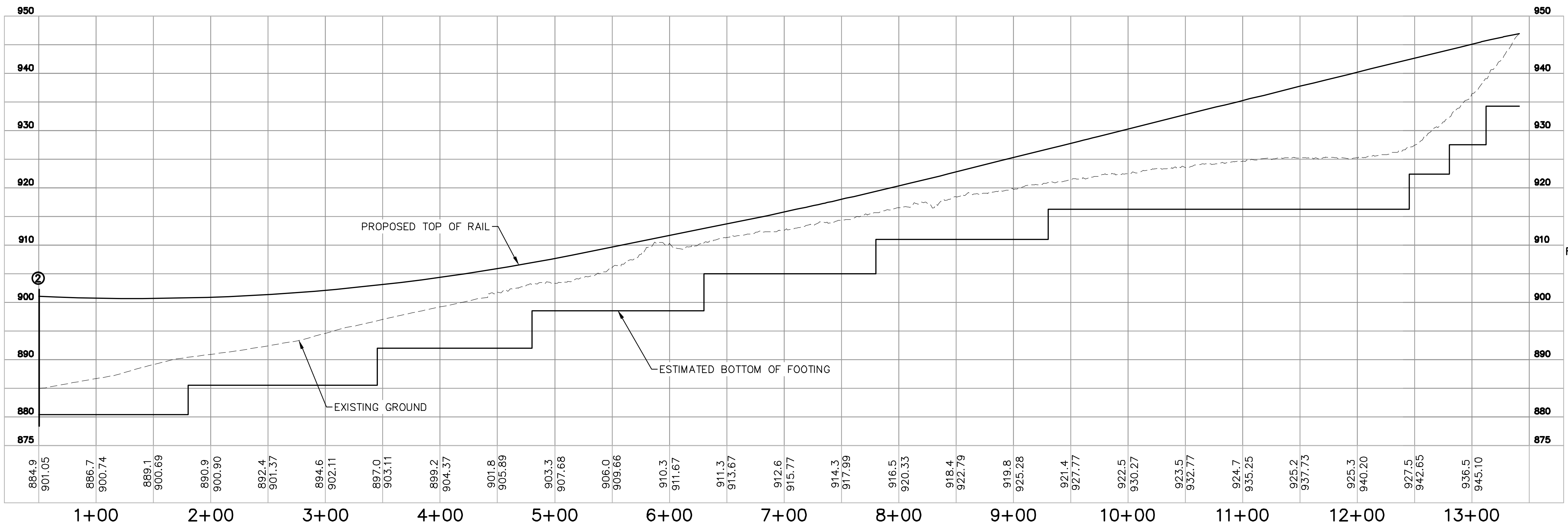
NOTE:
RTW-W207 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL.

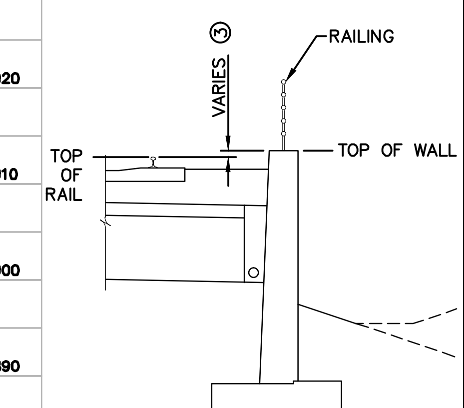


SCALE IN FEET: VERTICAL 0 5 10 20; HORIZONTAL 0 25 50 100

RTW-W207 PLAN



RTW-W207 PROFILE



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W207 TYPICAL SECTION

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

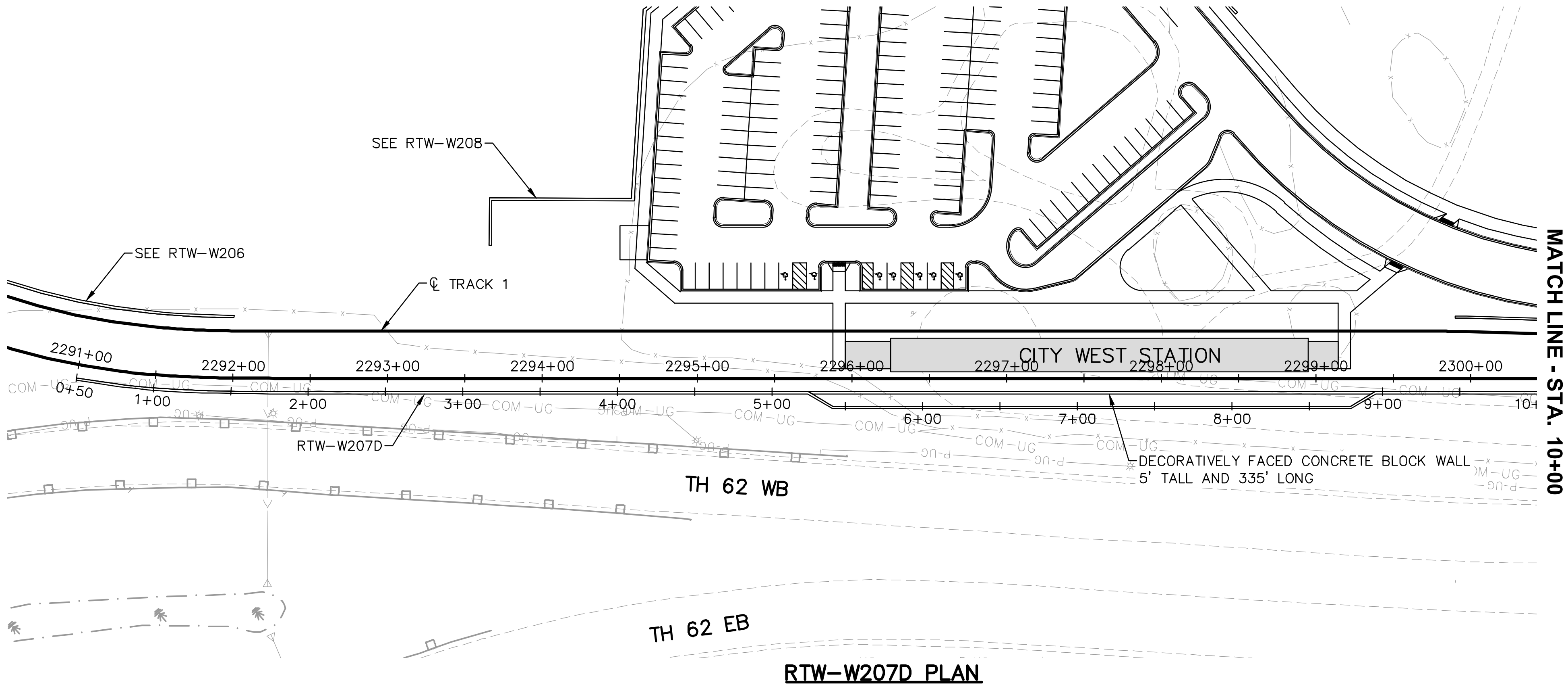
WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2
RTW-W207
PLAN AND PROFILE

DISCIPLINE: STRUCTURES

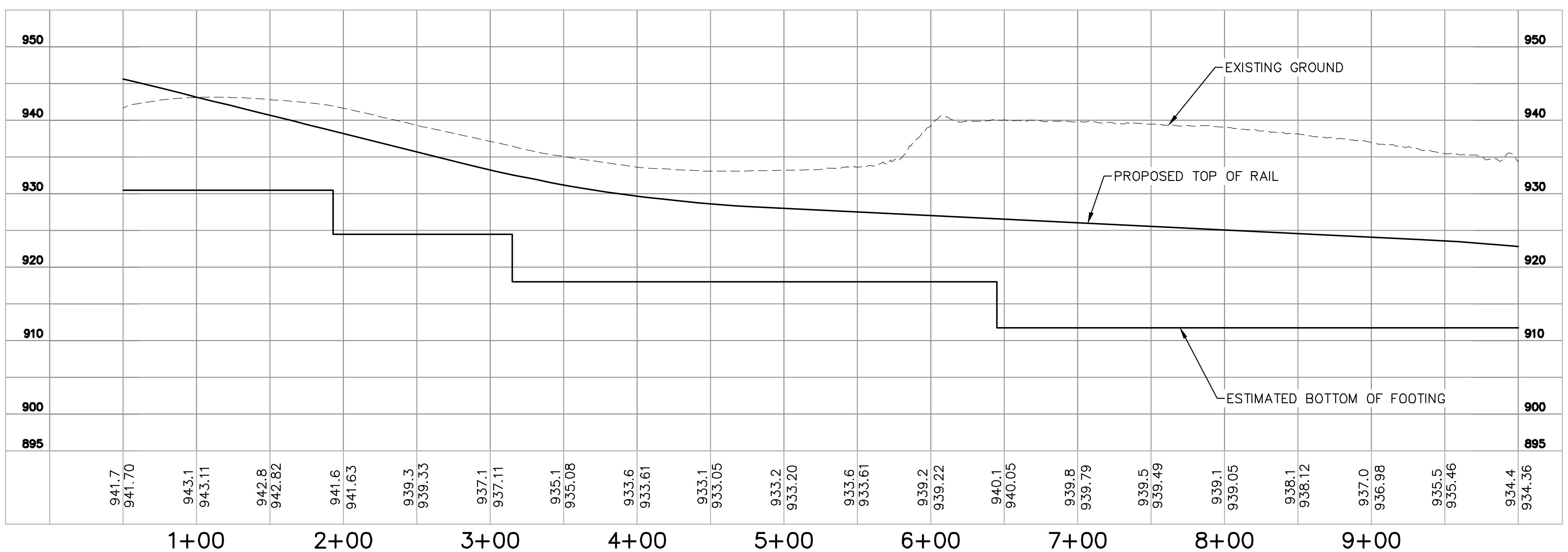
SHEET NAME: W2-STU-RTW-PPFL-008

SHEET 180 OF 197

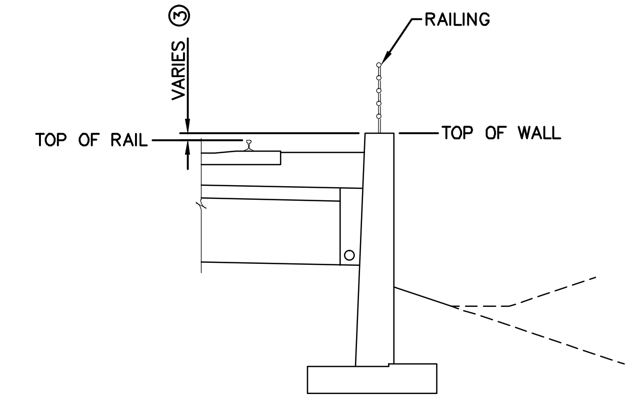
NOTE:
RTW-W207D IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.



RTW-W207D PLAN

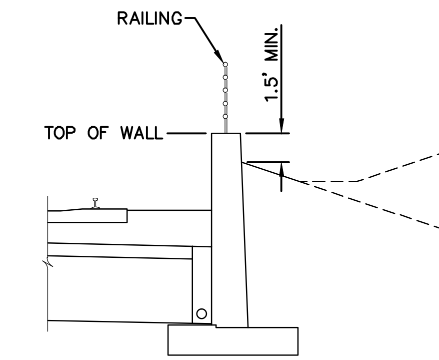


RTW-W207D PROFILE

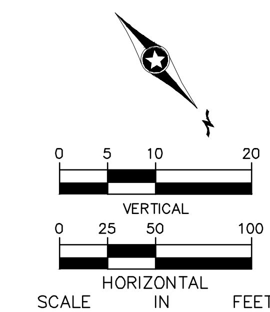


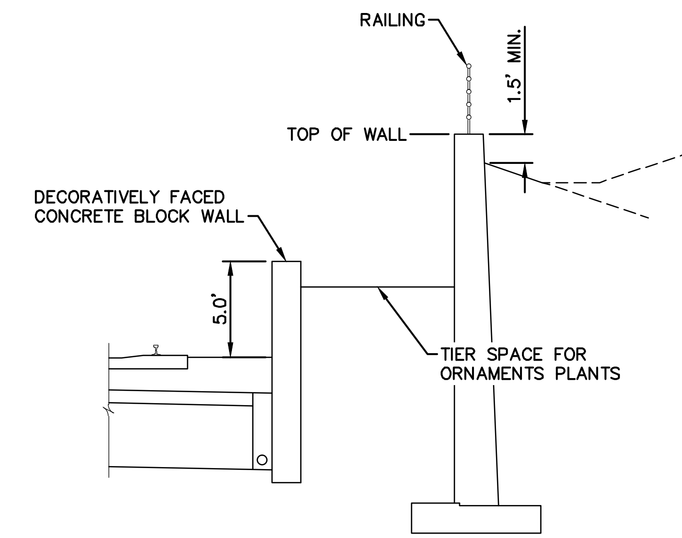
③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W207D TYPICAL SECTION
STA. 0+50 TO STA. 1+01



RTW-W207D TYPICAL SECTION
STA. 1+01 TO STA. 5+23
STA. 8+95 TO STA. 10+00





RTW-W207D TYPICAL SECTION
STA. 5+23 TO STA. 8+95

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AECOM
PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2 - RTW-W207D
PLAN AND PROFILE
STA. 0+50 TO STA. 10+00

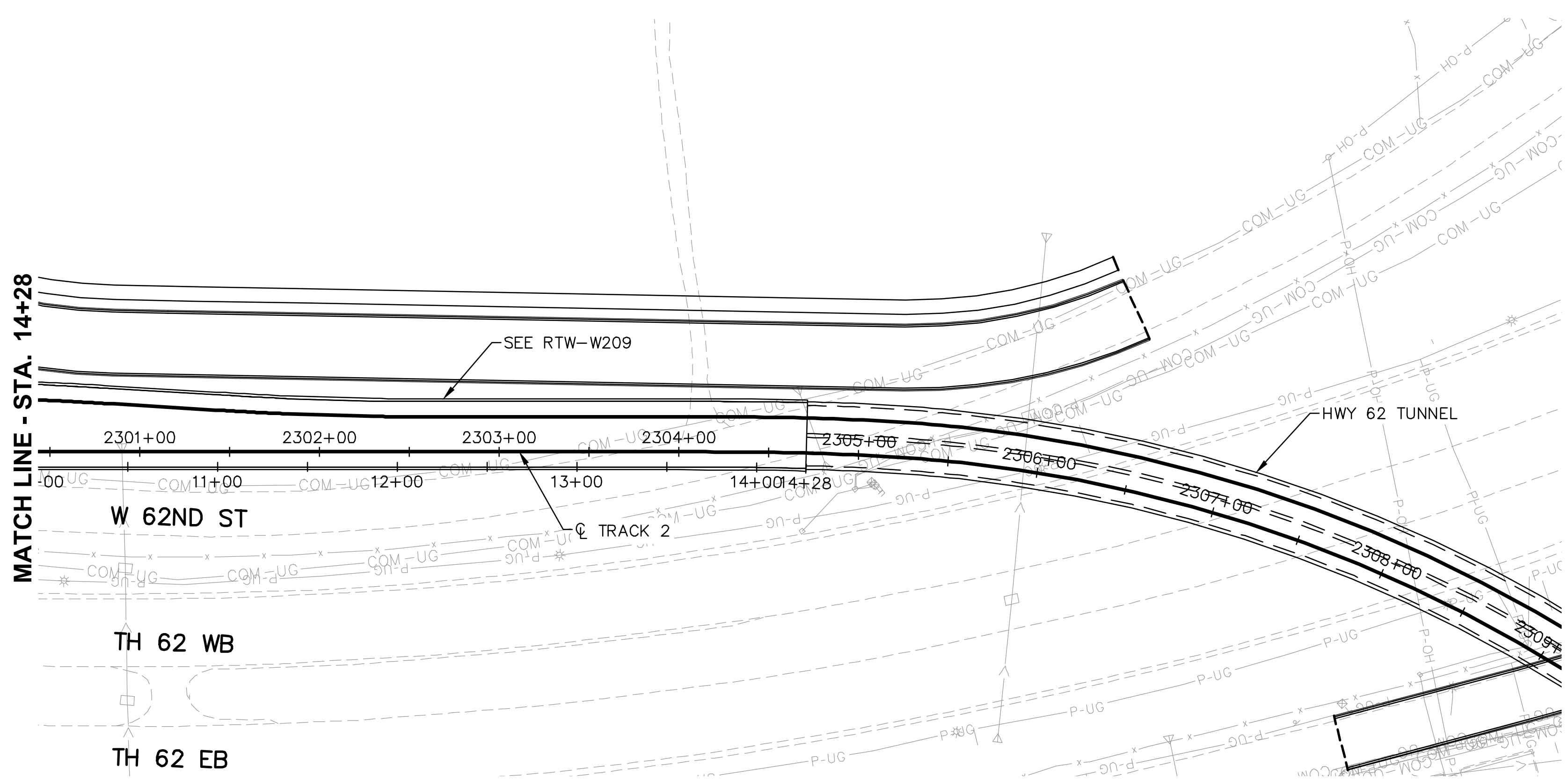
DISCIPLINE: STRUCTURES
SHEET NAME: W2-STU-RTW-PPFL-009

SHEET 181 OF 197

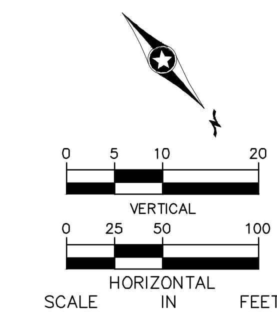
Jun. 13 2014 11:07 am V:\3200_PEC-W\CAD\SEGMENT-W2\SHEET\STRUCTURES\W2-STU-RETW.dwg By: NutzmaML

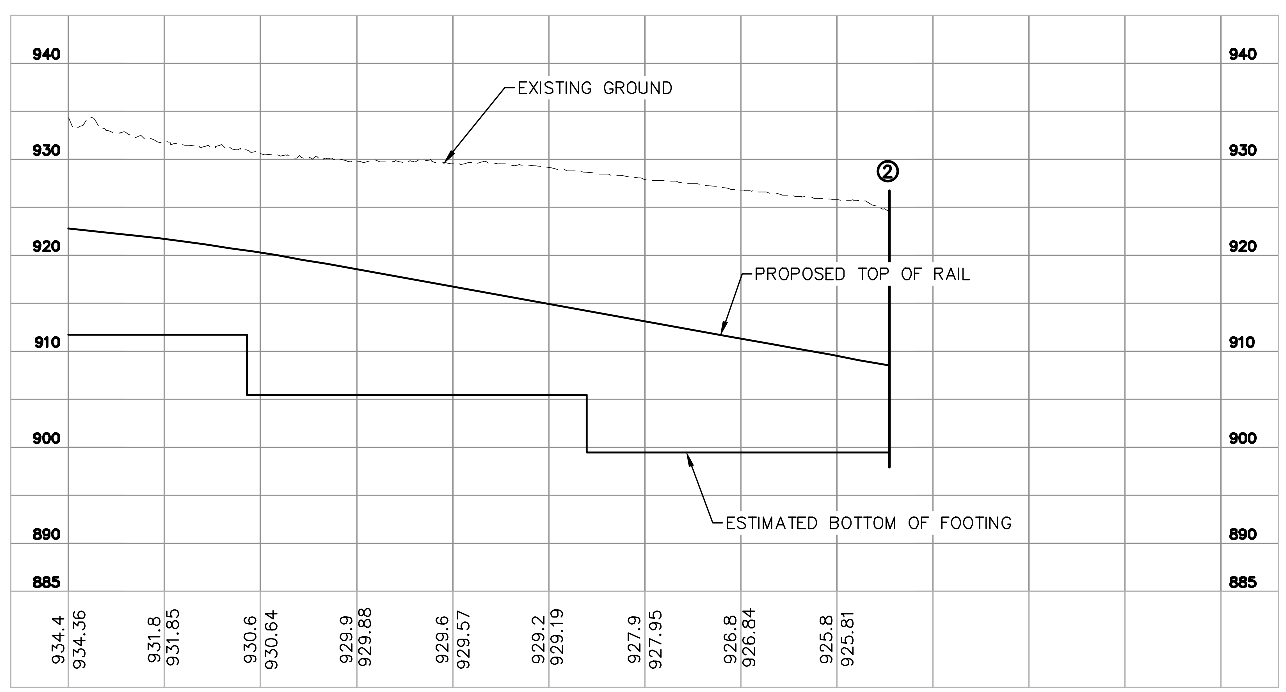
NOTE:
RTW-W207D IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

② JOINT LOCATION BETWEEN RETAINING WALL AND TUNNEL.

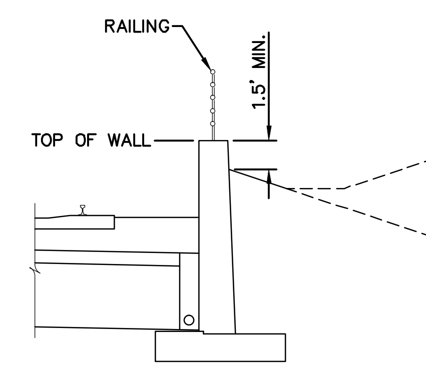


RTW-W207D PLAN





RTW-W207D PROFILE



RTW-W207D TYPICAL SECTION

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2 - RTW-W207D
PLAN AND PROFILE
STA. 10+00 TO STA. 14+28

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-RTW-PPFL-010

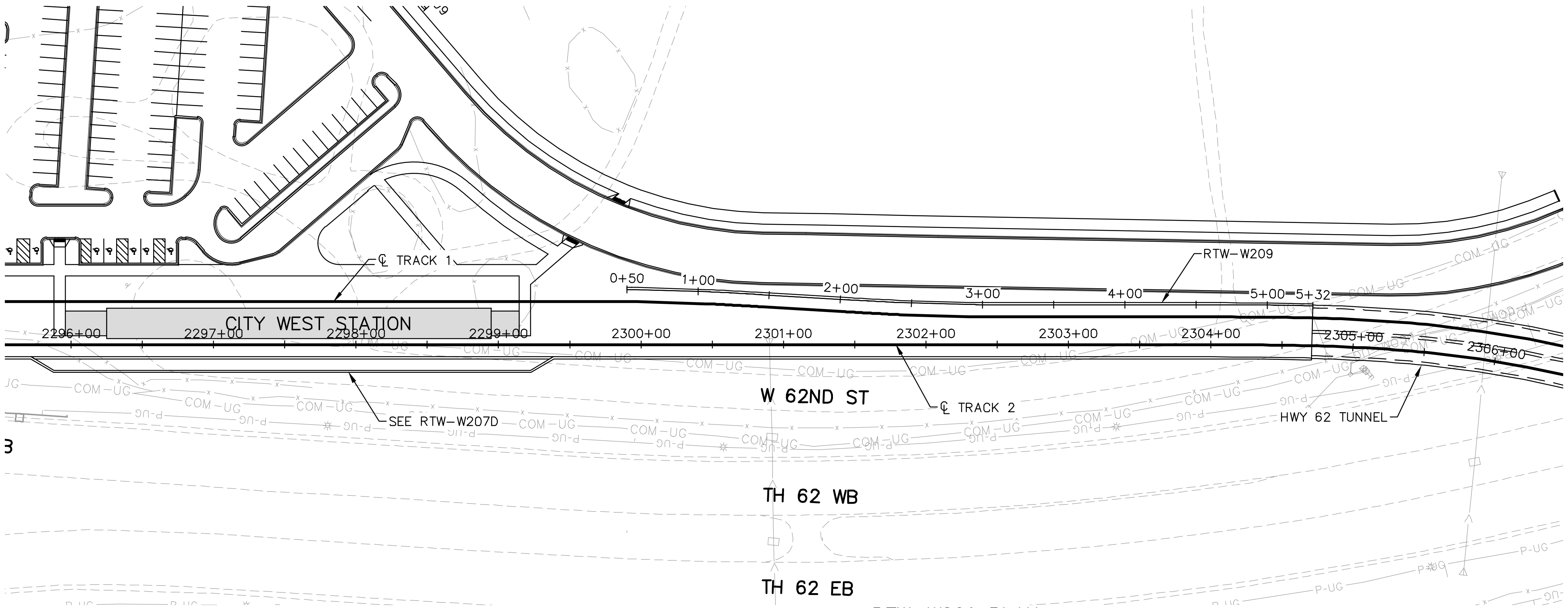
SHEET 182 OF 197

Jun. 13 2014 11:08 am V:\3200_PEC-W\CAD\SEGMENT-W2\SHEET\STRUCTURES\W2-STU-RETW.dwg By: NutzmaML

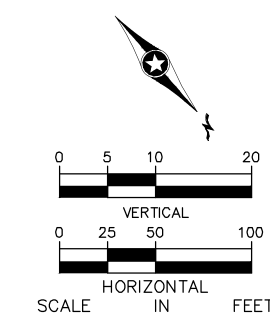
NOTE:
RTW-W209 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

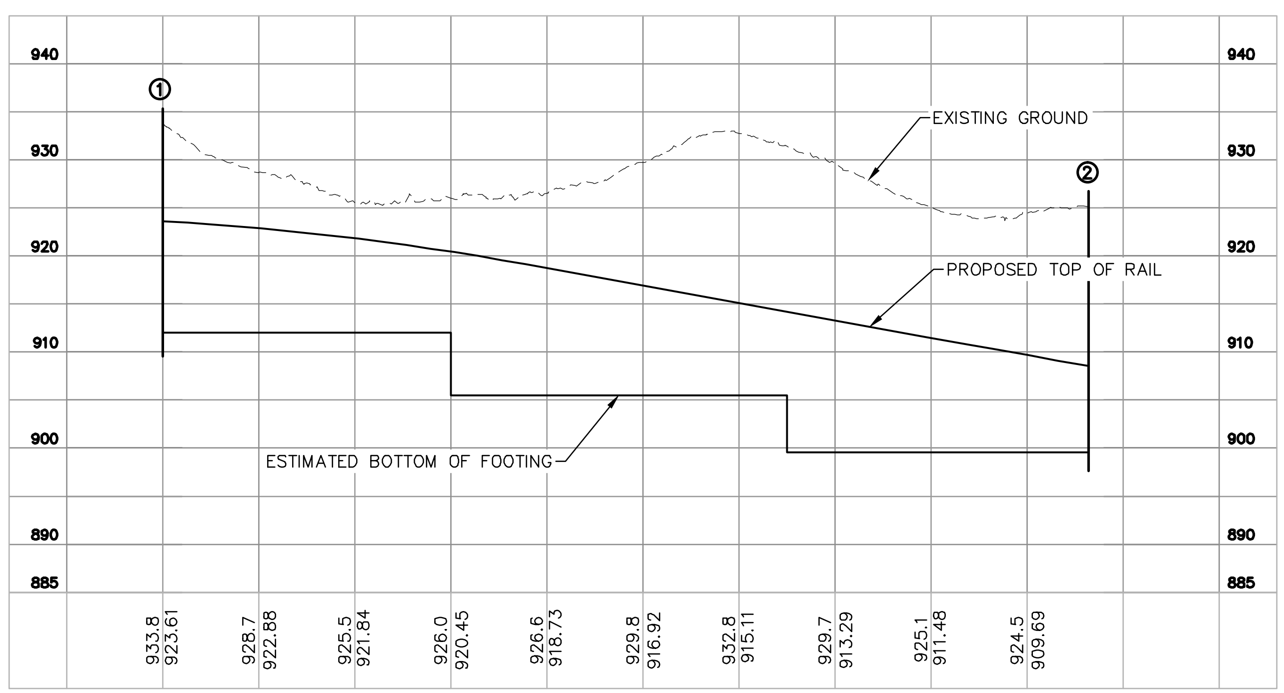
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

② JOINT LOCATION BETWEEN RETAINING WALL AND TUNNEL.

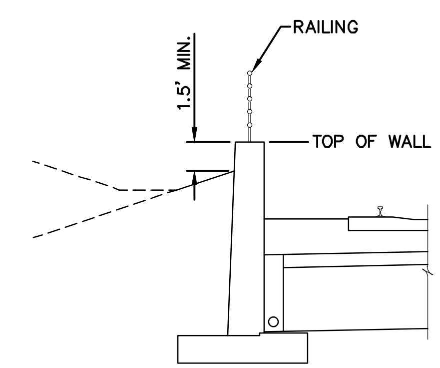


RTW-W209 PLAN





RTW-W209 PROFILE



RTW-W209 TYPICAL SECTION

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REVIEWED BY: DATE:

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2
RTW-W209
PLAN AND PROFILE

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-RTW-PPFL-011

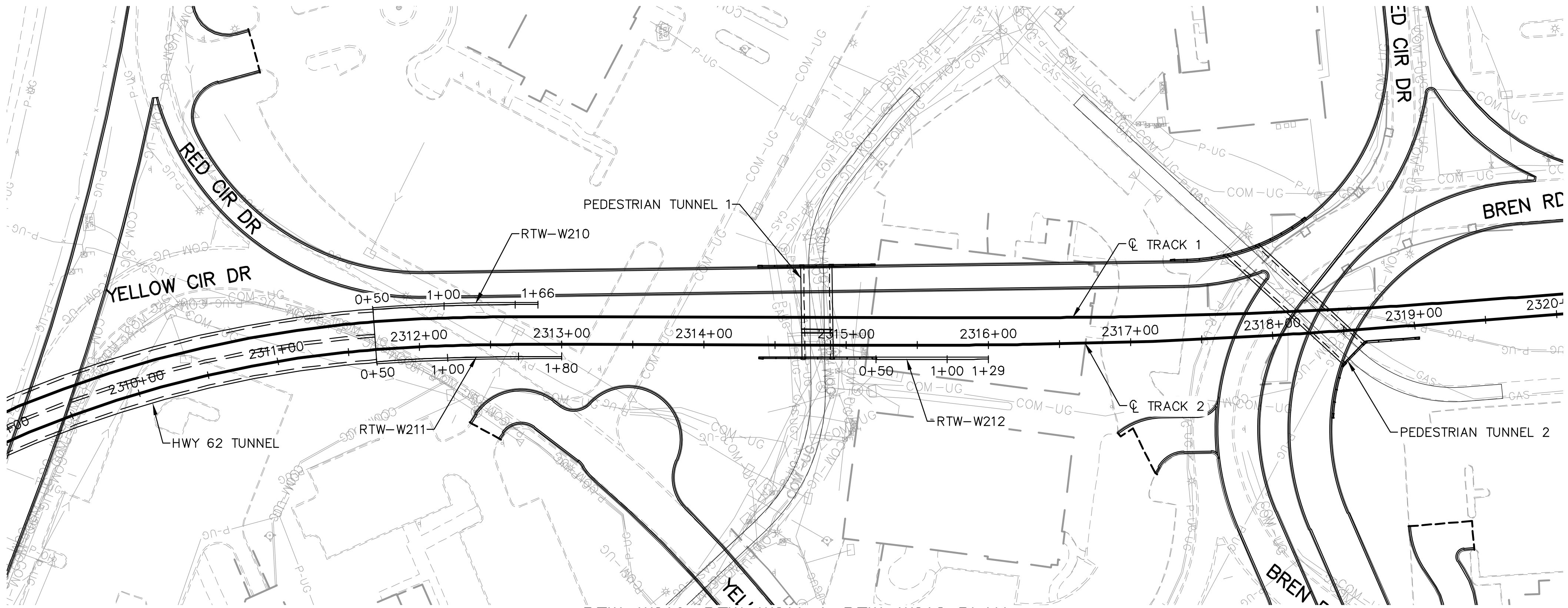
SHEET 183 OF 197

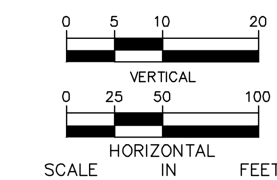
Jun. 13 2014 11:08 am V:\3200_PEC-W\CAD\SEGMENT-W2\SHEET\STRUCTURES\W2-STU-RETW.dwg By: NutzmaML

NOTE:
RTW-W210, RTW-W211 AND RTW-W212 ARE ANTICIPATED TO BE CAST-IN-PLACE RETAINING WALLS ON SPREAD FOOTINGS.

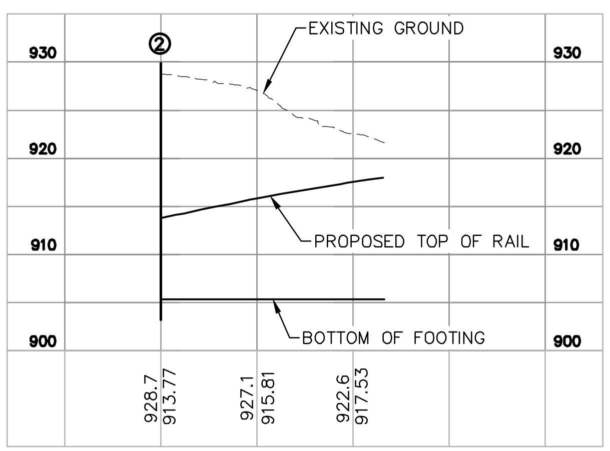
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL OR TUNNEL.

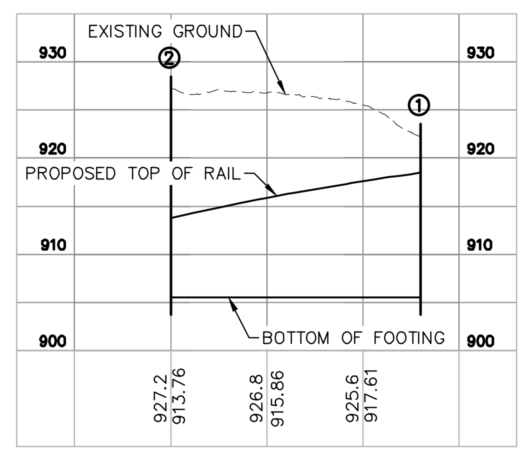




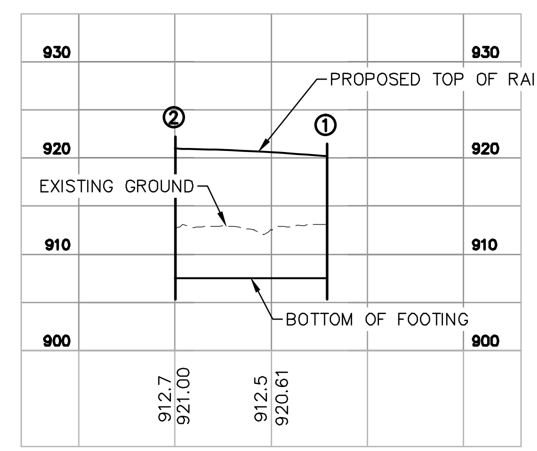
RTW-W210, RTW-W211 & RTW-W212 PLAN



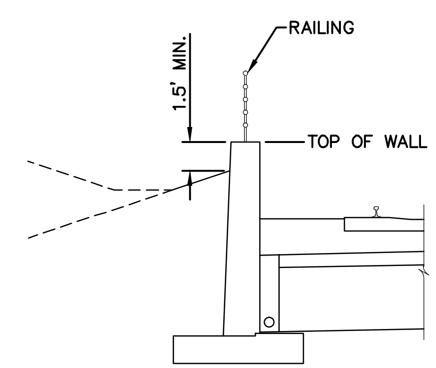
RTW-W210 PROFILE



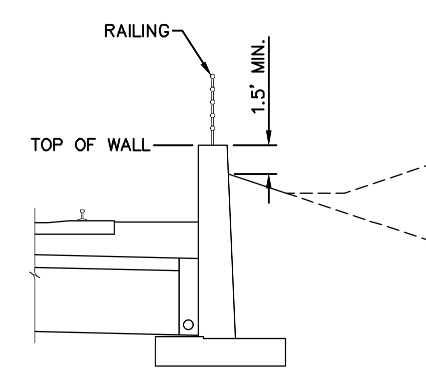
RTW-W211 PROFILE



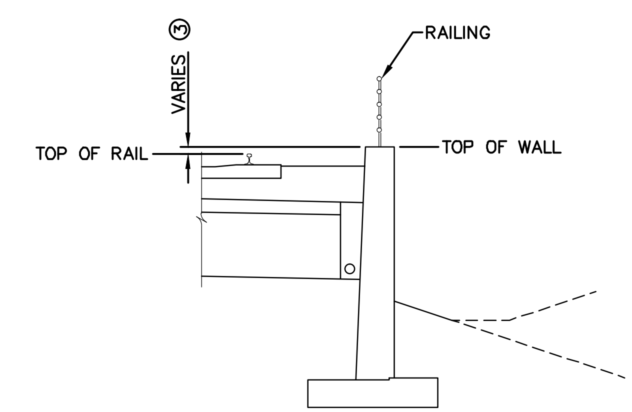
RTW-W212 PROFILE



RTW-W210 TYPICAL SECTION



RTW-W211 TYPICAL SECTION



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES

RTW-W212 TYPICAL SECTION

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

WEST-VOLUME 2 (STRUCTURES)
SEGMENT 2
RTW-W210, RTW-W211 & RTW-W212
PLAN AND PROFILE

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-RTW-PPFL-012

SHEET 184 OF 197

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2152SW	940.0 (Surveyed)

Location: Hennepin Co. Coordinate: X=492932 Y=136186 (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7507
Hammer CME Automatic Calibrated

Drilling Completed 6/3/14

Depth / Elev.	Classification	SPT N60	MC (%)	Other Tests Or Remarks
0.2 / 939.8	2 1/2 inches of bituminous.		5	
2.0 / 938.0	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, moist, (SP-SM), fill	11	14	
8.0 / 932.0	SANDY LEAN CLAY, trace Gravel, brown and dark gray, moist, (CL), fill	14	17	
		19	18	
		14	19	qp=2 1/4 tsf
		16	16	
		15	16	qp=2 tsf
		16	17	DD=114 pcf
22.0 / 918.0	SANDY LEAN CLAY, trace Gravel, brown, moist, stiff, (CL), till	15	17	qp=2 tsf
		21	16	
27.0 / 913.0	SANDY LEAN CLAY, trace Gravel, gray, moist, very stiff, (CL), till	21		qp=2 1/2 tsf
30.0 / 910.0	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, dense, (SM), till	42	9	
32.0 / 908.0	CLAYEY SAND, trace Gravel, brown, moist, hard, (SC), till	44		
		32	8	
36.0 / 904.0	SILTY SAND, fine- to medium-grained, trace Gravel, with frequent layers of Lean Clay, brown, wet, dense to medium dense, (SM), till	22	10	
		26	12	
40.0 / 900.0	CLAYEY SAND, trace Gravel, brown, wet, very stiff, (SC), till	40	13	
	SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense to very dense, (SM), till	28	9	

Columns COH (psf), γ (pcf), REC (%), RQD (%), ACL (ft), Core Breaks, Formation or Member: no entries.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45. Water level symbol at approximately 32 ft.

Index Sheet Code 3.0

(Continued Next Page)

Soil Class:J. Kirk Rock Class: Edit: Date: 7/18/14

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2152SW**	**940.0** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Other Tests Or Remarks / Formation or Member
					74*				*No sample recovery. Rock in tip of sampler.
			SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense to very dense, (SM), till *(continued)* With Gravel at 48 feet.		37	10			
50	51.0 / 889.0				39	9			

Bottom of Hole - 51 feet.
Water observed at a depth of 32 feet while drilling.
Water observed at 41 feet with 49 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2153SW	939.8 (Surveyed)

Location: Hennepin Co. Coordinate: X=492864 Y=136257 (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7507
Hammer CME Automatic Calibrated

SHEET 1 of 2

Drilling Completed 6/4/14

DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	0.5 / 939.3	2 1/2 inches of bituminous.		6			
		SANDY LEAN CLAY, trace Gravel, with Sand seams, dark brown and brown, moist, (CL), fill	11	14			
5			11	15			
	7.0 / 932.8	SANDY LEAN CLAY, trace Gravel, brown and gray, moist, stiff to hard, (CL), till	20	14			
10			25	14			qp=3 1/2 tsf DD=118 pcf
			20	15			
15			16	16			qp=3 tsf LL=31 PL=12 PI=19
			22	13			
20			31	14			qp=3 1/2 tsf
	22.0 / 917.8	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, medium dense to very dense, (SM), till	37	12			DD=120 pcf
25			*	15			*66 blows per 11-inch set.
			30	8			DD=120 pcf
30			41	13			P200=29%
			25	9			
35			32	9			DD=128 pcf
			*				*50 blows per 3-inch set. *No sample recovery. Rock in tip of sampler.
40			60	9			
			23	8			
45							

Index Sheet Code 3.0

(Continued Next Page)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2153SW**	**939.8** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, medium dense to very dense, (SM), till *(continued)*		35	9				
					39	9				
50	51.0 / 888.8				47	8				

Bottom of Hole - 51 feet.
Water not observed while drilling.
Water not observed with 49 1/2 feet of hollow-stem auger in the ground.

Soil Class:J. Kirk Rock Class: Edit: Date: 7/18/14
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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2154SW	938.7 (Surveyed)

Location: Hennepin Co. Coordinate: X=492797 Y=136323 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine: 7507

Hammer: CME Automatic Calibrated

Drilling Completed: 6/3/14

Depth / Elev.	Classification
1.0 / 937.7	12 inches of aggregate base.
4.0 / 934.7	CLAYEY SAND, trace Gravel, brown and gray, moist, (SC), fill
10.0 / 928.7	SANDY LEAN CLAY, trace Gravel, brown, moist, rather stiff to very stiff, (CL), till
20.0 / 918.7	CLAYEY SAND, trace Gravel, brown, moist, very stiff, (SC), till
30.0 / 908.7	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, medium dense to dense, (SM), till With Gravel at 25 feet.
37.0 / 901.7	SILTY SAND, fine- to medium-grained, with Gravel, with lenses of Lean Clay, heavy Gravel layers encountered from 30 to 3 feet, brown, moist, very dense to dense, (SM), till
	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, dense to very dense, (SC), till

SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	12			
9	16			
10	16			
19	15			
26	9			DD=129 pcf
26	13			
26	10			P200=33%
23	11			
23	10			DD=131 pcf
19	8			
47	8			P200=21%
39*				*No sample recovery. Rock in tip of sampler.
81	8			
62	10			
31	9			
36	8			DD=130 pcf
37	9			
34	9			

Index Sheet Code 3.0

(Continued Next Page)

Soil Class:J. Kirk Rock Class: Edit: Date: 7/18/14

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2154SW**	**938.7** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, dense to very dense, (SC), till *(continued)*		31	9				
			With Gravel at 48 feet.		49	8				
50	51.0 / 887.7				60	9				

Bottom of Hole - 51 feet.
Water not observed while drilling.
Water not observed with 49 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2155SW	936.5 (Surveyed)

Location: Hennepin Co. Coordinate: X=492716 Y=136395 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine: 7507

Hammer: CME Automatic Calibrated

SHEET 1 of 2

Drilling Completed: 6/4/14

Depth	Elev.	Classification
0.5	936.0	6 inches of bituminous.
2.0	934.5	SANDY LEAN CLAY, dark brown, moist, (CL), fill
4.0	932.5	SANDY LEAN CLAY, trace Gravel, dark brown and gray, moist, (CL), fill
6.0	930.5	SANDY LEAN CLAY, with layers of Silty Sand, dark brown and brown, moist, (CL), fill
15.0	921.5	SANDY LEAN CLAY, trace Gravel, brown, moist, stiff to very stiff, (CL), till
20.0	916.5	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, dense, (SM), till
22.0	914.5	POORLY GRADED SAND, fine- to medium-grained, brown, moist, medium dense, (SP), outwash
42.0	894.5	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, medium to dense, (SM), till
45.0		POORLY GRADED SAND, fine-grained, brown, moist, medium dense, (SP), outwash

SPT N60
14
20
14
16
22
38
34
30
31
28
30
41
34
39
39
43
25

MC (%)
13
15
18
16
16
15
9
9
2
8
8
8
8
7
8
6
9
9
8

Other Tests Or Remarks:

- DD=115 pcf (approx. 13 ft)
- DD=125 pcf (approx. 18 ft)
- P200=4% (approx. 20.5 ft)

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	*Bridge No. or Job Desc.*	*Trunk Highway/Location*	*Boring No.*	*Ground Elevation*
		SWLRT	**2155SW**	**936.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	891.5		SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, dense, (SM), till		33	2				
	47.0 / 889.5		POORLY GRADED SAND, fine-grained, brown, moist, dense to very dense, (SP), outwash		41	4				
50	51.0 / 885.5				53					

Bottom of Hole - 51 feet.
Water not observed while drilling.
Water not observed with 49 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2156SW	934.7 (Surveyed)

Location: Hennepin Co. Coordinate: X=492643 Y=136467 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine: 7507

Hammer: CME Automatic Calibrated

SHEET 1 of 2

Drilling Completed: 6/4/14

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	0.4 / 934.3		2 1/2 inches of bituminous over 2 inches of aggregate base.							
	3.0 / 931.7		SANDY LEAN CLAY, trace Gravel, dark brown and gray, moist, (CL), fill		12					
5	7.0 / 927.7		SANDY LEAN CLAY, trace Gravel, brown, moist, rather stiff, (CL), till		10					
10	12.0 / 922.7		LEAN CLAY, trace Gravel, brown and gray, moist, (CL), till		15 9					
15	17.0 / 917.7		CLAYEY SAND, trace Gravel, brown, moist, very stiff to stiff, (SC), till		28 14					
	20.0 / 914.7		POORLY GRADED SAND, fine- to medium-grained, brown, moist, loose. (SP), outwash		10					
20	25.0 / 909.7		SANDY LEAN CLAY, trace Gravel, brown, moist, very stiff, (CL), till		16 23					
25	27.0 / 907.7		SANDY LEAN CLAY, trace Gravel, brown, moist, very stiff, (CL), till		28					DD=118 pcf qp=2 1/2 tsf
30	32.0 / 902.7		SILTY SAND, trace Gravel, with frequent layers of Lean Clay, brown, moist, medium dense, (SM), till		21 16					
35			POORLY GRADED SAND, fine- to medium-grained, light brown and brown, moist, medium dense, (SP), outwash		23 28*					*No sample recovery. Rock in tip of sample.
40					24 27 18					
45										

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2156SW**	**934.7** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			POORLY GRADED SAND, fine- to medium-grained, light brown and brown, moist, medium dense, (SP), outwash *(continued)*		21					
					27					
50					31					
55	56.0 / 878.7				29					

Bottom of Hole - 56 feet.
Water not observed while drilling.
Water not observed with 54 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2157SW	930.0 (Surveyed)

Location: Hennepin Co. Coordinate: X=492489 Y=136595 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7507

Hammer CME Automatic Calibrated

SHEET 1 of 2

Drilling Completed 6/5/14

Depth / Elev.	Classification
1.3 / 928.7	4 inches of bituminous over 12 inches of aggregate base.
6.0 / 924.0	SANDY LEAN CLAY, trace Gravel, brown and gray, moist, (CL), fill
14.0 / 916.0	SANDY LEAN CLAY, trace Gravel, brown and gray, moist, stiff to very stiff, (CL), till
20.0 / 910.0	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, medium dense, (SM), till
25.0 / 905.0	CLAYEY SAND, trace Gravel, with Sand seams, brown, moist to 22 1/2 feet then wet, very stiff to stiff, (SC), till
28.0 / 902.0	SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense, (SM), till
32.0 / 898.0	SANDY LEAN CLAY, trace Gravel, brown, wet, very stiff, (CL), till
42.0 / 888.0	SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense to dense, (SM), till
	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, with frequent layers of Silty Sand, brown, moist, dense, (SP), outwash

SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	17			
13	14			
12	15			
16	17			
20	16			
16	13			
22	11			DD=128 pcf
17	9			
23	12			
15	15			
21	8			
35*				*No sample recovery.
24	14			DD=122 pcf
25	10			
30	9			
27	11			
41	9			
39	7			

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2157SW**	**930.0** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
			POORLY GRADED SAND, fine- to medium-grained, trace Gravel, with frequent layers of Silty Sand, brown, moist, dense, (SP), outwash *(continued)*		42	3				
					42	10				
50					46	11				
	53.0 / 877.0		POORLY GRADED SAND WITH SILT, fine- to medium-grained, trace Gravel, brown, wet, medium dense, (SP-SM), outwash							
55	56.0 / 874.0				28	11				

Bottom of Hole - 56 feet.
Water observed at 22 1/2 feet while drilling.
Water observed at 53 feet with 54 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2158SW	927.7 (Surveyed)

Location: Hennepin Co. Coordinate: X=492409 Y=136645 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7507

Hammer CME Automatic Calibrated

Drilling Completed 6/6/14

Depth / Elev.	Classification
2.0 / 925.7	SILTY SAND, fine- to medium-grained, trace Gravel, dark brown, moist, (SM), fill
6.0 / 921.7	CLAYEY SAND, trace Gravel, brown and gray, moist, (SC), fill
17.0 / 910.7	SANDY LEAN CLAY, trace Gravel, brown, moist, rather stiff to very stiff, (CL), till
25.0 / 902.7	CLAYEY SAND, with Gravel, brown, moist, very stiff to hard, (SC), till
41.0 / 886.7	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, very dense to medium dense, (SM), till
45.0	CLAYEY SAND, trace Gravel, brown, moist, hard, (SC), till

Water level symbol shown at 25 ft depth.

SPT N_{60}	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	9			
13	13			
12	10			
12	16			
14	14			
13	17			DD=114 pcf
20	16			DD=124 pcf
26	12			
34	14			
27*				*No sample recovery. Rock in tip of sampler.
52*				*No sample recovery. Rock in tip of sampler.
41	8			
62	8			P200=25%
28	7			
33	6			
35	8			Heavy Gravel noted from 37 to 40 feet.
35	7			
25	12			

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2158SW**	**927.7** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	882.7		SILTY SAND, fine- to medium-grained, with Gravel, brown, moist, medium dense, (SM), till		25	11				
					22	6				
50	50.0 / 877.7		POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, wet, medium dense, (SP-SM), outwash		22	10				
55	56.0					14				
	871.7		Bottom of Hole - 56 feet. Water observed at 25 feet while drilling. Water observed at 50 feet with 54 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.							

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2017SW	(Surveyed)

Location: Hennepin Co. Coordinate: X=492023 Y=137450 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine **7506**

Hammer **CME Automatic Calibrated**

SHEET 1 of 2

Drilling Completed **8/1/13**

Depth	Elev.	Classification
0.5		3 inches of Bituminous over 3 1/2 inches of Aggregate Base.
4.0		FILL: Lean Clay, slightly organic, trace roots, dark gray, wet.
7.0		FILL: Clayey Sand, with Gravel, brown and gray, wet.
19.0		CLAYEY SAND, trace Gravel, with occasional Sand lenses and seams, brown with rust stains, wet, medium to very stiff, (SC), till
39.0		SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff, (CLS), till
44.0		SILTY SAND, fine- to medium-grained, with Gravel, reddish brown, moist to 43 feet then waterbearing, very dense, (SM), till

Depth (approx.)	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
3	5	24			OC=3%
5.5	12	11			
8	11				
10.5	8	16			P200=32%
13	11				
15.5	12				
18	19				
20.5	20	17			P200=60%
25.5	17				
30.5	26				
35.5	28				qp=2 1/2 tsf
40.5	58				

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BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2017SW**	(Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
50	51.0		POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, reddish brown, waterbearing, medium dense to very dense, (SP-SM), outwash *(continued)*		* 15					*50 blows per 6-inch set.

Bottom of Hole - 51 feet.
Water observed at 43 feet with 49 1/2 feet of hollow-stem auger in the ground.
Water not observed to cave-in depth of 37 feet immediately after withdrawal of auger.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2018SB	925.5 (Surveyed)

Location: Hennepin Co. Coordinate: X=492322 Y=136715 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7512

Hammer CME Automatic Calibrated

Drilling Completed 4/24/13

Depth / Elev.	Classification	SPT N60	MC (%)	Other Tests Or Remarks
1.0 / 924.5	SILTY SAND, coarse-grained, trace Gravel, brown, (SM), topsoil fill	8	15	
8.0 / 917.5	CLAYEY SAND, trace Gravel, brown and gray, wet, (SC), fill	14	16	
14.0 / 911.5	CLAYEY SAND, trace Gravel, brown, wet, stiff, (CS), till	TW	16	qu=3280 psf DD=116 pcf
19.0 / 906.5	SANDY LEAN CLAY, trace Gravel, brown, wet, stiff, (CL), till	14	16	
27.0 / 898.5	CLAYEY SAND, trace Gravel, brown, moist, very stiff, (SC), till	TW	18	qu=6060 psf DD=112 pcf
		26	10	
		30	13	
32.0 / 893.5	SILTY SAND, fine- to medium-grained, with some Gravel, borwn, moist, dense, (SM), till	34	6	
		40	8	
37.0 / 888.5	CLAYEY SAND, trace Gravel, brown, moist, very stiff, (SC), till	22	7	
		30	10	
	SILTY SAND, fine- to medium-grained, trace Gravel, moist to 50 feet then wet, dense to very dense, (SM), till	27	9	
		28	6	
		49	11	Switched to mud rotary drilling method after 40-foot sample.

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2018SB	925.5 (Surveyed)

DEPTH	Depth / Elev.	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Other Tests Or Remarks / Formation or Member
		SILTY SAND, fine- to medium-grained, trace Gravel, moist to 50 feet then wet, dense to very dense, (SM), till *(continued)*		42	11			
			PD	48	13			Gravel at 47 feet.
50			PD	100	15			
			PD	55	10			
55			PD	49	11			
			PD	44	10			
60	61.0 / 864.5		PD	*	11			*100 blows per 6-inch set.
		SILTY SAND, fine- to medium-grained, trace Gravel, gray, wet, medium dense, (SM), till	PD	28	11			
65	67.0 / 858.5		PD	19	9			
	69.0 / 856.5	CLAYEY SAND, trace Gravel, gray, wet, hard, (SC), till	PD	33	14			
70		SILT, brown, wet, very dense, (ML), till	PD	100	19			
75			PD	100				See attached Grain Size Accumulation Curve
80	79.0 / 846.5	SANDY SILT, trace Gravel, brown, wet, very dense, (SM), till	PD	102	22			
85			PD	90				See attached Grain Size Accumulation Curve
90	90.0		PD					

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

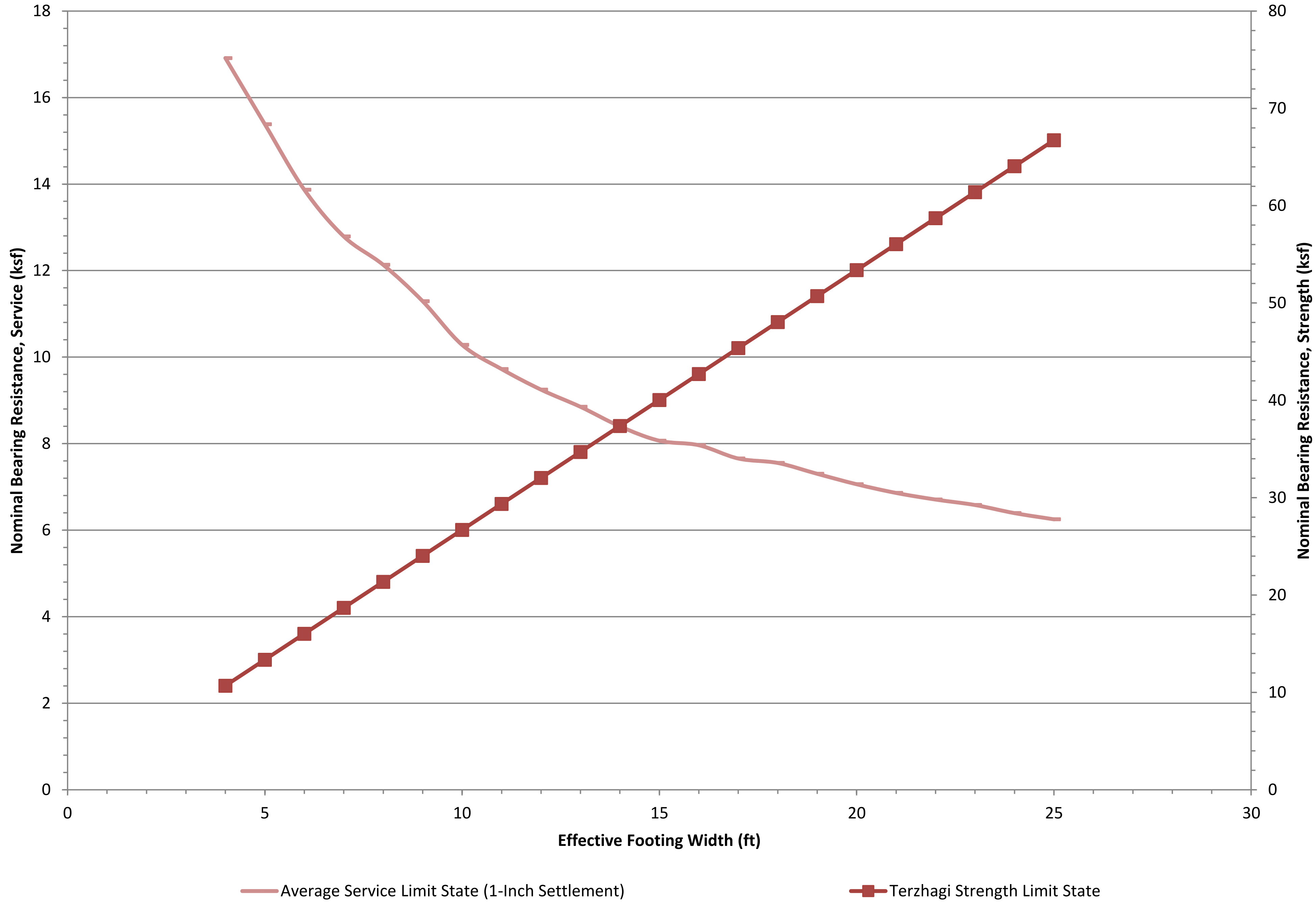
MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

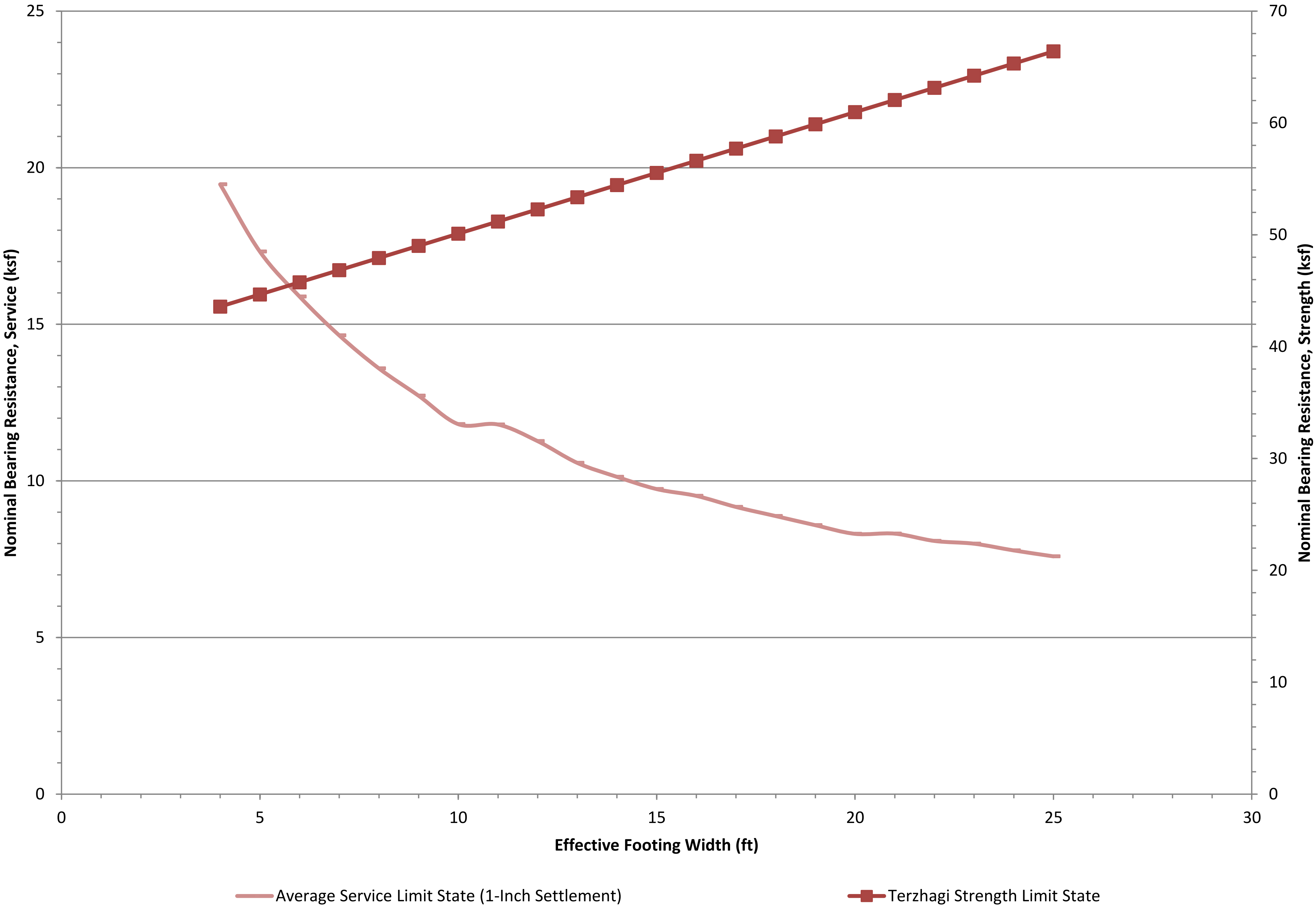
State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2018SB**	**925.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
	835.5				100*					*No sample recovery.
				PD						
95			SILTY SAND, fine- to medium-grained, trace Gravel, gray, wet, medium dense, (SM), till		100					See attached Grain Size Accumulation Curve
				PD						
100	101.0				87	27				
	824.5		Bottom of Hole - 101 feet. Water level obscured due to drilling fluids used during mud rotary drilling operation. Boring then sealed with bentonite grout. NOTE: Piezometer placed to a depth of about 50 feet in adjacent borehole.							

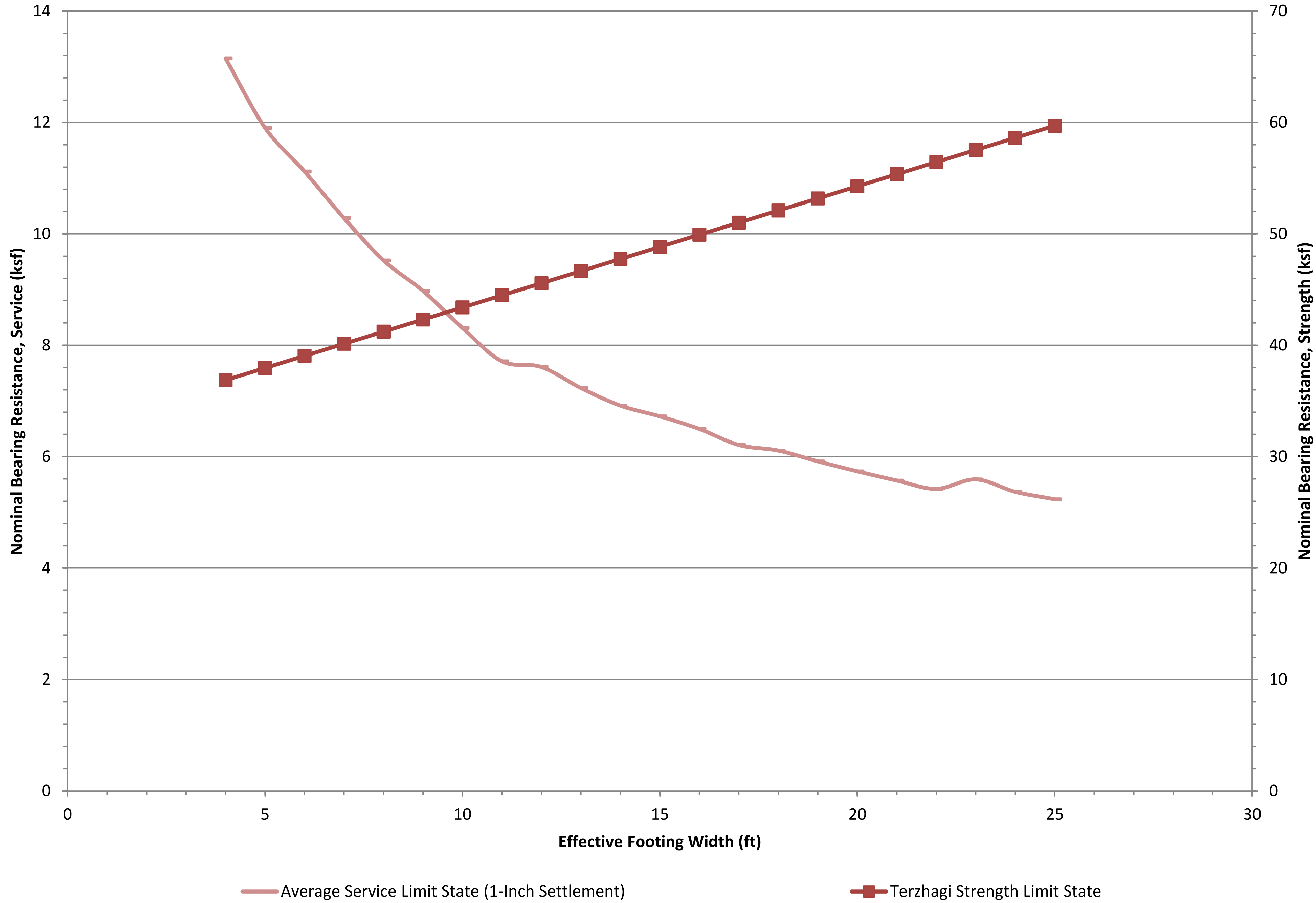
Limit State Shallow Foundation Analysis
RTW-W207D(2156SW) - 1-inch Settlement



Limit State Shallow Foundation Analysis
RTW-W209 (2018SB) - 1-inch Settlement



Limit State Shallow Foundation Analysis
RTW-W210 and RTW-W211 (2017SB) - 1-inch Settlement



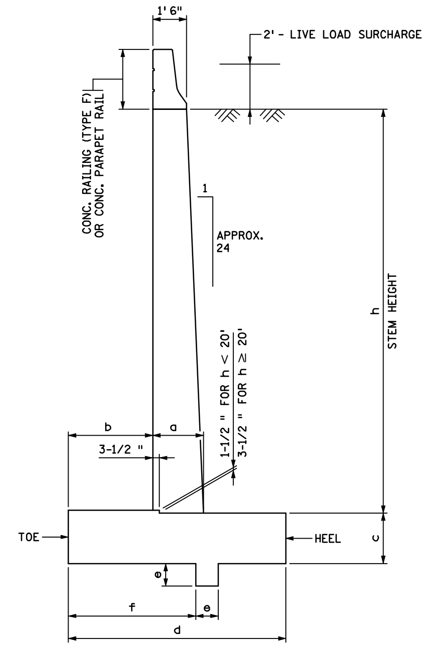
WALL LOADING CASE:
2' - LIVE LOAD SURCHARGE

WALL GEOMETRICS AND DATA - SPREAD FOOTING							QUANTITIES PER FOOT - SPREAD FOOTING					BASE PRESSURE KIPS/SQ. FT.	
							STRUCTURAL CONCRETE		REINFORCEMENT				
STEM HEIGHT h	STEM WIDTH a	TOE WIDTH b	FOOTING THICKNESS c	FOOTING WIDTH d	SHEAR KEY SIZE e	SHEAR KEY LOCATION f	1A43 (CU.YD.) FOOTING	3Y43 (CU.YD.) STEM	PLAIN (POUND)	EPOXY (POUND)	WALL DETAILING SCHEME (1)	TOE	HEEL
5	1'-8 1/2"	1'-0"	1'-5"	3'-6"	N/A	N/A	0.187	0.296	15.38	38.16	SHORT	1.670	0.070
6	1'-9"	1'-2"	1'-5"	4'-0"	N/A	N/A	0.211	0.360	16.43	41.74	SHORT	1.820	0.090
7	1'-9 1/2"	1'-4"	1'-5"	4'-6"	N/A	N/A	0.235	0.425	19.70	45.34	SHORT	1.970	0.120
8	1'-10"	1'-6"	1'-5"	5'-0"	N/A	N/A	0.259	0.492	20.75	48.89	SHORT	2.110	0.150
9	1'-10 1/2"	1'-8"	1'-5"	5'-6"	N/A	N/A	0.283	0.561	24.13	52.69	SHORT	2.250	0.180
10	1'-11"	1'-9"	1'-5"	6'-0"	N/A	N/A	0.306	0.631	25.18	62.49	MEDIUM	2.446	0.199
11	1'-11 1/2"	2'-0"	1'-5"	6'-6"	N/A	N/A	0.331	0.703	31.28	66.85	MEDIUM	2.536	0.239
12	2'-0"	2'-3"	1'-5"	6'-9"	1'-0"	3'-10 5/8"	0.380	0.776	35.38	72.23	MEDIUM	2.758	0.156
13	2'-0 1/2"	2'-6"	1'-5"	7'-0"	1'-0"	4'-2 1/8"	0.393	0.851	40.30	76.82	MEDIUM	2.986	0.013
14	2'-1"	2'-9"	1'-6"	7'-8"	1'-0"	4'-5 3/4"	0.477	0.928	40.49	81.74	MEDIUM	3.147	0.078
15	2'-1 1/2"	3'-0"	1'-6"	8'-2"	1'-0"	4'-9 1/4"	0.506	1.006	40.10	99.57	TALL	3.239	0.111
16	2'-2"	3'-3"	1'-9"	8'-8"	1'-0"	5'-0 7/8"	0.615	1.085	41.38	105.97	TALL	3.494	0.056
17	2'-2 1/2"	3'-6"	1'-9"	9'-2"	1'-0"	5'-4 3/8"	0.649	1.166	49.02	111.90	TALL	3.586	0.089
18	2'-3"	3'-9"	1'-9"	9'-8"	1'-0"	5'-7 7/8"	0.682	1.249	50.52	129.74	TALL	3.679	0.121
19	2'-3 1/2"	4'-0"	2'-0"	10'-2"	1'-0"	5'-11 1/2"	0.810	1.333	54.26	137.41	TALL	3.935	0.066
20	2'-4"	4'-3"	2'-0"	10'-8"	1'-0"	6'-3"	0.875	1.417	61.38	165.51	TALL	4.056	0.090
21	2'-4 1/2"	4'-6"	2'-0"	11'-2"	1'-0"	6'-6 1/2"	0.916	1.504	71.34	174.30	TALL	4.151	0.122
22	2'-5"	4'-9"	2'-3"	11'-8"	1'-0"	6'-10 1/8"	1.064	1.593	85.93	183.51	TALL	4.407	0.067
23	2'-5 1/2"	5'-0"	2'-6"	12'-2"	1'-0"	7'-1 3/4"	1.221	1.683	84.82	224.49	TALL	4.663	0.012
24	2'-6"	5'-3"	2'-9"	12'-9"	1'-0"	7'-5 3/8"	1.396	1.775	94.03	234.03	TALL	4.872	0.020
25	2'-6 1/2"	5'-6"	2'-9"	13'-3"	1'-0"	7'-8 7/8"	1.449	1.868	100.13	288.16	TALL	4.967	0.052
26	2'-7"	5'-10"	3'-0"	13'-9"	1'-0"	8'-1 1/2"	1.631	1.963	102.26	299.67	TALL	5.189	0.000
27	2'-7 1/2"	6'-2"	3'-3"	14'-4"	1'-0"	8'-6 1/8"	1.832	2.059	127.34	315.84	TALL	5.364	0.000
28	2'-8"	6'-6"	3'-3"	15'-0"	1'-0"	8'-10 5/8"	1.916	2.157	140.92	394.98	TALL	5.334	0.140
29	2'-8 1/2"	6'-10"	3'-6"	15'-6"	1'-0"	9'-3 1/4"	2.123	2.257	148.00	407.90	TALL	5.558	0.077
30	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTE:
EPOXY REINFORCEMENT QUANTITY ASSUMES AN EXPANSION JOINT IS USED ON BOTH PANEL ENDS. THE QUANTITY MUST BE ADJUSTED WHEN CONSTRUCTION JOINTS ARE USED. QUANTITIES ON THIS SHEET DO NOT INCLUDE RAILING. SEE RAILING SHEETS FOR RAIL REINFORCEMENT (EPOXY) AND RAIL CONCRETE (3Y46).

(1) SEE STANDARD PLANS 5-297.621 TO .623 FOR REINFORCING DETAILS.

DESIGN CRITERIA
1992 A.A.S.H.T.O. DESIGN SPECIFICATIONS DESIGN METHOD: WORKING STRESS - STABILITY, FOUNDATIONS LOAD FACTOR DESIGN - REINFORCED CONCRETE f'c = 4,000 PSI fy = 60,000 PSI FACTOR OF SAFETY OVERTURNING: 2.0 MINIMUM FACTOR OF SAFETY SLIDING: 1.5 MINIMUM LOCATION OF RESULTANT: MIDDLE 1/3 OF FOOTING NEGLECTING SOIL IN FRONT OF WALL. SEE FOUNDATION REPORT FOR ALLOWABLE BEARING PRESSURE AND COEFFICIENT OF FRICTION. BACKFILL CHARACTERISTICS: INTERNAL ANGLE OF FRICTION: 35° = 33 PCF EQUIVALENT FLUID PRESSURE ACTIVE STATE = 53 PCF EQUIVALENT FLUID PRESSURE AT REST STATE βe = 1.0 COEFFICIENT OF FRICTION: 0.55 UNIT WEIGHT: 125 PCF



TYPICAL SECTION

REVISED:
APPROVED: MAY 31, 2006
Daniel L. Dorgan
STATE BRIDGE ENGINEER

STANDARD SHEET NO. 5-297.632 (1 OF 4)	TITLE: RETAINING WALL (LIVE LOAD SURCHARGE) SPREAD FOOTING GEOMETRY AND DATA
STANDARD APPROVED: MAY 31, 2006	
STATE PROJ. NO.	(TH) SHEET NO. OF SHEETS

Table 5. Correlation results for sand. (Column A = Number in Table x Row B.)

A \ B	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	N bl/ft
E_o tsf	1	0.125	8	1.15	57.5	4
E_R tsf	8	1	64	6.25	312.5	22.7
p^*_L tsf	0.125	0.0156	1	0.11	5.5	0.5
q_c tsf	0.87	0.16	9	1	50	5
f_s tsf	0.0174	0.0032	0.182	0.02	1	0.1
N bl/ft	0.25	0.044	2	0.2	10	1

Table 6. Correlation results for clay. (Column A = Number in Table x Row B.)

A \ B	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	S_u tsf
E_o tsf	1	0.278	14	2.5	56	100
E_R tsf	3.6	1	50	13	260	300
p^*_L tsf	0.071	0.02	1	0.2	4	7.5
q_c tsf	0.40	0.077	5	1	20	27
f_s tsf	0.079	0.0038	0.25	0.05	1	1.6
S_u tsf	0.010	0.0033	0.133	0.037	0.625	1

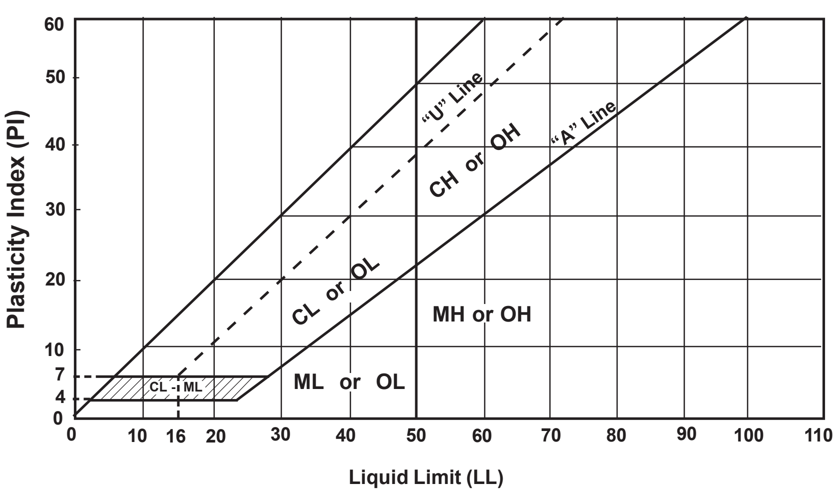
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils			Primarily organic matter, dark in color and organic odor	PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
   Coarse .... 3/4" to 3"
   Fine .... No. 4 to 3/4"
Sand
   Coarse .... No. 4 to No. 10
   Medium .... No. 10 to No. 40
   Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix F

TH 62 Tunnel Crossing

BRAUN INTERTEC
The Science You Build On.

Braun Intertec Corporation
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Minneapolis, MN 55438

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Fax: 952.995.2020
Web: braunintertec.com

August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Results of Field Exploration and Recommendations – 100% Design
Proposed TH 62 Tunnel Crossing
STA 2304+71 to STA 2311+69
Southwest LRT, West Segment 2
Eden Prairie/Minnetonka, Minnesota

Dear Mr. Demers:

Braun Intertec has completed the requested drilling and geotechnical evaluation for the design of the tunnel to be constructed under Highway 62 as part of the SWLRT (Southwest Light Rail Transit) project in Eden Prairie and Minnetonka, Minnesota. The following sections provide recommendations for the design of the tunnel, embankment design, and construction on the project.

This report is part of a larger series of reports for the west segment of the SWLRT project. Recommendations for the retaining walls adjacent to the tunnel and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project information

The Southwest Light Rail Transit Project Office (SPO) requested subsurface soil and groundwater information and a Foundation Analysis Design Recommendation Report (FADR) in the area of TH 62, where a tunnel is being considered beneath the highway for the future light rail transit line.

A.1. Type of Structures

The design report provides foundations recommendations for the tunnel under TH 62. The tunnel is proposed to be a 700-foot long structure extending beneath both lanes of traffic of TH 62, as well as Yellow Circle Drive, located to the north of the highway.

B. Subsurface Investigation Summary

B.1. Summary of Borings Taken

A total of four (4) standard penetration tests (SPT) soil borings were performed between August 1, 2013 and May 15, 2014. Appendix A of this report includes copies of the borings and a boring layout sketch.

B.2. Description of Foundation Soil Conditions

Two borings generally encountered fill soils consisting of silty sand and clayey sand with some gravel to depths ranging from 4 to 8 feet beneath the surface. The other two borings encountered sandy lean clay topsoil ranging in thickness from ½ to 1-foot thick.

Beneath the topsoil and fill, glacially deposited soils consisting of poorly graded sand (SP), poorly graded sand with silt (SP-SM), silty sand (SM), clayey sand (SC), sandy silt (ML), silt (ML), and sandy lean clay (CL) were encountered. The Penetration resistances within this deposit ranged from 5 to 120 blows per foot (BPF), indicating loose to very dense sandy soils and rather soft to hard clayey soils.

B.3. Summary of Water Level Measurements

Groundwater was difficult to determine during and immediately after drilling operations due to the low-permeability soil and use of mud rotary drilling techniques. Two piezometers were installed, one at 2018SB and one at 2019SB to evaluate the static groundwater level over a period of approximately three weeks. The piezometers were installed to depths of 50 feet and groundwater levels were monitored at the intervals noted below in Table 1.

Table 1. Groundwater Measurements at TH 62 Piezometer Locations

Location	Boring Surface Elevation (ft)	Piezometer Reference Elevation (ft.)	Groundwater at time of Drilling (ft)	Boring Groundwater Elevation on April 29, 2013 (ft)	Groundwater Elevation on May 3, 2013 (ft)	Groundwater Elevation on May 9, 2013 (ft)	Groundwater Elevation on May 17, 2013 (ft)
Boring 2018SB	925.5	928.8	NA	879.9	879.9	879.9	879.9
Boring 2019SB	934.4	937.3	879.4	NE	NE	NE	NE
Boring 2138SB	923.0	-	896.0	-	-	-	-
Boring 2138SB	931.0	-	871.0	-	-	-	-

*NE=Not encountered

Groundwater was not observed when measured in April and May, 2013, in Boring 2019SB and likely was below the invert depth of the piezometers. Additionally, due to the relatively clayey nature of the soils encountered at shallow depths, specifically the glacial till, perched groundwater on top of these layers may be encountered at the time of construction following rainy periods. Fluctuations in groundwater levels should be anticipated throughout the year due to seasonal variations in rainfall and other factors.

B.4. Interpretation of Water Level

Based on the water level measurements in the borings and the piezometer placed, the static groundwater level appears to be between elevations 857 and 880. If given time to stabilize, we anticipate groundwater will be nearer to 880 based on current and historical information from borings near this location. While not encountered by the borings, isolated pockets of perched water may be encountered and will need to be drained during construction.

C. Foundation Analysis

Based on the soil conditions encountered in the borings, we recommend the use of a spread footing or mat foundation system to carry the proposed tunnel and train loads. Given the dimensions of the tunnel excavations, the soils at the bottom of footing depth will experience an “unload” condition from the removal of the overburden soils and replacement with a tunnel.

C.1. Bearing Capacity

The geologic materials, specifically the glacial tills encountered at the proposed foundation elevations, appear competent and suitable for support of the tunnel foundation.

Based on our calculations and understanding, the soil conditions noted in the borings are anticipated to provide a bearing resistance in excess of the required capacity.

C.2. Settlement

Based on anticipated fill heights of up to 36 feet, and the recommendations provided in Section D.4 below, we anticipate settlement will be within the service limit of one-inch.

C.3. Time Rate of Settlement

Due to the consistency of the underlying soils beneath the tunnel, we anticipate that any consolidation of the existing soils will occur during construction of the tunnel and embankment. Following the recommended compaction specifications noted below, we estimate less than 1-inch of long term settlement from the embankment and underlying soils.

C.4 Tunnel Foundations

Settlements were calculated based on two methods. The first is the Hough method with Boussinesq and Westergaard, which utilizes the standard penetration test (SPT) values from the soil borings. The second is the Menard method, which is based on pressuremeter determinations of soil parameters that were collected in the field or modified from the SPT values from the soil borings. For the Menards Method, where pressuremeter testing was not performed, conservative correlations were used to estimate pressuremeter values based on N_{60} factors provided in Federal Highway Administration (FHWA) Publication No. FHWA-IP-89-008. Tables 5 and 6 from this publication are attached for reference. After these two methods were evaluated, the results were averaged.

Terzhagi's strength limit state is also included on the nominal bearing graphs in the Appendix, for reference. The strength limit state (bearing) will not control design.

The service limit state (settlement) will control the design and the average service limit state should be used for design of tunnel foundations. A maximum settlement of 1 inch is specified for this project.

D. Summarize Design Assumptions

It is our understanding the tunnel will be a cast-in-place concrete structure, and will be backfilled to near existing grade. It is anticipated the construction will take place in multiple phases to keep lanes of traffic open on TH 62.

The top of rail elevation (TOR) ranges from 908 on the south end of the tunnel to 913 on the north end, with a low point of 904. The excavation bottom extends approximately 5 ½ feet below the top of rail elevation.

The total width of the tunnel is approximately 38 feet (outside to outside) to accommodate the two tracks with a separator wall in between. The tunnel is 16.5 feet tall, with a 2-foot thick concrete roof. The total height of the tunnel is proposed to be 20 feet.

We understand the tunnel will be a cast-in-place structure, utilizing a cut and cover method of construction. Total fill thicknesses will vary from 32 to 36 feet beneath the roadways, with approximately 13 feet over cover between the top of the tunnel and the roadway. The construction will be staged, shifting traffic while constructing the first half of the tunnel and roadway, then diverting traffic over the new tunnel, and constructing the second half. Temporary shoring will be required to facilitate construction.

D.1. Embankment Heights, Unit Weights, and Slopes

As mentioned above, 32 to 36 feet of fill soils will be required to re-establish roadway elevations upon excavation for the tunnel. Because settlement of the backfill soils will be critical to the construction staging and scheduling, we recommend using select granular borrow soil meeting the requirements of MnDOT 3149.2B2 instead of the onsite soils to reduce the time rate of settlement. We estimate all settlement of this soil will occur during construction. This soil has an assumed unit weight of 120 pounds per cubic foot (pcf) and a friction angle of 35 degrees.

The native silty sands and clayey sands are considered Type B Soil under OSHA guidelines. Unsupported excavations should therefore be maintained at a gradient no steeper than 1 to 1 (horizontal: vertical). Slopes constructed in this manner may still exhibit surface sloughing. If site constraints do not allow the construction of temporary slopes with these dimensions, then temporary shoring may be required, and OSHA requires slope or excavations over 20 feet in depth to be evaluated by an engineer.

An OSHA approved competent person should review this soil classification in the field. Excavations must comply with the requirements of OSHA 29 CFR, Part 2926, Subpart P, “Excavations and Trenches.” This document states that excavation safety is the responsibility of the contractor. Reference to these OSHA requirements should be included in the project specifications.

In the event there is insufficient room to slope excavations, or if the excavations are exposed to surcharges and need to be shored, we recommend designing the shoring based on the parameters presented below in Table 2. The parameters shown have not been reduced by safety factors.

Saturated unit weights are recommended to account for the potential buildup of hydrostatic pressure behind undrained support structures.

Table 2. Lateral Load Parameters and Coefficient of Friction

Geologic Material	Saturated Unit Weight (pcf)	Friction Angle (deg)	Active Coefficient (K_A)	At Rest Coefficient (K_O)	Passive Coefficient (K_P)	Coefficient of Friction (ð)
Imported Select Granular Borrow (MnDOT 3419.2B2)	120	35	0.27	0.42	3.09	0.45
Silty Sand (SM)	130	30	0.33	0.50	3.00	0.40
Clayey Sand (SC)	135	28	0.36	0.53	2.76	0.35
Sandy Lean Clay (CL)	130	28	0.36	0.53	2.76	0.35

D.2. Design Methodologies – Tunnel Foundation Structures

The LRFD (Load and Resistance Factor Design Method) was used for design of the bridge substructures supported on shallow foundations. Resistance factors were obtained from the Sixth Edition of the AASHTO (American Association of State Highway and Transportation Officials) LRFD Bridge Design Specifications (6th edition with 2013 interim revisions).

D.3. Construction Considerations

D.3.a. Subcut Recommendations and Backfill Requirements

We recommend excavating the soils to the proposed bottom of subgrade elevations as noted on the plans. We anticipate silty sand and clayey sand soils will be encountered in the excavation bottoms. While not encountered by the borings, perched groundwater conditions may be encountered throughout the excavation depending on seasonal and annual precipitation. If encountered, temporary dewatering may be needed along with the placement of crushed rock and the use of sumps and pumps to assist in controlling groundwater seepage and to provide a stable working platform during construction.

As noted in the plans, we recommend placing a 12-inch layer of crushed rocks beneath the tunnel foundation to act as a leveling pad and protect the subgrade soils during construction. Perforated draintile is also recommended at the bottom of excavation elevation to collect and dispose of any accumulated groundwater. If additional excavations are needed during construction, this should be taken into consideration when installing the draintile. The draintile should be placed directly upon a non-permeable or low permeability layer, such as the native glacial soils to prevent the accumulation of groundwater beneath the tile elevation.

We anticipate the excavation will be widened several feet beyond the outside of the wall to facilitate construction.

We recommend backfilling the excavation with Select Granular Borrow. We also recommend compacting the soils to meet the requirements as noted in Table 3 below based on the 2014 MnDOT Standard Specification for Construction.

Table 3. Material and Compaction Specifications for Backfill and Fill

Material	Material Specification	Compaction Specification
Leveling Pad Beneath Foundation	3138.2B	2211.3C
Tunnel and Excavation Backfill	3149.2B2*	21053.3F

*We recommend backfill material used for the tunnel excavation consist of Select Granular Modified 10%. Select Granular Modified 10% shall comply with Specification 3149.2B2, modified to 10% or less passing the 0.075 mm (#200) sieve. For excavations extending near or below groundwater, a crushed rock with less than 10% percent passing the 0.075 mm(#200) sieve shall be used for backfill and to provide a working platform and to help control groundwater seepage.

E. Foundation Recommendations

E.1. Nominal Bearing Capacities and Associated Resistance Factors

Please refer to the figures in the Appendix for the recommended bearing resistances and service limit states for the tunnel foundation. These graphs are based on the settlement methods discussed in Section D.2 of this report. For the service limit state, a resistance factor of 1.0 shall be applied.

The resistance factors for evaluating the strength limit state performance are based on the current LRFD code:

Bearing Resistance, using SPT = 0.45
Sliding, Cast-in-Place Concrete on Sand =0.8

Also, refer to the attached figures in the Appendix for the ultimate bearing resistances of the foundations. We based the figures on the settlement methods discussed in Section 3.2 of this report. We recommend that the average service limit state be used for retaining wall base pressure verification as identified on the MnDOT Retaining Wall standard plans.

E.2. Recommended Design Soil Parameters (e.g., Coefficient of Friction, Lateral Earth Pressure Coefficients, etc.)

Refer to Table 2. In section D.1 for recommended soils design parameters for use in the design of the tunnel walls.

F. Material Classification and Testing

F.1. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

F.2. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures and follow by MnDOT guidelines.

F.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced. The boreholes were then backfilled or sealed with bentonite grout.

G. Qualifications

G.1. Variations in Subsurface Conditions

G.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore, strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

G.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

H. Continuity of Professional Responsibility

H.1. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

H.2. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

I. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

J. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these bridge foundation recommendations, please call Josh Kirk at 952.995.2222 or jkirk@braunintertec.com or Ray Huber at 952.995.2260 or rhuber@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification, or report
Was prepared by me or under my direct supervision
And that I am a duly Licensed Professional Engineer
Under the laws of the State of Minnesota.

JOSHUA L. KIRK
LICENSED PROFESSIONAL ENGINEER
45005
STATE OF MINNESOTA

Joshua L. Kirk, PE
Associate Principal / Project Engineer
License Number: 45005

Reviewed by:

"for"

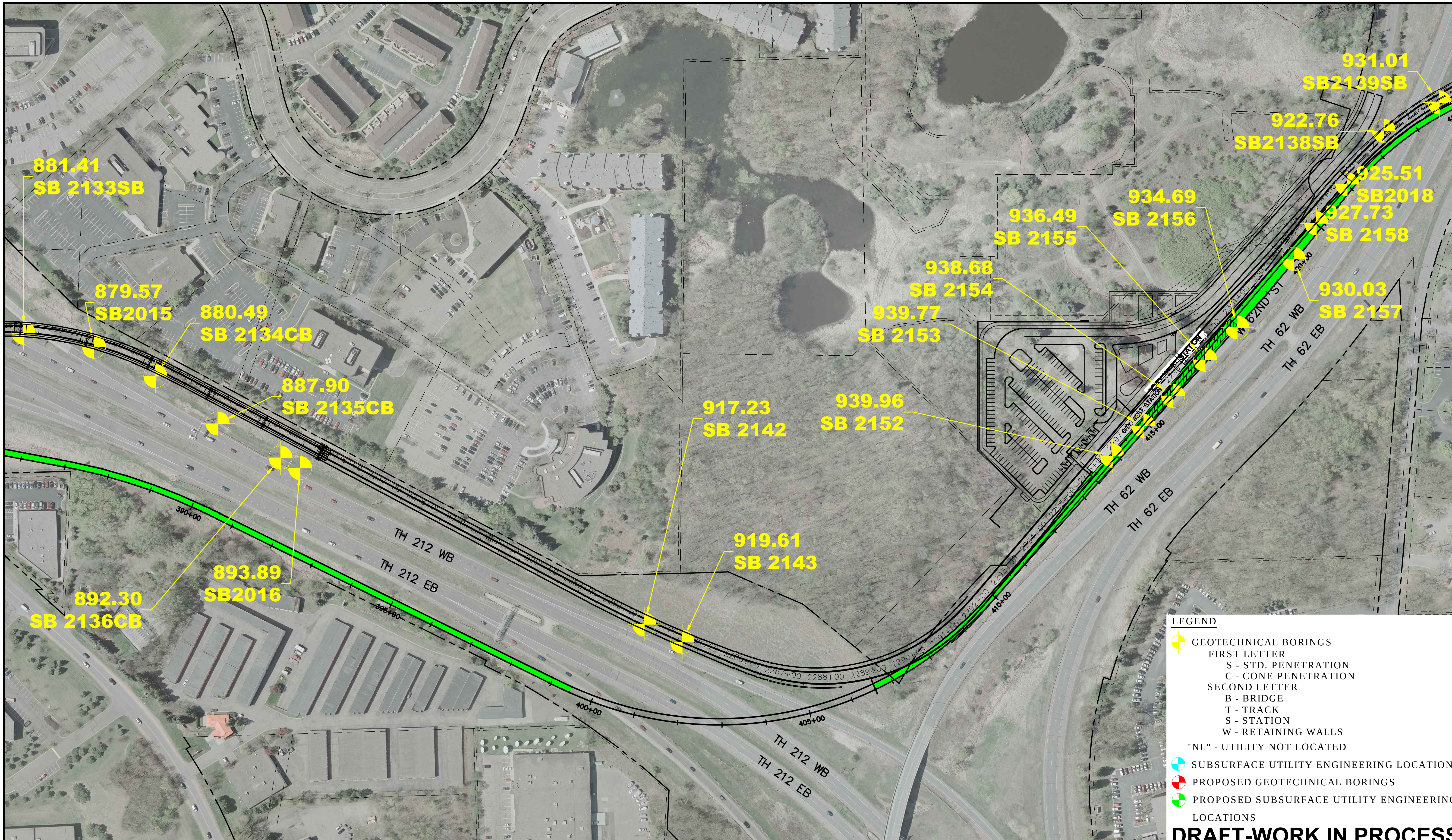
Ray A. Huber, PE
Vice President/Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Soil Boring Location Sketch
Preliminary Engineering Plan and Profile Sheets-Tunnel Structure under Highway 62
Soil Boring Logs 2018SB, 2019SB, 2138SB, and 2139SB
Limit State Analysis Graphs
Publication No. FHWA-IP-89-008 N_{60} Correlation Tables
Descriptive Terminology

APPENDIX



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SOUTHWEST Green Line LRT Extention

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 8 OF 12

IRT: N/A

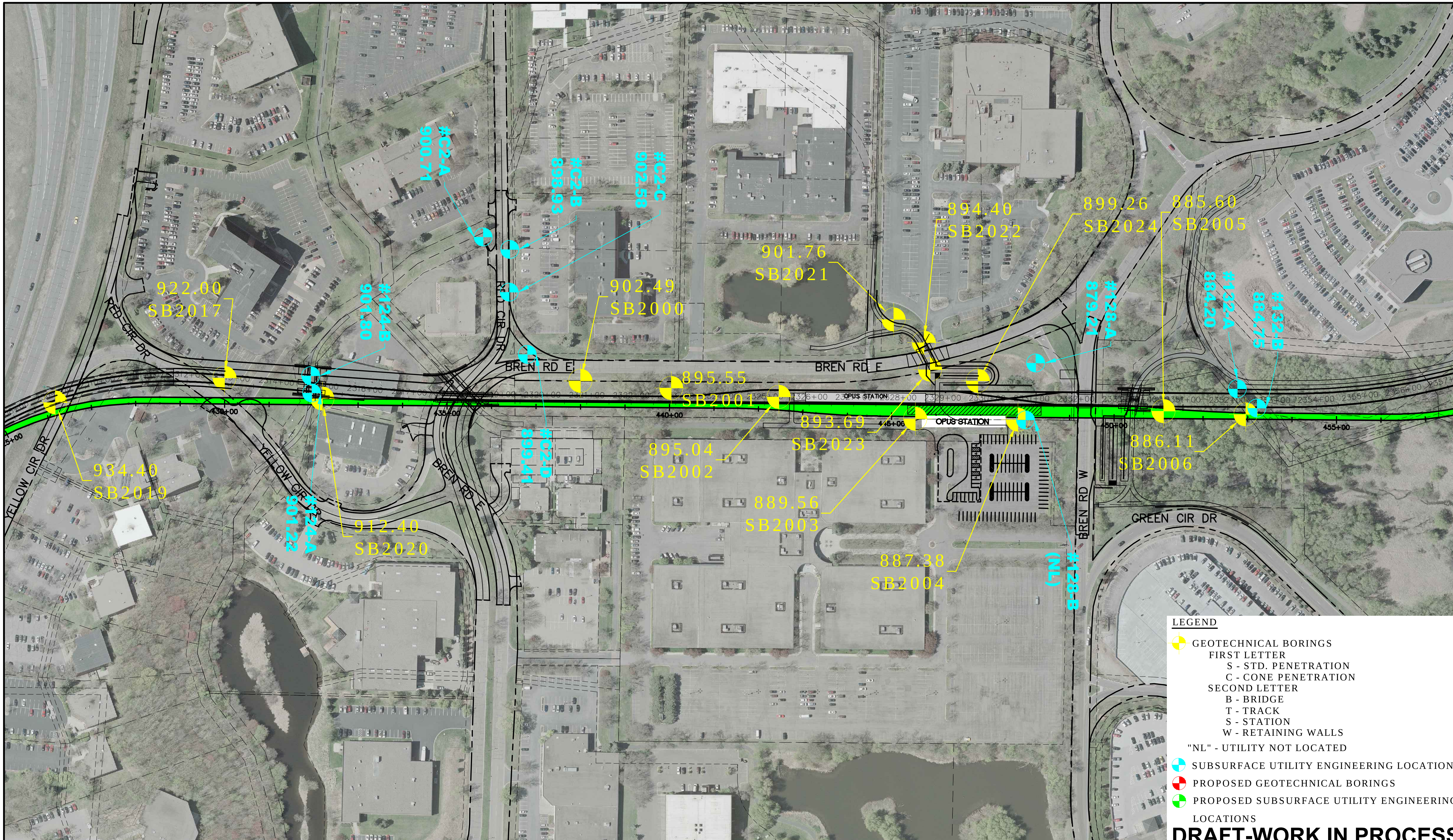
REV: 0

DATE: 06/30/2014

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.



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SOUTHWEST Green Line LRT Extension

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 9 OF 12

IRT: N/A

REV: 0

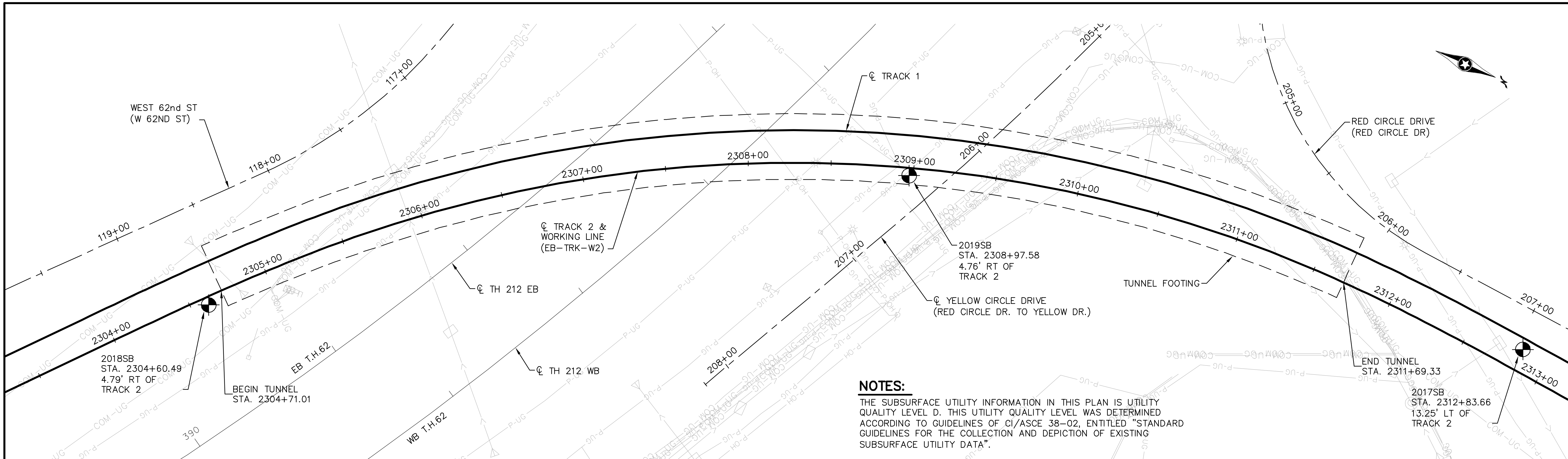
DATE: 06/30/2014

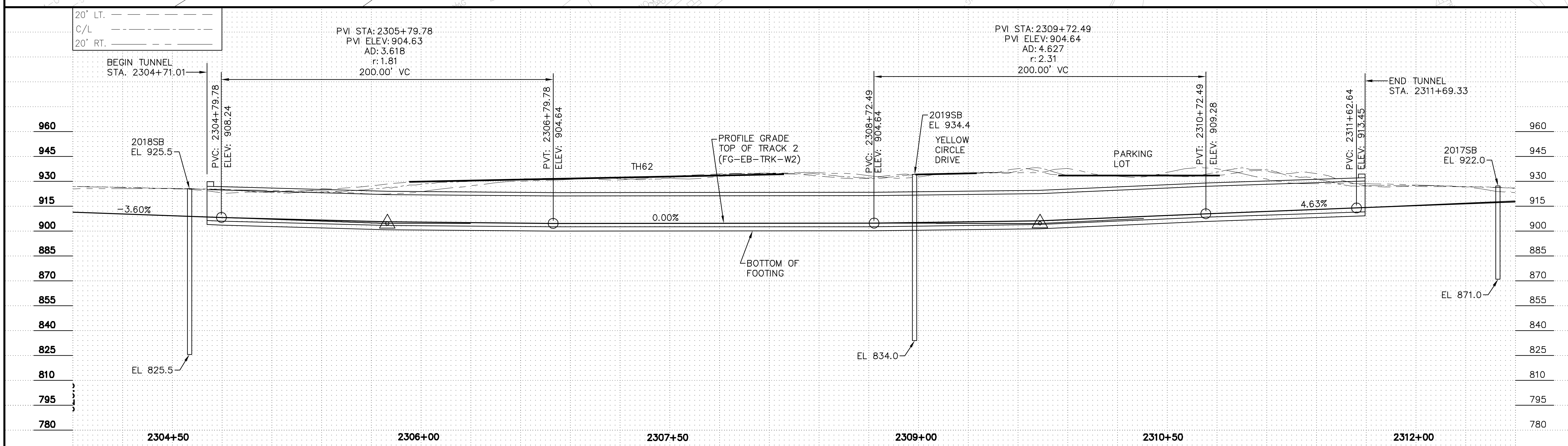
NORTH
0 50 100 200

METROPOLITAN COUNCIL

AECOM

SRF Consulting Group, Inc.





NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM PARSONS BRINCKERHOFF

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL SOUTHWEST Green Line LRT Extension

WEST SEGMENT 2
TUNNEL STRUCTURE UNDER HWY 62
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-TUNL-TH62-SUR3

SHEET 118 OF 197

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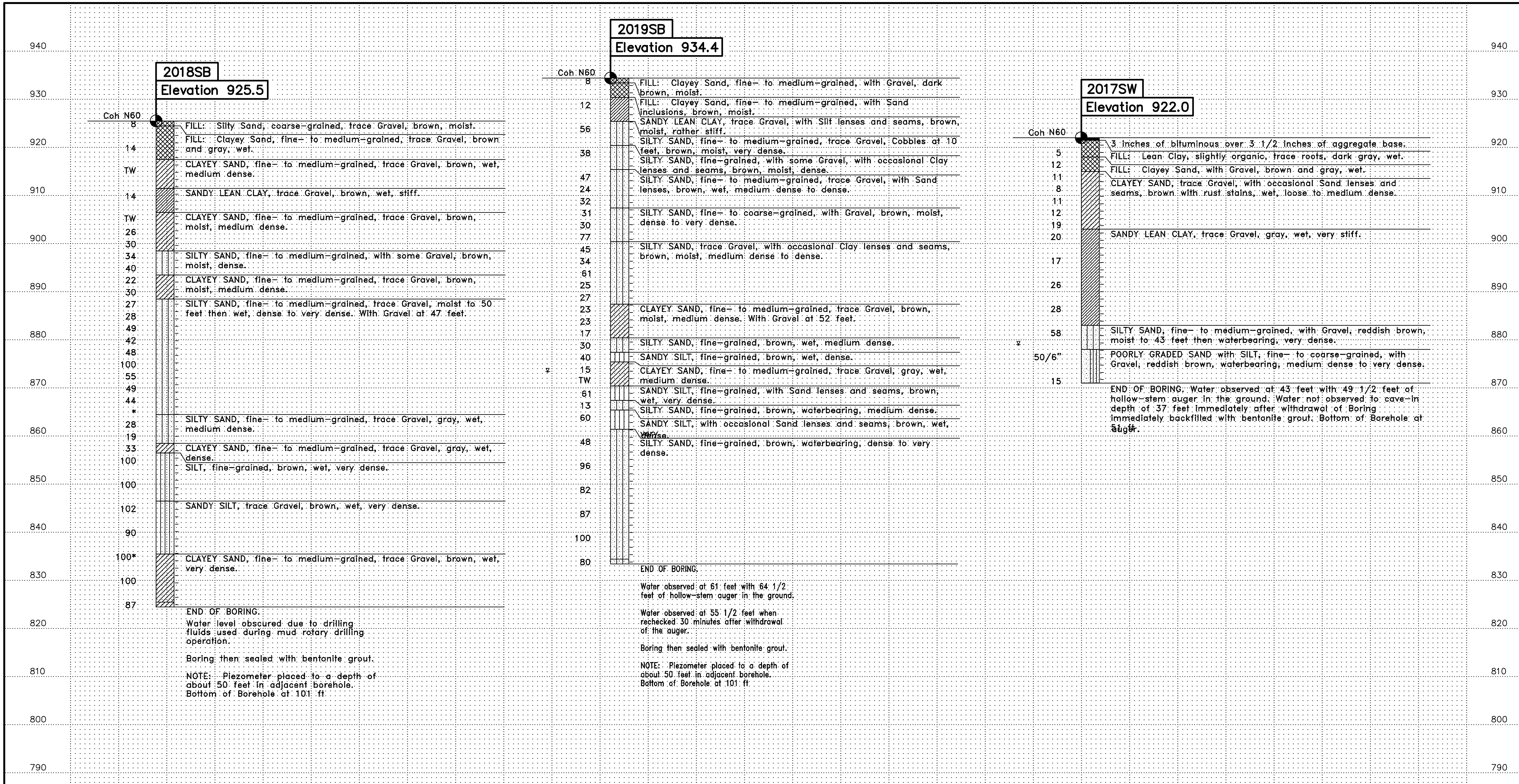

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM: D2488.

NO.	DATE	BY	CHECK	DESIGN	REVISION / SUBMITTAL

AECOM PARSONS BRINCKERHOFF

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL SOUTHWEST Green Line LRT Extension

WEST SEGMENT 2
TUNNEL STRUCTURE UNDER HWY 62
BRIDGE XXXXX (LRT)
BORINGS

DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-BRG-TH62-BOR1

SHEET 119 OF 197

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2017SW	(Surveyed)

Location: Hennepin Co. Coordinate: X=492023 Y=137450 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7506

Hammer CME Automatic Calibrated

SHEET 1 of 2

Drilling Completed 8/1/13

DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	0.5	3 inches of Bituminous over 3 1/2 inches of Aggregate Base.					
	4.0	FILL: Lean Clay, slightly organic, trace roots, dark gray, wet.	5	24			OC=3%
5	7.0	FILL: Clayey Sand, with Gravel, brown and gray, wet.	12	11			
10, 15	19.0	CLAYEY SAND, trace Gravel, with occasional Sand lenses and seams, brown with rust stains, wet, medium to very stiff, (SC), till	11				
			8	16			P200=32%
			11				
			12				
			19				
20, 25, 30, 35	39.0	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff, (CLS), till	20	17			P200=60%
			17				
			26				
			28				qp=2 1/2 tsf
40	44.0	SILTY SAND, fine- to medium-grained, with Gravel, reddish brown, moist to 43 feet then waterbearing, very dense, (SM), till	58				
45							

Index Sheet Code 3.0

(Continued Next Page)

Soil Class: Rock Class: Edit: Date: 8/15/14

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2017SW**	(Surveyed)

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock: Other Tests Or Remarks / Formation or Member
50	51.0		POORLY GRADED SAND with SILT, fine- to coarse-grained, with Gravel, reddish brown, waterbearing, medium dense to very dense, (SP-SM), outwash *(continued)*		* 15				*50 blows per 6-inch set.

Bottom of Hole - 51 feet.
Water observed at 43 feet with 49 1/2 feet of hollow-stem auger in the ground.
Water not observed to cave-in depth of 37 feet immediately after withdrawal of auger.
Boring immediately backfilled with bentonite grout.

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2018SB	925.5 (Surveyed)

Location: Hennepin Co. Coordinate: X=492322 Y=136715 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7512

Hammer CME Automatic Calibrated

SHEET 1 of 3

Drilling Completed 4/24/13

Depth / Elev.	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
1.0 / 924.5	SILTY SAND, coarse-grained, trace Gravel, brown, (SM), topsoil fill		8	15			
8.0 / 917.5	CLAYEY SAND, trace Gravel, brown and gray, wet, (SC), fill		14	16			
14.0 / 911.5	CLAYEY SAND, trace Gravel, brown, wet, stiff, (CS), till		TW	16			qu=3280 psf DD=116 pcf
19.0 / 906.5	SANDY LEAN CLAY, trace Gravel, brown, wet, stiff, (CL), till		14	16			
27.0 / 898.5	CLAYEY SAND, trace Gravel, brown, moist, very stiff, (SC), till		TW	18			qu=6060 psf DD=112 pcf
			26	10			
			30	13			
32.0 / 893.5	SILTY SAND, fine- to medium-grained, with some Gravel, borwn, moist, dense, (SM), till		34	6			
			40	8			
37.0 / 888.5	CLAYEY SAND, trace Gravel, brown, moist, very stiff, (SC), till		22	7			
			30	10			
	SILTY SAND, fine- to medium-grained, trace Gravel, moist to 50 feet then wet, dense to very dense, (SM), till	PD	27	9			
		PD	28	6			
		PD	49	11			Switched to mud rotary drilling method after 40-foot sample.
		PD					

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45

Index Sheet Code 3.0

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LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2018SB**	**925.5** *(Surveyed)*

Depth / Elev.	Classification	Drilling Operation	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	SILTY SAND, fine- to medium-grained, trace Gravel, moist to 50 feet then wet, dense to very dense, (SM), till *(continued)*		42	11			
		PD	48	13			Gravel at 47 feet.
		PD	100	15			
		PD	55	10			
		PD	49	11			
		PD	44	10			
61.0 / 864.5		PD	*	11			*100 blows per 6-inch set.
	SILTY SAND, fine- to medium-grained, trace Gravel, gray, wet, medium dense, (SM), till	PD	28	11			
67.0 / 858.5		PD	19	9			
69.0 / 856.5	CLAYEY SAND, trace Gravel, gray, wet, hard, (SC), till	PD	33	14			
	SILT, brown, wet, very dense, (ML), till	PD	100	19			
79.0 / 846.5		PD	100				See attached Grain Size Accumulation Curve
	SANDY SILT, trace Gravel, brown, wet, very dense, (SM), till	PD	102	22			
90.0		PD	90				See attached Grain Size Accumulation Curve

Depth scale: 50, 55, 60, 65, 70, 75, 80, 85, 90

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2018SB**	**925.5** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N60 / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Other Tests Or Remarks / Formation or Member
	835.5			X	100*				*No sample recovery.
				PD					
95			SILTY SAND, fine- to medium-grained, trace Gravel, gray, wet, medium dense, (SM), till	X	100				See attached Grain Size Accumulation Curve
				PD					
100	101.0			X	87	27			
	824.5		Bottom of Hole - 101 feet. Water level obscured due to drilling fluids used during mud rotary drilling operation. Boring then sealed with bentonite grout. NOTE: Piezometer placed to a depth of about 50 feet in adjacent borehole.						

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2019SB	934.4 (Surveyed)

Location: Hennepin Co. Coordinate: X=492079 Y=137069 (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7512
Hammer CME Automatic Calibrated

Drilling Completed 4/25/13

Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
1.0 / 933.4	CLAYEY SAND, with Gravel, brown, moist, (SC), topsoil fill	8	8			
4.0 / 930.4	CLAYEY SAND, with Sand inclusions, brown, moist, (SC), fill					
9.0 / 925.4	SANDY LEAN CLAY, trace Gravel, with Silt lenses and seams, brown, moist, rather stiff, (CL), till	12	16			
14.0 / 920.4	SILTY SAND, fine- to medium-grained, trace Gravel, cobbles at 10 feet, brown, moist, very dense, (SM), till	56	5			TW sample attempted. Bent at tip. Switched to SPT for sampling.
19.0 / 915.4	SILTY SAND, fine-grained, with some Gravel, with occasional Clay lenses and seams, brown, moist, dense, (SM), till	38	4			
27.0 / 907.4	SILTY SAND, fine- to medium-grained, trace Gravel, with Sand lenses, brown, wet, medium dense to dense, (SM), till	47	8			
		24	10			
		32	8			
34.0 / 900.4	SILTY SAND, fine- to coarse-grained, with Gravel, brown, moist, dense to very dense, (SM), till	31	6			
		30	6			
		77	4			
44.0 / 890.4	SILTY SAND, trace Gravel, with occasional Clay lenses and seams, brown, moist, medium dense to dense, (SM), till	45	7			
		34	14			
		61	7			
		25	10			

Index Sheet Code 3.0

(Continued Next Page)

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2019SB**	**934.4** (Surveyed)

Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
		27	8			
		23	11			
54.0 / 880.4	CLAYEY SAND, trace Gravel, brown, moist, very stiff, (SC), till	23	12			
		17	11			Gravel at 52 feet.
57.0 / 877.4	SILTY SAND, fine-grained, brown, wet, medium dense, (SM), till	30	18			
59.0 / 875.4	SANDY SILT, fine-grained, brown, wet, dense, (SM), till	40	19			
64.0 / 870.4	CLAYEY SAND, trace Gravel, gray, wet, stiff, (SC), till	15	12			
		TW	22			DD=106 pcf
67.0 / 867.4	SANDY SILT, fine-grained, with Sand lenses and seams, brown, wet, very dense, (SM), till	61	21			
69.0 / 865.4	SILTY SAND, fine-grained, brown, waterbearing, medium dense, (SM), till	13	28			
73.0 / 861.4	SANDY SILT, with occasional Sand lenses and seams, brown, wet, very dense, (ML), till	60	21			
	SILTY SAND, fine-grained, brown, waterbearing, dense to very dense, (SM), till	48	17			
		96	19			
		82	21			

(Continued Next Page)

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

METROPOLITAN COUNCIL

MINNESOTA DEPARTMENT OF TRANSPORTATION

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2019SB**	**934.4** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	Drilling Operation	SPT N_{60} / REC (%)	MC (%) / RQD (%)	COH (psf) / ACL (ft)	γ (pcf) / Core Breaks	Soil / Rock	Other Tests Or Remarks / Formation or Member
					87	21				
95			SILTY SAND, fine-grained, brown, waterbearing, dense to very dense, (SM), till *(continued)*		100	14				
100	101.0 / 833.4				80	20				

Bottom of Hole - 101 feet.
Water observed at 61 feet with 64 1/2 feet of hollow-stem auger in the ground.
Water observed at 55 1/2 feet when rechecked 30 minutes after withdrawal of the auger.
Boring then sealed with bentonite grout.
NOTE: Piezometer placed to a depth of about 50 feet in adjacent borehole.

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION

LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2138SB	923.0 (Surveyed)

Location: Hennepin Co. Coordinate: X=492201 Y=136797 (ft.)

Latitude (North)= Longitude (West)=

No Station-Offset Information Available

Drill Machine 7506

Hammer CME Automatic Calibrated

Drilling Completed 5/15/14

Depth / Elev.	Classification	SPT N60	MC (%)	Other Tests Or Remarks
0.2 / 922.8	SANDY LEAN CLAY, trace roots, black. (CLS), topsoil		28	
		5	17	qu=1 1/4 tsf
22.0 / 901.0	SANDY LEAN CLAY, trace Gravel, brown and gray, wet, rather soft to very stiff. (CLS), till	11	17	
		19	16	qu=3 tsf
		19	16	DD=108 pcf
		20	16	
		18	16	
		23	15	
		26	13	P200=45%
34.0 / 889.0	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist to wet, medium dense to dense. (SM), till	24	11	
		22	9	
		37	10	
		32	5	
		35	8	
37.0 / 886.0	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, moist, dense. (SP), outwash	34	7	
42.0 / 881.0	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, with lenses of Lean Clay, brown, moist. (SP-SM), outwash	39	5	
		35	9	
	SILTY SAND, fine- to medium-grained, trace Gravel, with lenses of Lean Clay, brownish gray, moist, loose to dense. (SM), till	13	11	

Index Sheet Code 3.0

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Soil Class:J. Kirk Rock Class: Edit: Date: 6/4/14

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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION
LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2138SB**	**923.0** *(Surveyed)*

DEPTH	Depth / Elev.	Lithology	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
				22	10			DD=133 pcf
				19*				*No sample recovery.
50				9	12			
55			SILTY SAND, fine- to medium-grained, trace Gravel, with lenses of Lean Clay, brownish gray, moist, loose to dense. (SM), till *(continued)*	20	11			
60				44	13			
	63.0 / 860.0							
65	66.0 / 857.0		SANDY SILT, gray, moist, very dense. (MLS), glaciofluvium	51	19			

Bottom of Hole - 66 feet.
Water observed at a depth of 27 1/2 feet while drilling.
Water observed at 56 feet with 64 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION
LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

U.S. Customary Units

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	2139SB	931.0 (Surveyed)

Location: Hennepin Co. Coordinate: X=492138 Y=136922 (ft.)
Latitude (North)= Longitude (West)=
No Station-Offset Information Available

Drill Machine 7506
Hammer CME Automatic Calibrated

Drilling Completed 5/15/14

DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
	1.0 / 930.0	SANDY LEAN CLAY, trace roots, dark brown and black, moist. (CLS), topsoil		28			Note: Boring was performed utilizing full-flight sampling techniques due to restricted work zone hours.
5			20	16			DD=112 pcf qu=3 1/2 tsf
10		SANDY LEAN CLAY, trace Gravel, brown and gray, wet, stiff to very stiff. (CLS), till	32	9			
15	18.0 / 913.0		107*				*Rock in tip of sampler.
20	23.0 / 908.0	SILTY SAND, fine- to medium-grained, with Gravel, with lenses of Lean Clay, brown, moist, dense. (SM), till	43	9			P200=31%
25	28.0 / 903.0	POORLY GRADED SAND with SILT, fine- to medium-grained, brown, moist, dense. (SP-SM), outwash	36	6			
30	33.0 / 898.0	SILTY SAND, fine- to medium-grained, brown, moist, dense. (SM), outwash	41	9			
35			40	2			P200=5%
40	43.0 / 888.0	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, moist, dense. (SP), outwash	34	3			
45		SILTY SAND, fine- to medium-grained, trace Gravel, with lenses of Lean Clay, brown, moist, very dense to medium*					*dense. (SM), till

Index Sheet Code 3.0

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Soil Class:J. Kirk Rock Class: Edit: Date: 6/4/14
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MINNESOTA DEPARTMENT OF TRANSPORTATION - GEOTECHNICAL SECTION
LABORATORY LOG & TEST RESULTS - SUBSURFACE EXPLORATION

BRAUN INTERTEC

UNIQUE NUMBER

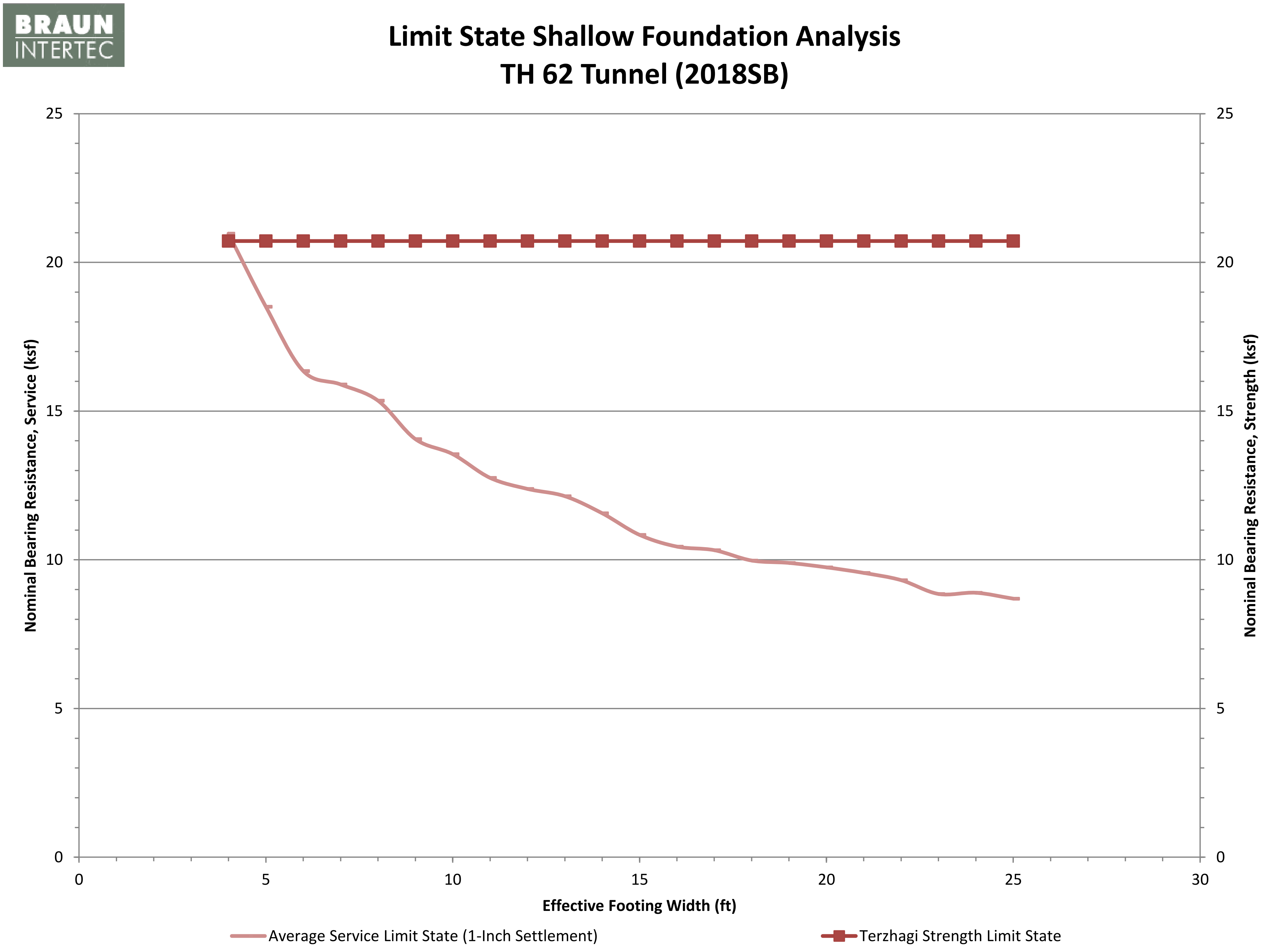
U.S. Customary Units

Mn/DOT GEOTECHNICAL SECTION - LOG & TEST RESULTS

State Project	Bridge No. or Job Desc.	Trunk Highway/Location	Boring No.	Ground Elevation
		SWLRT	**2139SB**	**931.0** *(Surveyed)*

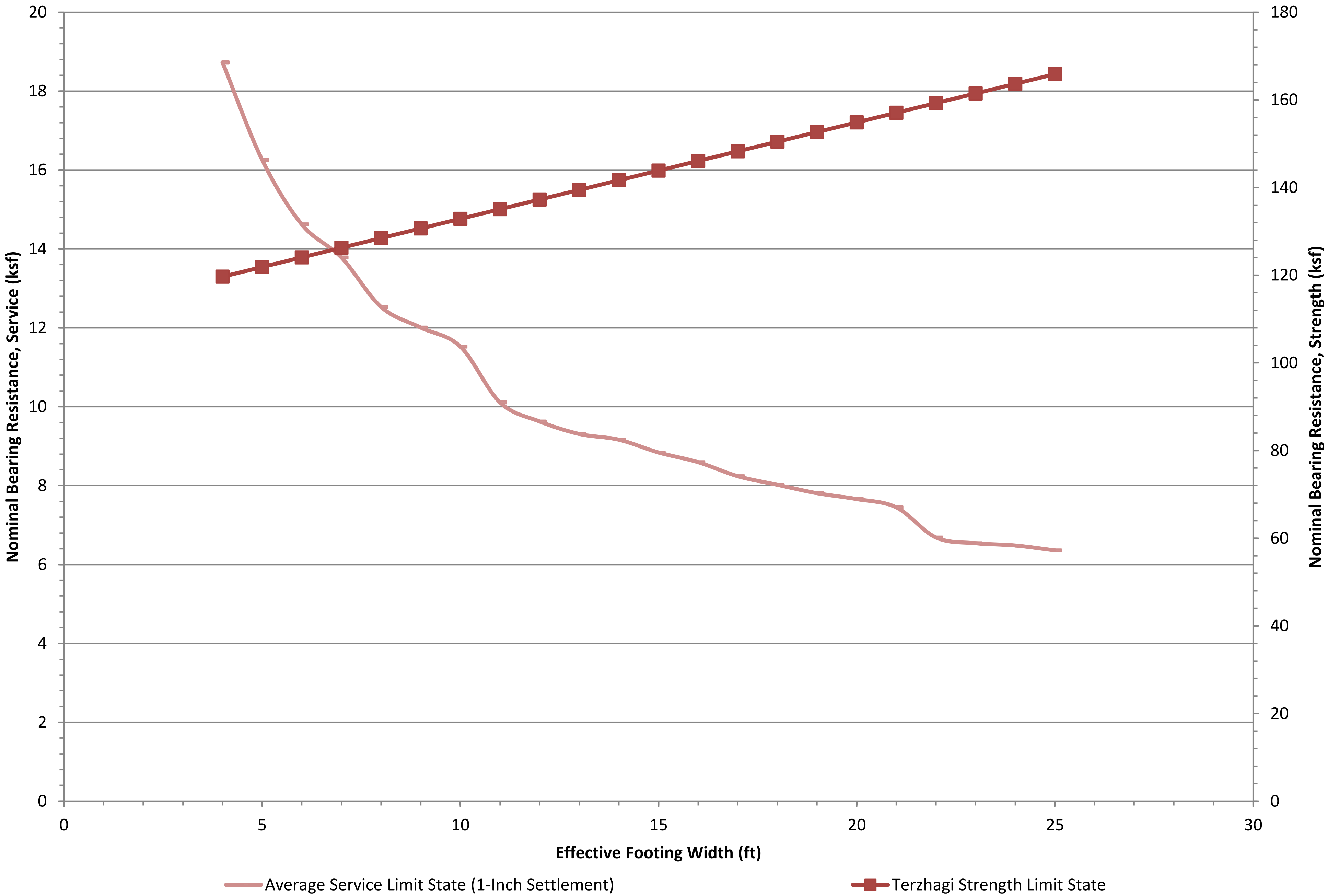
DEPTH	Depth / Elev.	Classification	SPT N60	MC (%)	COH (psf)	γ (pcf)	Other Tests Or Remarks
		SILTY SAND, fine- to medium-grained, trace Gravel, with lenses of Lean Clay, brown, moist, very dense to medium* *(continued)*	56	9			
50			28	11			P200=22%
55			17	12			
	58.0 / 873.0	SILT, brown, wet, very dense. (MLS), glaciofluvium					
▼60			55	22			DD=113 pcf
	63.0 / 868.0	POORLY GRADED SAND with SILT, fine- to medium-grained, brown, wet, very dense. (SP-SM), outwash					
65			52	22			P200=6%
70			120	19			
	71.0 / 860.0	Bottom of Hole - 71 feet.					

Water observed at a depth of 60 feet while drilling.
Water observed at 58 feet with 69 1/2 feet of hollow-stem auger in the ground.
Boring immediately backfilled with bentonite grout.

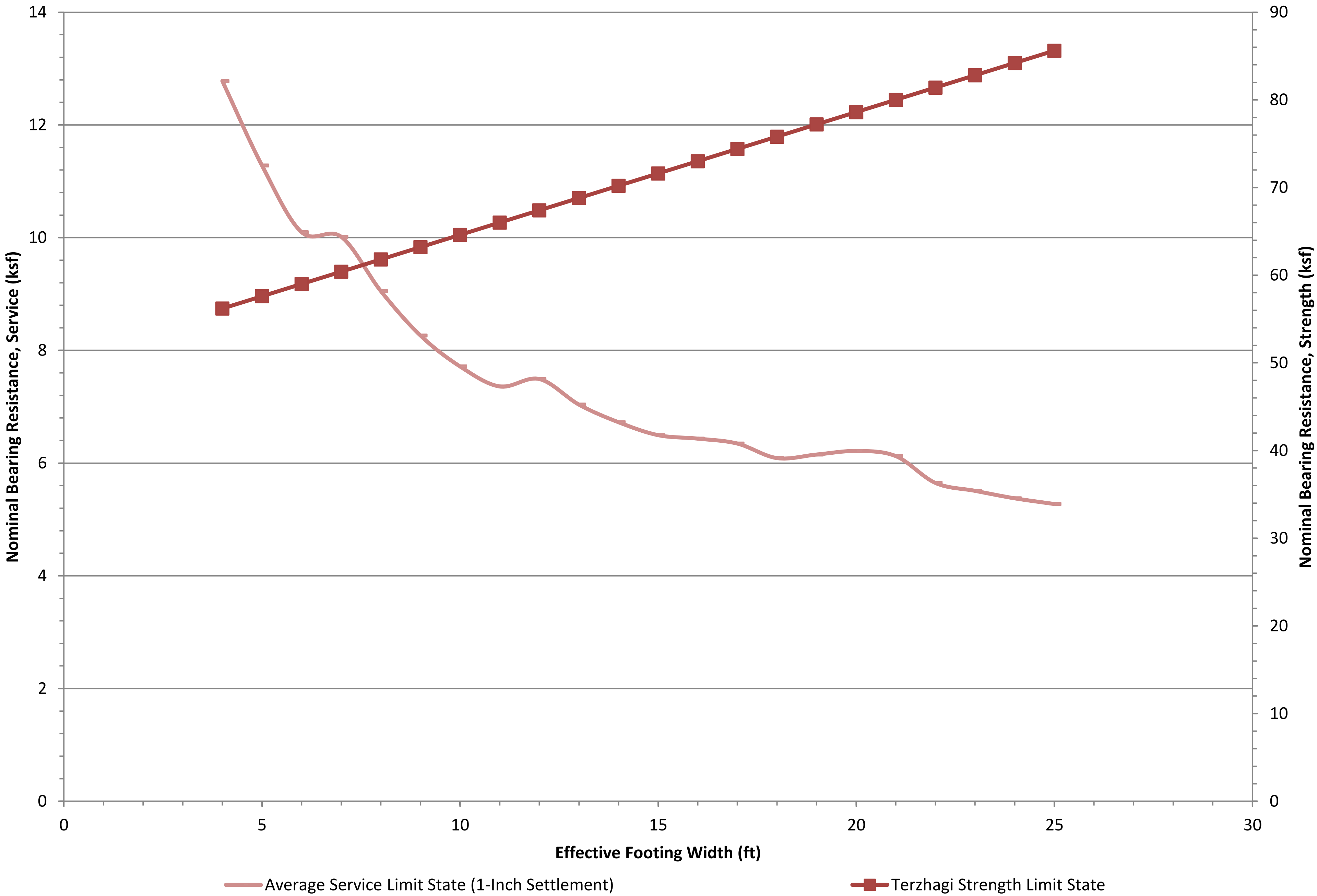


BRAUN INTERTEC
Limit State Shallow Foundation Analysis
TH 62 Tunnel (2018SB)
Nominal Bearing Resistance, Service (ksf)
Nominal Bearing Resistance, Strength (ksf)
0
5
10
15
20
25
30
Effective Footing Width (ft)
Average Service Limit State (1-Inch Settlement)
Terzhagi Strength Limit State

Limit State Shallow Foundation Analysis
TH 62 Tunnel (2019SB)



Limit State Shallow Foundation Analysis
TH 62 Tunnel (2138SB)



Limit State Shallow Foundation Analysis
TH 62 Tunnel (2139SB)

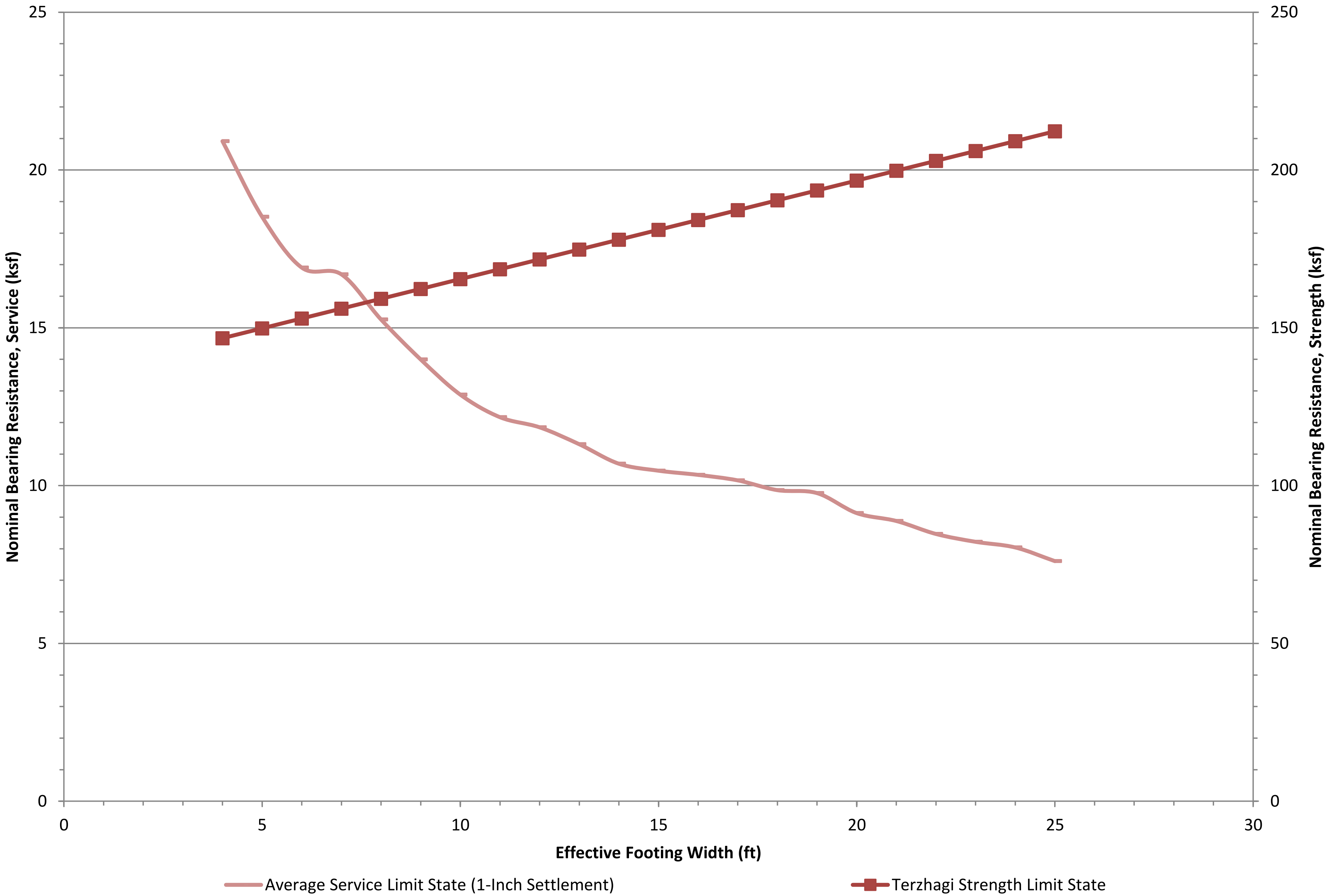


Table 5. Correlation results for sand. (Column A = Number in Table x Row B.)

A \ B	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	N bl/ft
E_o tsf	1	0.125	8	1.15	57.5	4
E_R tsf	8	1	64	6.25	312.5	22.7
p^*_L tsf	0.125	0.0156	1	0.11	5.5	0.5
q_c tsf	0.87	0.16	9	1	50	5
f_s tsf	0.0174	0.0032	0.182	0.02	1	0.1
N bl/ft	0.25	0.044	2	0.2	10	1

Table 6. Correlation results for clay. (Column A = Number in Table x Row B.)

A \ B	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	S_u tsf
E_o tsf	1	0.278	14	2.5	56	100
E_R tsf	3.6	1	50	13	260	300
p^*_L tsf	0.071	0.02	1	0.2	4	7.5
q_c tsf	0.40	0.077	5	1	20	27
f_s tsf	0.079	0.0038	0.25	0.05	1	1.6
S_u tsf	0.010	0.0033	0.133	0.037	0.625	1

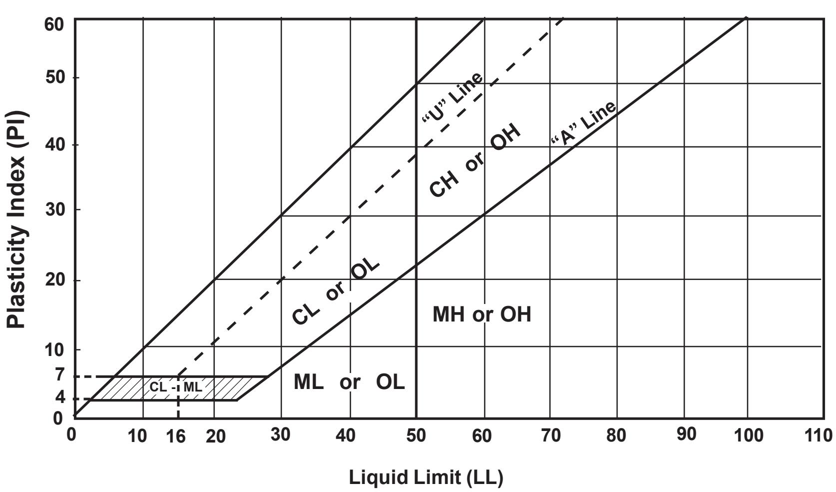
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils			Primarily organic matter, dark in color and organic odor	PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
  Coarse .... 3/4" to 3"
  Fine .... No. 4 to 3/4"
Sand
  Coarse .... No. 4 to No. 10
  Medium .... No. 10 to No. 40
  Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix G

Opus Area

BRAUN INTERTEC
The Science You Build On.

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August 29, 2014

Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Preliminary Foundation Analysis Design Recommendation Report
Proposed Opus Area Construction – 100% design
STA 2314+00 to STA 2362+00
Southwest LRT, West Segment 2
Eden Prairie/Minnetonka, Minnesota

Dear Mr. Demers:

Braun Intertec has completed the preliminary geotechnical evaluation for the proposed Opus Area construction between STA 2314+00 to STA 2362+00. The following sections provide our recommendations for the design and construction of the five pedestrian underpasses, retaining walls RTW-W212 and RTW-W213, and general track construction.

This report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for the Opus Platform Station and pole foundations for the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project information

The west segment of the SWLRT project is proposing to construct a light rail transit line through Hopkins, Minnetonka, and Eden Prairie, Minnesota. This portion of the project considers the design and construction of five pedestrian underpasses, associated retaining walls, and track construction between Stations 2314+00 and 2362+00.

A.1. Type of Structures

The sections below provide preliminary design and construction recommendations for five pedestrian underpasses, retaining walls RTW-W212 and RTW-W213, and general track construction between STA 2314+00 and STA 2362+00 based on a limited soil boring program. Prior to final design, we recommend completing a boring program to obtain more complete subsurface soil and groundwater information. Based on the boring information available at the time of this report, we anticipate the five pedestrian underpasses and two retaining walls will be supported on cast-in-place (CIP) concrete spread footing foundations.

A.2. Location of Pedestrian Underpasses

A.2.a. Pedestrian Underpass 1

Pedestrian Underpass 1 will be constructed to carry the light rail alignment over Red and Yellow Circle Trail between STA 2314+69 and STA 2314+91. Underpass 1 is proposed to consist of a 20-foot long span of a continuous cast-in place slab with a width of approximately 66 feet supported on spread footings with an approximate width of 10 feet. Retaining wall RTW-W212 will be constructed adjacent to the northeast corner of the underpass structure. It is anticipated that RTW-W212 will be a cast-in place retaining wall on spread footings.

A.2.b. Pedestrian Underpass 2

Pedestrian Underpass 2 will be constructed to carry the light rail alignment, Red Circle Drive, and Bren Road E, between STA 2318+25 and STA 2318+56. Underpass 2 is proposed to consist of a 28-foot long span of a continuous cast-in place slab with a width of approximately 108 feet supported on spread footings with an approximate width of 10 feet.

A.2.c. Pedestrian Underpass 3

Pedestrian Underpass 3 will be constructed to support Bren Road E over a proposed pedestrian path. Underpass 3 is proposed to consist of a 21-foot long span of a continuous cast-in place slab with a width of approximately 45 feet supported on spread footings with an approximate width of 10 feet

A.2.d. Pedestrian Underpass 4

Pedestrian Underpass 4, between STA 2333+17 to STA 2333+39, will be constructed to support the light rail tracks over the pedestrian path, which will be lowered to accommodate construction. Underpass 4 is proposed to consist of a 20-foot long span of a continuous cast-in place slab with a width of approximately 50 feet supported on spread footings with an approximate width of 10 feet.

A.2.e. Pedestrian Underpass 5

Pedestrian Underpass 5, between STA 2361+30 to STA 2361+59, will be constructed to support the light rail tracks over the pedestrian path, which will be lowered to accommodate construction. Underpass 5 is proposed to consist of a 26 ½-foot long span of a continuous cast-in place slab with a width of approximately 54 feet supported on spread footings with an approximate width of 10 feet.

A.3. Location of Retaining Walls

A.3.a. RTW-W212

Wall RTW-W212 is located adjacent to the northeast wing wall of Pedestrian Underpass 1. RTW-W212 is anticipated to have an average exposed height of 8 feet and average 12 feet between the top of wall and top of footing. The wall is approximately 80 feet long. The bottom of footing elevation for the wall is near 907, with a finished grade of approximately 920, resulting in the placement of approximately 8 feet of new fill to establish top of rail elevation.

A.3.b. RTW-W213

Wall RTW-W213 is located adjacent to the northwest corner of the Opus Station Platform. RTW-W213 is anticipated to have an average exposed height of 9 feet and average 17 feet between the top of wall and top of footing. The wall is approximately 200 feet long. The bottom of footing elevation for the wall is near 880, which steps down to approximately 876 to avoid an existing utility. The top of rail elevation near the wall is approximately 890, resulting in cuts into the existing soils to establish top of rail elevations.

A.4. Other Information

As part of the future construction, one building will be demolished to construct the alignment as well as the realignment of several roadways including Yellow Circle Drive, Red Circle Drive, Bren Road E, and Bren Road W. As part of the roadway realignments, new underpasses for pedestrian walkways will also need to be constructed.

The Opus business park, constructed as early as the 1970's, included areas of deep soil corrections to remove organic soils, and associated deep fills. In areas that were previously landscaped areas, or green areas, the organic soils were not completely removed prior to the placement of fill.

B. Subsurface Investigation Summary

B.1. Summary of Borings Taken

Braun Intertec performed 12 standard penetration test borings (2000ST, 2001ST, 2002ST, 2003SS, 2004SS, 2005ST, 2006ST, 2020ST, 2021SW, 2022SW, 2023SW, and 2024SW) in the vicinity of the proposed Opus Area construction. Logs of the borings are included in the Appendix, along with a Boring Location Sketch.

B.2. Description of Foundation Soil Conditions

B.2.a. Topsoil

The borings initially encountered about 4 to 6 feet of topsoil. The topsoil consisted of lean clay, sandy lean clay, and clayey sand that was dark brown to black and moist to wet.

B.2.b. Fill

Fill was encountered within two of the four boring locations and consisted of poorly graded sand with silt (SP-SM), silty sand (SM), clayey sand (SC), sandy lean clay (CL). Table 1 below illustrates the depth and type of fill material encountered.

Table 1. Fill Depths

Boring No.	Boring Elevation (ft)	Approximate Depth of Fill (ft)	Elevation at Bottom of Fill (ft)	Fill Composition
2000ST	902.5	12	890 ½	SM, CL
2001ST	895.6	12	883 ½	CL
2002ST	895.0	9	886	SC, OL
2003SS	889.6	7	882 ½	SP-SM
2004SS	887.4	7	880 ½	SP-SM, CL
2005ST	885.6	N/A	N/A	N/A
2006ST	886.1	N/A	N/A	N/A
2020ST	912.4	24	888 ½	SP-SM, SM, SC, CL
2021SW	901.8	4	898	SM, SC
2022SB	894.4	N/A	N/A	N/A
2023SB	893.7	4	889 ½	CL
2024SW	889.3	17	882	SC, CL

Penetration resistances varied from 7 to 35 blows per foot (BPF), although some of the higher penetration resistances were likely influenced by encountering a rock or debris in the sampler.

B.2.c. Swamp Deposits

Swamp deposit soils consisting of organic lean clay (OL), Peat (Pt), and sandy silt (ML) were encountered in Borings 2002ST, 2003SS, 2004SS, and 2024SW. Penetration resistances within the swamp deposits ranged from 2 to 16 BPF.

B.2.d. Alluvium

Alluvial silts were encountered beneath the swamp deposits in Borings 2003SS and 2004SS at depths ranging from 12 to 14 feet beneath the surface at both locations. The silts were generally gray in color and contained trace amounts of roots. Penetration resistances in the silts were 8 BPF, indicating loose conditions.

B.2.e. Glacial Till

Glacial till soils were encountered throughout the soil profile beneath the topsoil, fill swamp deposits, and alluvium. The tills consisted of silty sand (SM), silt (ML), clayey sand (SC), and sandy lean clay (CL). The till soils contained a trace to some gravel, were moist to wet or waterbearing and were brown to gray. Penetration resistances varied from 7 to 46 BPF, indicating the granular soils were in a loose to dense condition and the cohesive soils were medium to hard in consistency.

B.2.f. Glacial Outwash

Glacial outwash soils were also encountered beneath the fill, swamp deposits, and alluvium throughout the area. The glacial outwash soils consisted of poorly graded sand (SP) and poorly graded sand with silt (SP-SM). The sands generally contained some gravel. Penetration resistances varied from 12 to 44 BPF, indicating the soil was medium dense to dense.

B.3. Summary of Water Level Measurements

Due to the impermeable nature of the clayey soils and mud rotary drilling techniques, the depth of the static groundwater level was difficult to determine and the boring logs likely do not reflect the actual groundwater levels. It appears that water is perched on top of and between clayey soils and within sandy soil layers at depth. Piezometers may be needed to determine more accurate groundwater levels. Groundwater was measured or estimated to be located at the depths shown in Table 2.

Table 2. Groundwater Summary

Location	Surface Elevation	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
2000ST	902.5	17 ½	885
2001ST	895.6	31	864 ½
2002ST	895.0	20	875
2003SS	889.6	15	874 ½
2004SS	887.4	15	872 ½
2005ST	885.6	35 ½	850
2006ST	886.1	30	856
2020ST	912.4	41	871 ½
2021ST	901.8	N/A	N/A
2022SB	894.4	N/A	N/A
2023SB	893.7	11	882 ½
2024SW	899.3	21	878

-Note: Seasonal and annual fluctuations of groundwater should be anticipated.

B.4. Foundation Analysis

Based on anticipated soil conditions, soil conditions encountered in the borings, and the loads anticipated on the pedestrian underpasses and retaining walls structures, we recommend the use of spread footing foundations.

B.5. Embankments and Slopes – Pedestrian Underpasses and Retaining Walls

The pedestrian underpasses and retaining walls will be new structures constructed adjacent to or beneath various roadways and will be constructed on spread footing foundations. Retaining walls RTW-W212 and RTW-W213 are proposed to be CIP concrete walls used to support the embankment. Foundation preparation will include the removal of topsoil and fill as well as partial subcuts into the native soils. After the removals, the foundation preparation will consist of surface compacting the underlying soils and backfilling to proposed subgrade elevations with controlled backfill.

B.5.a. Settlement

Based on the current boring program and the recommended soil corrections, settlements are anticipated be within the service limit state for settlement of one-inch. Upon completion of a final boring program, additional settlement analyses will be performed.

B.5.b. Bearing Capacity

Soil borings have not yet been performed for every structure. Based on the current borings, it appears the bottom of footing elevation will be founded in fill or native soils. We anticipate limited soil corrections will be required in some areas to provide a bearing resistance in excess of the required capacities.

B.5.c. Global Stability

Based on the proposed wall heights, slope angles, and the anticipated soil conditions, the factor of safety is anticipated to exceed the required minimum value of 1.5, but will be re-analyzed upon completion of a boring program. Local stability of the walls and associated reinforced embankments, which is separate from the global stability, will be determined by the retaining wall engineer.

B.6. Spread Footing Foundations

Settlements were calculated based on two methods. The first is the Hough method with Boussinesq and Westergaard stress distributions, which utilizes the standard penetration test (SPT) values from the soil borings. The second is the Menard method, which is based on pressuremeter determinations of soil parameters that were collected in the field or modified from the SPT values from the soil borings. For the Menard Method, where pressuremeter testing was not performed, conservative correlations were used to estimate pressuremeter values based on N_{60} factors provided in Federal Highway Administration (FHWA) Publication No. FHWA-IP-89-008. Tables 5 and 6 from this publication are in the Appendix for reference. After these two methods were evaluated, the results were averaged.

Terzhagi's strength limit state is also included on the nominal bearing graphs in the Appendix, for reference. The strength limit state (bearing) will not control design.

B.7. Summarize Design Assumptions

B.7.a. Retaining Wall Loading Information

It is assumed a 2-foot live load surcharge will be used for the design of the retaining walls. We recommend the design loads and footing widths follow the MnDOT standard plans included in the Appendix.

B.7.b. Design Methodologies – Spread-Footing-Supported Structures

The LRFD (Load and Resistance Factor Design Method) was used for design of the bridge and retaining wall foundations supported on shallow foundations. Resistance factors were obtained from the Sixth Edition of the AASHTO (American Association of State Highway and Transportation Officials) LRFD Bridge Design Specifications (6th edition with 2013 interim revisions).

The ASD (Allowable Strength Design Method) was referenced for design of the retaining wall footings supported on shallow foundations. Strength design and safety factors were taken from the MnDOT design criteria for retaining walls with a 2-foot live load surcharge.

C. Construction Considerations

C.1. Design of Temporary and Permanent Slopes

The permanent slopes can match the existing slopes, except they must be not steeper than 1V:2H. The select granular borrow is anticipated have an angle of internal friction of approximately 35 degrees. This soil could be temporarily placed at a slope of 1V:1.5H, but must be limited to 1V:2H or flatter for the permanent condition.

C.2. Subcut Recommendations and Backfill Requirements for Pedestrian Underpasses and Retaining Walls

C.2.a. Pedestrian Underpass 1

The proposed bottom of footing elevation is 899, which means 10 feet of existing fill soils are present beneath proposed footing grades. Up to 10 feet of new fill is proposed to attain proposed design grade elevations. Based on our calculations, we estimate the new fill load and the maximum toe pressure from the wall will produce less than one-inch of settlement on the existing soils. However, there is an inherent risk of constructing on undocumented fill soils as the consistency of the soil may vary away from the boring location.

To help reduce the variability of the fill soils, a soil correction beneath the footings of three to five feet could be conducted to reduce differential settlement across the wall. It should be noted that a two-foot thick layer of sand fill was encountered by the boring at bottom of footing elevation; however, it cannot be assumed this layer is present throughout the underpass footprint. We recommend fill placed for Underpass 1 meet the material and compaction specifications noted in Table 3 below.

A conservative approach to constructing the footings includes removing all fill soils beneath the proposed abutment and wing wall footings, and its associated oversize areas. An excavation of this size may impact neighboring structures and utilities, and may require the use of shoring to support the sidewalls of the excavation. Rammed aggregate piers or helical anchors could also be considered as a means of supporting the footings and walls.

C.2.b. Pedestrian Underpass 2

Existing grades near Underpass 2 appear to range from approximately 902 to 910, with finished grade near 915, resulting in raises in grade as much as 13 feet.

Soils borings have not yet been completed within the footprint of Underpass 2 to verify soil conditions and provide applicable recommendations; therefore general recommendations can be provided based on Boring 2020ST. The general recommendations provided for Pedestrian Underpass 1 apply to Pedestrian Underpass 2.

C.2.c. Pedestrian Underpass 3

Existing grades near Underpass 3 appear near 894, with finished grade of the pedestrian path near 882, resulting in cuts on the order of 12 feet.

The soils encountered at the anticipated subgrade elevations of the underpass footings in Borings 2022SB and 2023SB generally appear suitable for support of conventional spread footings. The anticipated subgrade soils appear to consist of a mixture of sand and lean clay.

It appears the pedestrian underpass will be excavated into the existing soils, so additional stresses from raises in grade are not expected.

The geologic materials encountered at the anticipated subgrade elevations of the underpass footings in Boring 2022SB performed on the west side of the north abutment appear to bear on sandy lean clay to the termination depth of the boring. To reduce the risk for differential settlement, we recommend subcutting the clay subgrade soils a minimum of two-feet below bottom of footing elevation and replacing the material with imported material meeting the specifications of Table 3 below.

C.2.c.1. Groundwater Considerations

We anticipate groundwater will be encountered at or above proposed footing elevation for the abutment near 2023SB. The normal water level (NWL) of the adjacent pond is 888 with a high water level of 893.3. Dewatering may be difficult due to the proximity of the pond.

To prevent draining the pond, we recommend a cut-off wall be constructed around the underpass above the elevation of the high water level to reduce the risk of draining the pond. The wall should extend significantly below the bottom of the underpass to avoid heave of the soils at the bottom of the underpass. Additional borings would be needed along the underpass and near the pond to evaluate the extent and elevation of sand pockets which are present in this area and were found by the completed borings.

Even with a cut-off wall there is a risk that the pond water levels will be affected without wrapping and sealing the underpass area completely. Drains would likely be needed beneath the underpass to prevent flooding and instability. The different water elevations across the wall sections may cause some reduction in the pond water elevation. If there are sand seams in the glacial soils or if the additional borings performed do not identify all of the sand pockets at depth, there could be a complete drawdown of the pond. The pond may be required to be lined to maintain the existing water level. The hydraulics team for the project should evaluate the need of outflow structures to handle spikes in a lined pond.

C.2.d. Pedestrian Underpass 4

Existing grades near the underpass appear to be near 885, with finished grade of the pedestrian path near 871, resulting in cuts on the order of 14 feet.

Our preliminary recommendations are based on Boring 2005ST, located approximately 55 feet north of Underpass 4.

The soils encountered at proposed bottom of footing elevations consist of glacially deposited lean clays, which appear suitable to support the proposed structure. Based on the preliminary engineering plans, we anticipate settlement of the underlying soils will be less than one-inch due to the overall unload condition associated with the proposed 14-foot cut.

C.2.d.1. Groundwater Considerations

Existing lowlands and swamps are present north of Underpass 4, and groundwater may be encountered at shallow elevations as a result. If groundwater is encountered within the excavation, we recommend removing the water with sumps and pumps.

C.2.e. Pedestrian Underpass 5

Existing grades near the underpass appear to be near 908, with finished grade of the pedestrian path near 900. Based on the current and proposed elevations cuts on the order of 8 feet will be needed to reach proposed pedestrian path elevation, and raises in grade on the order of 7 feet will be required to reach top of rail elevation of 915.

Soils borings have not yet been completed in the vicinity of Underpass 5 to verify soil conditions and provide applicable recommendations; therefore general recommendations can be provided based on Boring 2005SB. The general recommendations provided for Pedestrian Underpass 4 should be applied to Pedestrian Underpass 5.

C.2.f. Selection, Placement, and Compaction of Underpass Fill and Backfill

We recommend fill placed for the underpasses and retaining walls meet the material and compaction specifications noted in Table 3 below.

Table 3. Material and Compaction Specification for Backfill and Fill

Material	Material Specification	Compaction Specification
Subgrade Fill	MnDOT 2105.1A6	MnDOT 2105.3F
Leveling Pad Beneath Footings	MnDOT 3138	MnDOT 2211.3C
Retaining Wall Backfill	MnDOT 3149.2D2	MnDOT 2105.3F
Guideway Select Granular Layer	MnDOT 3149.2B2	100% of standard Proctor Density (ASTM D698)
Guideway Subballast	MnDOT 3138	MnDOT 2211.3C

Although not anticipated, if groundwater is encountered within the excavation, we recommend backfilling over wet or submerged excavation bottoms with at least 2 feet of coarse sand having less than 50 percent of the particles by weight passing a #40 sieve, and less than 5 percent of the particles passing a #200 sieve.

C.3. Guideway Construction

C.3.a. Excavations

Throughout the track profile, a five-foot subcut beneath the top of rail elevation is anticipated for construction of the Guideway. The following subsections provide preliminary recommendations to prepare the subgrades for the track. Additional borings will be required for final design recommendations.

C.3.a.1. Guideway Subgrade Preparation

We recommend excavating the soils down to the proposed bottom of subgrade elevation. We expect a combination of native soils, previously placed fill, and engineered fill associated with the underpass abutments and wing walls. Areas of the track between STA 2319+00 and STA 2332+00 may contain pockets of organic soils at depth. We recommend removing all vegetation, topsoil, and any soft or wet soils encountered at the surface. If soft or otherwise unsuitable soils are encountered at subgrade elevations, additional excavations may be necessary. Table 4 below provides our recommended excavation depths the boring locations.

Table 4. Recommended Guideway Subgrade Correction Depths

Boring	Boring Elevation (ft)	Guideway Subgrade Elevation (ft)	Recommended Excavation Depth Below Subgrade (ft)	Excavation Bottom Elevation (ft)
2000ST	902.5	903	----	901 ½
2001ST	895.6	895	1 ½	893 ½
2002ST	895.0	887	6	881
2003SS	889.6	885	9	876
2004SS	887.4	883	7 ½	875 ½
2005ST	885.6	882	3	879
2006ST	886.1	881	3	878
2020ST	912.4	915	----	912
20023SW	893.7	885	----	885
2024SW	899.3	884	4	880

Excavation depths will vary away from the boring locations and could be deeper. We recommend a geotechnical engineer or experienced technician working under the supervision of a geotechnical engineer observe the subgrade soils prior to the placement of fill. If pockets of unsuitable fill or soft native soils are encountered, the excavations may extend beyond the depths noted in the table above.

Fat clays were encountered at Guideway subgrade elevations near Borings 2005ST and 2006ST. We recommend a three-foot subcut of the fat clays beneath the proposed subgrade elevation and replacement with onsite lean clay soils. Fat clays are considered highly sensitive to changes in moisture content and the placement of a lean clay buffer, which is less susceptible to changes in moisture content, will provide greater stability to the Guideway subgrade.

We recommend performing a final boring program for the track alignment to evaluate excavation depths along the alignment and to further evaluate potential deep fill areas or areas containing possible organics.

C.3.b. Excavation Dewatering

We recommend removing groundwater from the excavations. Sumps and pumps can be considered for excavations in low-permeability silt- and clay-rich soils, or where groundwater can be drawn down 2 feet below the bottoms of excavations in more permeable sands. In large excavations, or where groundwater must be drawn down more than 2 feet, a well contractor should review our logs to determine if wells are required, how many will be required, and to what depths they will need to be installed.

We expect any groundwater encountered will be perched within sandy layers of soils encountered during the excavation process. Seasonal and annual precipitation will influence the amount and extent of groundwater that will be encountered at some locations. At other locations, such as near Underpass 3, we anticipate we will be at or below static groundwater levels.

C.3.c. Selecting Excavation Backfill and Additional Required Fill

C.3.c.1. General Subgrade Fill

We initially recommend backfilling over wet or submerged excavation bottoms with at least 2 feet of coarse sand having less than 50 percent of the particles by weight passing a #40 sieve, and less than 5 percent of the particles passing a #200 sieve. We anticipate that this material will need to be imported.

On-site soils free of organic soil and debris can be considered for reuse as subgrade backfill and fill. The clays, however, being fine-grained, will be more difficult to compact if wet or allowed to become wet, or if spread and compacted over wet surfaces. We do not recommend reusing fat clay soils as engineered fill. Fat clays may be used as fill in landscaped or green areas.

Imported material needed to replace excavation spoils or balance cut and fill quantities, may consist of sand, silty sand, clayey sand, sandy lean clay or lean clay. We recommend, however, that the plastic index of these materials not exceed 20.

C.3.c.2. Guideway Fill

Based on the proposed design sections, the Guideway will be composed of 40-inch thick layer of granular material, under a minimum of 12-inches of subballast material. We recommend specifying Guideway fill to meet the requirements of the Minnesota Department of Transportation (MnDOT) 3149.2B2 (Select Granular Borrow) for the granular material, and 3138 (Aggregate Base) for the subballast.

C.3.d. Placement and Compaction of Backfill and Fill

We recommend spreading backfill and fill in loose lifts of approximately 6 to 12 inches. We recommend compacting backfill and fill in accordance with the criteria presented below in Table 5. The relative compaction of utility backfill should be evaluated based on the structure below which it is installed, and vertical proximity to that structure.

Table 5. Material and Compaction Specification for Backfill and Fill

Material	Material Specification	Compaction Specification
Guideway Subgrade Fill	Onsite Material Free of Debris and Organic Material	100% of standard Proctor Density (ASTM D698)
Guideway Select Granular Layer	MnDOT 3149.2B2	100% of standard Proctor Density (ASTM D698)
Guideway Subballast	MnDOT 3138	MnDOT 2211.3C

*-Select Granular Borrow Modified 10% as noted in D.2.a.2

C.3.e. Drainage Control

We recommend installing subdrains at low points of the Guideway. Preferably the subdrains should consist of perforated pipes embedded in washed gravel, which in turn is wrapped in filter fabric. Perforated pipes encased in a filter “sock” and embedded in washed gravel, however, may also be considered.

D. Foundation Recommendations

D.1. Nominal Bearing Capacities and Associated Resistance Factors

Refer to the figures in the Appendix for the recommended bearing resistance, service limit state for the underpass abutments and walls. These graphs are based on the settlement methods discuss in Section C.4 of this report. For the service limit state, a resistance factor of 1.0 shall be applied.

The resistance factors for evaluating the strength limit state performance are based on the current LRFD code:

Bearing Resistance, using SPT = 0.45
Sliding, Cast-in-Place Concrete on Sand = 0.8

D.2. Recommended Design Soil Parameters (e.g., Coefficient of Friction, Lateral Earth Pressure Coefficients, etc.)

The recommended soil parameters to be used for design are as follows:

Table 6. Recommended Soil Design Parameters

Soil Type	Angle of Internal Friction (degrees)	Effective Unit Weight (pcf)	Coefficient of Sliding Friction Rough Concrete	Active Earth Pressure Coefficient	At-Rest Earth Pressure Coefficient
Select Granular Borrow Modified 10%	35	120	0.6	0.27	0.43
Granular Borrow	30	120	0.5	0.33	0.50

We define "retained soil" as soil that extends at least 2 horizontal feet beyond the bottom outer edges of the wall footings (the wall heel, not the stem) and then (2) rises up and away from the wall at an angle no steeper than 60 degrees from horizontal. We anticipate these geometric conditions will be met if the excavations meet OSHA requirements for the types of soils likely to be exposed in the excavation.

D.3. Recommended Footing Sizes and Embedment Depths

We recommend the underpass abutment and retaining walls be supported on spread footings. The size of the footing should be determined in accordance with Section C.4 and the limit state graphs in the Appendix. We recommend placing footings a minimum of 4 ½ feet below the proposed grade.

D.4. Recommended Slope Angles

Temporary slopes in the Granular Borrow or Select Granular Borrow backfill are recommended to be constructed at 1V:1.5H or shallower. Temporary slopes constructed in natural material are recommended to be constructed at 1V:2H or shallower. In a temporary condition; these slopes have a Factor of Safety against global failure in excess of 1.3.

D.5. Excavation Support and Shoring

The anticipated soils within the utility trenches will include sand and clay fill, swamp deposit soils, and native sands and clay, which are considered Type C Soil under OSHA guidelines. Unsupported excavations should therefore be maintained at a gradient no steeper than 1 ½ to 1 (horizontal: vertical). Slopes constructed in this manner may still exhibit surface sloughing. If site constraints do not allow the construction of temporary slopes with these dimensions, then temporary shoring may be required, and we should be consulted for additional recommendations. OSHA requires that slope or excavations over 20 feet in depth need to be evaluated by an engineer.

An OSHA approved competent person should review this soil classification in the field. Excavations must comply with the requirements of OSHA 29 CFR, Part 2926, Subpart P, "Excavations and Trenches." This document states that excavation safety is the responsibility of the contractor. Reference to these OSHA requirements should be included in the project specifications.

In the event there is insufficient room to slope excavations, or if the excavations are exposed to surcharges and need to be shored, we recommend designing the shoring based on the parameters presented below in Table 6. The parameters shown have not been reduced by safety factors.

Saturated unit weights are recommended to account for the potential build up of hydrostatic pressure behind undrained support structures. We recommend that saturated unit weights be reduced by 62.4 pounds per cubic foot for strata or portions of a stratum extending below the groundwater levels at the structure location or as noted in the borings.

Table 7. Parameters for Shoring Design

Geologic Material	Saturated Unit Weight (pcf)	Friction Angle (deg)	K_A	K_O	K_P
Sand Fill (SP, SP-SM)	120	30	.33	.50	3.00
Sand Fill (SM, SC)	125	28	.36	.53	2.76
Clay Fill (CL)	125	26	.39	.56	2.56
Swamp Deposit Soils (PT)	75	14	.61	.76	1.63
Swamp Deposit Soils (OL, ML)	90	22	.46	.62	2.20
Glacial Sands (SP, SP-SM)	120	32	.31	.47	3.25
Glacial Lean Clay (CL)	130	28	.36	.53	2.76
Glacial Fat Clay (CH)	120	24	.42	.59	2.37

D.6. Building Demolition and Removal of Existing Structures

Based on the proposed track alignment, it appears one building may be demolished, along with the realignment of several roadways walkways, and likely utilities. We recommend completely removing all building materials from the excavations including concrete, bituminous, aggregate base, utility pipes, and any bedding material associated with the utilities prior to the placement of fill. If it is not conducive to remove existing utility lines, we recommend they be abandoned and filled with sand, flowable fill, or concrete.

E. Material Classification and Testing

E.1. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

E.2. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on the appropriate attached exploration logs. The tests were performed in accordance with ASTM procedures and follow MnDOT guidelines.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced. The boreholes were then backfilled or sealed with bentonite grout.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore, strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

F.3. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

G. General

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these bridge foundation recommendations, please call Josh Kirk at 952.995.2222 or Ray Huber at 952.995.2260.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

JOSHUA L. KIRK
LICENSED PROFESSIONAL ENGINEER
45005
STATE OF MINNESOTA

Joshua L. Kirk, PE
Associate Principal/Project Engineer
License Number: 45005

Reviewed by:

(For)
Ray A. Huber, PE
Vice President-Principal Engineer

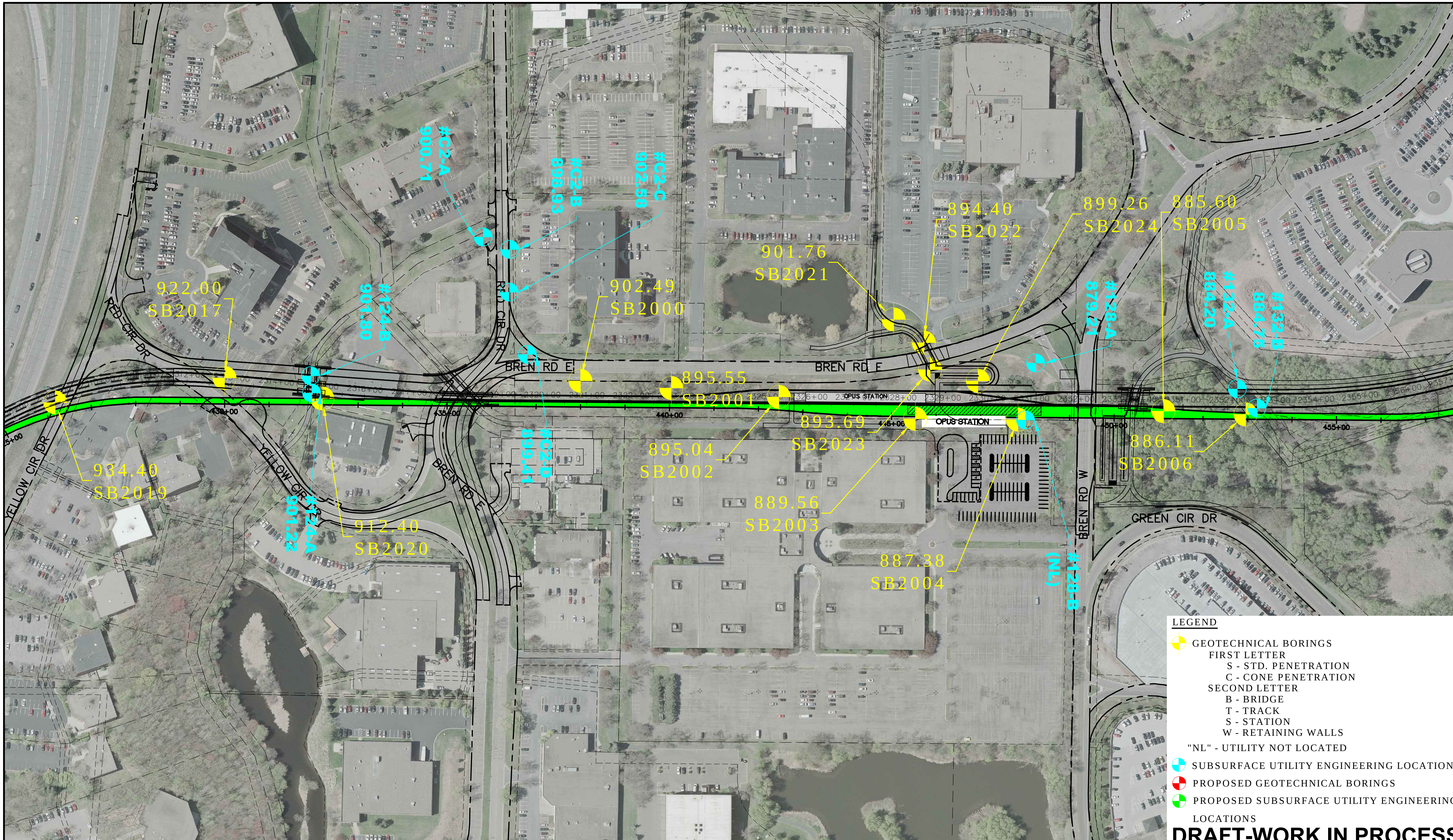
Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Boring Location Sketch
Preliminary Engineering Plan and Profile Sheets for Opus Area
Preliminary Engineering Plan and Profile Pages for Retaining Walls RTW-W212 and RTW-W213
Log of Boring Sheets (Borings 2000ST, 2001ST, 2002ST, 2003SS, 2004SS, 2005ST, 2006ST, 2020ST, 2021SB, 2022SB, 2023SB and 2024SW)
Limit State Analysis Charts
Publication No. FHWA IP-89-008 N Correlation Table
MnDOT Standard Sheet No. 5-297.623. 1 of 4 (2' LL Surcharge, spread footing supported retaining walls)
SPT Descriptive Terminology

c: Mr. Jeff Stewart: SPO
Ms. Laura Amundson: SPO

APPENDIX



SOUTHWEST LIGHT RAIL

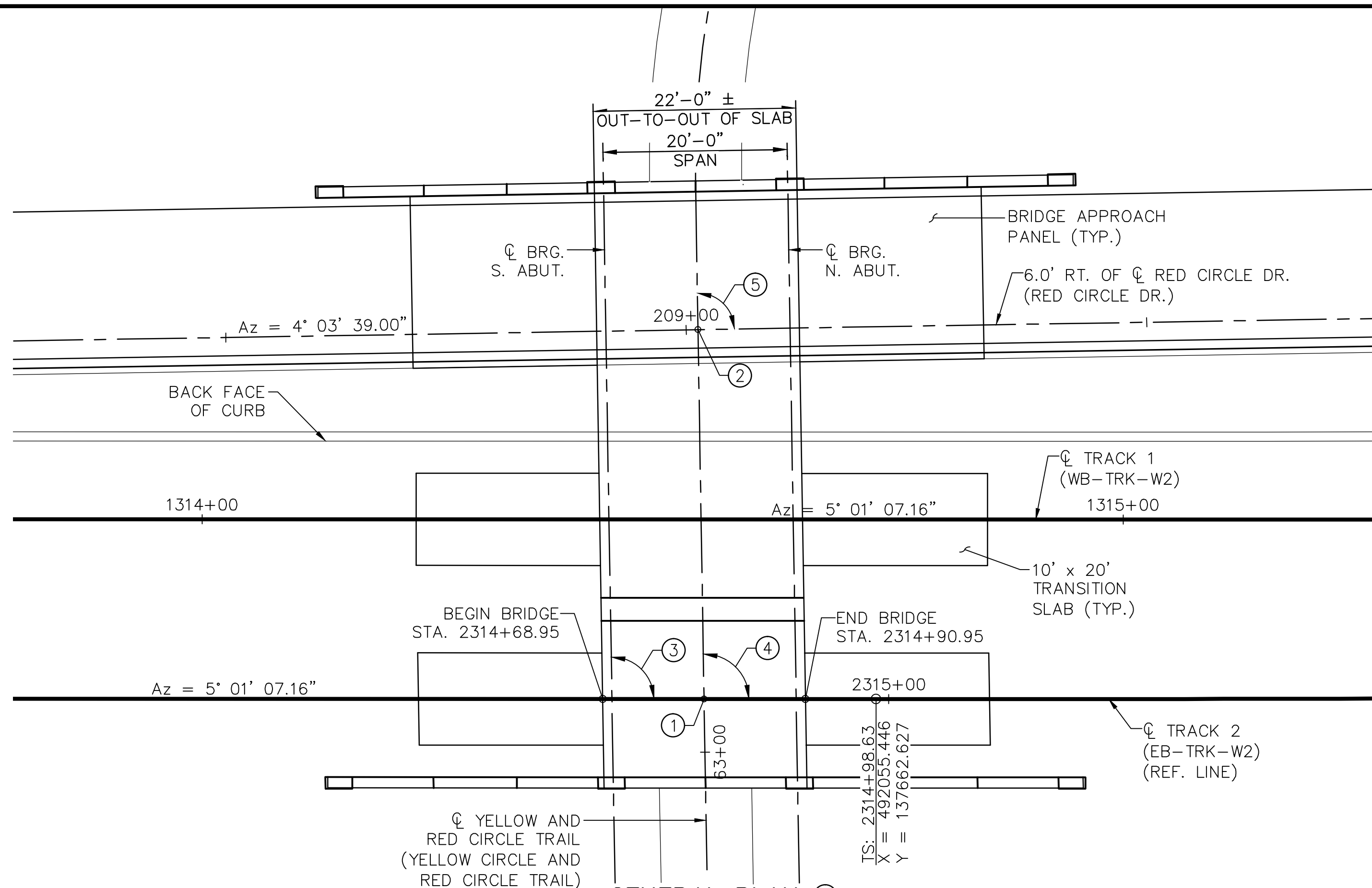
SOIL BORINGS
SHEET 9 OF 12

IRT: N/A
REV: 0
DATE: 06/30/2014

SOUTHWEST Green Line LRT Extension — METROPOLITAN COUNCIL — AECOM — SRF Consulting Group, Inc.

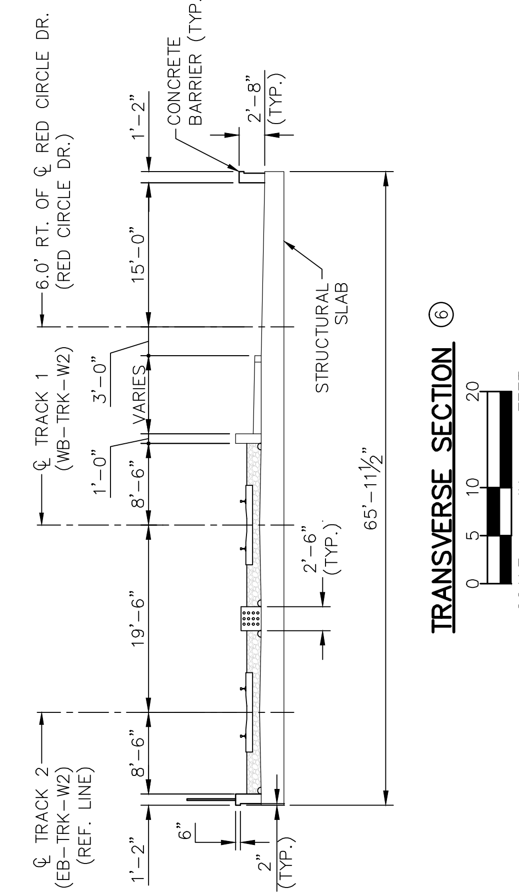
0 50 100 200

Aug. 28 2014 11:33 am V:\3200_PEC-W\CAD\OVERALL\EXHIBITS\CIVIL\EXHB-CIV-SOIL BORINGS.dwg By: Boscha



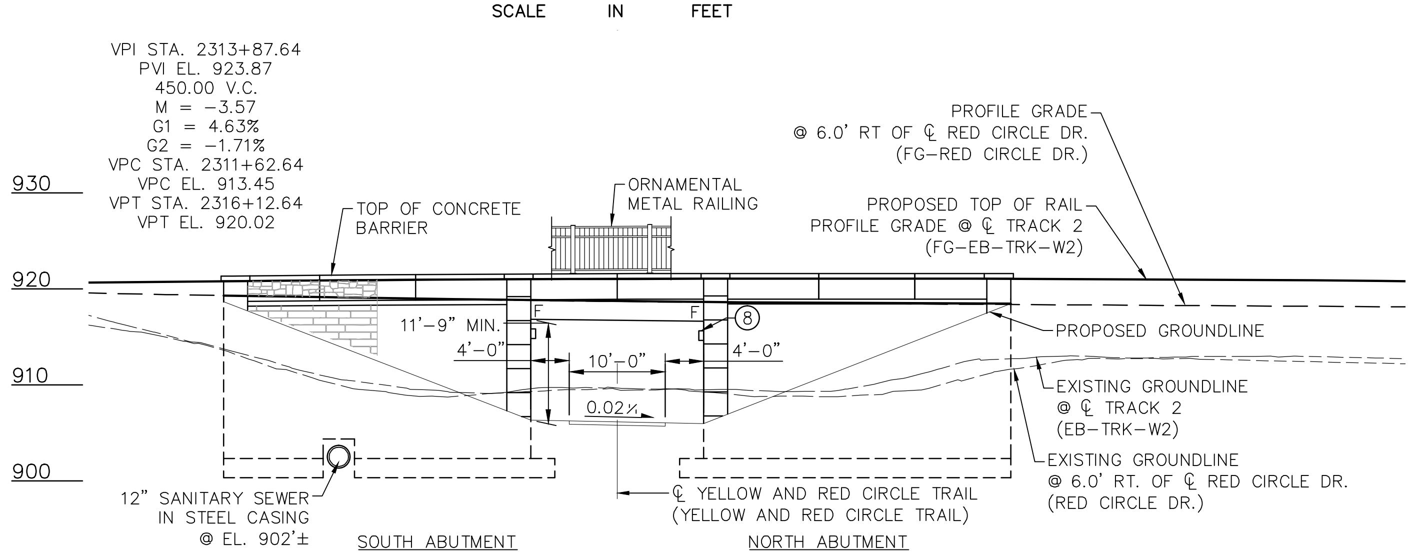
GENERAL PLAN (7)

SCALE 0 5 10 20 IN FEET



TRANSVERSE SECTION (6)

SCALE 0 5 10 20 IN FEET



GENERAL ELEVATION (7)

SCALE 0 5 10 20 IN FEET

NOTES:

1. ℄ TRACK 2 (EB-TRK-W2) STA. 2314+79.95 ℄ YELLOW AND RED CIRCLE TRAIL (YELLOW AND RED CIRCLE TRAIL) STA. 62+94.22
2. 6.0' RT. OF ℄ RED CIRCLE DR. (RED CIRCLE DR.) STA. 209+01.27 ℄ YELLOW AND RED CIRCLE TRAIL (YELLOW AND RED CIRCLE TRAIL) STA. 62+54.10
3. 90°-57'-28.2" (TYP. AT ABUTMENTS)
4. 90°-57'-28.2"
5. 90°-00'-00"
6. MEASURED PARALLEL TO ABUTMENTS.
7. UTILITIES ARE NOT SHOWN FOR CLARITY. SEE CIVIL PLANS, BORING PLAN & PROFILE.
8. UNDER BRIDGE LIGHTING, SEE AESTHETIC DETAILS.

DESIGN DATA

2012 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 6TH EDITION AND CURRENT INTERIMS

SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 3.0)

LRV & MV LOAD DIAGRAM SHOWN ON SHEET 2

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

DESIGN SPEED: OVER = 30 MPH (LRT)
UNDER = 30 MPH

APPROXIMATE DECK AREA: 1451 SQ. FT.

LIST OF SHEETS

NO.	DESCRIPTION
1	GENERAL PLAN & ELEVATION
2-3	BRIDGE SURVEY
4	LOADING DIAGRAM
5	BORING - PLAN & PROFILE
6	BORINGS LOG
7	AESTHETIC DETAILS

20XX PROJECTED TRAFFIC VOLUMES

ROADWAY OVER		ROADWAY UNDER
XXXX	AADT	N/A
XXXX	DHV	N/A
XXXXX	ADTT	N/A

PROPOSED TYPE OF STRUCTURE

SUPERSTRUCTURE:
1 SPAN - CAST-IN-PLACE CONCRETE
SLAB - CONTINUOUS WITH ABUTMENTS
SUBSTRUCTURE:
INTEGRAL ABUTMENTS SUPPORTED ON SPREAD FOOTINGS
DEPTH OF STRUCTURE:
2'-0" GUTTER TO LOW BRIDGE

BRIDGE NO. XXXXX

SOUTHWEST LRT OVER YELLOW & RED CIRCLE TRAIL
0.02 MI. W OF JCT. T.H. 62/T.H. 169 IN MINNETONKA

20'-0" CAST-IN-PLACE CONCRETE SLAB SPAN
63'-7½" ROADWAY AND RAILWAY WIDTH
0°-57'-28.1" SKEW

BRIDGE I.D. NO. XXXXX

GENERAL PLAN AND ELEVATION

SEC 36 T117N R22W
CITY OF MINNETONKA HENNEPIN COUNTY

APPROVED: ______ STATE BRIDGE ENGINEER DATE

MNDOT REVIEW:

DES: RMS DR: ARH
CHK: MJC CHK: MJC

NO.	DATE		CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

SRF Consulting Group, Inc.

PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST SEGMENT PEDESTRIAN TUNNEL BRIDGE [illegible] PLAN AND ELEVATION

DISCIPLINE: STRUCTURES

SHEET NAME: W[illegible]-ST[illegible]-T[illegible]DP[illegible]-[illegible]PE

SHEET [illegible] OF [illegible]

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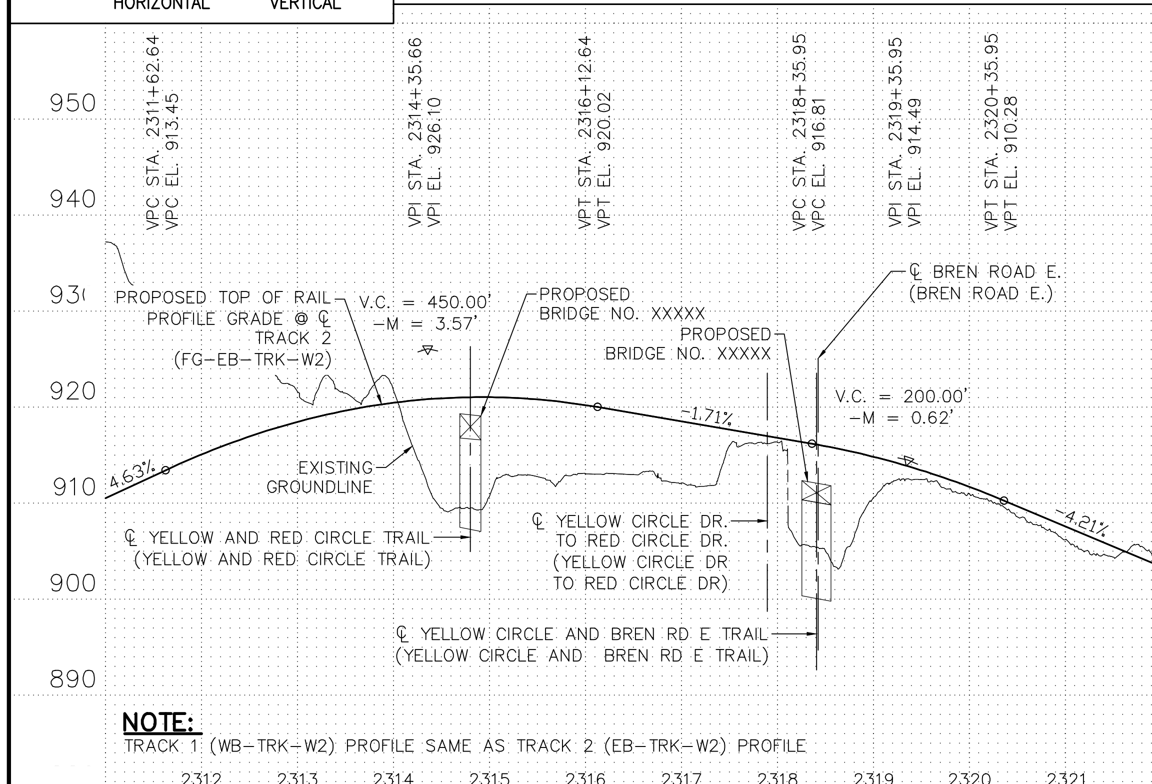
CONTRACTED PROFI□E

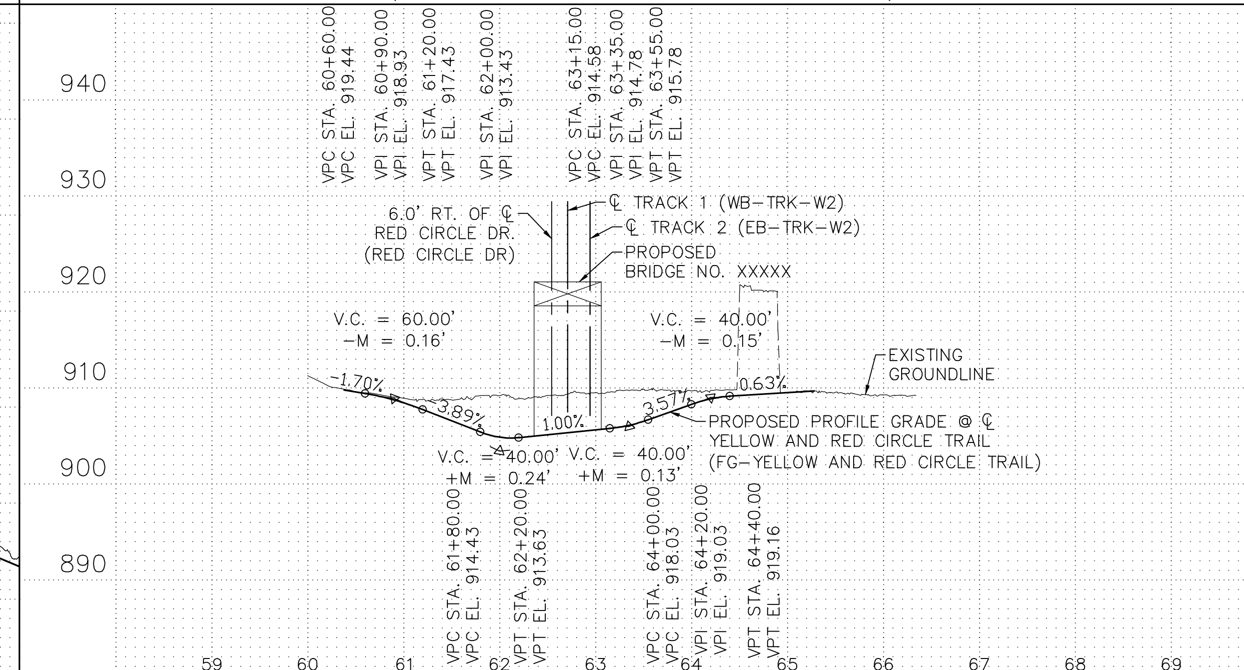
SCALE : 0 50' 100' HORIZONTAL 0 5' 10' VERTICAL

PROFILE GRADE @ ℄ TRACK 2 (FG-EB-TRK-W2)

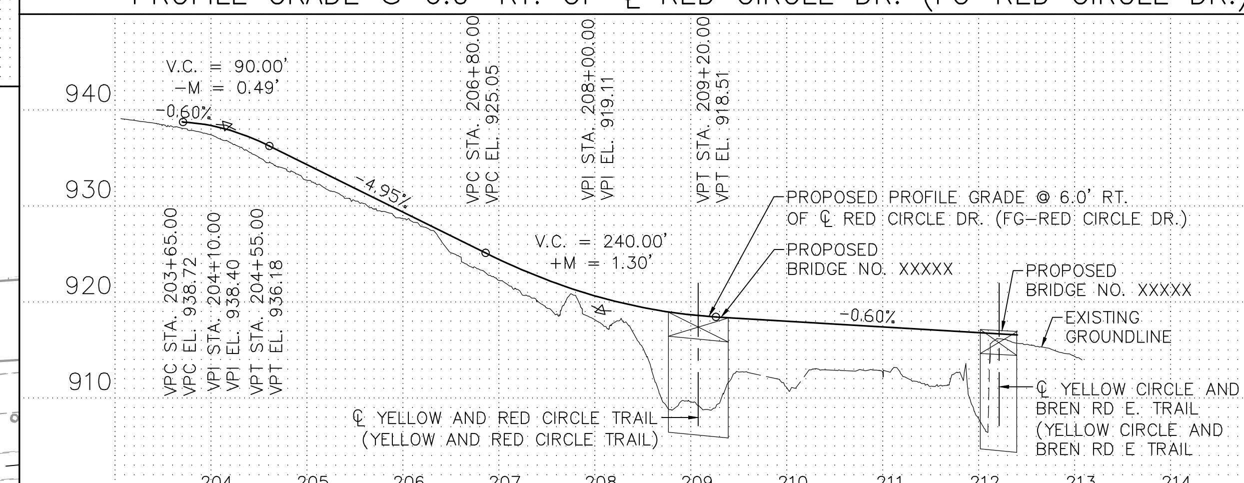


NOTE:
TRACK 1 (WB-TRK-W2) PROFILE SAME AS TRACK 2 (EB-TRK-W2) PROFILE

PROFILE GRADE @ ℄ YELLOW & RED CIRCLE TRAIL (FG-YELLOW & RED CIRCLE TRAIL)

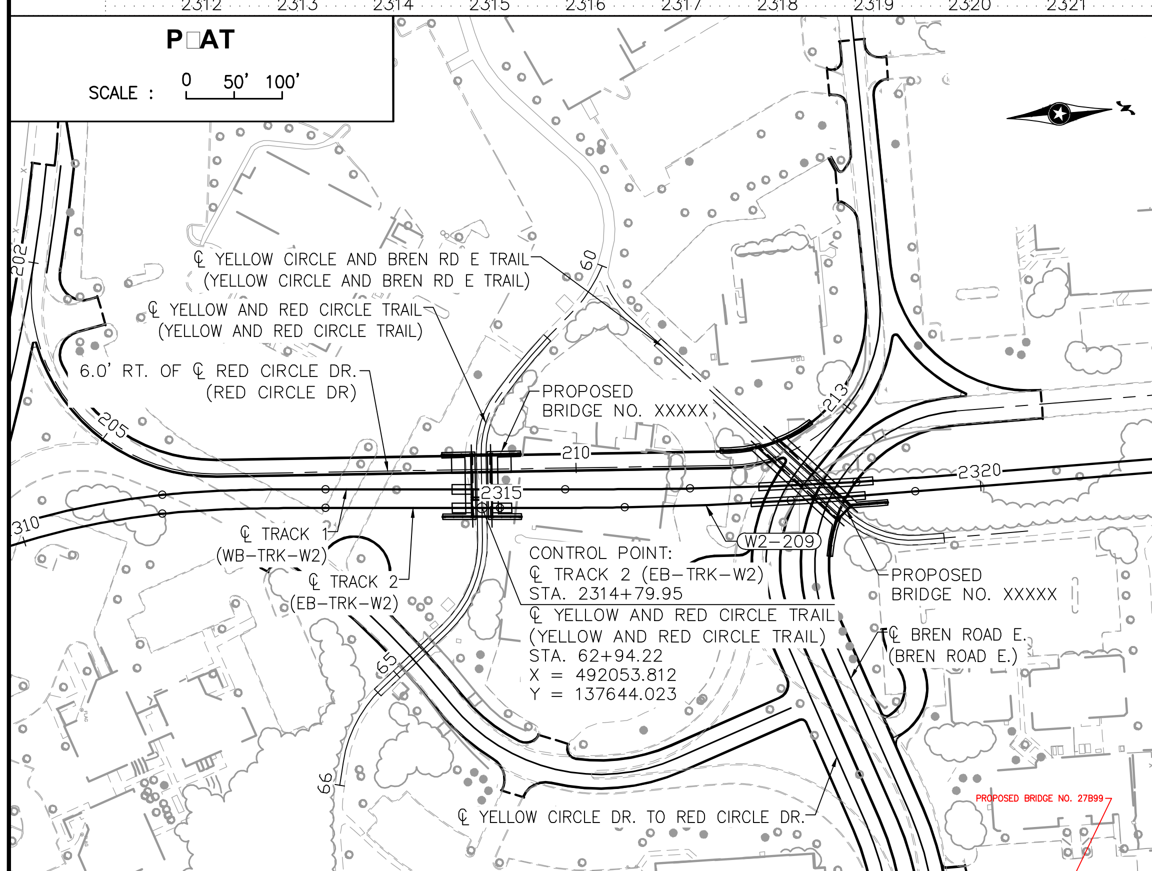


PROFILE GRADE @ 6.0' RT. OF ℄ RED CIRCLE DR. (FG-RED CIRCLE DR.)



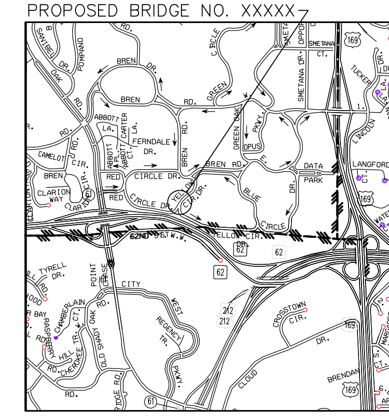
P□AT

SCALE : 0 50' 100'



CURVE NO. W2-209
R = 3800'
Lc = 173.37'
Ls = 130'
Ea = 1.75"
Eu = 1.40"
V = 55 MPH

PROPOSED BRIDGE NO. XXXXX



R22W
INDEX-MAP

□OCATION EN□INEER□S O□SER□ATIONS AT □RID□E SITE

1. SPECIAL FEATURES: WATERFALLS, DAMS, FLOODS, ICE, DEBRIS, SLIDING BANKS, RECREATIONAL BOATING.
2. OTHER BRIDGES OR CULVERTS OVER THE SAME STREAM (PARTICULARLY STRUCTURES WHICH CARRY HIGH WATER WITHOUT OVERFLOW OF ROADWAY) : GIVEN LOCATION,TYPE, LENGTH, HEIGHT ABOVE HIGH WATER, CROSS-SECTIONAL AREA ETC.
3. APPARENT HIGHWATER ELEVATION OBTAINED FROM:
4. OTHER DATA: APPROX. VELOCITY OF WATER AT TIME OF SURVEY.

□□DRA□□IC EN□INEERS RECOMMENDATION

DATE –

STREAM OR DITCH DESIGNATION –
DRAINAGE AREA –
MAX. FLOOD ON RECORD –
MAXIMUM OBSERVED HIGHWATER ELEVATION –
DESIGN FLOOD (–YR. FREQ.) – C.F.S.
DESIGN STAGE ELEVATION –
DESIGN MEAN VELOCITY THROUGH STRUCTURE – F.P.S.
TOTAL STAGE INCREASE – F.P.S.
LOW MEMBER AT OR ABOVE ELEVATION –
FLOWLINE ELEVATION – SKEW ANGLE –
WATERWAY AREA REQUIRED BELOW ELEVATION – = – SQ.FT. AT RIGHT ANGLES TO CHANNEL
BASIC FLOOD (100 YR. FREQ.) – C.F.S.
STAGE ELEVATION – FT.
TOTAL STAGE INCREASE – FT.
MEAN VELOCITY THROUGH STRUCTURE – F.P.S.
ESTIMATED DEPTH OF PIER SCOUR = – FT.
SCOUR CODE =–

BRIDGE SURVEY SHEETS MADE FROM SURVEY PERFORMED BY RANI ENGINEERING

MNDOT NAME: 2773A
NORTHING (HEN. COUNTY COORDINATES): 137082.117
EASTING (HEN. COUNTY COORDINATES): 490527.817
BENCHMARK ELEVATION (NAVD88): 963.180
MONUMENT DESCRIPTION: BRASS MONUMENT IN BRIDGE ABUTMENT
LOCATION: IN EDEN PRAIRIE, 1.1 MILES EAST ALONG T.H. HWY 62 FROM JCT. OF T.H. 62 & I-494

MONUMENT NAME: CONTROL POINT 6
NORTHING (HEN. COUNTY COORDINATES): 142016.680
EASTING (HEN. COUNTY COORDINATES): 489989.960
BENCHMARK ELEVATION (NAVD88): 932.956
MONUMENT DESCRIPTION: CAST IRON MONUMENT
LOCATION: 0.2 MILES EAST ALONG SMETANA ROAD FROM JCT. OF SMETANA ROAD & NOLAN DR

T117N

CIT□ OF MINNETONKA

□RID□E S□R□E□

AT MILE POINT – ON –
– (T.H., C.S.A.H.,C.R. etc.)
PROPOSED BRIDGE LOCATED 0.02 MILES WEST OF JCT. T.H. 62 & T.H. 169

SEC 36 TWP T117N R R22W
CITY OF MINNETONKA COUNTY HENNEPIN

DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION	S□□MITTA□

AECOM

SRF Consulting Group, Inc.

PRE□IMINAR□ P□ANS

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □RT□
□RID□E S□R□E□ □□ OF □□

DISCIP□INE□ STR□CT□RES

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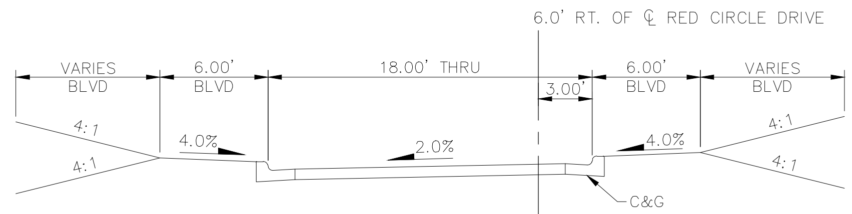
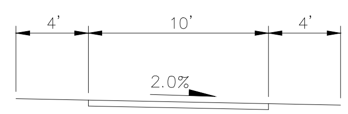
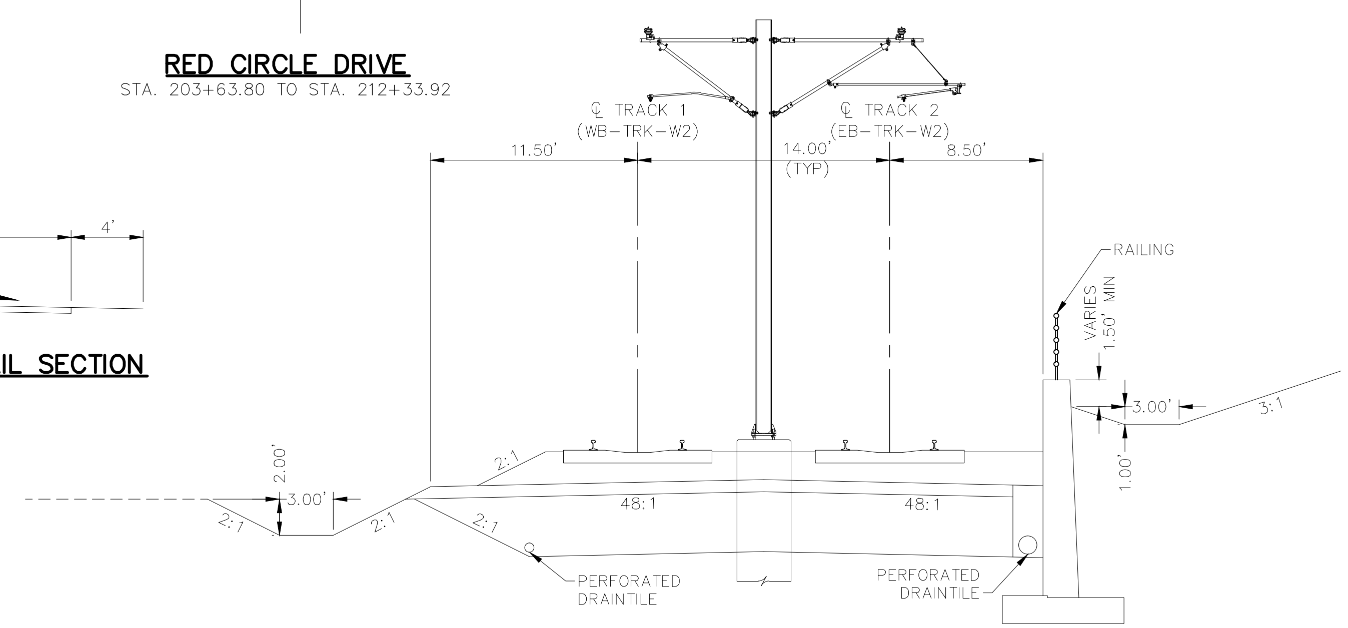


RED CIRCLE DRIVE

STA. 203+63.80 TO STA. 212+33.92



TYPICAL TRAIL SECTION



TYPICAL TRACK APPROACH SECTION

STA. 2314+50 TO STA. 2316+00

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

DES: RMS DR: ARH
CHK: MJC CHK: MJC

AECOM
SRF Consulting Group, Inc.

PRE□IMINAR□ P□ANS

METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □□RT□
□RID□E S□R□E□ □□ OF □□

DISCIP□INE□ STR□CT□RES

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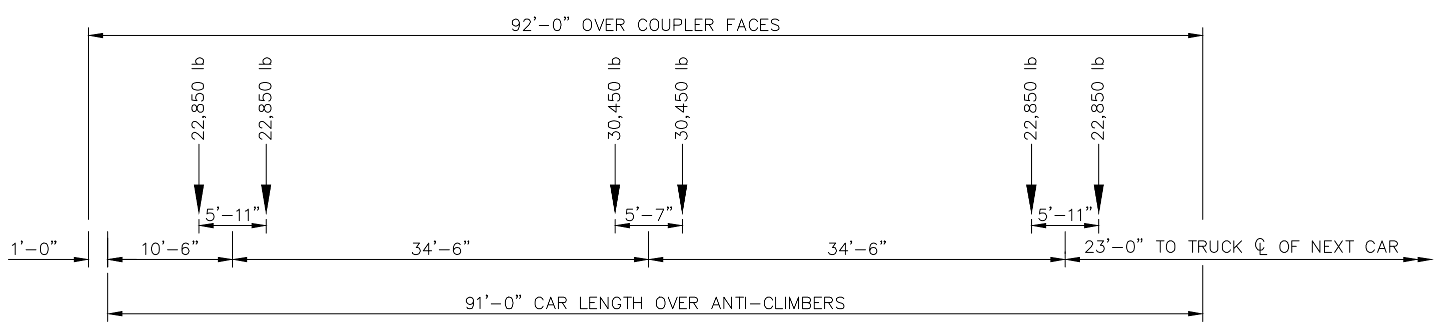
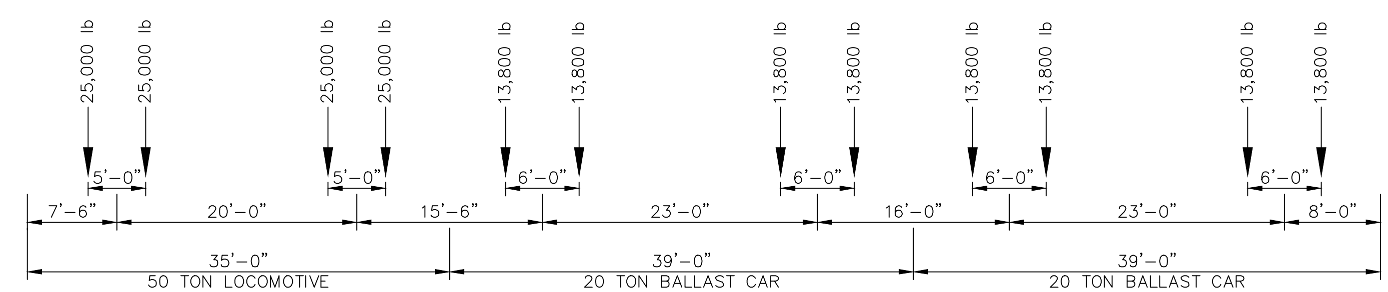


LIGHT RAIL VEHICLE LOADING DIAGRAM

NOTES:

1. THE LRT TRAIN SHALL CONSIST OF EITHER ONE, TWO OR THREE CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. LOADING DIAGRAM REPRESENTS MAXIMUM LOAD AT EACH TRUCK IN ACCORDANCE WITH SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 2.0) FIGURE 8-2.



MAINTENANCE TRAIN LOADING DIAGRAM

NOTES:

1. THE MAINTENANCE TRAIN SHALL CONSIST OF ONE LOCOMOTIVE AND ONE, TWO, THREE, OR FOUR BALLAST CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. WEIGHT OF EMPTY BALLAST CAR IS 15,000 POUNDS.

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

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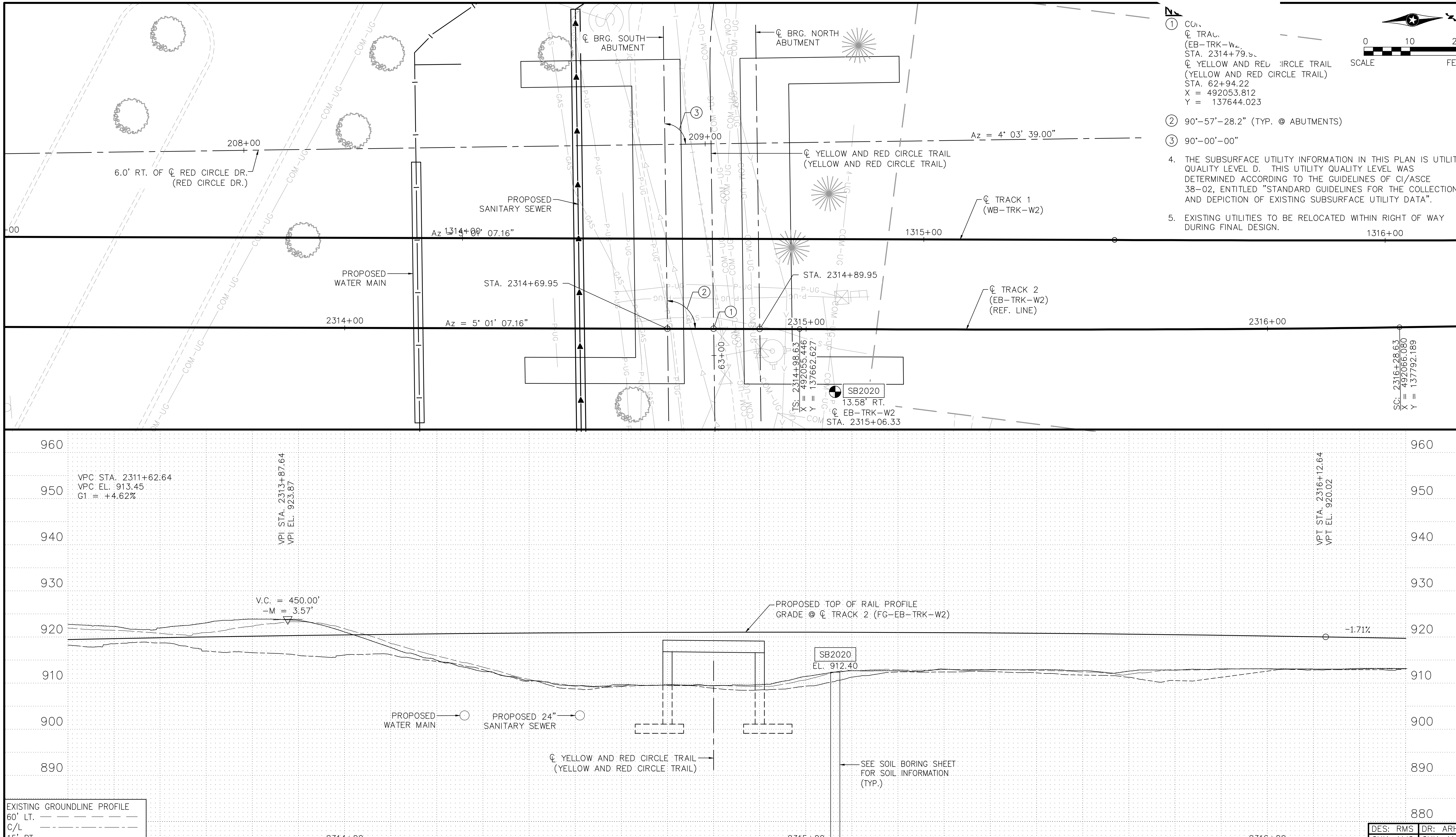
METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

DES: RMS | DR: ARH
CHK: MJC | CHK: MJC

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □RT□
□OADIN□ DIA□RAM

DISCIP□INE□ STR□CT□RES
S□EET NAME□ W□-ST□-T□DP□□-□OAD

S□EET □□□ OF □□□



N...

1. CO... Ⅽ TRA... (EB-TRK-W... STA. 2314+79.9... Ⅽ YELLOW AND RED CIRCLE TRAIL (YELLOW AND RED CIRCLE TRAIL) STA. 62+94.22 X = 492053.812 Y = 137644.023
2. 90°-57'-28.2" (TYP. @ ABUTMENTS)
3. 90°-00'-00"
4. THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO THE GUIDELINES OF CI/ASCE 38-02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".
5. EXISTING UTILITIES TO BE RELOCATED WITHIN RIGHT OF WAY DURING FINAL DESIGN.

DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO.	DATE		CHECK	DESIGN	REVISION SUBMITTAL

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PRELIMINARY PLANS

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST SEGMENT □
PEDESTRIAN TUNNEL □
BRIDGE □□□□□ □RT□
BORING - PLAN AND PROFILE

DISCIPLINE: STRUCTURES

SHEET NAME: W□-ST□-TUDP□□-BOR

SHEET □□□ OF □□□

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NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488. THE SOIL GROUP CATEGORY PER THE AASHTO SOIL CLASSIFICATION SYSTEM IS ALSO SHOWN.

NO.	DATE		CHECK	DESIGN	REVISION SUBMITTAL

DES: RMS | DR: ARH
CHK: MJC | CHK: MJC

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SOUTHWEST Green Line LRT Extension

WEST SE□MENT □
PEDESTRAIN T□NNE□ □
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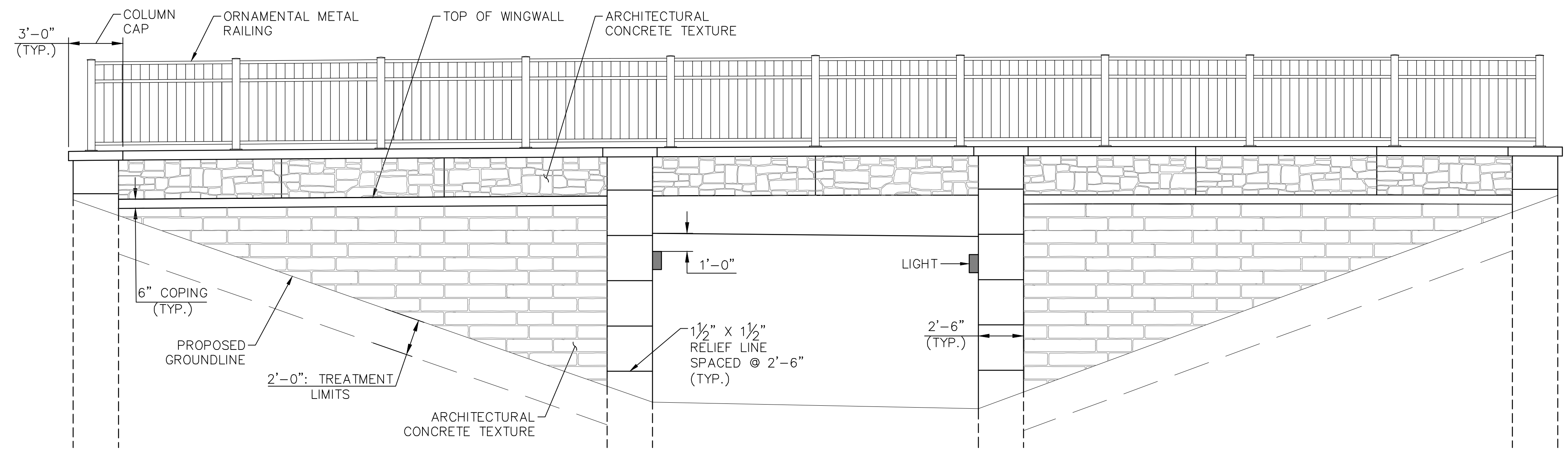
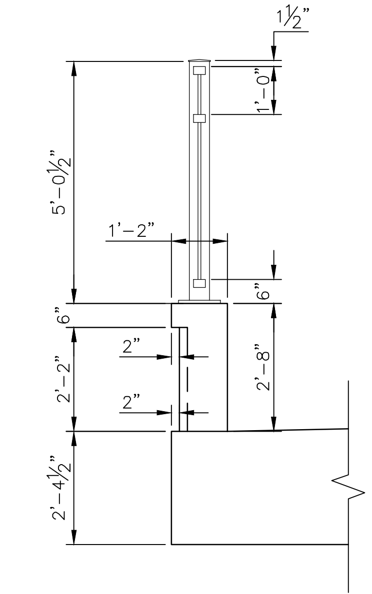
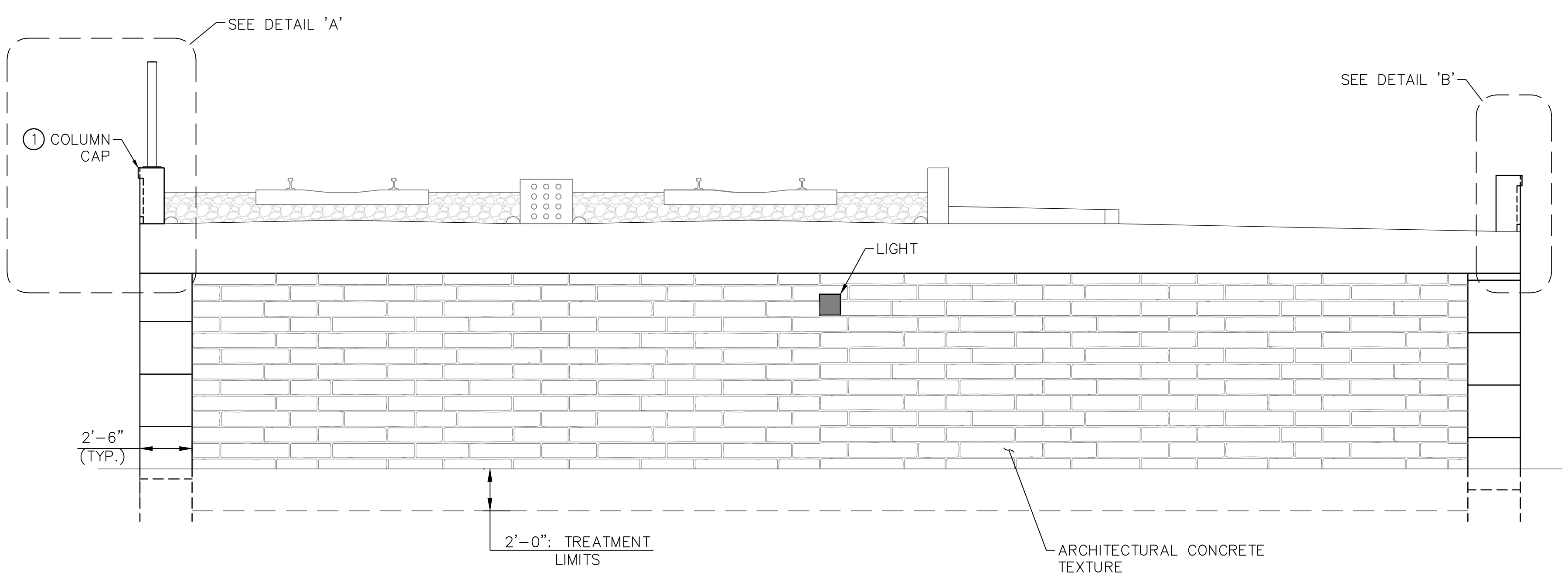


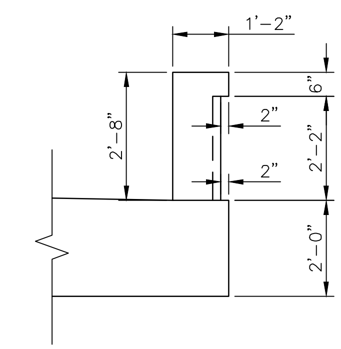
ARCHITECTURAL ELEVATION



DETAIL 'A'



TYPICAL ABUTMENT ELEVATION
(LOOKING SOUTH, NORTH REVERSED)



DETAIL 'B'

NOTES:
1. ARCHITECTURAL COLUMN CAP TO EXTEND 1" BEYOND CONCRETE BARRIER COPING.

DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

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SOUTHWEST Green Line LRT Extension

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WEST SE□MENT □
PEDESTRIAN T□NNE□ □
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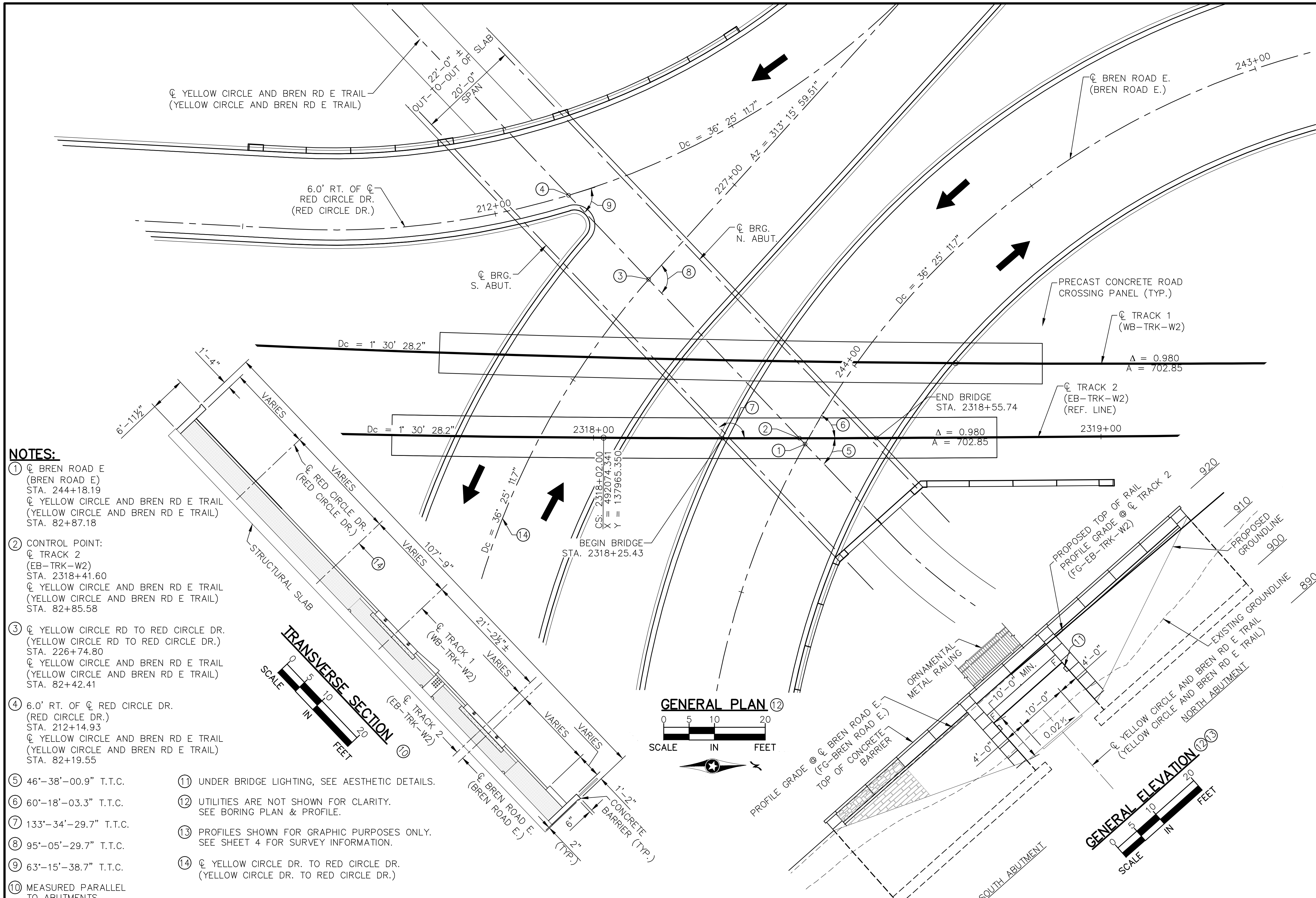

NOTES:

1. ℄ BREN ROAD E (BREN ROAD E) STA. 244+18.19
   ℄ YELLOW CIRCLE AND BREN RD E TRAIL (YELLOW CIRCLE AND BREN RD E TRAIL) STA. 82+87.18
2. CONTROL POINT: ℄ TRACK 2 (EB-TRK-W2) STA. 2318+41.60
   ℄ YELLOW CIRCLE AND BREN RD E TRAIL (YELLOW CIRCLE AND BREN RD E TRAIL) STA. 82+85.58
3. ℄ YELLOW CIRCLE RD TO RED CIRCLE DR. (YELLOW CIRCLE RD TO RED CIRCLE DR.) STA. 226+74.80
   ℄ YELLOW CIRCLE AND BREN RD E TRAIL (YELLOW CIRCLE AND BREN RD E TRAIL) STA. 82+42.41
4. 6.0' RT. OF ℄ RED CIRCLE DR. (RED CIRCLE DR.) STA. 212+14.93
   ℄ YELLOW CIRCLE AND BREN RD E TRAIL (YELLOW CIRCLE AND BREN RD E TRAIL) STA. 82+19.55
5. 46°-38'-00.9" T.T.C.
6. 60°-18'-03.3" T.T.C.
7. 133°-34'-29.7" T.T.C.
8. 95°-05'-29.7" T.T.C.
9. 63°-15'-38.7" T.T.C.
10. MEASURED PARALLEL TO ABUTMENTS
11. UNDER BRIDGE LIGHTING, SEE AESTHETIC DETAILS.
12. UTILITIES ARE NOT SHOWN FOR CLARITY. SEE BORING PLAN & PROFILE.
13. PROFILES SHOWN FOR GRAPHIC PURPOSES ONLY. SEE SHEET 4 FOR SURVEY INFORMATION.
14. ℄ YELLOW CIRCLE DR. TO RED CIRCLE DR. (YELLOW CIRCLE DR. TO RED CIRCLE DR.)

DESIGN DATA

2012 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 6TH EDITION AND CURRENT INTERIMS

SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 3.0)

LRV & MV LOAD DIAGRAM SHOWN ON SHEET 2

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

DESIGN SPEED: OVER = 30 MPH (LRT)
UNDER = 30 MPH

APPROXIMATE DECK AREA: 2377 SQ. FT.

LIST OF SHEETS

NO.	DESCRIPTION
1	GENERAL PLAN & ELEVATION
2-3	BRIDGE SURVEY
4	LOADING DIAGRAM
5	BORINGS - PLAN & PROFILE
6	BORING LOGS
7	AESTHETIC DETAILS

20XX PROJECTED TRAFFIC VOLUMES

ROADWAY OVER		ROADWAY UNDER
XXXX	AADT	N/A
XXXX	DHV	N/A
XXXXX	ADTT	N/A

PROPOSED TYPE OF STRUCTURE

SUPERSTRUCTURE:
1 SPAN - CAST-IN-PLACE CONCRETE
SLAB - CONTINUOUS WITH ABUTMENTS

SUBSTRUCTURE:
INTEGRAL ABUTMENTS SUPPORTED ON
SPREAD FOOTINGS

DEPTH OF STRUCTURE:
2'-0" MINIMUM SLAB
4'-0"± OVERBURDEN

BRIDGE NO. XXXXX

SOUTHWEST LRT OVER YELLOW CIRCLE & BREN RD E TRAIL
0.02 MI. W OF JCT. T.H. 62/T.H. 169 IN MINNETONKA

20'-0" CAST-IN-PLACE CONCRETE SLAB SPAN
105'-3" ROADWAY AND RAILWAY WIDTH (VARIES)
SKEW VARIES

BRIDGE I.D. NO. XXXXX

GENERAL PLAN AND ELEVATION

SEC 36 T117N R22W
CITY OF MINNETONKA HENNEPIN COUNTY

APPROVED: ____________ STATE BRIDGE ENGINEER DATE

MNDOT REVIEW:

DES: RMS DR: ARH
CHK: MJC CHK: MJC

NO.	DATE		CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

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METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

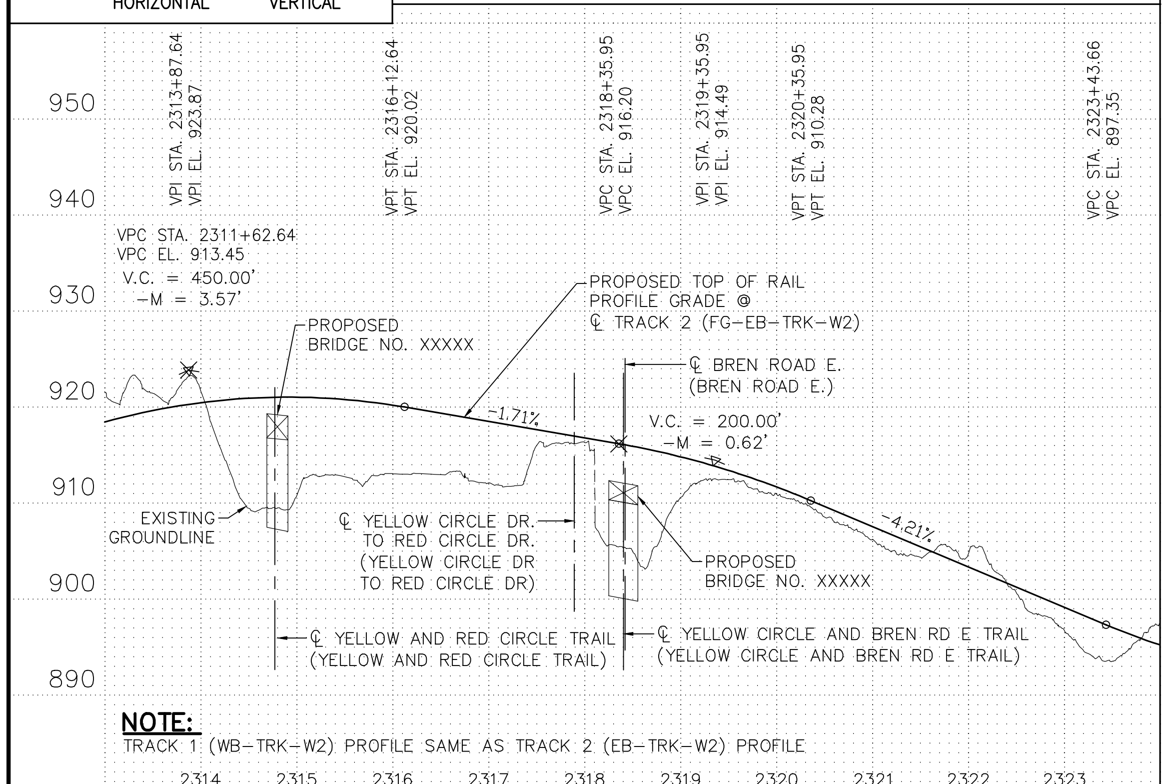
PRELIMINARY ENGINEERING

WEST SEGMENT 2
PEDESTRIAN TUNNEL
BRIDGE XXXXX LRT
GENERAL PLAN AND ELEVATION

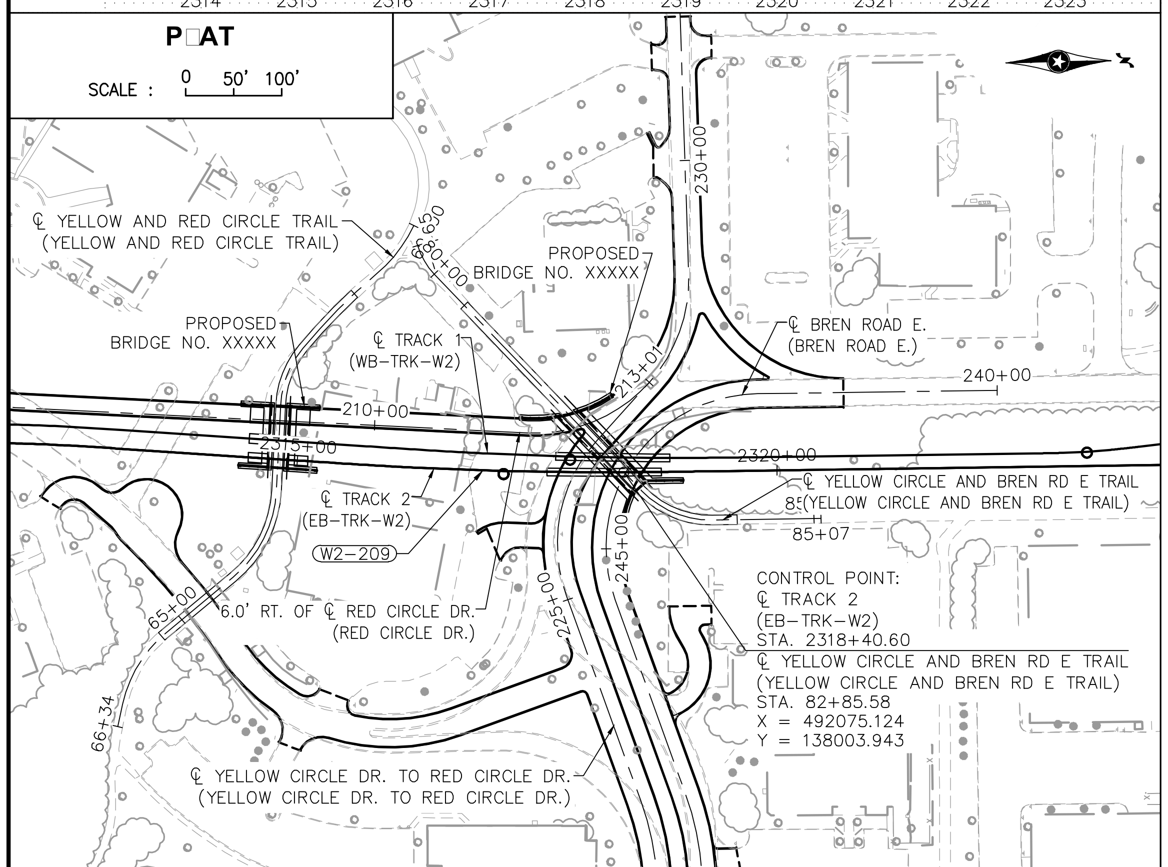
DISCIPLINE: STRUCTURES

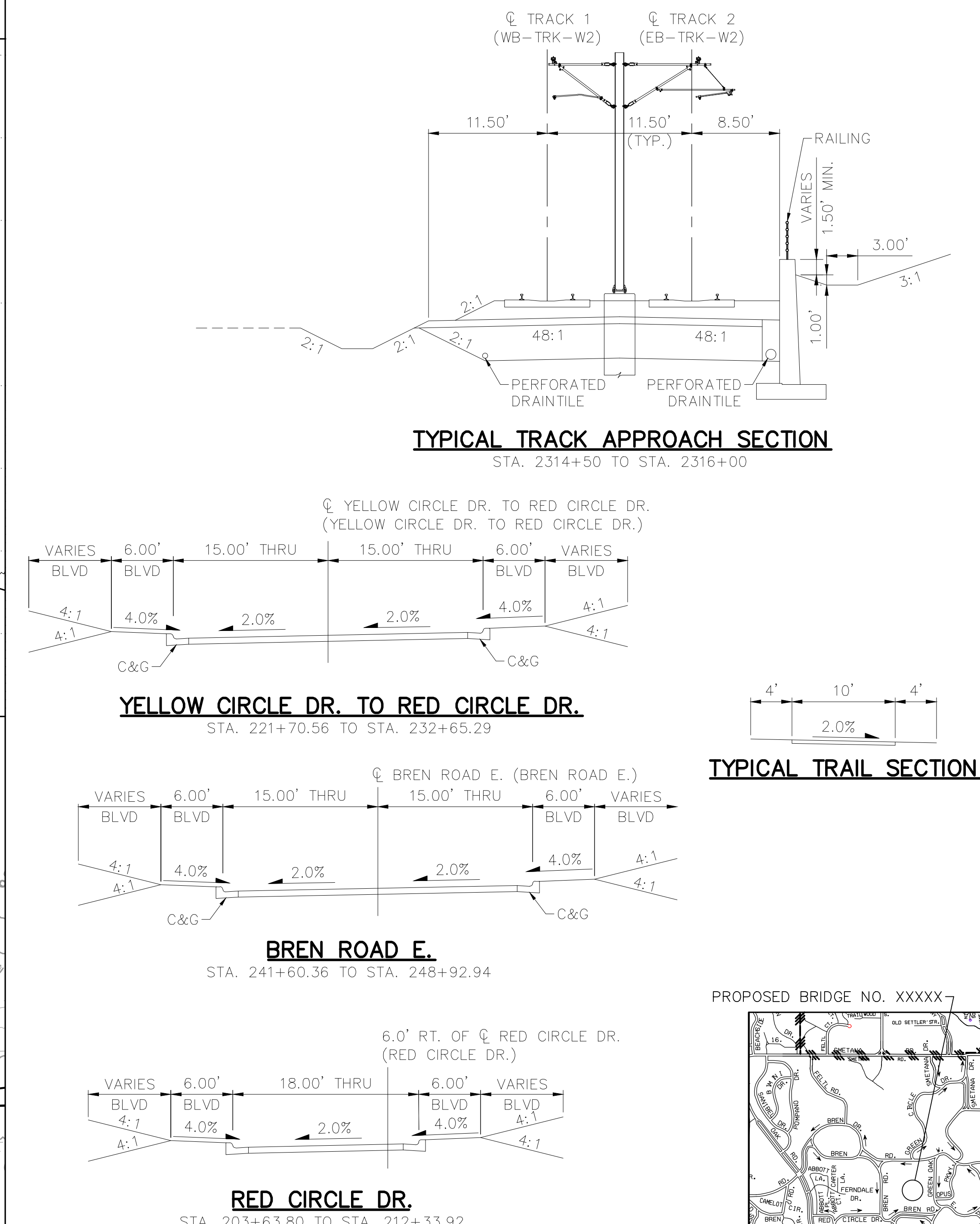
SHEET NAME: W2-STU-TUDP02-GPE

SHEET ___ OF ___



NOTE:
TRACK 1 (WB-TRK-W2) PROFILE SAME AS TRACK 2 (EB-TRK-W2) PROFILE





□OCATION EN□INEER□S O□SER□ATIONS AT □RID□E SITE

1. SPECIAL FEATURES: WATERFALLS, DAMS, FLOODS, ICE, DEBRIS, SLIDING BANKS, RECREATIONAL BOATING.
2. OTHER BRIDGES OR CULVERTS OVER THE SAME STREAM (PARTICULARLY STRUCTURES WHICH CARRY HIGH WATER WITHOUT OVERFLOW OF ROADWAY) : GIVEN LOCATION,TYPE, LENGTH, HEIGHT ABOVE HIGH WATER, CROSS-SECTIONAL AREA ETC.
3. APPARENT HIGHWATER ELEVATION OBTAINED FROM:
4. OTHER DATA: APPROX. VELOCITY OF WATER AT TIME OF SURVEY.

□□DRA□□IC EN□INEERS RECOMMENDATION

DATE -

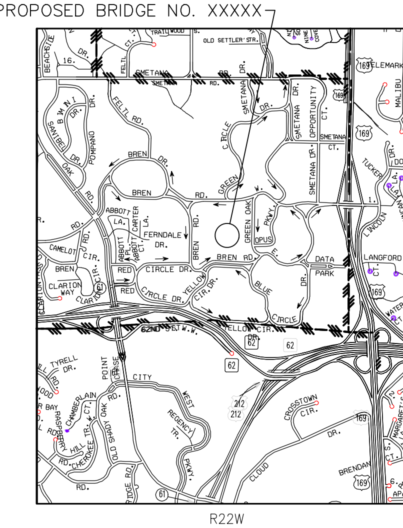
STREAM OR DITCH DESIGNATION -
DRAINAGE AREA -
MAX. FLOOD ON RECORD -
MAXIMUM OBSERVED HIGHWATER ELEVATION -
DESIGN FLOOD (-YR. FREQ.) - C.F.S.
DESIGN STAGE ELEVATION -
DESIGN MEAN VELOCITY THROUGH STRUCTURE - F.P.S.
TOTAL STAGE INCREASE - F.P.S.
LOW MEMBER AT OR ABOVE ELEVATION -
FLOWLINE ELEVATION - SKEW ANGLE -
WATERWAY AREA REQUIRED BELOW ELEVATION - = - SQ.FT. AT RIGHT ANGLES TO CHANNEL
BASIC FLOOD (100 YR. FREQ.) - C.F.S.
STAGE ELEVATION - FT.
TOTAL STAGE INCREASE - FT.
MEAN VELOCITY THROUGH STRUCTURE - F.P.S.
ESTIMATED DEPTH OF PIER SCOUR = - FT.
SCOUR CODE =-

BRIDGE SURVEY SHEETS MADE FROM SURVEY PERFORMED BY RANI ENGINEERING

MNDOT NAME: 2773A
NORTHING (HEN. COUNTY COORDINATES): 137082.117
EASTING (HEN. COUNTY COORDINATES): 490527.817
BENCHMARK ELEVATION (NAVD88): 963.180
MONUMENT DESCRIPTION: BRASS MONUMENT IN BRIDGE ABUTMENT
LOCATION: IN EDEN PRAIRIE, 1.1 MILES EAST ALONG T.H. HWY 62 FROM JCT. OF T.H. 62 & I-494

MONUMENT NAME: CONTROL POINT 6
NORTHING (HEN. COUNTY COORDINATES): 142016.680
EASTING (HEN. COUNTY COORDINATES): 489989.960
BENCHMARK ELEVATION (NAVD88): 932.956
MONUMENT DESCRIPTION: CAST IRON MONUMENT
LOCATION: 0.2 MILES EAST ALONG SMETANA ROAD FROM JCT. OF SMETANA ROAD & NOLAN DR

PROPOSED BRIDGE NO. XXXXX



CIT□ OF MINNETONKA

□RID□E S□R□E□

AT MILE POINT - ON -
- (T.H., C.S.A.H.,C.R. etc.)
PROPOSED BRIDGE LOCATED 0.02 MILES WEST OF JCT. T.H. 62 & T.H. 169
SEC 36 TWP T117N R R22W
CITY OF MINNETONKA COUNTY HENNEPIN

DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION / S□□MITTA□

AECOM
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METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

PER□IMINAR□ EN□INEERIN□

WEST SE□MENT □
PEDESTRAIN T□NNE□ □
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□RID□E S□R□E□

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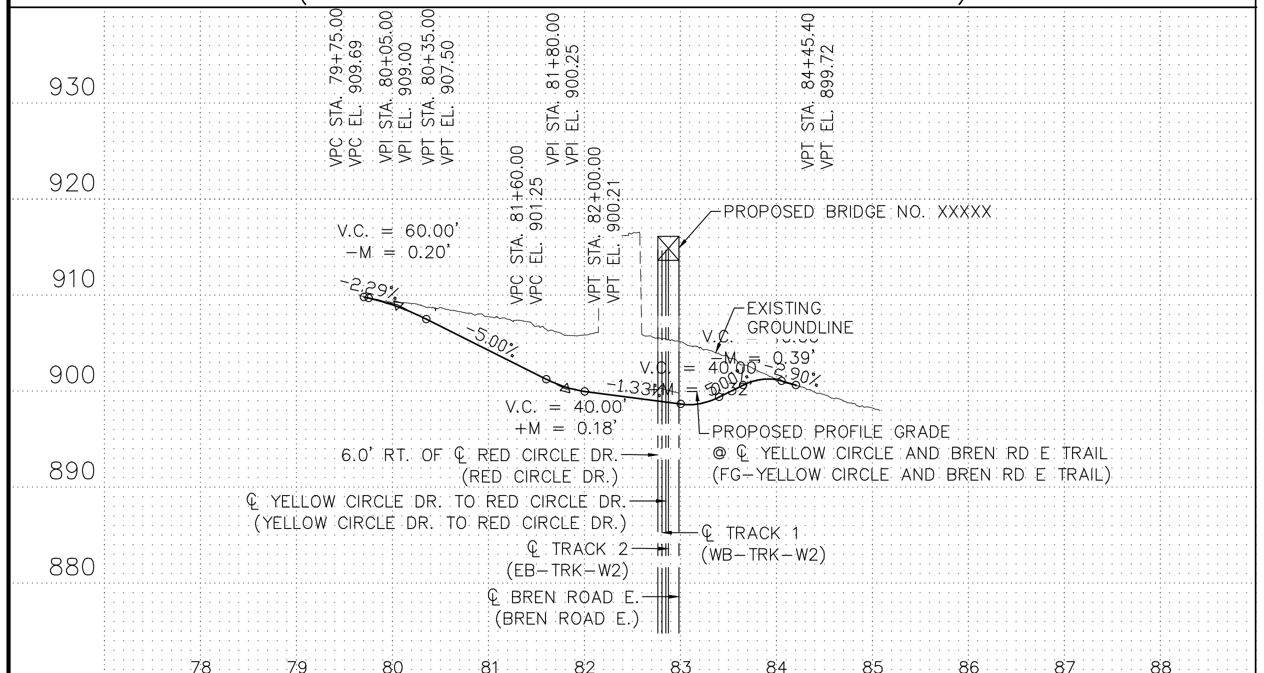
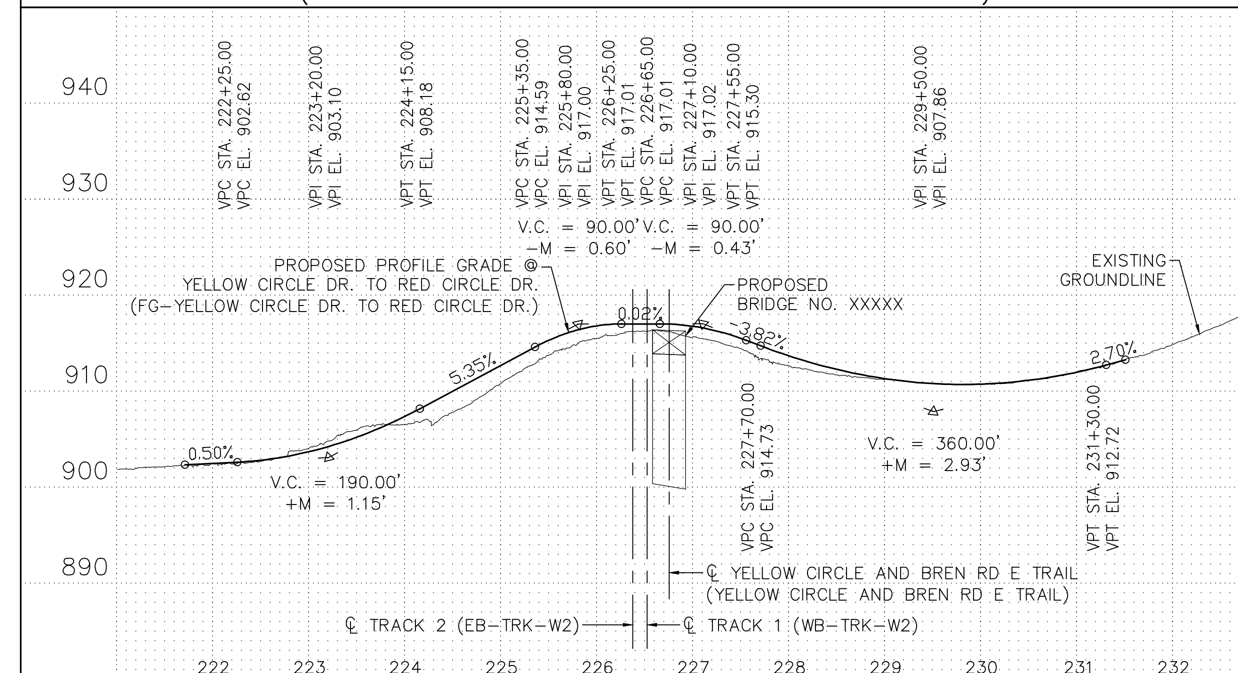
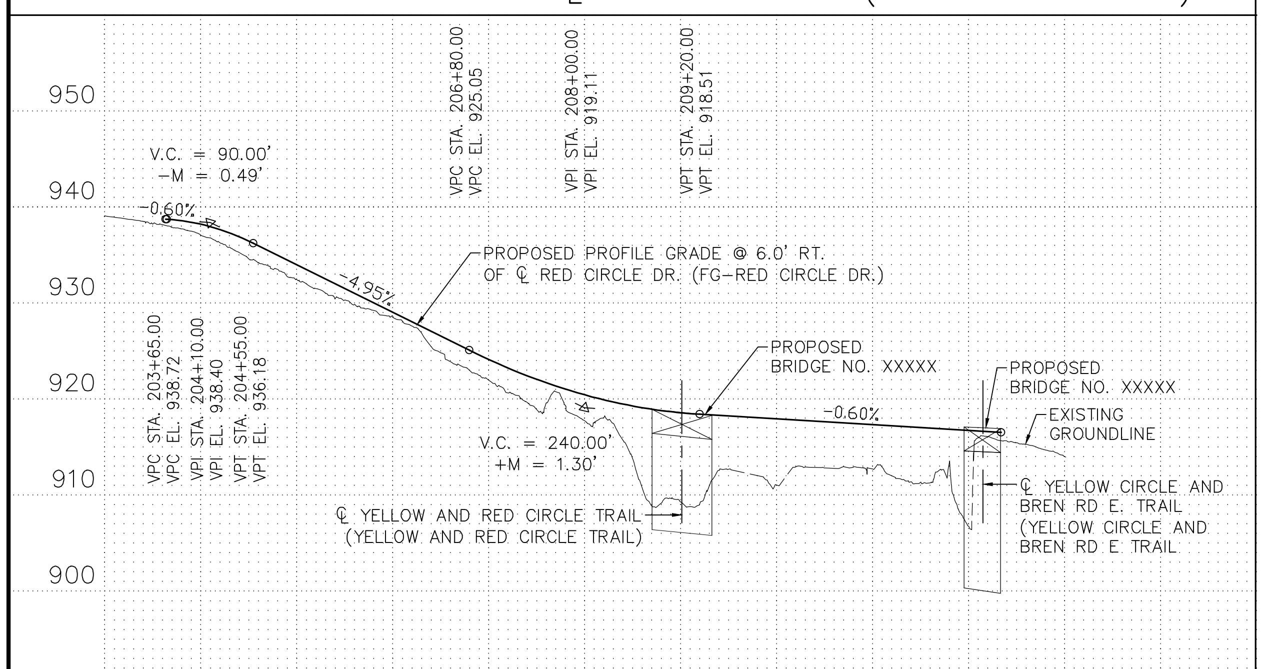
PROFILE GRADE @ ℄ YELLOW CIRCLE AND BREN RD E TRAIL (FG-YELLOW CIRCLE AND BREN RD E TRAIL)



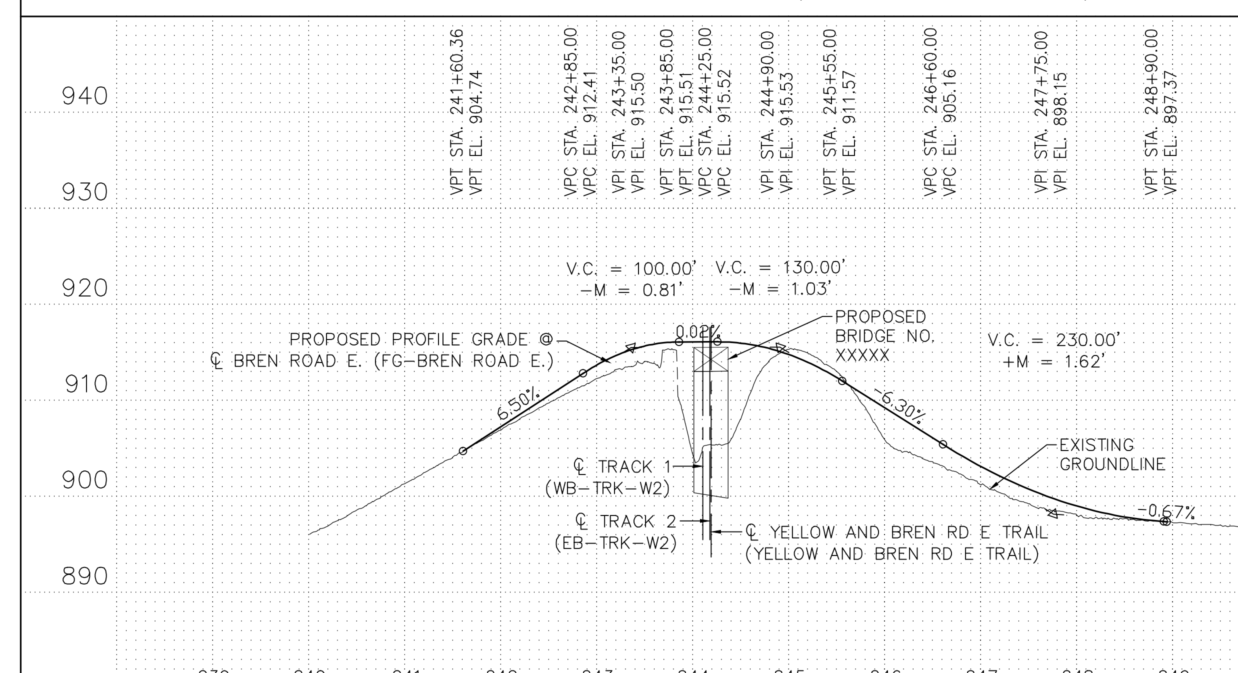
PROFILE GRADE @ ℄ YELLOW CIRCLE DR. TO RED CIRCLE DR. (FG-YELLOW CIRCLE DR. TO RED CIRCLE DR.)



PROFILE GRADE @ 6.0' RT. OF ℄ RED CIRCLE DR. (FG-RED CIRCLE DR.)



PROFILE GRADE @ ℄ BREN ROAD E. (FG-BREN ROAD E.)



DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

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DISCIP□INE□ STR□CT□RES

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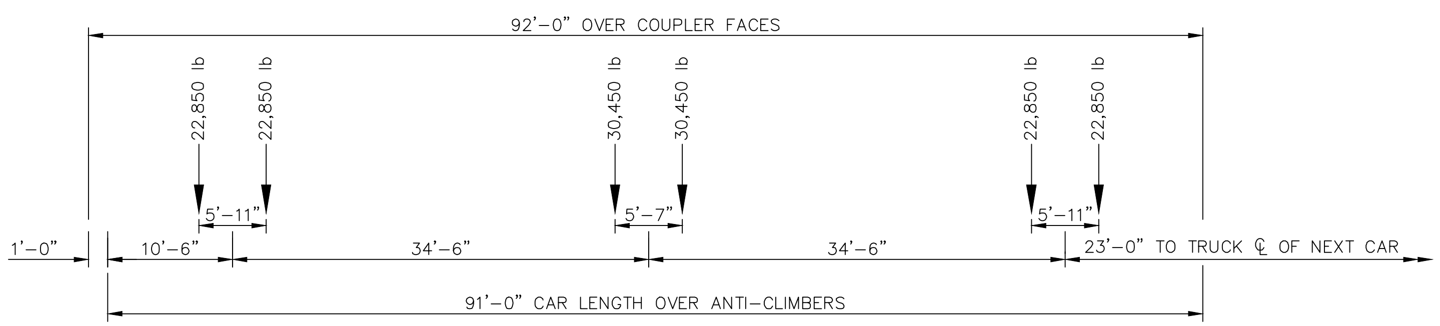
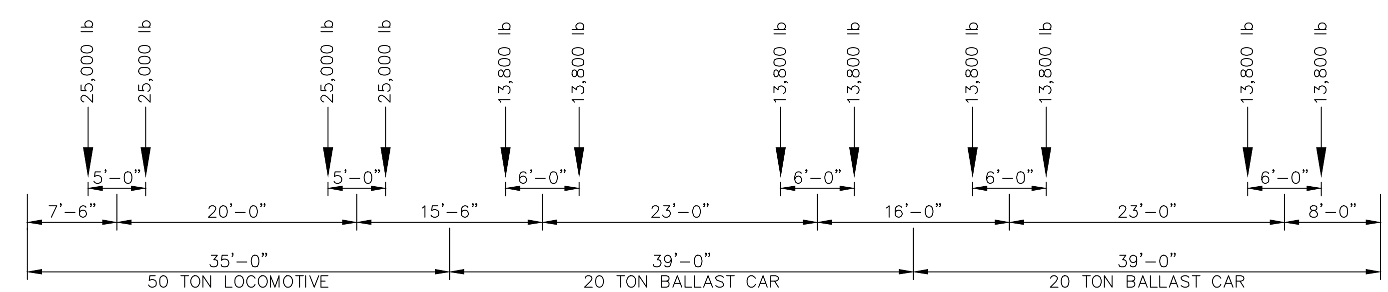


LIGHT RAIL VEHICLE LOADING DIAGRAM



MAINTENANCE TRAIN LOADING DIAGRAM

NOTES:

1. THE LRT TRAIN SHALL CONSIST OF EITHER ONE, TWO OR THREE CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. LOADING DIAGRAM REPRESENTS MAXIMUM LOAD AT EACH TRUCK IN ACCORDANCE WITH SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 2.0) FIGURE 8-2.

NOTES:

1. THE MAINTENANCE TRAIN SHALL CONSIST OF ONE LOCOMOTIVE AND ONE, TWO, THREE, OR FOUR BALLAST CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. WEIGHT OF EMPTY BALLAST CAR IS 15,000 POUNDS.

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION□S□□MITTA□

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SOUTHWEST Green Line LRT Extension

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WEST SE□MENT □
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□OADIN□ DIA□RAM

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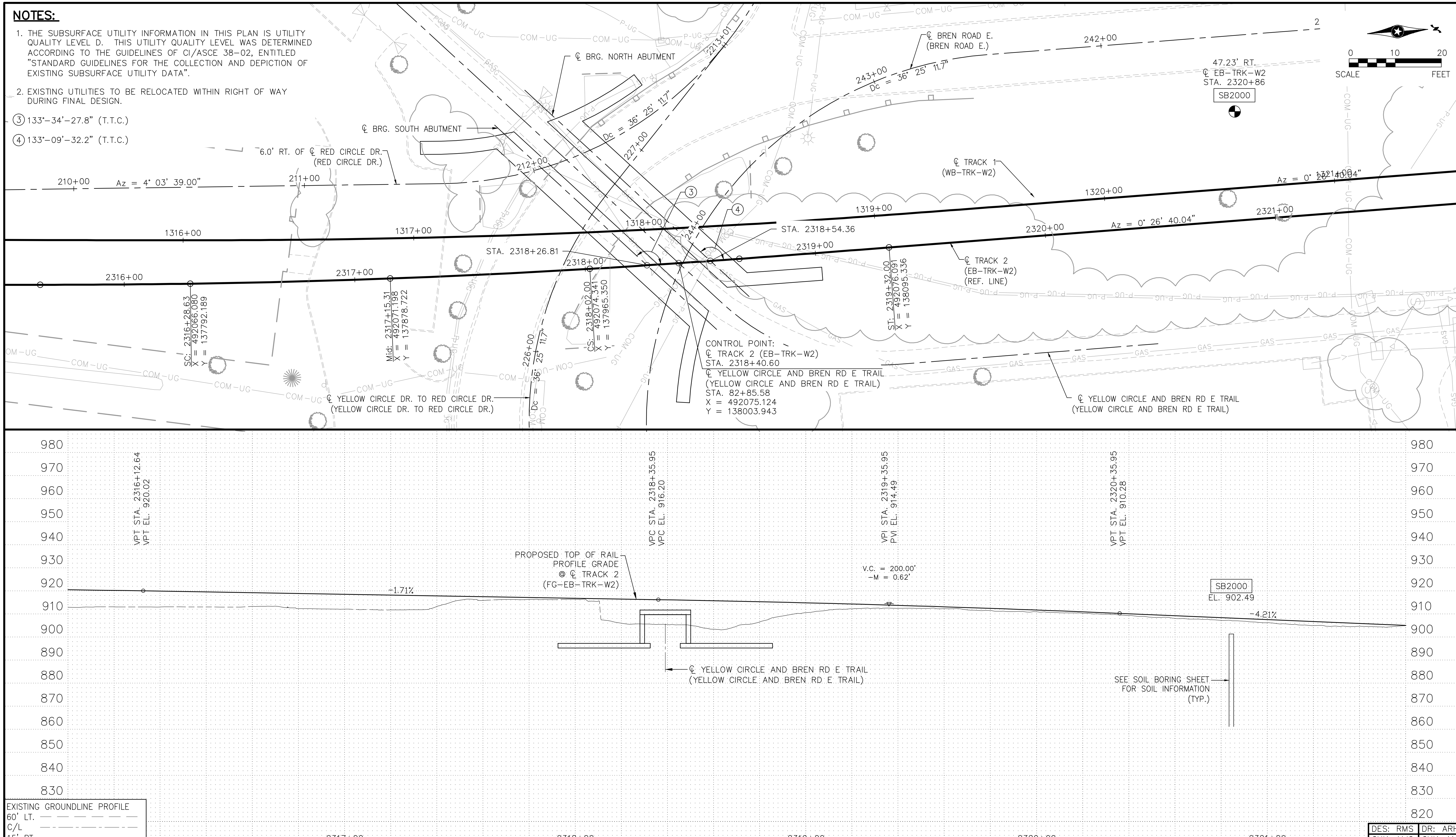
NOTES:

1. THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO THE GUIDELINES OF CI/ASCE 38-02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".
2. EXISTING UTILITIES TO BE RELOCATED WITHIN RIGHT OF WAY DURING FINAL DESIGN.

(3) 133°-34'-27.8" (T.T.C.)

(4) 133°-09'-32.2" (T.T.C.)



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METROPOLITAN COUNCIL — SOUTHWEST Green Line LRT Extension

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □RT□
P□AN AND PROFI□E

DISCIP□INE□ STR□CT□RES

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2000SW

Elevation 902.5

Elevation	Coh (psf)	SPT-N (BPF)	Description
905			
900		10	FILL: Lean Clay, dark brown, frozen.
		11	FILL: Silty Sand, fine- to medium-grained, with Lean Clay lenses, brown, moist.
895		7	FILL: Sandy Lean Clay, brown, wet.
		9	FILL: Sandy Lean Clay, trace Gravel, brown, wet.
890		27	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel and Cobbles, brown, moist to wet, medium dense.
		26	
885	▽	22	SILTY SAND, fine- to medium-grained, with occasional Lean Clay lenses, trace Gravel, brown to 22 feet then gray, wet, medium dense.
		22	
880		20	
		22	CLAYEY SAND, trace Gravel, gray, wet, very stiff.
875		32	SILTY SAND, fine- to medium-grained, trace Gravel, gray, moist, medium dense to dense. With Lean Clay layers at 30 feet.
		28	
870		34	CLAYEY SAND, trace Gravel, with frequent Sand lenses, gray to 37 feet then brown, wet, very stiff to hard.
		27	
865		25	
		27	
860		30	
		31	
855		15	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, brown, waterbearing, medium dense.
		24	
850			SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense.
		15	
845			
		18	
840			END OF BORING.* Bottom of Borehole at 61 ft
835			

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488. THE SOIL GROUP CATEGORY PER THE AASHTO SOIL CLASSIFICATION SYSTEM IS ALSO SHOWN.

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION S□□MITTA□

DES: RMS DR: ARH
CHK: MJC CHK: MJC

AECOM

SRF Consulting Group, Inc.

PER□IMINAR□ EN□INEERIN□

METROPOLITAN COUNCIL

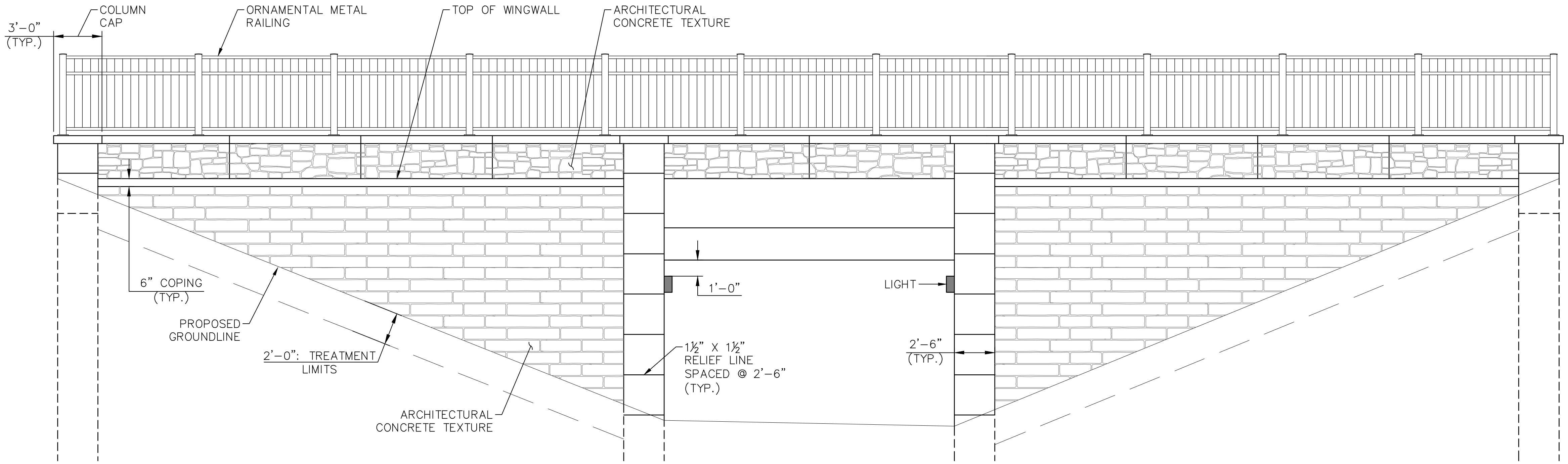
SOUTHWEST Green Line LRT Extension

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □□RT□
SOI□ □ORIN□S

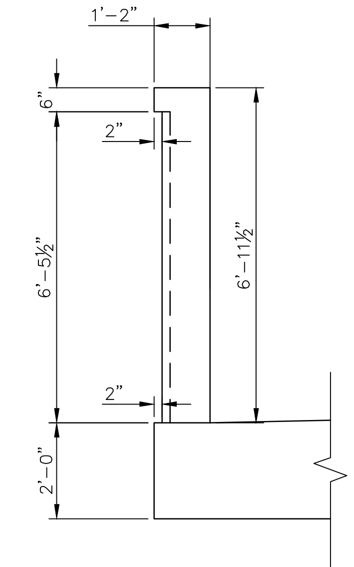
DISCIP□INE□ STR□CT□RES

S□EET NAME□ W□-ST□-T□DP□□-□OR

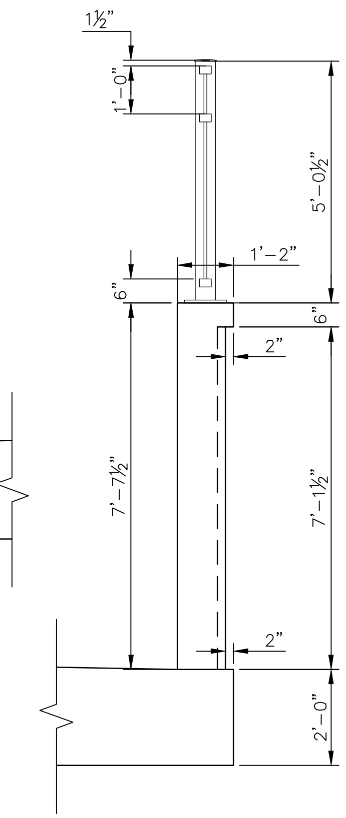
S□EET □□□ OF □□□



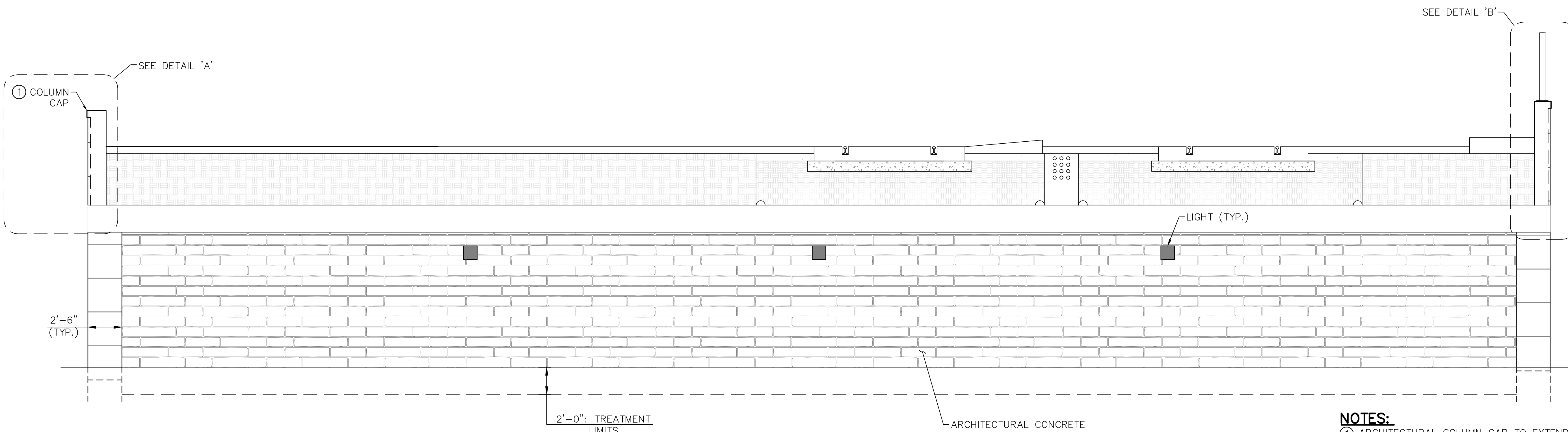
ARCHITECTURAL ELEVATION



DETAIL 'A'



DETAIL 'B'



NOTES:
1. ARCHITECTURAL COLUMN CAP TO EXTEND 1" BEYOND CONCRETE BARRIER COPING.

TYPICAL ABUTMENT ELEVATION
(LOOKING SOUTH, NORTH REVERSED)

DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

PER□IMINAR□ EN□INEERIN□

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □RT□
AEST□ETIC DETAI□S

DISCIP□INE□ STR□CT□RES

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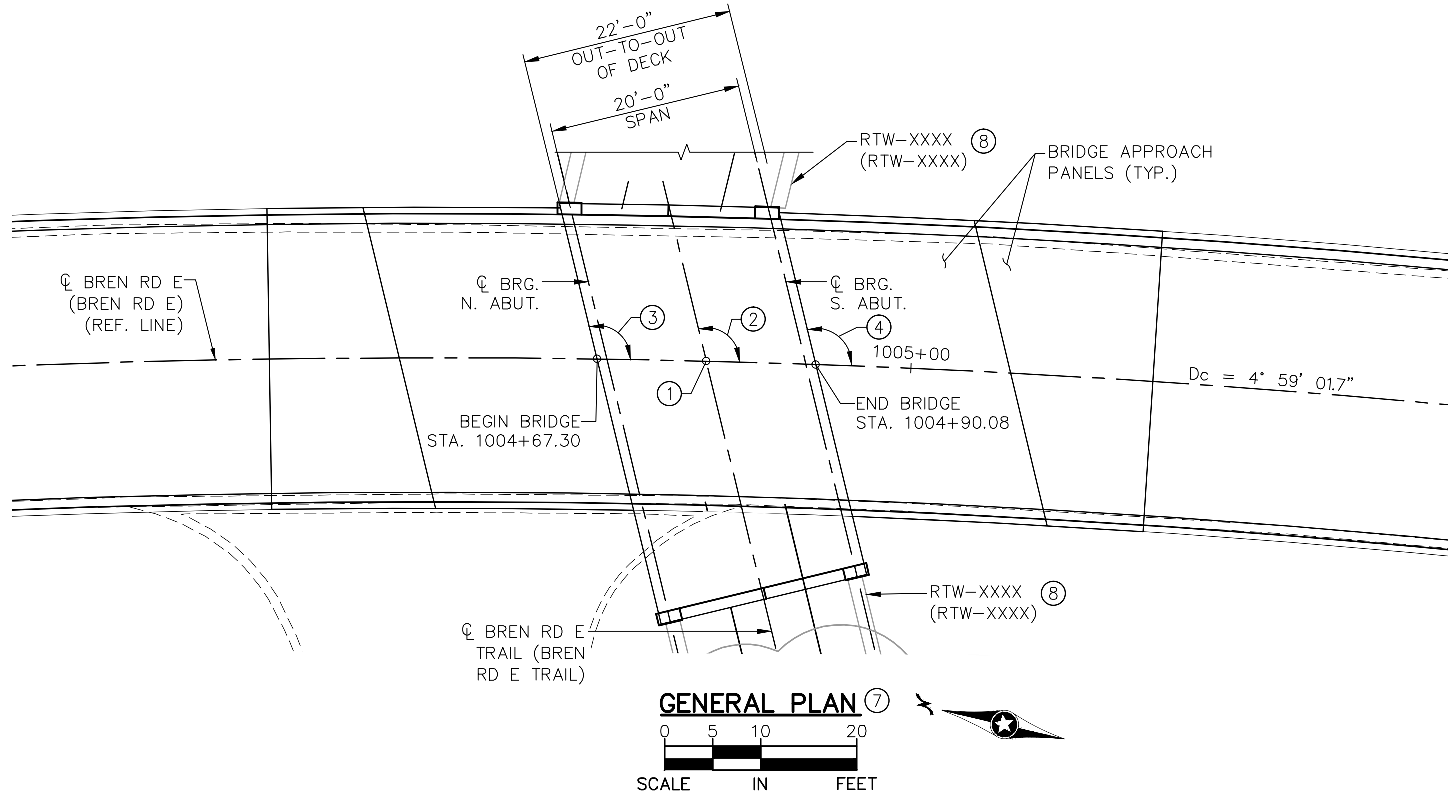
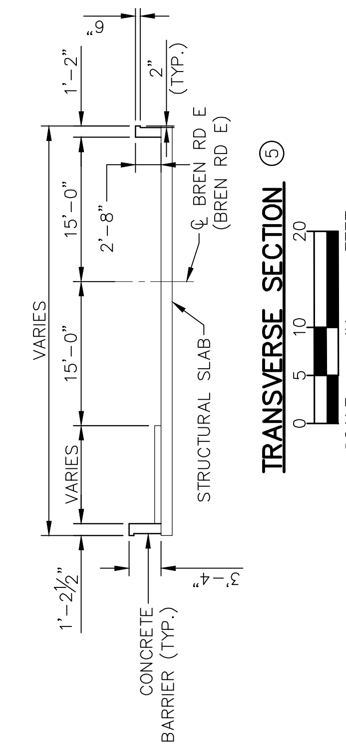
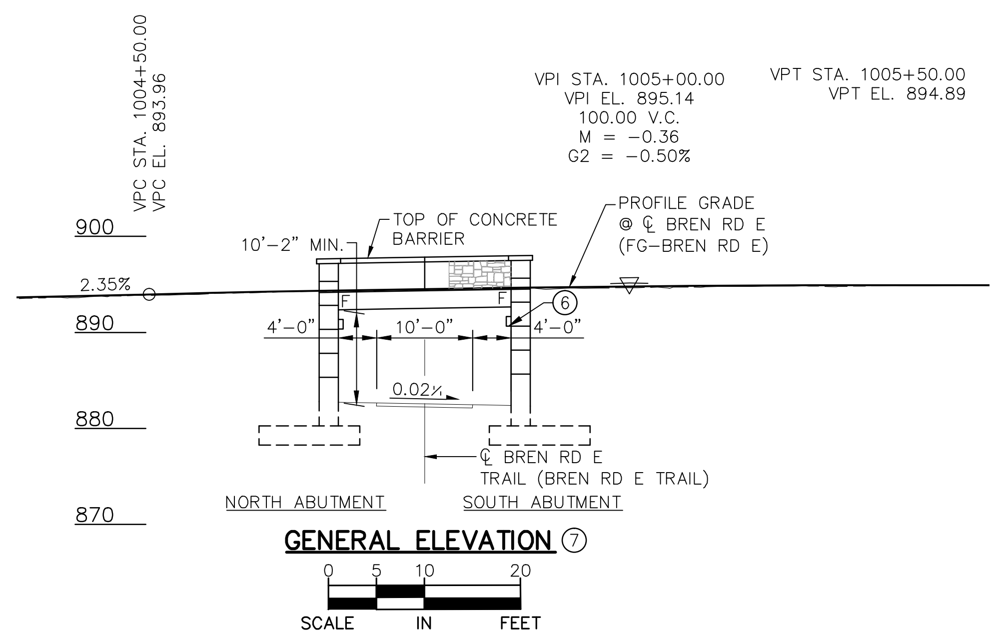


GENERAL PLAN (7)



TRANSVERSE SECTION



GENERAL ELEVATION (7)

NOTES:

1. ℄ BREN RD E (BREN RD E) STA. 1004+78.67
   ℄ BREN RD E TRAIL (BREN RD E TRIAL) STA. 133+51.19
2. 105°-00'-02.4" (T.T.C.)
3. 104°-29'-51.8" (T.T.C.)
4. 105°-37'-07" (T.T.C.)
5. MEASURED PERPENDICULAR ACROSS BRIDGE WIDTH
6. UNDER BRIDGE LIGHTING, SEE AESTHETIC DETAILS.
7. UTILITIES ARE NOT SHOWN FOR CLARITY. SEE BORING PLAN AND PROFILE.
8. RETAINING WALL GEOMETRY TO BE PROVIDED DURING ADVANCED DESIGN.

DESIGN DATA

2012 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 6TH EDITION AND CURRENT INTERIMS

SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 3.0)

HL-93 LIVE LOADING

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

DESIGN SPEED: OVER = 30 MPH (LRT)
UNDER = 30 MPH

APPROXIMATE DECK AREA: 929 SQ. FT.

LIST OF SHEETS

NO.	DESCRIPTION
1	GENERAL PLAN & ELEVATION
2	BRIDGE SURVEY
3	BORING - PLAN & PROFILE
4	BORING LOGS
5	AESTHETIC DETAILS

20XX PROJECTED TRAFFIC VOLUMES

ROADWAY OVER		ROADWAY UNDER
XXXX	AADT	N/A
XXXX	DHV	N/A
XXXXX	ADTT	N/A

PROPOSED TYPE OF STRUCTURE

SUPERSTRUCTURE:
1 SPAN - CAST-IN-PLACE CONCRETE SLAB - CONTINUOUS WITH ABUTMENTS

SUBSTRUCTURE:
INTEGRAL ABUTMENTS SUPPORTED ON SPREAD FOOTINGS

DEPTH OF STRUCTURE:
2'-0" GUTTER TO LOW BRIDGE

BRIDGE NO. XXXXX

SOUTHWEST LRT OVER BREN RD. E TRAIL
0.02 MI. W OF JCT. T.H. 62/T.H. 169 IN MINNETONKA

20'-0" CAST-IN-PLACE CONCRETE SLAB SPAN
30'-0" ROADWAY WIDTH
SKEW VARIES

BRIDGE I.D. NO. XXXXX

GENERAL PLAN AND ELEVATION

SEC 36 T117N R22W
CITY OF MINNETONKA HENNEPIN COUNTY

APPROVED: STATE BRIDGE ENGINEER DATE

MNDOT REVIEW:

DES: RMS DR: ARH
CHK: MJC CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□
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□	□	□	□	□	□

AECOM

SRF Consulting Group, Inc.

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

PER□IMINAR□ EN□INEERIN□

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□
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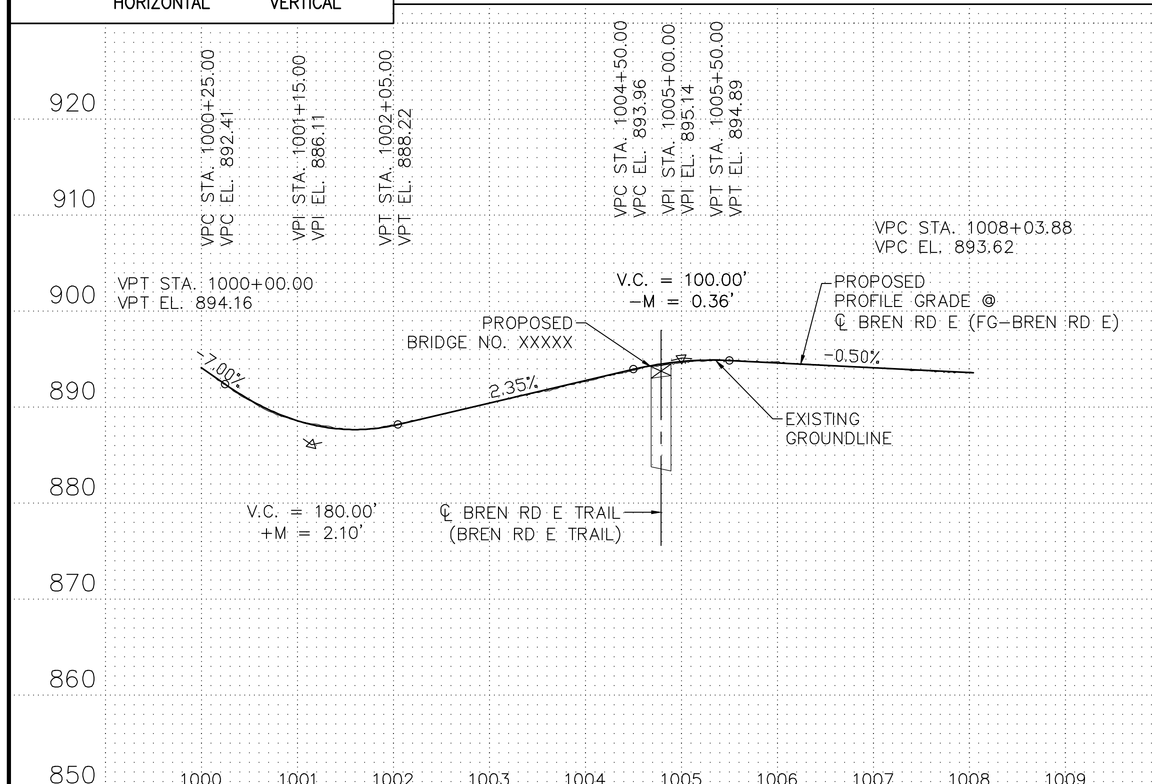
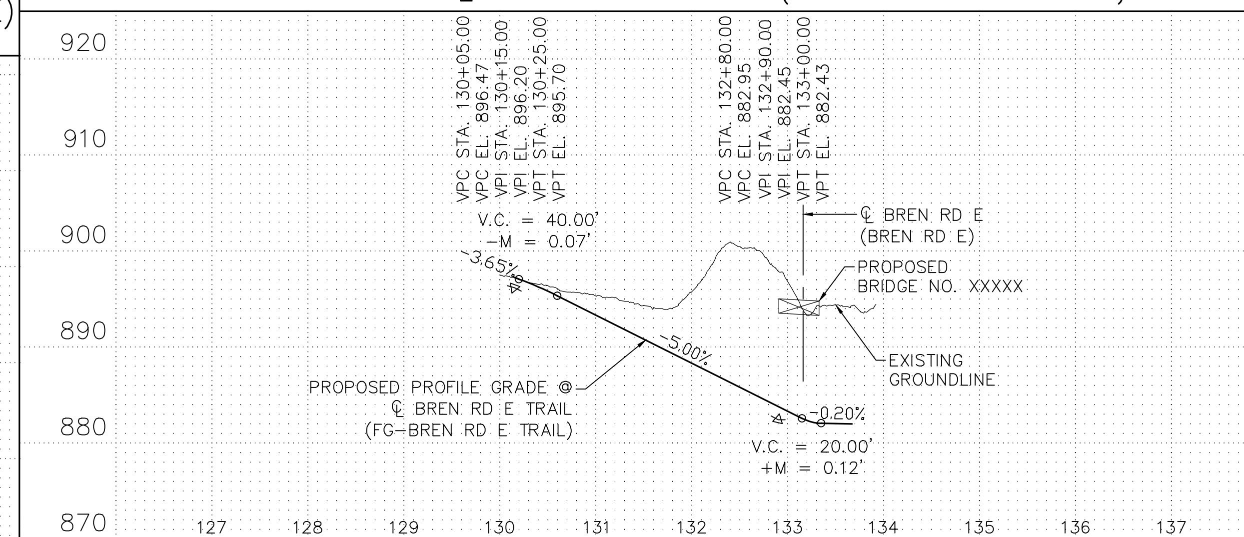
S□EET □□□ OF □□□

CONTRACTED PROFI□E

SCALE : 0 50' 100' HORIZONTAL; 0 5' 10' VERTICAL





□OCATION EN□INEER□S O□SER□ATIONS AT □RID□E SITE

1. SPECIAL FEATURES: WATERFALLS, DAMS, FLOODS, ICE, DEBRIS, SLIDING BANKS, RECREATIONAL BOATING.
2. OTHER BRIDGES OR CULVERTS OVER THE SAME STREAM (PARTICULARLY STRUCTURES WHICH CARRY HIGH WATER WITHOUT OVERFLOW OF ROADWAY) : GIVEN LOCATION,TYPE, LENGTH, HEIGHT ABOVE HIGH WATER, CROSS-SECTIONAL AREA ETC.
3. APPARENT HIGHWATER ELEVATION OBTAINED FROM:
4. OTHER DATA: APPROX. VELOCITY OF WATER AT TIME OF SURVEY.

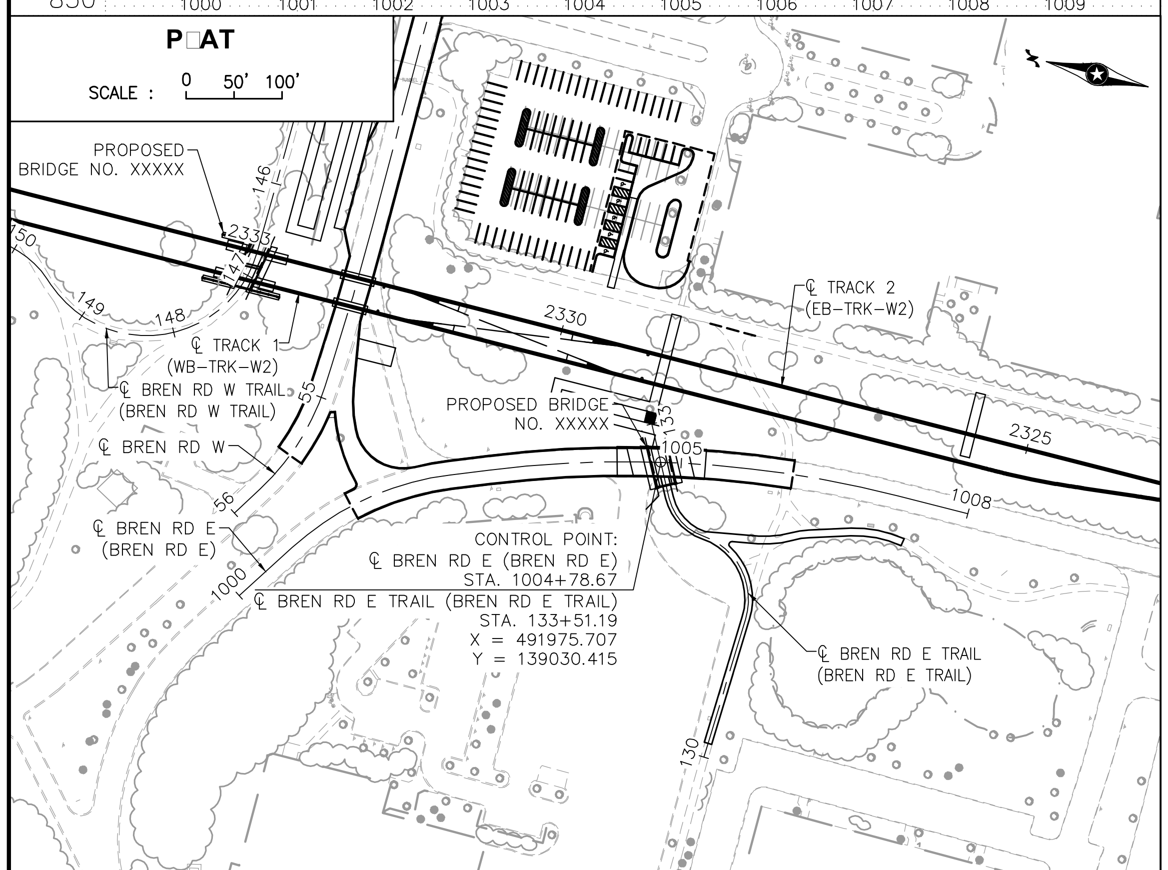
□□DRA□□IC EN□INEERS RECOMMENDATION

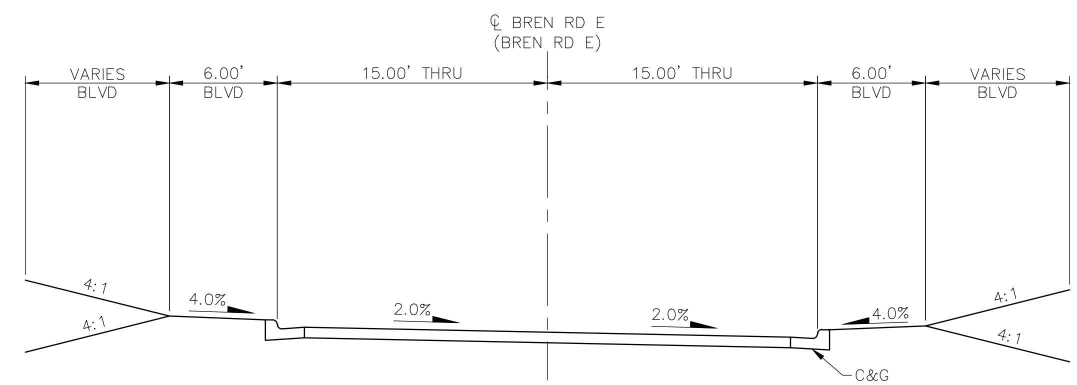
DATE –

STREAM OR DITCH DESIGNATION –
DRAINAGE AREA –
MAX. FLOOD ON RECORD –
MAXIMUM OBSERVED HIGHWATER ELEVATION –
DESIGN FLOOD (–YR. FREQ.) – C.F.S.
DESIGN STAGE ELEVATION –
DESIGN MEAN VELOCITY THROUGH STRUCTURE – F.P.S.
TOTAL STAGE INCREASE – F.P.S.
LOW MEMBER AT OR ABOVE ELEVATION –
FLOWLINE ELEVATION – SKEW ANGLE –
WATERWAY AREA REQUIRED BELOW ELEVATION – = – SQ.FT. AT RIGHT ANGLES TO CHANNEL
BASIC FLOOD (100 YR. FREQ.) – C.F.S.
STAGE ELEVATION – FT.
TOTAL STAGE INCREASE – FT.
MEAN VELOCITY THROUGH STRUCTURE – F.P.S.
ESTIMATED DEPTH OF PIER SCOUR = – FT.
SCOUR CODE =–

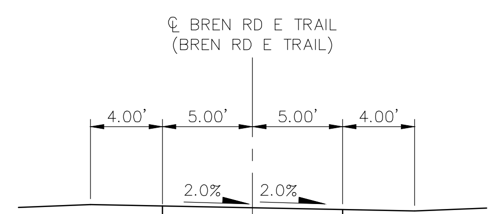
P□AT

SCALE : 0 50' 100'



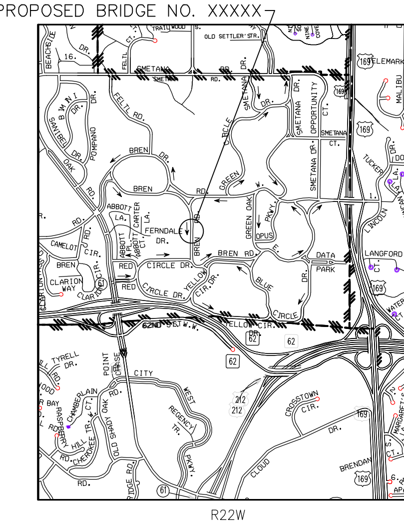


NORTH APPROACH SECTION



TYPICAL TRAIL SECTION

PROPOSED BRIDGE NO. XXXXX



R22W INDEX-MAP

BRIDGE SURVEY SHEETS MADE FROM SURVEY PERFORMED BY RANI ENGINEERING

MNDOT NAME: 2773A
NORTHING (HEN. COUNTY COORDINATES): 137082.117
EASTING (HEN. COUNTY COORDINATES): 490527.817
BENCHMARK ELEVATION (NAVD88): 963.180
MONUMENT DESCRIPTION: BRASS MONUMENT IN BRIDGE ABUTMENT
LOCATION: IN EDEN PRAIRIE, 1.1 MILES EAST ALONG T.H. HWY 62 FROM JCT. OF T.H. 62 & I-494

MONUMENT NAME: CONTROL POINT 6
NORTHING (HEN. COUNTY COORDINATES): 142016.680
EASTING (HEN. COUNTY COORDINATES): 489989.960
BENCHMARK ELEVATION (NAVD88): 932.956
MONUMENT DESCRIPTION: CAST IRON MONUMENT
LOCATION: 0.2 MILES EAST ALONG SMETANA ROAD FROM JCT. OF SMETANA ROAD & NOLAN DR

CIT□ OF MINNETONKA

□RID□E S□R□E□

AT MILE POINT – ON – – (T.H., C.S.A.H.,C.R. etc.)
PROPOSED BRIDGE LOCATED 0.02 MILES WEST OF JCT. T.H. 62 & T.H. 169
SEC 36 TWP T117N R R22W
CITY OF MINNETONKA COUNTY HENNEPIN

DES: RMS | DR: ARH
CHK: MJC | CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□MITTA□

AECOM SRF Consulting Group, Inc.

PRE□IMINAR□ P□ANS

METROPOLITAN COUNCIL SOUTHWEST Green Line LRT Extension

WEST SE□MENT □ PEDESTRIAN T□NNE□ □ □RID□E □□□□□ □RID□E S□R□E□

DISCIP□INE□ STR□CT□RES

S□EET NAME□ W□-ST□-T□DP□□-S□R

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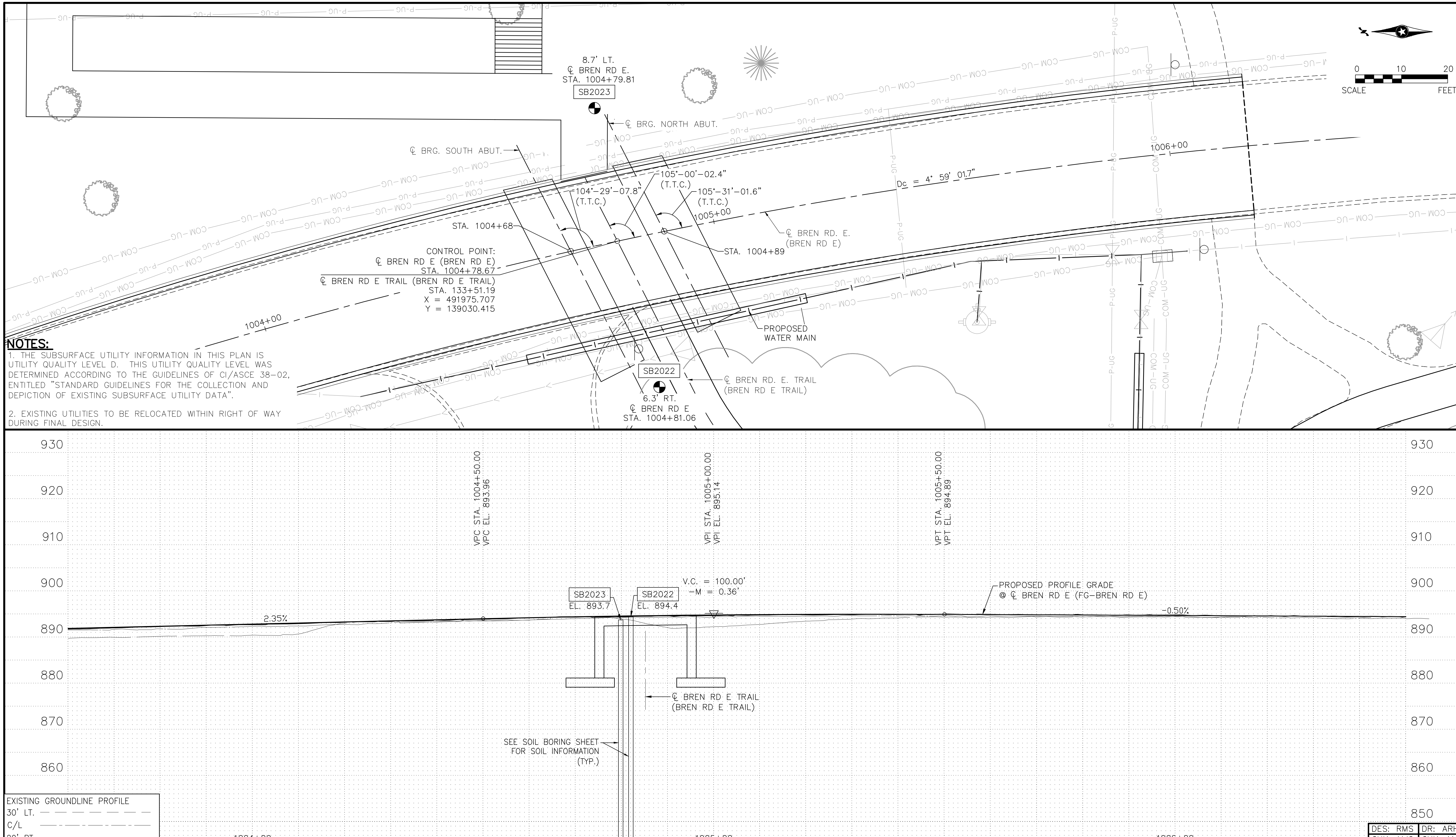


NOTES:

1. THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO THE GUIDELINES OF CI/ASCE 38-02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".

2. EXISTING UTILITIES TO BE RELOCATED WITHIN RIGHT OF WAY DURING FINAL DESIGN.

Jun, 13 2014 12:24 am H:\Projects\7984\3200_PEC-W\CAD\SEGMENT-W2\SHEET\STRUCTURES\W2-STU-TUDP03-BOR.dwg By: ahouser

DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO.	DATE		CHECK	DESIGN	REVISION SUBMITTAL

AECOM
SRF Consulting Group, Inc.

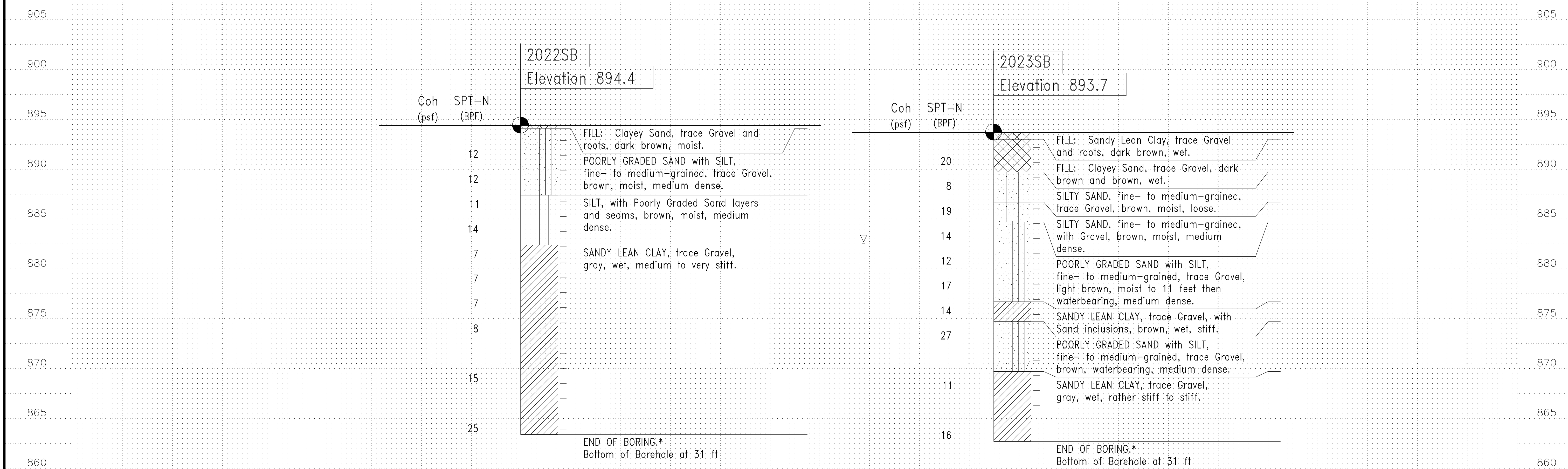
PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

WEST SEGMENT
PEDESTRIAN TUNNEL
BRIDGE
PLAN AND PROFILE

DISCIPLINE: STRUCTURES
SHEET NAME: W-ST-TDP-OR

SHEET
OF



NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488. THE SOIL GROUP CATEGORY PER THE AASHTO SOIL CLASSIFICATION SYSTEM IS ALSO SHOWN.

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION S□□MITTA□

DES: RMS | DR: ARH
CHK: MJC | CHK: MJC

AECOM
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METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

WEST SE□MENT □
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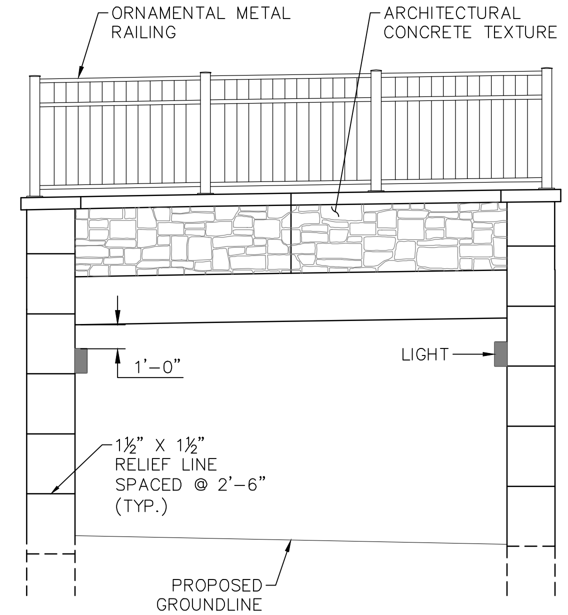
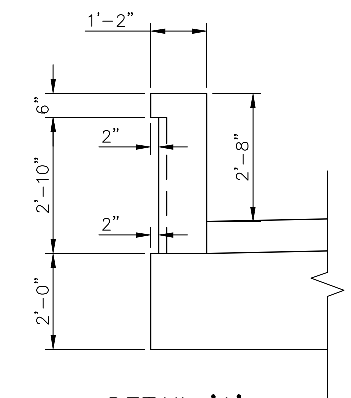
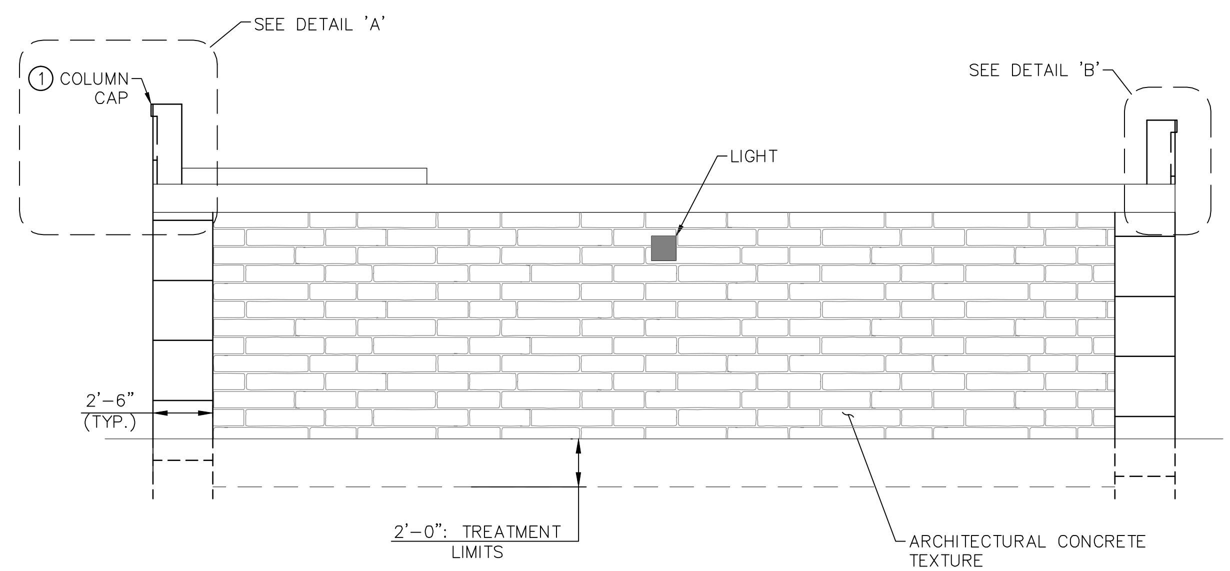


ARCHITECTURAL ELEVATION

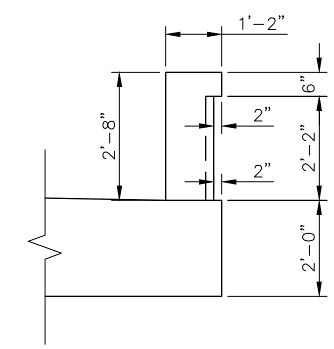


DETAIL 'A'



TYPICAL ABUTMENT ELEVATION

(LOOKING NORTH, SOUTH REVERSED)



DETAIL 'B'

NOTES:

① ARCHITECTURAL COLUMN CAP TO EXTEND 1" BEYOND CONCRETE BARRIER COPING.

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

DES: RMS | DR: ARH
CHK: MJC | CHK: MJC

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SOUTHWEST Green Line LRT Extension

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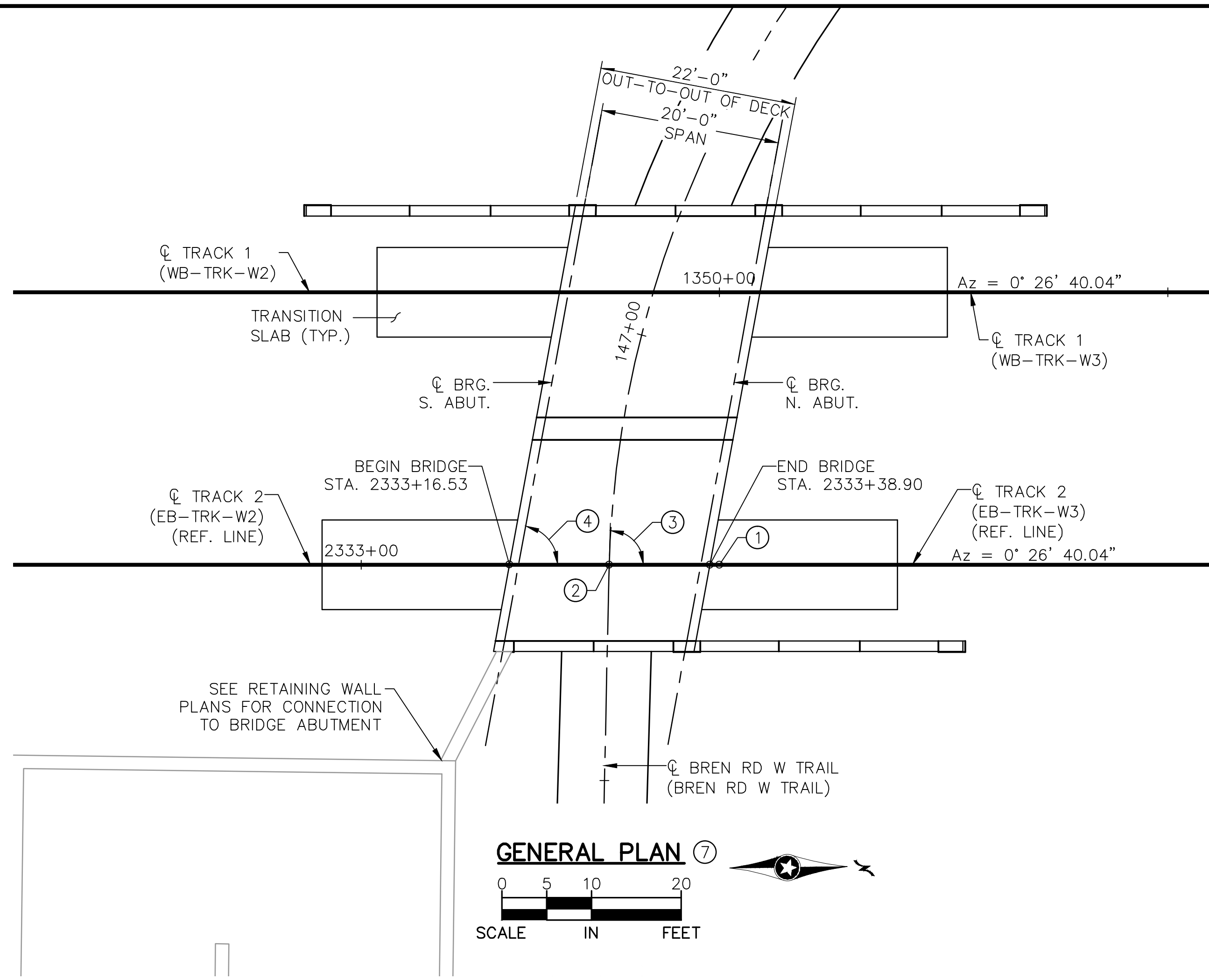
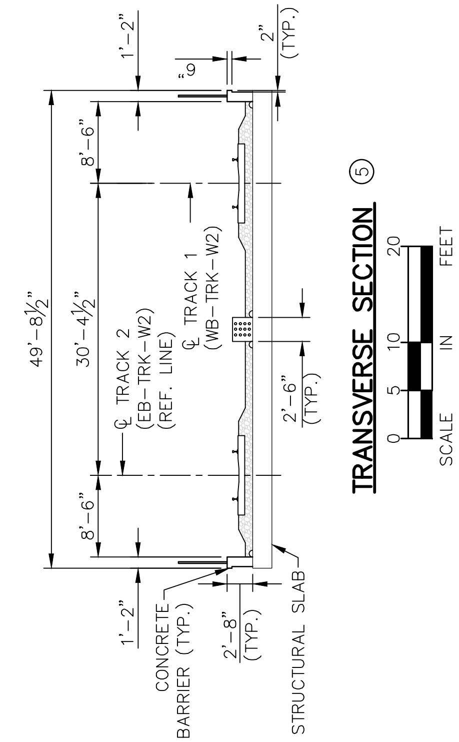


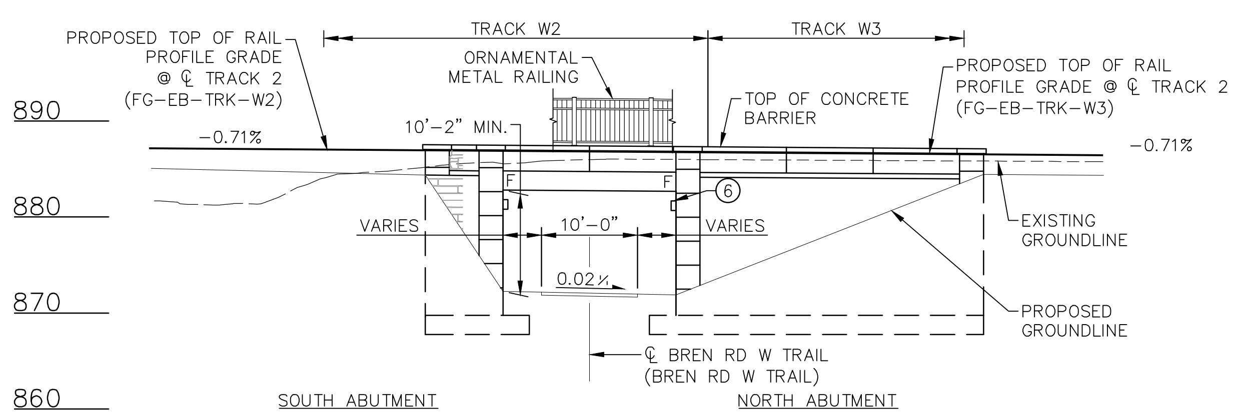
GENERAL PLAN ⑦

SCALE IN FEET (0, 5, 10, 20)



TRANSVERSE SECTION ⑤

SCALE IN FEET (0, 5, 10, 20)



GENERAL ELEVATION ⑦

SCALE IN FEET (0, 5, 10, 20)

NOTES:

1. END TRACK 2 (EB-TRK-W2) STA. 2333+39.97
   BEGIN TRACK 2 (EB-TRK-W3) STA. 2350+00.00
2. CONTROL POINT:
   ℄ TRACK 2 (EB-TRK-W2) STA. 2333+27.64
   ℄ BREN RD W TRAIL (BREN RD W TRAIL) STA. 146+74.11
3. 88°-09'-26.1" (T.T.C.)
4. 79°-36'-28.4" (TYP. @ ABUT.)
5. MEASURED PERPENDICULAR ACROSS BRIDGE WIDTH
6. UNDER BRIDGE LIGHTING, SEE AESTHETIC DETAILS.
7. UTILITIES ARE NOT SHOWN FOR CLARITY. SEE BORING PLAN & PROFILE.

DESIGN DATA

2012 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS
6TH EDITION AND CURRENT INTERIMS

SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA
(REVISION 3.0)

LRV & MV LOAD DIAGRAM SHOWN ON SHEET 2

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

DESIGN SPEED: OVER = 30 MPH (LRT)
UNDER = 30 MPH

APPROXIMATE DECK AREA: 1112 SQ. FT.

LIST OF SHEETS

NO.	DESCRIPTION
1	GENERAL PLAN & ELEVATION
2	BRIDGE SURVEY
3	LOADING DIAGRAM
4	BORING - PLAN & PROFILE
5	BORING LOGS
6	AESTHETIC DETAILS

20XX PROJECTED TRAFFIC VOLUMES

ROADWAY OVER		ROADWAY UNDER
XXXX	AADT	N/A
XXXX	DHV	N/A
XXXXX	ADTT	N/A

PROPOSED TYPE OF STRUCTURE

SUPERSTRUCTURE:
1 SPAN - CAST-IN-PLACE CONCRETE
SLAB - CONTINUOUS WITH ABUTMENTS
SUBSTRUCTURE:
INTEGRAL ABUTMENTS SUPPORTED ON
SPREAD FOOTINGS
DEPTH OF STRUCTURE:
2'-0" GUTTTER TO LOW BRIDGE

BRIDGE NO. XXXXX

SOUTHWEST LRT OVER BREN RD W TRAIL
0.02 MI. W OF JCT. T.H. 62/T.H. 169 IN MINNETONKA

20'-0" CAST-IN-PLACE CONCRETE SLAB SPAN
47'-4½" RAILWAY WIDTH
10°-23'-31.6" SKEW

BRIDGE I.D. NO. XXXXX

GENERAL PLAN AND ELEVATION

SEC 36 T117N R22W
CITY OF MINNETONKA HENNEPIN COUNTY

APPROVED: STATE BRIDGE ENGINEER DATE

MNDOT REVIEW:

DES: RMS DR: ARH
CHK: MJC CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□MITTA□

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METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

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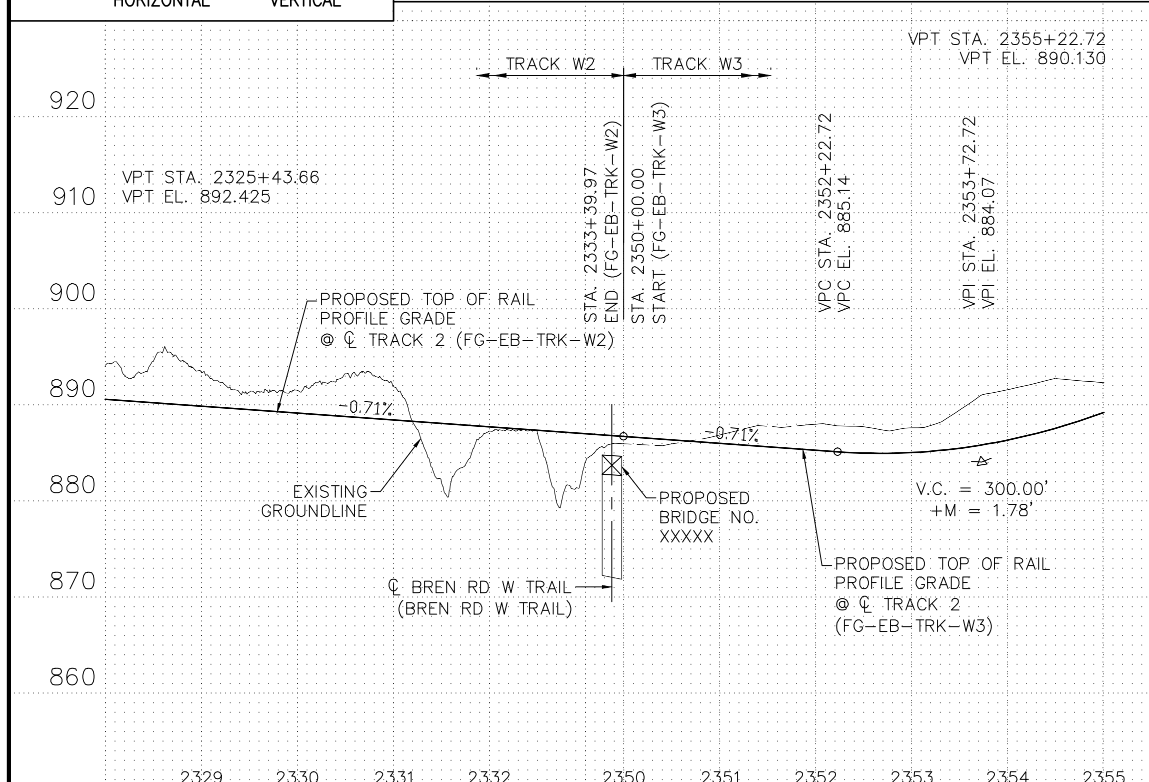
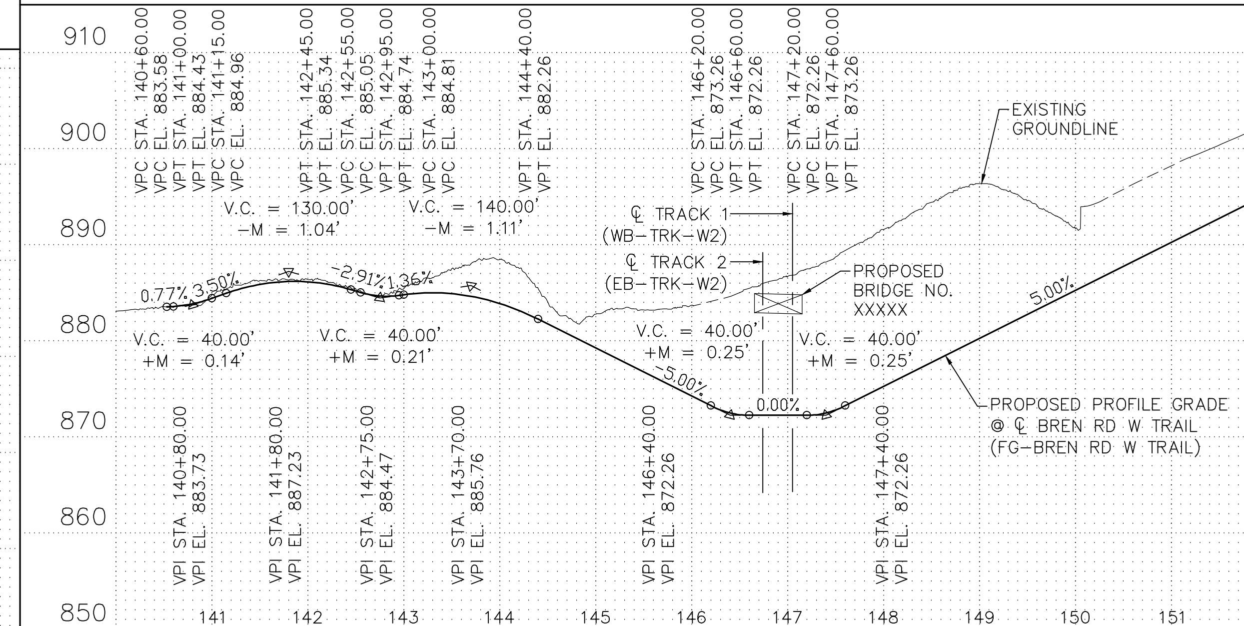
CONTRACTED PROFI□E

SCALE : 0 50' 100' HORIZONTAL 0 5' 10' VERTICAL

PROFILE GRADE @ ℄ TRACK 2 (FG-EB-TRK-W2) & (FG-EB-TRK-W3)



PROFILE GRADE @ ℄ BREN RD W TRAIL (FG-BREN RD W TRAIL)



□OCATION EN□INEER□S O□SER□ATIONS AT □RID□E SITE

1. SPECIAL FEATURES: WATERFALLS, DAMS, FLOODS, ICE, DEBRIS, SLIDING BANKS, RECREATIONAL BOATING.
2. OTHER BRIDGES OR CULVERTS OVER THE SAME STREAM (PARTICULARLY STRUCTURES WHICH CARRY HIGH WATER WITHOUT OVERFLOW OF ROADWAY) : GIVEN LOCATION,TYPE, LENGTH, HEIGHT ABOVE HIGH WATER, CROSS-SECTIONAL AREA ETC.
3. APPARENT HIGHWATER ELEVATION OBTAINED FROM:
4. OTHER DATA: APPROX. VELOCITY OF WATER AT TIME OF SURVEY.

□□DRA□□IC EN□INEERS RECOMMENDATION

DATE –

STREAM OR DITCH DESIGNATION –
DRAINAGE AREA –
MAX. FLOOD ON RECORD –
MAXIMUM OBSERVED HIGHWATER ELEVATION –
DESIGN FLOOD (-YR. FREQ.) – C.F.S.
DESIGN STAGE ELEVATION –
DESIGN MEAN VELOCITY THROUGH STRUCTURE – F.P.S.
TOTAL STAGE INCREASE – F.P.S.
LOW MEMBER AT OR ABOVE ELEVATION –
FLOWLINE ELEVATION – SKEW ANGLE –
WATERWAY AREA REQUIRED BELOW ELEVATION – = – SQ.FT. AT RIGHT ANGLES TO CHANNEL
BASIC FLOOD (100 YR. FREQ.) – C.F.S.
STAGE ELEVATION – FT.
TOTAL STAGE INCREASE – FT.
MEAN VELOCITY THROUGH STRUCTURE – F.P.S.
ESTIMATED DEPTH OF PIER SCOUR = – FT.
SCOUR CODE =-

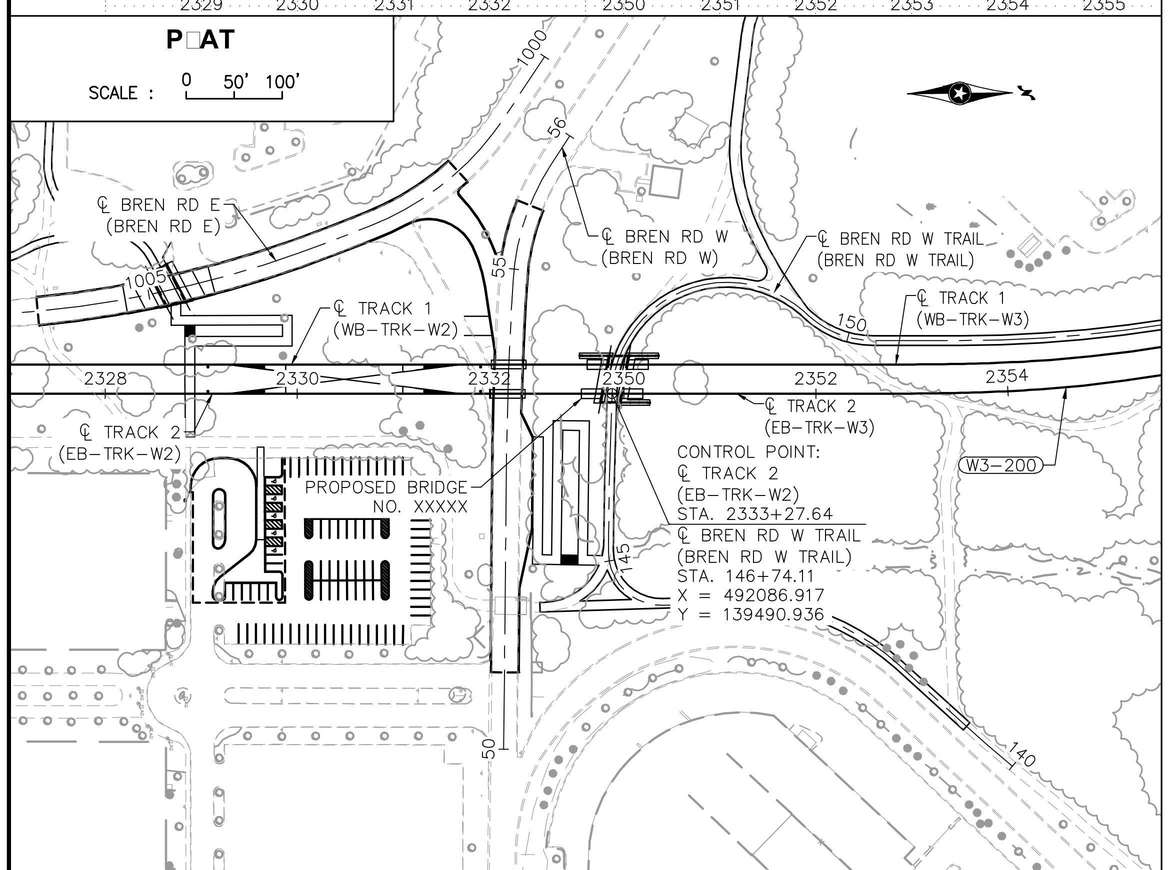
BRIDGE SURVEY SHEETS MADE FROM SURVEY PERFORMED BY RANI ENGINEERING

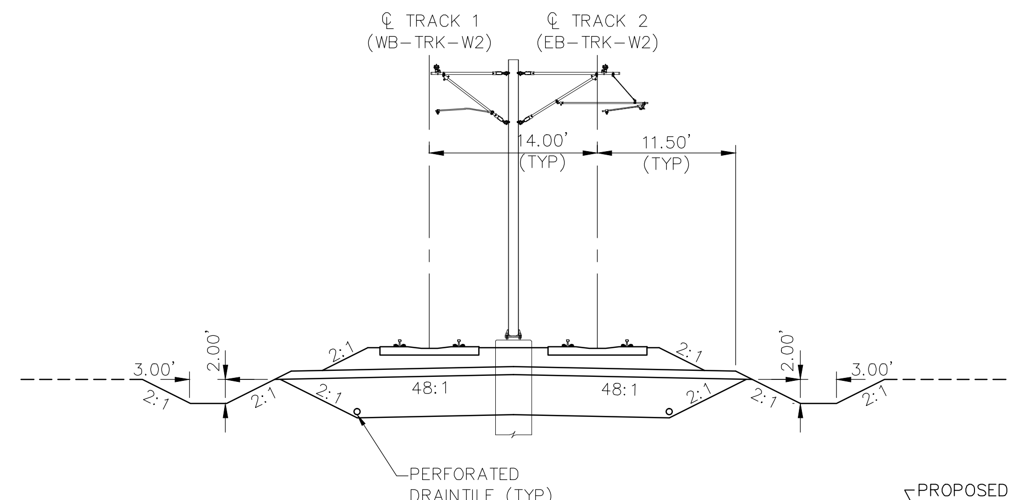
MNDOT NAME: 2773A
NORTHING (HEN. COUNTY COORDINATES): 137082.117
EASTING (HEN. COUNTY COORDINATES): 490527.817
BENCHMARK ELEVATION (NAVD88): 963.180
MONUMENT DESCRIPTION: BRASS MONUMENT IN BRIDGE ABUTMENT
LOCATION: IN EDEN PRAIRIE, 1.1 MILES EAST ALONG T.H. HWY 62 FROM JCT. OF T.H. 62 & I-494

MONUMENT NAME: CONTROL POINT 6
NORTHING (HEN. COUNTY COORDINATES): 142016.680
EASTING (HEN. COUNTY COORDINATES): 489989.960
BENCHMARK ELEVATION (NAVD88): 932.956
MONUMENT DESCRIPTION: CAST IRON MONUMENT
LOCATION: 0.2 MILES EAST ALONG SMETANA ROAD FROM JCT. OF SMETANA ROAD & NOLAN DR

P□AT

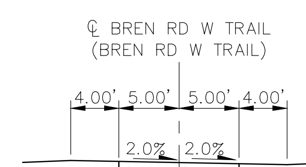
SCALE : 0 50' 100'





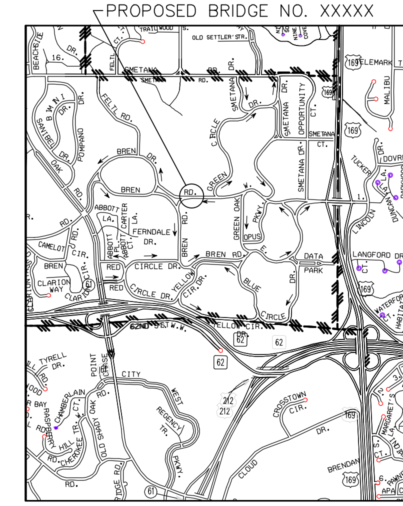
NORTH APPROACH SECTION

CURVE NO. W3-200
R = 1,400.00'
Lc = 992.18'
Ls = 200.00'
Ea = 2.75"
Eu = 2.98"
V = 45 MPH

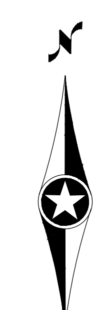


TYPICAL TRAIL SECTION

PROPOSED BRIDGE NO. XXXXX



INDEX-MAP



CIT□ OF MINNETONKA

□RID□E S□R□E□

AT MILE POINT – ON –
– (T.H., C.S.A.H.,C.R. etc.)
PROPOSED BRIDGE LOCATED 0.02 MILES WEST OF JCT. T.H. 62 & T.H. 169

SEC 36 TWP T117N R R22W
CITY OF MINNETONKA COUNTY HENNEPIN

DES: RMS DR: ARH
CHK: MJC CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

AECOM

SRF Consulting Group, Inc.

PER□IMINAR□ EN□INEERIN□

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

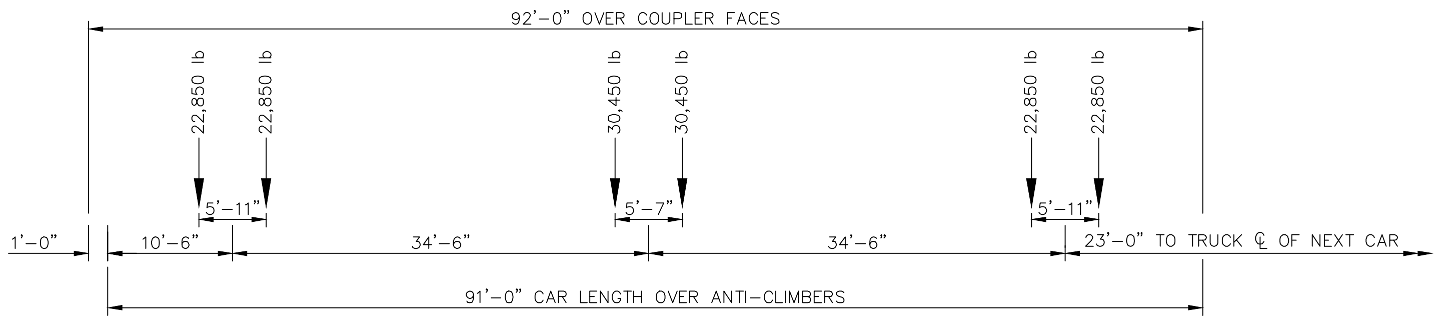
WEST SE□MENT □□ □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □RT□
□RID□E S□R□E□

DISCIP□INE□ STR□CT□RES

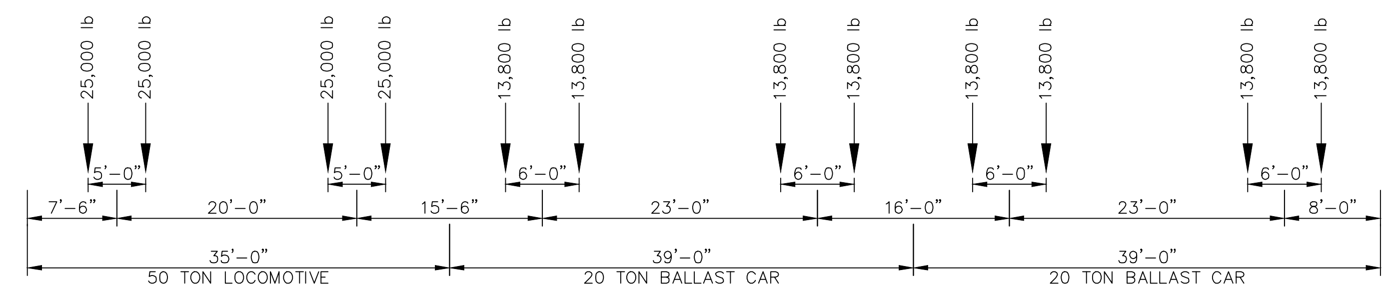
S□EET NAME□ W□-ST□-T□DP□□-S□R

S□EET □□□ OF □□□

Jun, 13 2014 12:26 am H:\Projects\7984\3200_PEC-W\CAD\SEGMENT-W2\SHEET\STRUCTURES\W2-STU-TUDP04-SUR.dwg By: ahouser



LIGHT RAIL VEHICLE LOADING DIAGRAM



MAINTENANCE TRAIN LOADING DIAGRAM

NOTES:

1. THE LRT TRAIN SHALL CONSIST OF EITHER ONE, TWO OR THREE CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. LOADING DIAGRAM REPRESENTS MAXIMUM LOAD AT EACH TRUCK IN ACCORDANCE WITH SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 2.0) FIGURE 8-2.

NOTES:

1. THE MAINTENANCE TRAIN SHALL CONSIST OF ONE LOCOMOTIVE AND ONE, TWO, THREE, OR FOUR BALLAST CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. WEIGHT OF EMPTY BALLAST CAR IS 15,000 POUNDS.

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□MITTA□

DES: RMS | DR: ARH
CHK: MJC | CHK: MJC

PER□IMINAR□ EN□INEERIN□

WEST SE□MENT □□ □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □□RT□
□OADIN□ DIA□RAM

DISCIP□INE□ STR□CT□RES

S□EET NAME□ W□-ST□-T□DP□□-□OAD

S□EET □□□ OF □□□

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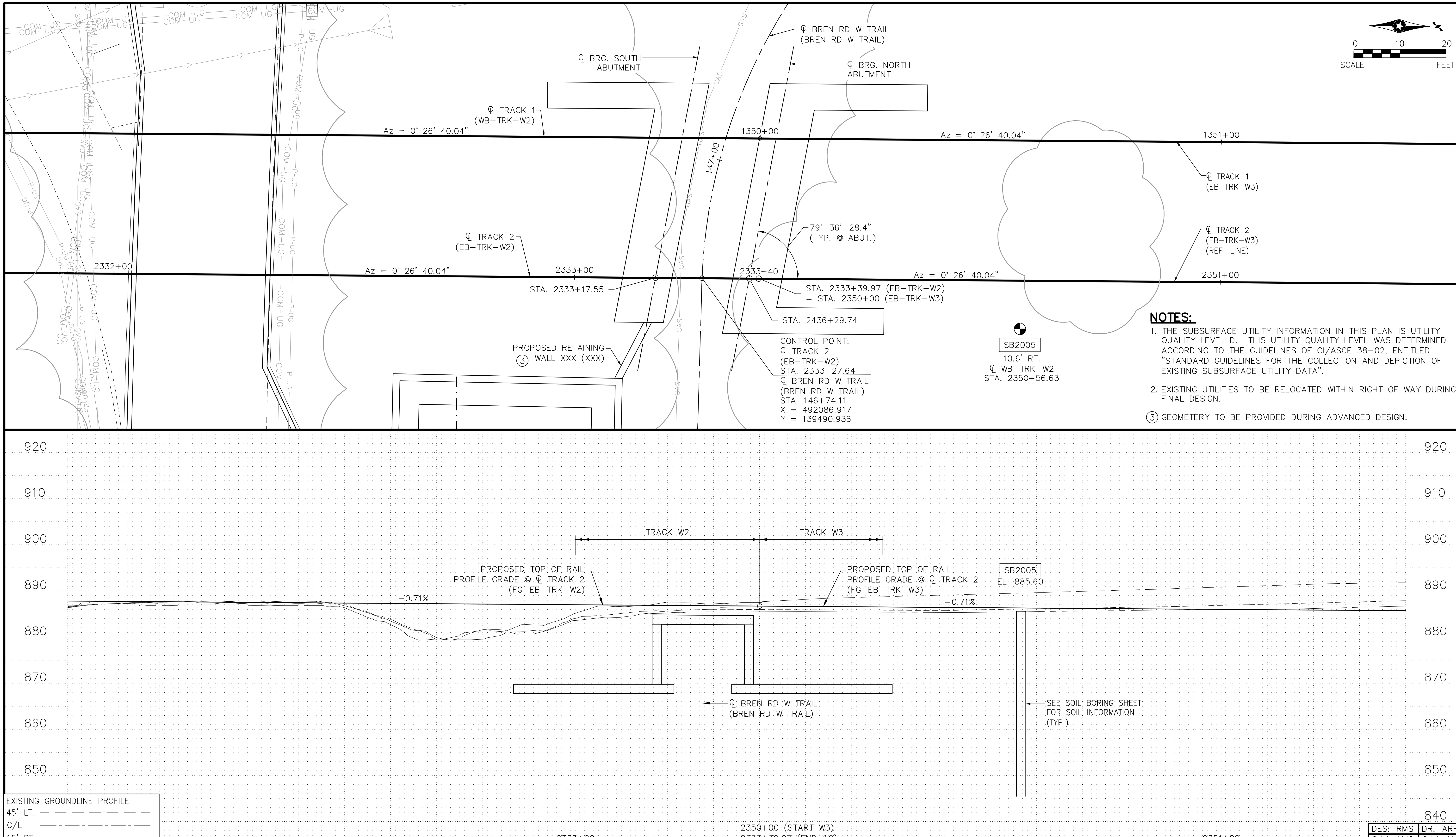

NOTES:

1. THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO THE GUIDELINES OF CI/ASCE 38–02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".
2. EXISTING UTILITIES TO BE RELOCATED WITHIN RIGHT OF WAY DURING FINAL DESIGN.

(3) GEOMETERY TO BE PROVIDED DURING ADVANCED DESIGN.

DES: RMS | DR: ARH | CHK: MJC | CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□□MITTA□

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SRF Consulting Group, Inc.

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

PER□IMINAR□ EN□INEERIN□

WEST SE□MENT □□ □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □RT□
P□AN AND PROFI□E

DISCIP□INE□ STR□CT□RES

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2004SS

Elevation 887.4

Coh (psf)	SPT-N (BPF)	Description
		FILL: Sandy Lean Clay, trace roots, black, frozen.
	8	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, trace Gravel, brown, moist.
	9	
	6	FILL: Lean Clay, trace Gravel, dark brown to black, wet.
	5	PEAT, fibrous, black, wet. Shells at 10 feet.
	8	SILT, with Silty Sand lenses, trace roots, gray, moist, loose.
	12	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, with Lean Clay lenses, gray, moist to 15 feet then waterbearing, loose to medium dense.
	10	
	11	SILTY SAND, fine- to medium-grained, trace Gravel, with Poorly Graded Sand and Lean Clay lenses, gray, waterbearing, medium dense.

END OF BORING.

Water observed at 15 feet with 15 feet of hollow-stem auger in the ground.

Water observed at 15 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.
Bottom of Borehole at 26 ft

Elevation scale: 895, 890, 885, 880, 875, 870, 865, 860, 855, 850, 845, 840, 835

2005ST

Elevation 885.6

Coh (psf)	SPT-N (BPF)	Description
		LEAN CLAY, black, frozen.
	11	LEAN CLAY, with Sand, trace Gravel, brown, wet, rather stiff.
	16	FAT CLAY, with Silty Sand and Silt seams, brown to 12 feet then gray, wet, medium to stiff.
	8	
	8	
	13	
	12	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to hard.
	10	
	12	
	14	
	23	With occasional Sand lenses from 35-60 feet.
	22	
	24	
	20	
	36	
	24	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense.
	35	CLAYEY SAND, trace Gravel, brown and gray, wet, hard.
	46	
	30	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense.

END OF BORING.

Water not encountered during drilling due to mud rotary drilling.

Boring immediately backfilled with bentonite grout.
Bottom of Borehole at 76 ft

Elevation scale: 890, 885, 880, 875, 870, 865, 860, 855, 850, 845, 840, 835, 830, 825, 820, 815, 810, 805

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488. THE SOIL GROUP CATEGORY PER THE AASHTO SOIL CLASSIFICATION SYSTEM IS ALSO SHOWN.

DES: RMS | DR: ARH
CHK: MJC | CHK: MJC

NO.	DATE		CHECK	DESIGN	REVISION SUBMITTAL

AECOM

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

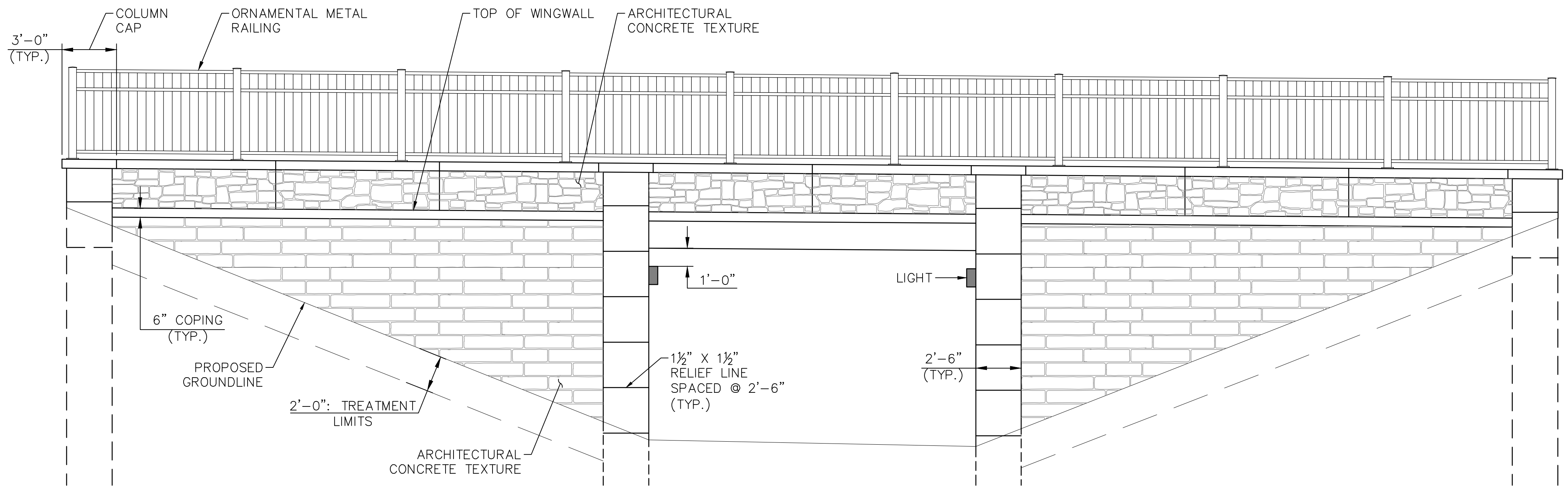
SOUTHWEST Green Line LRT Extension

WEST SEGMENT
PEDESTRIAN TUNNEL
BRIDGE REPORT
SOIL BORINGS

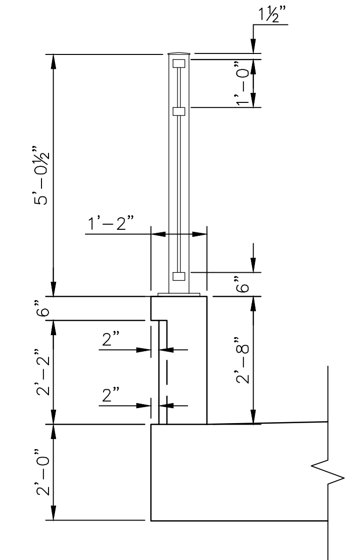
DISCIPLINE: STRUCTURES

SHEET NAME: W2-STU-TUDP04-BOR

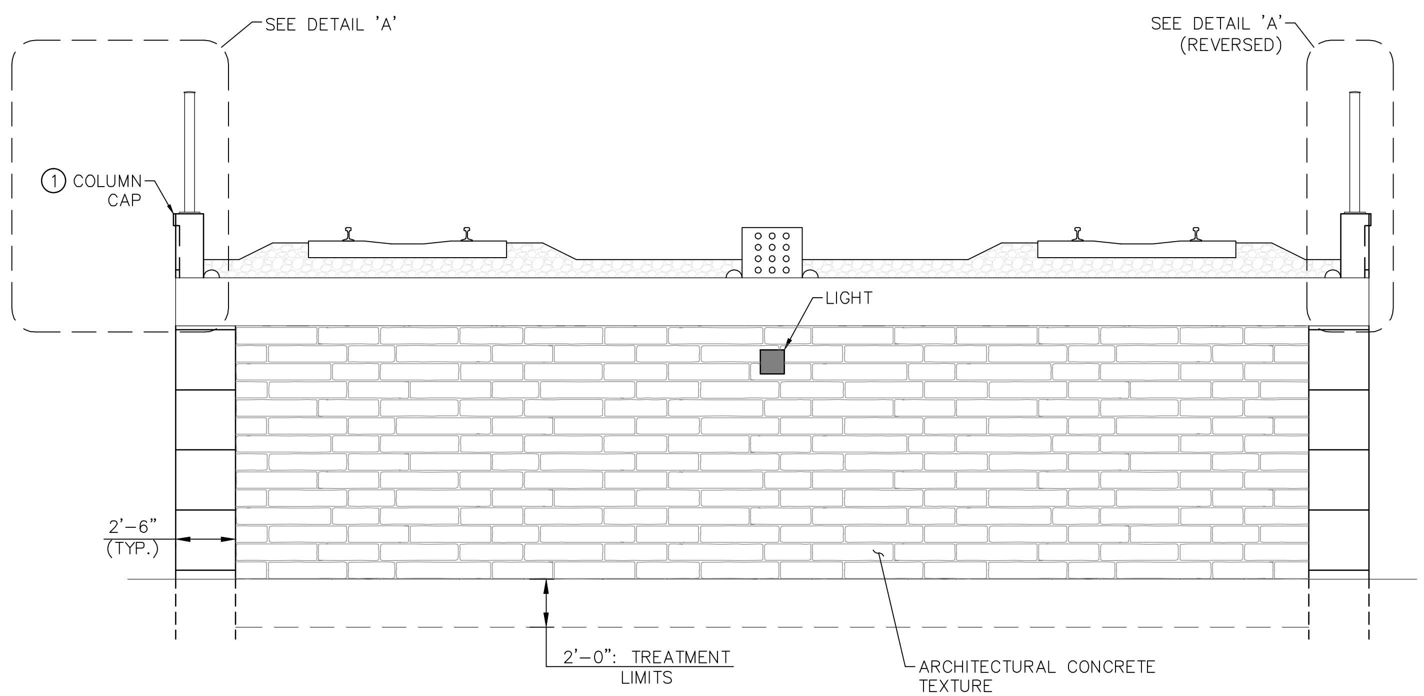
SHEET OF



ARCHITECTURAL ELEVATION



DETAIL 'A'



TYPICAL ABUTMENT ELEVATION
(LOOKING SOUTH, NORTH REVERSED)

NOTES:

1. ARCHITECTURAL COLUMN CAP TO EXTEND 1" BEYOND CONCRETE BARRIER COPING.

DES: RMS	DR: ARH
CHK: MJC	CHK: MJC

NO.	DATE		CHECK	DESIGN	REVISION / SUBMITTAL

AECOM

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

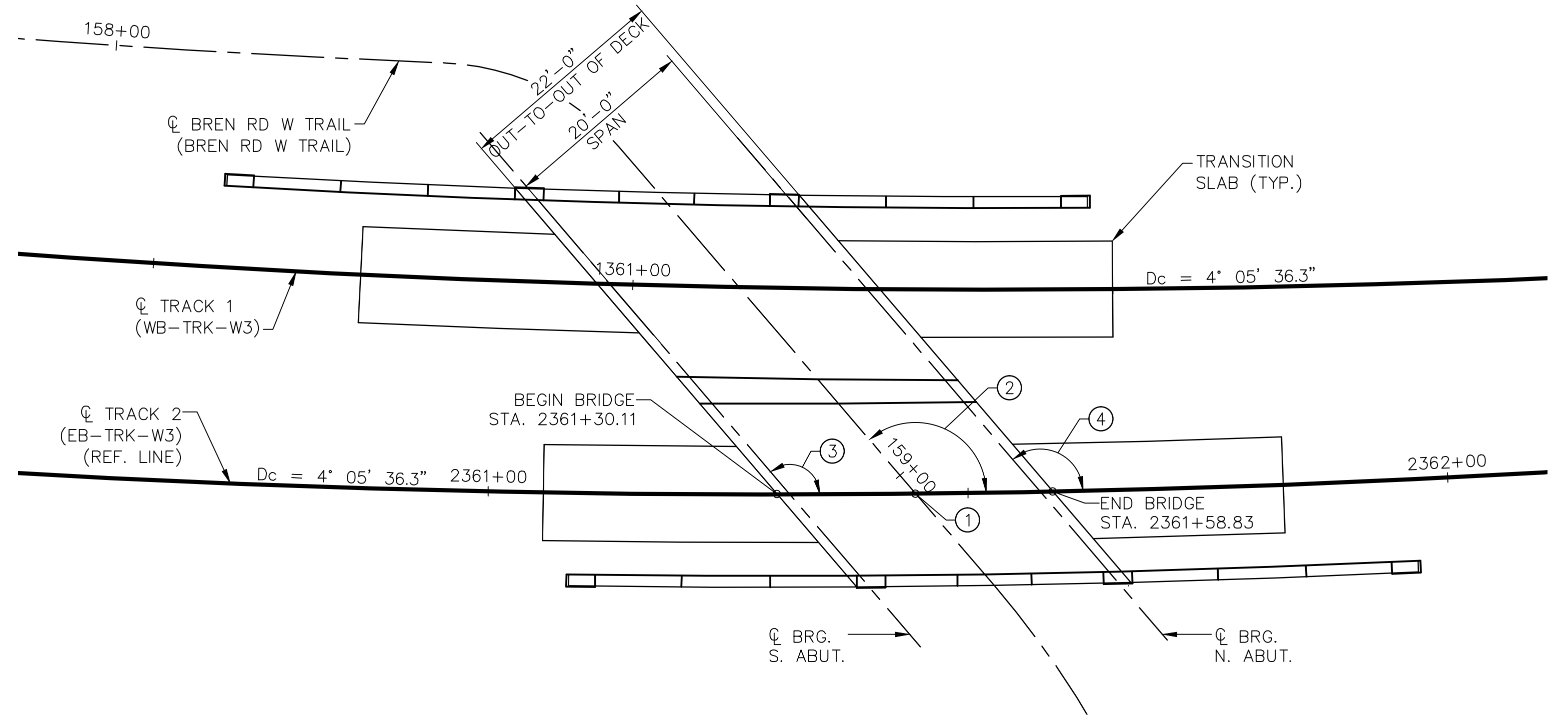
SOUTHWEST Green Line LRT Extension

WEST SEGMENT
PEDESTRIAN TUNNEL
BRIDGE
AESTHETIC DETAILS

DISCIPLINE: STRUCTURES

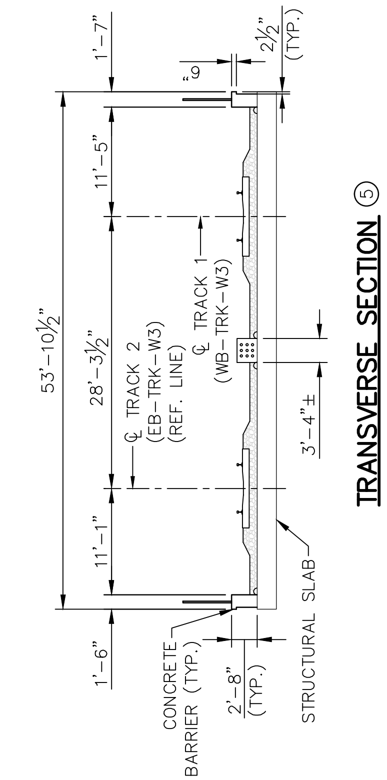
SHEET NAME: W2-STU-TUDP04-ARCH

SHEET OF



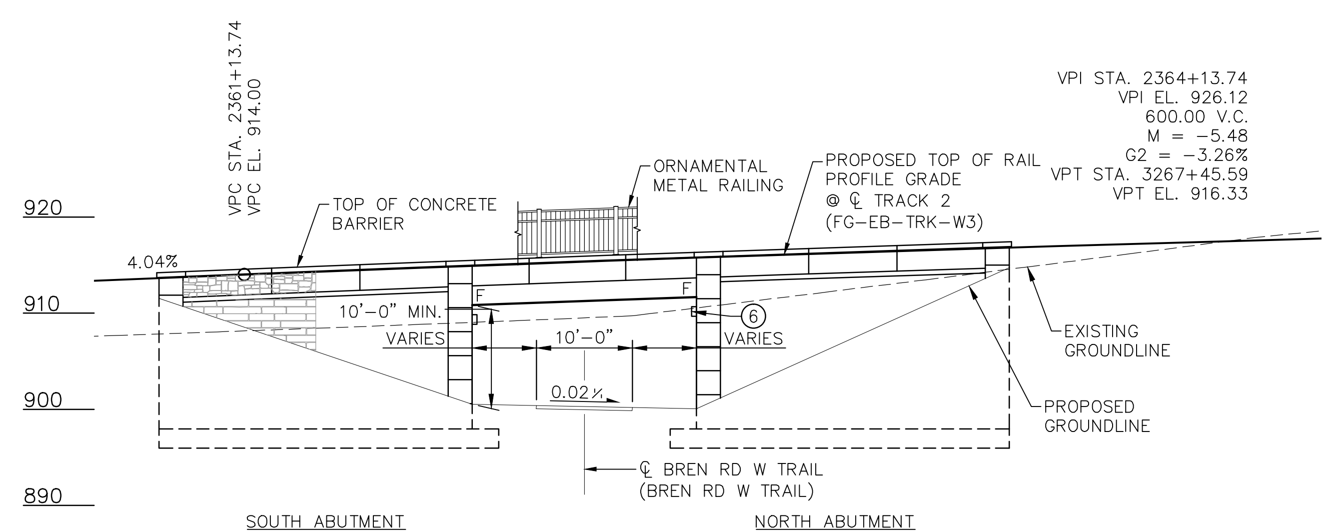
GENERAL PLAN ⑥

SCALE 0 5 10 20 IN FEET



TRANSVERSE SECTION ⑤

SCALE 0 5 10 20 IN FEET



GENERAL ELEVATION ⑦

SCALE 0 5 10 20 IN FEET

NOTES:

1. CONTROL POINT:
   ℄ TRACK 2 (EB-TRK-W3)
   STA. 2361+44.51
   ℄ BREN RD W TRAIL (BREN RD W TRAIL)
   STA. 159+02.48
   X = 491866.957
   Y = 140605.180
2. 129°-89'-10.3" (T.T.C.)
3. 130°-30'-20.3" (T.T.C.)
4. 129°-26'-15.3" (T.T.C.)
5. MEASURED ALONG SECTION PARALLEL TO ABUTMENTS
6. UNDER BRIDGE LIGHTING, SEE AESTHETIC DETAILS.
7. UTILITIES ARE NOT SHOWN FOR CLARITY. SEE BORING PLAN & PROFILE.

DESIGN DATA

2012 AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS
6TH EDITION AND CURRENT INTERIMS

SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA
(REVISION 3.0)

LRV & MV LOAD DIAGRAM SHOWN ON SHEET 2

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

MATERIAL DESIGN PROPERTIES:
REINFORCED CONCRETE:
f'c = 4 ksi n = 8
fy = 60 ksi REINFORCEMENT

DESIGN SPEED: OVER = 30 MPH (LRT)
UNDER = 30 MPH

APPROXIMATE DECK AREA: 1186 SQ. FT.

LIST OF SHEETS

NO.	DESCRIPTION
1	GENERAL PLAN & ELEVATION
2	BRIDGE SURVEY
3	LOADING DIAGRAM
4	BORING - PLAN & PROFILE
5	BORING LOGS
6	AESTHETIC DETAILS

20XX PROJECTED TRAFFIC VOLUMES

ROADWAY OVER		ROADWAY UNDER
XXXX	AADT	N/A
XXXX	DHV	N/A
XXXXX	ADTT	N/A

PROPOSED TYPE OF STRUCTURE

SUPERSTRUCTURE:
1 SPAN - CAST-IN-PLACE CONCRETE
SLAB - CONTINUOUS WITH ABUTMENTS

SUBSTRUCTURE:
INTEGRAL ABUTMENTS SUPPORTED ON
SPREAD FOOTINGS

DEPTH OF STRUCTURE:
2'-0" GUTTER TO LOW BRIDGE

BRIDGE NO. XXXXX

SOUTHWEST LRT OVER BREN RD W TRAIL
0.02 MI. W OF JCT. T.H. 62/T.H. 169 IN MINNETONKA

20'-0" CAST-IN-PLACE CONCRETE SLAB SPAN
38'-6" RAILWAY WIDTH
SKEW VARIES

BRIDGE I.D. NO. XXXXX

GENERAL PLAN AND ELEVATION

SEC 36 T117N R22W
CITY OF MINNETONKA HENNEPIN COUNTY

APPROVED: STATE BRIDGE ENGINEER DATE

MNDOT REVIEW:

DES: RMS DR: ARH
CHK: DRF CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION / S□□MITTA□

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PER□IMINAR□ EN□INEERIN□

METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

WEST SE□MENT □
PEDESTRIAN T□NNE□ □
□RID□E □□□□□ □□RT□
P□AN AND E□E□ATION

DISCIP□INE□ STR□CT□RES
S□EET NAME□ W□-ST□-T□DP□□-□PE

S□EET □□□ OF □□□

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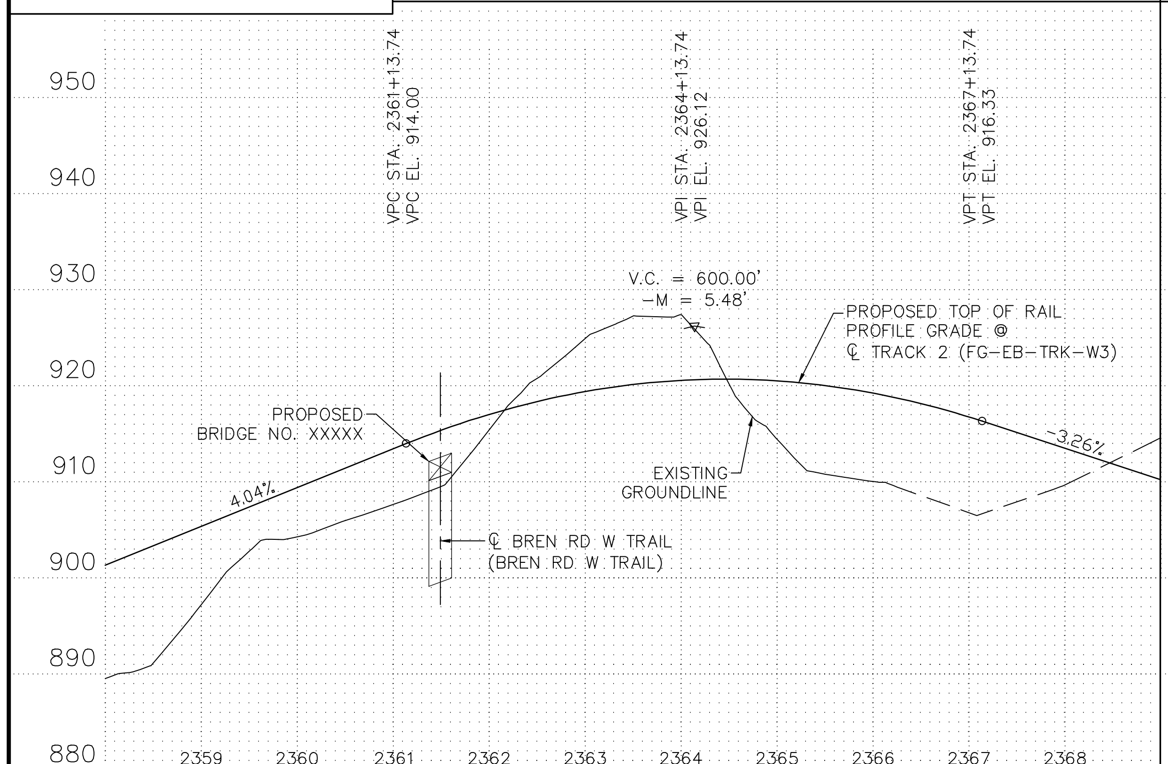
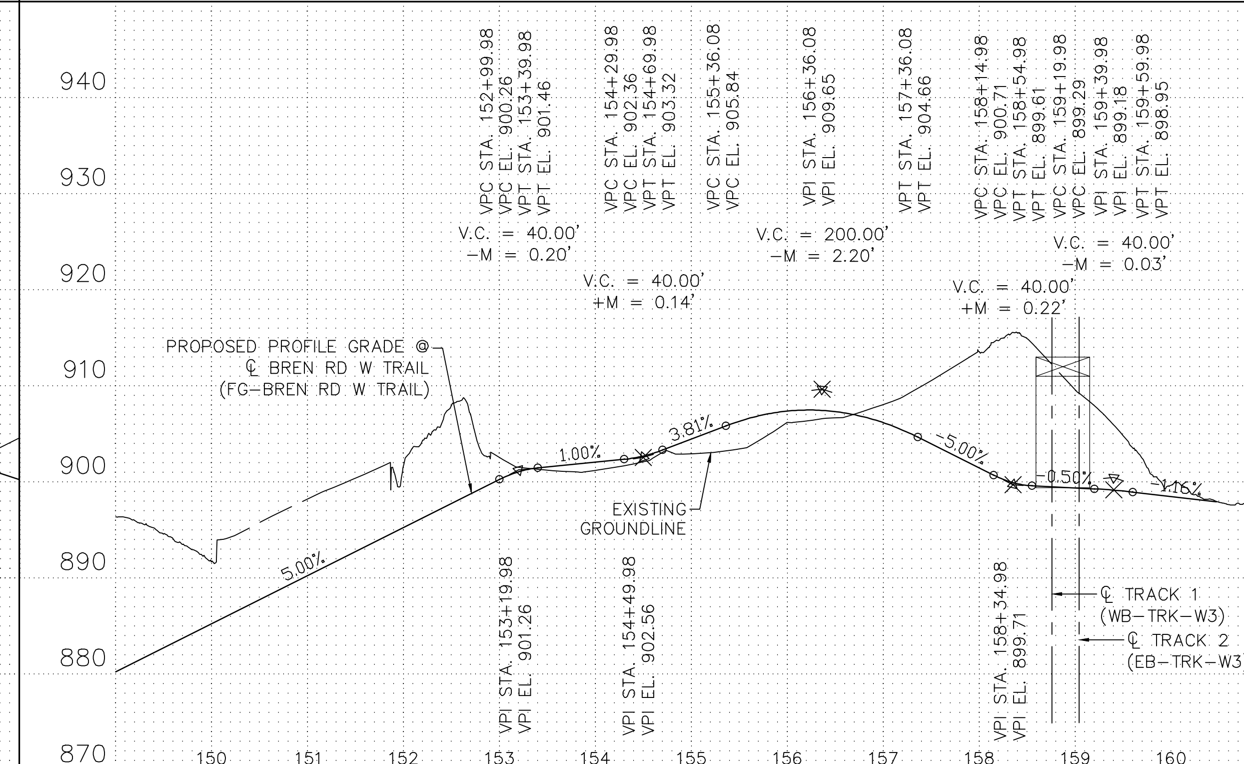
CONTRACTED PROFI□E

SCALE : 0 50' 100' HORIZONTAL 0 5' 10' VERTICAL

PROFILE GRADE @ ℄ TRACK 2 (FG-EB-TRK-W3)



PROFILE GRADE @ ℄ BREN RD W TRAIL (FG-BREN RD W TRAIL)



□OCATION EN□INEER□S O□SER□ATIONS AT □RID□E SITE

1. SPECIAL FEATURES: WATERFALLS, DAMS, FLOODS, ICE, DEBRIS, SLIDING BANKS, RECREATIONAL BOATING.
2. OTHER BRIDGES OR CULVERTS OVER THE SAME STREAM (PARTICULARLY STRUCTURES WHICH CARRY HIGH WATER WITHOUT OVERFLOW OF ROADWAY) : GIVEN LOCATION,TYPE, LENGTH, HEIGHT ABOVE HIGH WATER, CROSS-SECTIONAL AREA ETC.
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4. OTHER DATA: APPROX. VELOCITY OF WATER AT TIME OF SURVEY.

□□DRA□□IC EN□INEERS RECOMMENDATION

DATE -

STREAM OR DITCH DESIGNATION -
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TOTAL STAGE INCREASE - F.P.S.
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WATERWAY AREA REQUIRED BELOW ELEVATION - = - SQ.FT. AT RIGHT ANGLES TO CHANNEL
BASIC FLOOD (100 YR. FREQ.) - C.F.S.
STAGE ELEVATION - FT.
TOTAL STAGE INCREASE - FT.
MEAN VELOCITY THROUGH STRUCTURE - F.P.S.
ESTIMATED DEPTH OF PIER SCOUR = - FT.
SCOUR CODE =-

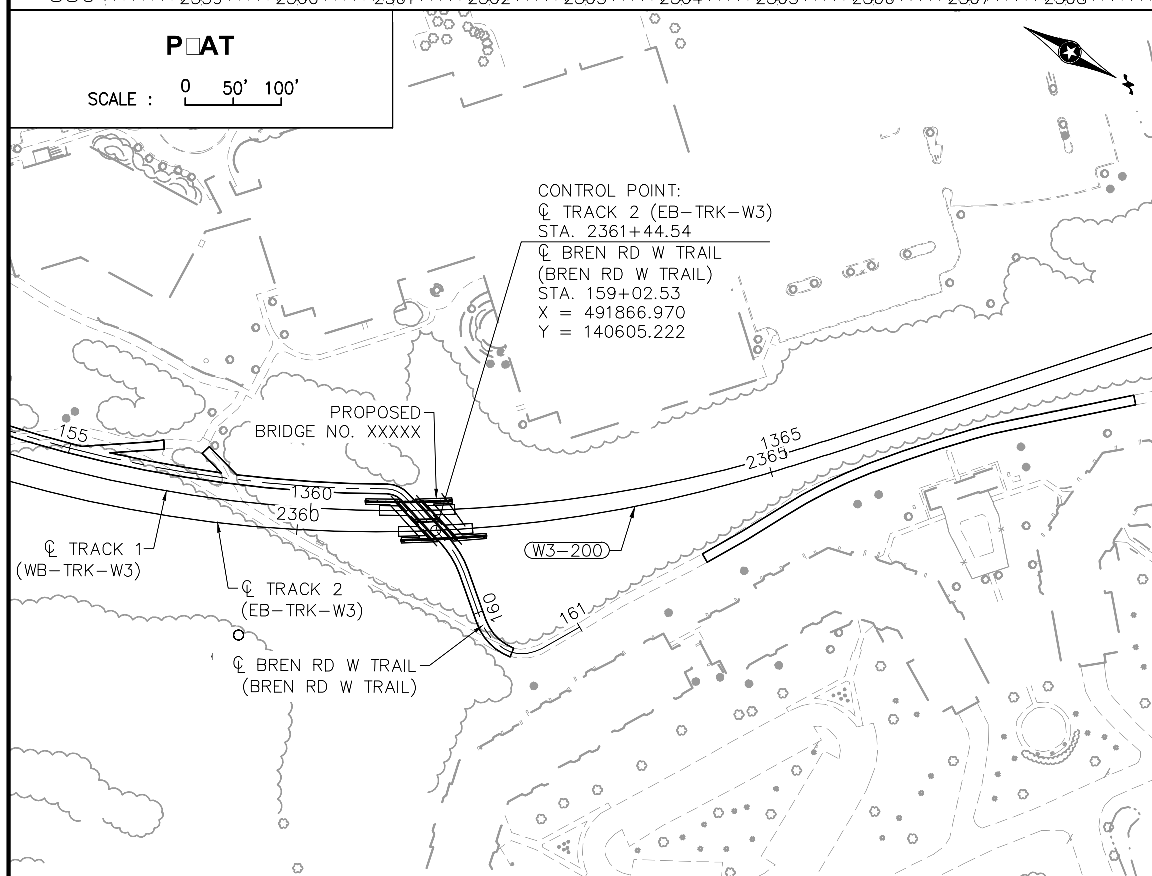
BRIDGE SURVEY SHEETS MADE FROM SURVEY PERFORMED BY RANI ENGINEERING

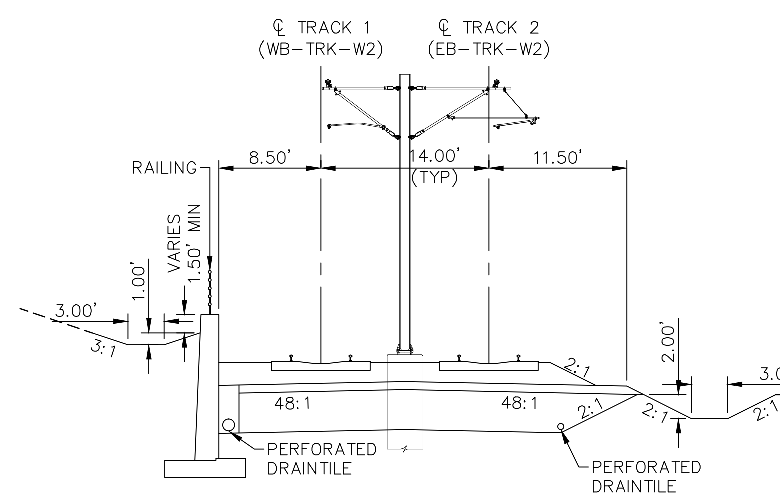
MNDOT NAME: 2773A
NORTHING (HEN. COUNTY COORDINATES): 137082.117
EASTING (HEN. COUNTY COORDINATES): 490527.817
BENCHMARK ELEVATION (NAVD88): 963.180
MONUMENT DESCRIPTION: B.M. DISK IN BRIDGE ABUTMENT
LOCATION: IN EDEN PRAIRIE, 1.1 MILES EAST ALONG T.H. HWY 62 FROM JCT. OF T.H. 62 & I-494

MONUMENT NAME: CONTROL POINT 6
NORTHING (HEN. COUNTY COORDINATES): 142016.680
EASTING (HEN. COUNTY COORDINATES): 489989.960
BENCHMARK ELEVATION (NAVD88): 932.956
MONUMENT DESCRIPTION: CAST IRON MONUMENT
LOCATION: 0.2 MILES EAST ALONG SMETANA ROAD FROM JCT. OF SMETANA ROAD & NOLAN DR

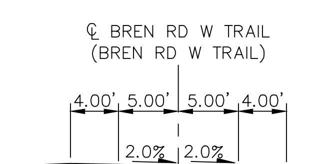
P□AT

SCALE : 0 50' 100'



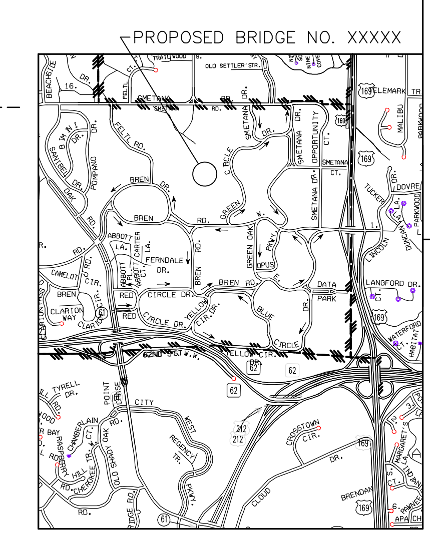


NORTH APPROACH SECTION

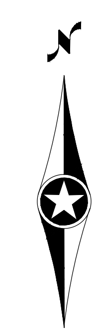


TYPICAL TRAIL SECTION

CURVE NO. W3-200
R = 1,400.00'
Lc = 992.18'
Ls = 200.00'
Ea = 2.75"
Eu = 2.98"
V = 45 MPH



R22W INDEX-MAP



CIT□ OF MINNETONKA

□RID□E S□R□E□

AT MILE POINT - ON -
- (T.H., C.S.A.H.,C.R. etc.)
PROPOSED BRIDGE LOCATED 0.02 MILES WEST OF JCT. T.H. 62 & T.H. 169

SEC 36 TWP T117N R R22W
CITY OF MINNETONKA COUNTY HENNEPIN

DES: RMS	DR: ARH
CHK: DRF	CHK: MJC

NO□	DATE	□□	C□ECK	DESI□N	RE□ISION □S□MITTA□

AECOM

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METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST SE□MENT □ PEDESTRIAN T□NNE□ □ □RID□E □□□□□ □RT□ □RID□E S□R□E□

DISCIP□INE□ STR□CT□RES

S□EET NAME□ W□-ST□-T□DP□□-S□R

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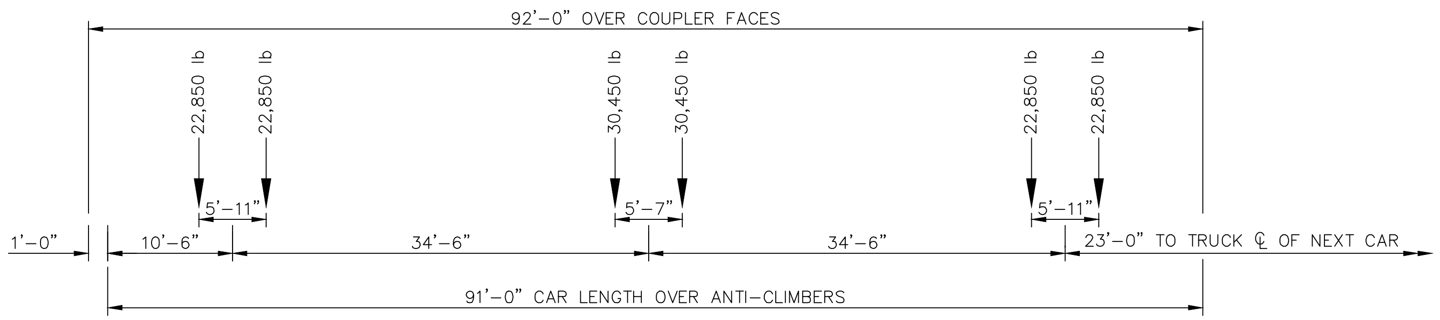
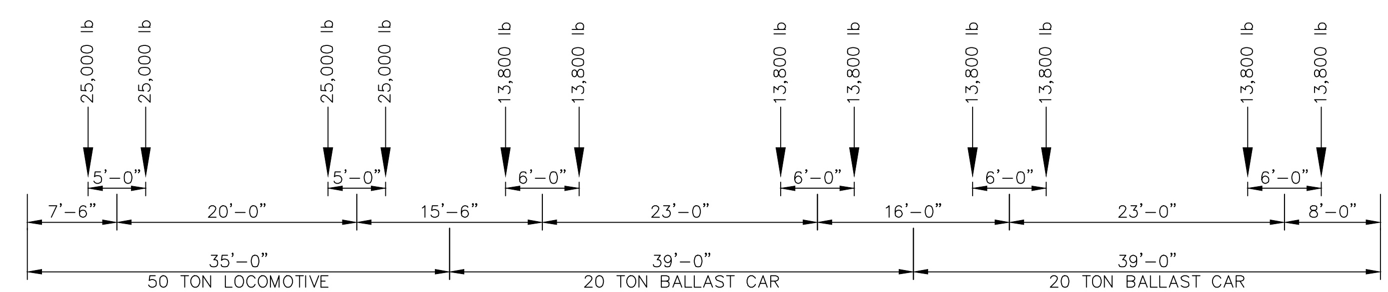
Jun. 13 2014 12:28 am H:\Projects\7984\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-TUDP05-SUR.dwg By: ahouser



LIGHT RAIL VEHICLE LOADING DIAGRAM



MAINTENANCE TRAIN LOADING DIAGRAM

NOTES:

1. THE LRT TRAIN SHALL CONSIST OF EITHER ONE, TWO OR THREE CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. LOADING DIAGRAM REPRESENTS MAXIMUM LOAD AT EACH TRUCK IN ACCORDANCE WITH SOUTHWEST LIGHT RAIL TRANSIT DESIGN CRITERIA (REVISION 2.0) FIGURE 8-2.

NOTES:

1. THE MAINTENANCE TRAIN SHALL CONSIST OF ONE LOCOMOTIVE AND ONE, TWO, THREE, OR FOUR BALLAST CARS, WHICHEVER PRODUCES THE MAXIMUM LOAD FOR THE ELEMENT UNDER CONSIDERATION.
2. AXLE LOAD IN POUNDS.
3. WEIGHT OF EMPTY BALLAST CAR IS 15,000 POUNDS.

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DES: RMS | DR: ARH
CHK: DRF | CHK: MJC

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SOUTHWEST Green Line LRT Extension

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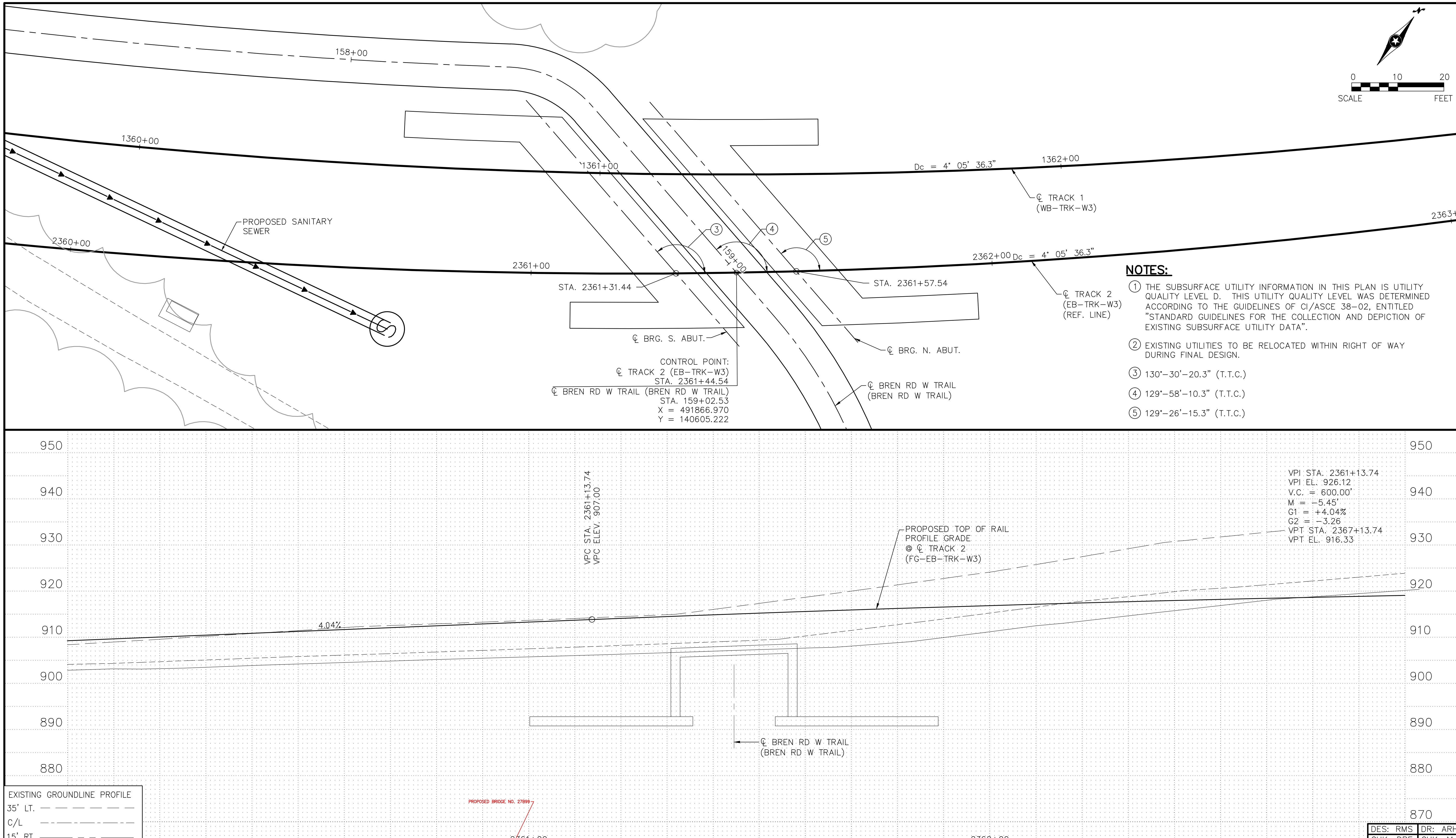

NOTES:

1. THE SUBSURFACE UTILITY INFORMATION IN THIS PLAN IS UTILITY QUALITY LEVEL D. THIS UTILITY QUALITY LEVEL WAS DETERMINED ACCORDING TO THE GUIDELINES OF CI/ASCE 38-02, ENTITLED "STANDARD GUIDELINES FOR THE COLLECTION AND DEPICTION OF EXISTING SUBSURFACE UTILITY DATA".
2. EXISTING UTILITIES TO BE RELOCATED WITHIN RIGHT OF WAY DURING FINAL DESIGN.
3. 130°-30'-20.3" (T.T.C.)
4. 129°-58'-10.3" (T.T.C.)
5. 129°-26'-15.3" (T.T.C.)

DES: RMS | DR: ARH
CHK: DRF | CHK: MJC

NO.	DATE		CHECK	DESIGN	REVISION SUBMITTAL

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PRELIMINARY ENGINEERING

METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

WEST SEGMENT PEDESTRAIN TUNNEL BRIDGE PORTAL PLAN AND PROFILE

DISCIPLINE: STRUCTURES

SHEET NAME: W-STU-TUDP05-BOR

SHEET OF

Jun. 13 2014 12:29 am H:\Projects\7984\3200_PEC-W\CAD\SEGMENT-W3\SHEET\STRUCTURES\W3-STU-TUDP05-BOR.dwg By: dhouser

915
910
905
900
895
890
885
880
875
870
865
860
855
850
845
840
835

NOTES:

THE MATERIAL DESCRIPTIONS ARE CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM. DETAILS ON THE SYSTEM CAN BE FOUND IN THE FADR AND IN ASTM:D2488.

NO	DATE		CHECK	DESIGN	REVISION SUBMITTAL

DES: RMS DR: ARH
CHK: DRF CHK: MJC

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METROPOLITAN COUNCIL
SOUTHWEST Green Line LRT Extension

PRELIMINARY ENGINEERING

WEST SEGMENT 3
PEDESTRAIN TUNNEL / BRIDGE
SOIL BORINGS

DISCIPLINE: STRUCTURES
SHEET NAME: W3-STU-TUDP05-BOR

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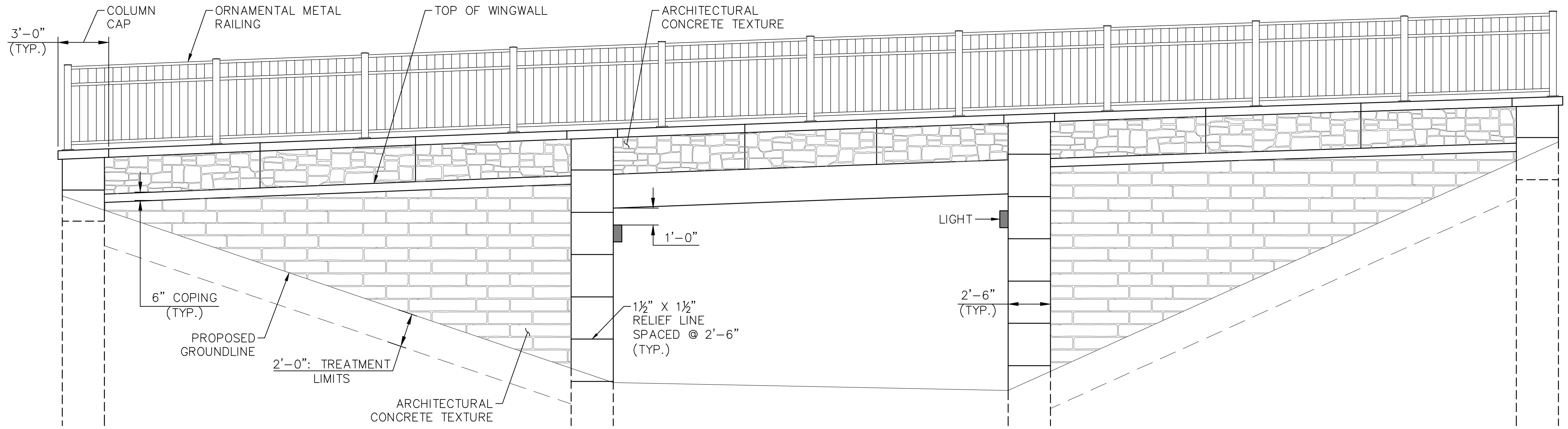
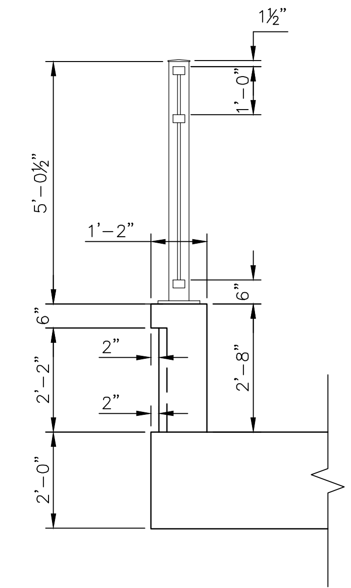
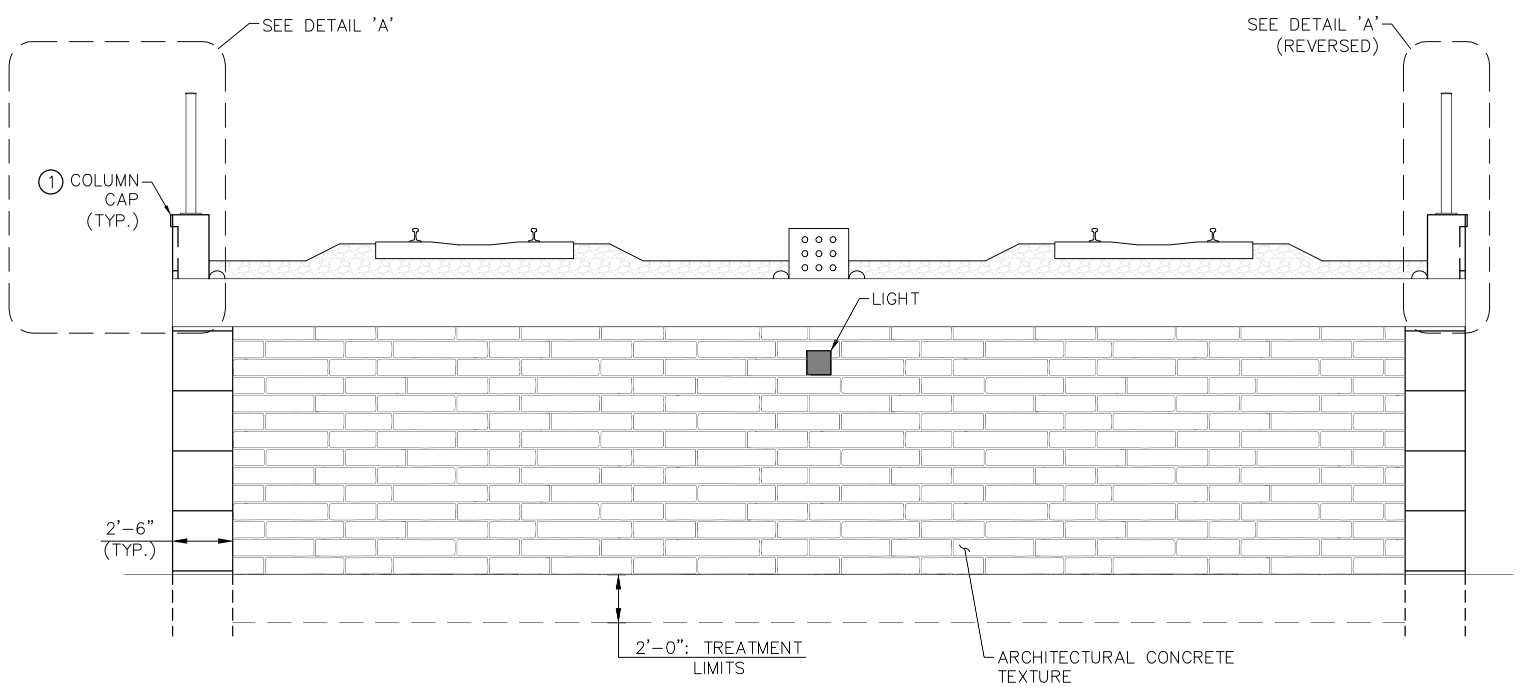


ARCHITECTURAL ELEVATION



DETAIL 'A'



TYPICAL ABUTMENT ELEVATION

(LOOKING SOUTH, NORTH REVERSED)

NOTES:

1. ARCHITECTURAL COLUMN CAP TO EXTEND 1" BEYOND CONCRETE BARRIER COPING.

DES: RMS	DR: ARH
CHK: DRF	CHK: MJC

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METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

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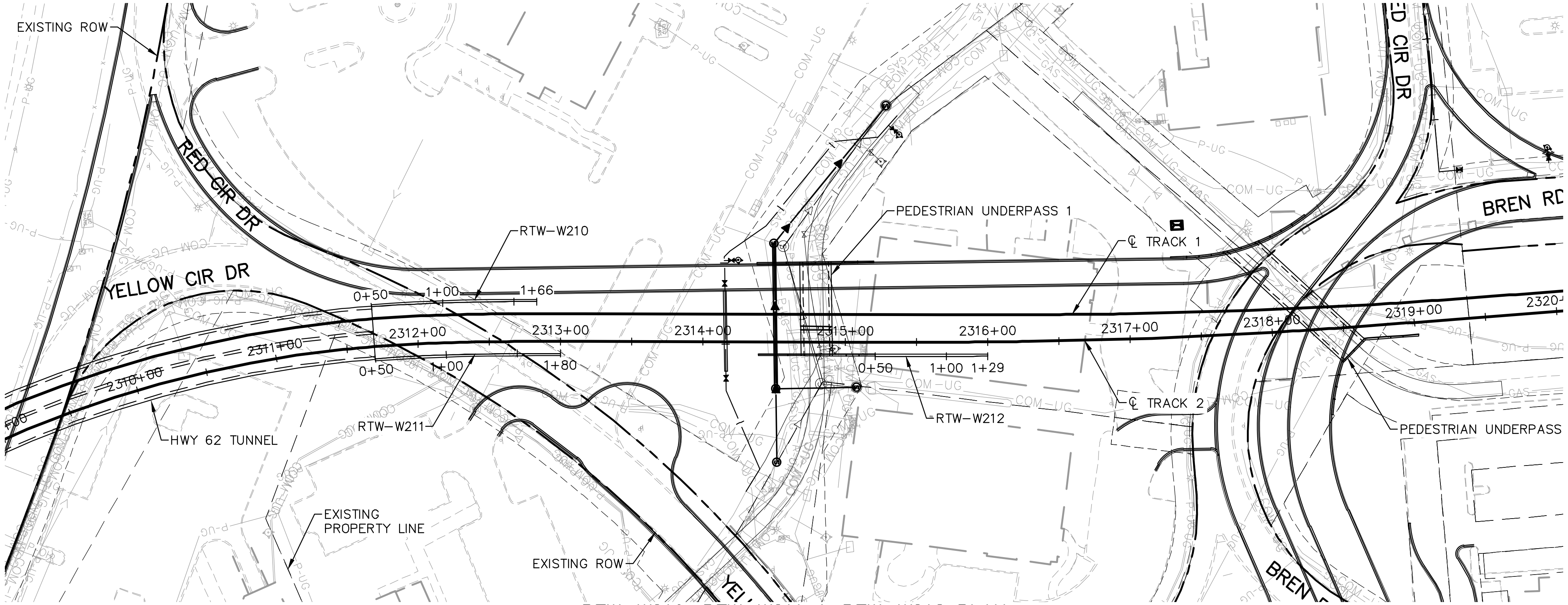
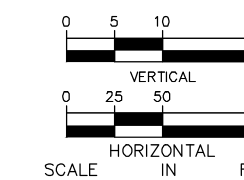
NOTE:
RTW-W210, RTW-W211 AND RTW-W212 ARE ANTICIPATED TO BE CAST-IN-PLACE RETAINING WALLS ON SPREAD FOOTINGS.

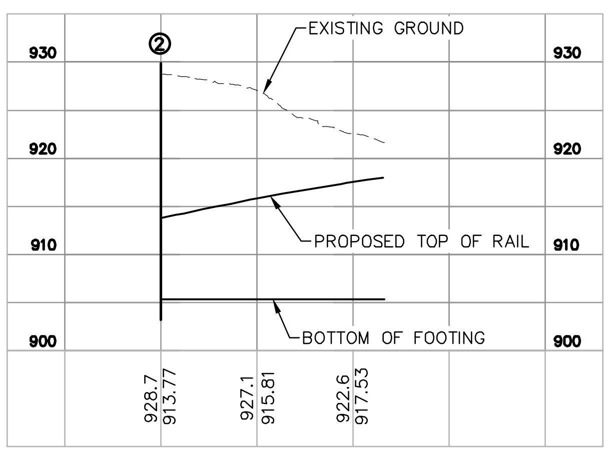
① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

② JOINT LOCATION BETWEEN RETAINING WALL AND BRIDGE WINGWALL OR TUNNEL.

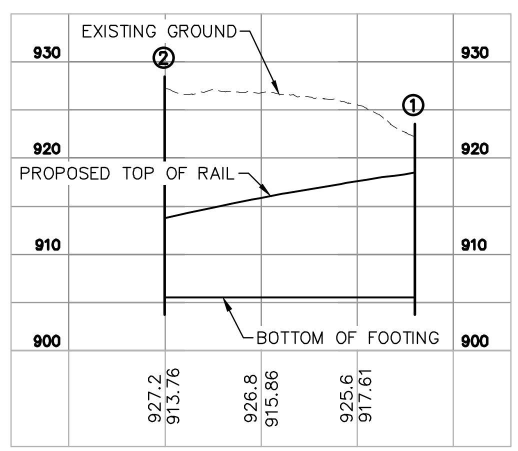




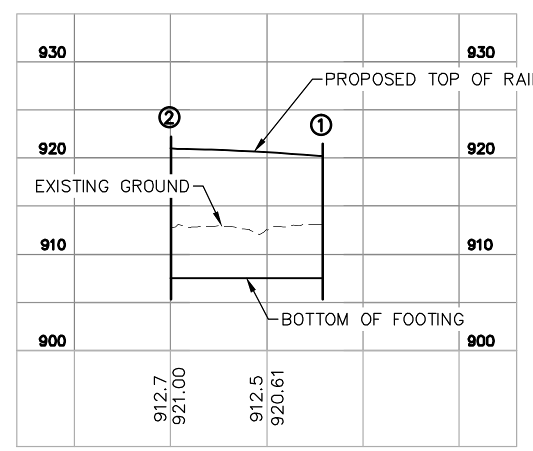
RTW-W210, RTW-W211 & RTW-W212 PLAN



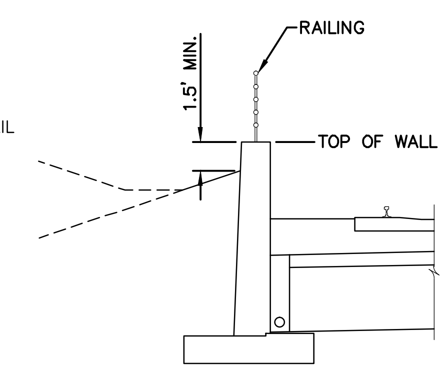
RTW-W210 PROFILE



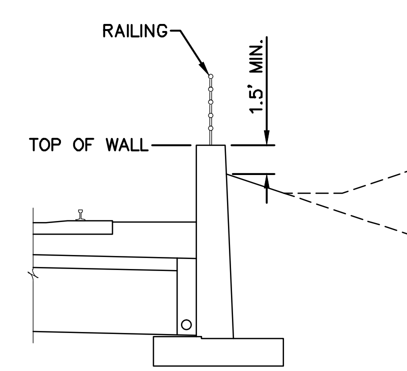
RTW-W211 PROFILE



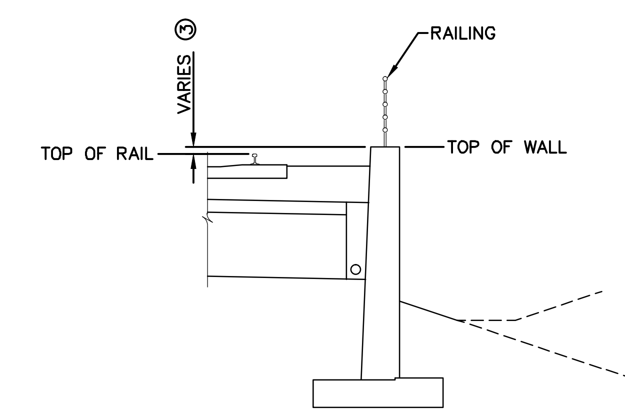
RTW-W212 PROFILE



RTW-W210 TYPICAL SECTION



RTW-W211 TYPICAL SECTION



③ TOP OF WALL = TOP OF RAIL THROUGH TANGENTS
TOP OF WALL = TOP OF RAIL + SUPERELEVATION THROUGH CURVES & SPIRALS

RTW-W212 TYPICAL SECTION

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METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extention

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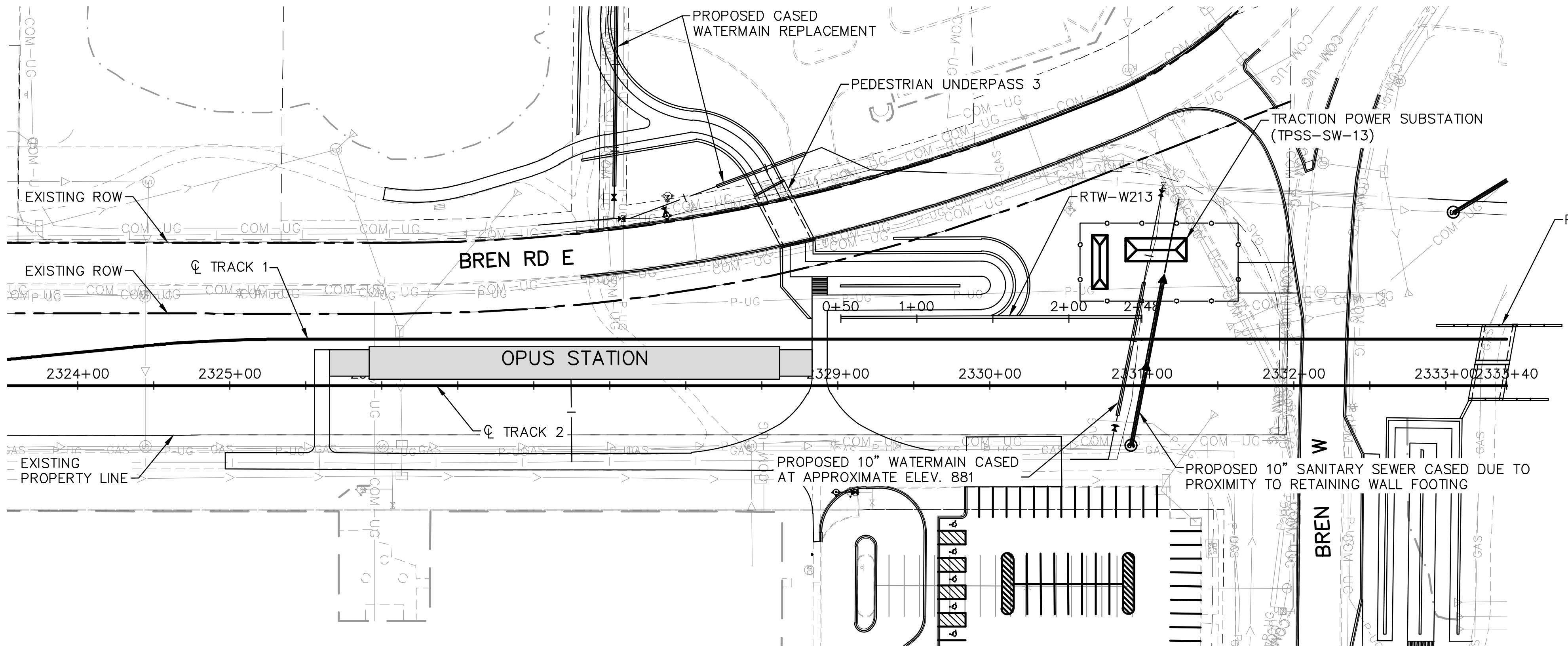
S□EET NAME□ W□-ST□-RTW-PPF□-□□□

S□EET □□□ OF □□□

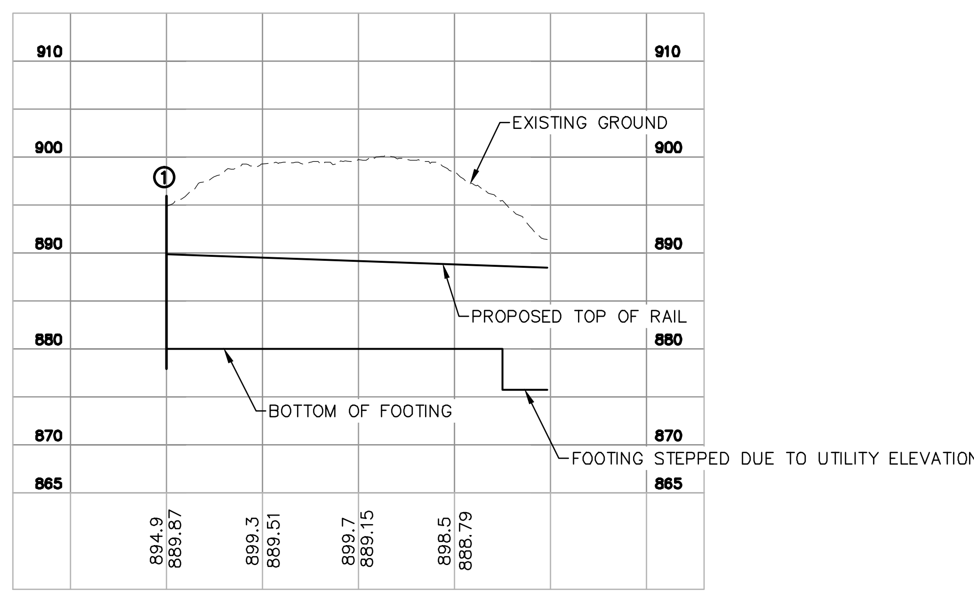
NOTE:
RTW-W213 IS ANTICIPATED TO BE A CAST-IN-PLACE RETAINING WALL ON SPREAD FOOTINGS.

① PROPOSED GROUND LINE AT 2H:1V MAXIMUM SLOPE AT WALL TERMINATION NOT SHOWN.

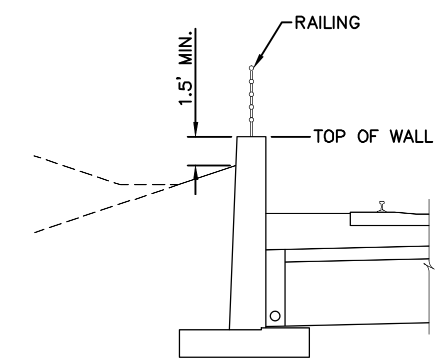


RTW-W213 PLAN

SCALE IN FEET: VERTICAL 0 5 10 20; HORIZONTAL 0 25 50 100



RTW-W213 PROFILE



RTW-W213 TYPICAL SECTION

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METROPOLITAN COUNCIL

SOUTHWEST Green Line LRT Extension

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BRAUN INTERTEC

LOG OF BORING -

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2000ST**

LOCATION: N: 138249.6; E: 492029.9
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/3/13** | SCALE: **1" = 4'**

Elev. feet 902.5	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
901.8	0.7	FILL	FILL: Lean Clay, dark brown, frozen. (Topsoil Fill)			26	
898.5	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, with Lean Clay lenses, brown, moist.	10		12	
895.5	7.0	FILL	FILL: Sandy Lean Clay, brown, wet.	11		27	
890.5	12.0	FILL	FILL: Sandy Lean Clay, trace Gravel, brown, wet.	7 9		15 16	
885.5	17.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with Gravel and Cobbles, brown, moist to wet, medium dense. (Glacial Outwash)	27 26		4 10	P200=8%
878.5	24.0	SM	SILTY SAND, fine- to medium-grained, with occasional Lean Clay lenses, trace Gravel, brown to 22 feet then gray, wet, medium dense. (Glacial Till)	22 22 20	▽	12 16 19	An open triangle in the water level (WL) column indicates the depth at which groundwater was observed while drilling. Groundwater levels fluctuate.
875.5	27.0	SC	CLAYEY SAND, trace Gravel, gray, wet, very stiff. (Glacial Till)	22		12	
870.5	32.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, gray, moist, medium dense to dense. (Glacial Till) With Lean Clay layers at 30 feet.	32 28		9 10	

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2000ST (cont.)**

LOCATION: N: 138249.6; E: 492029.9
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/3/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 870.5	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC % -	Tests or Notes -
		SC	CLAYEY SAND, trace Gravel, with frequent Sand lenses, gray to 37 feet then brown, wet, very stiff to hard.	34		13	
				27		10	
				25		10	
				27		7	
				30		10	
				31		9	
855.5	47.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	15		12	
				24		10	
851.5	51.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, brown, wet, medium dense. (Glacial Till)				
				15		10	*Water observed at 17 1/2 feet with 17 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.
				18		11	
841.5	61.0		END OF BORING.*				

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BRAUN INTERTEC

LOG OF BORING -

(See Descriptive Terminology sheet for explanation of abbreviations)

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2001ST**

LOCATION: N: 138453.7; E: 492046
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/4/13** | SCALE: **1" = 4'**

Elev. feet 895.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
		FILL	FILL: Lean Clay, dark brown, frozen. (Topsoil Fill)			17		
893.6	2.0	FILL	FILL: Sandy Lean Clay, trace Gravel, brown, moist to 7 feet then wet.	19		6		
				30		9		
				6		20		
				5		22		
883.6	12.0	SC	CLAYEY SAND, with Sand lenses, gray, wet, rather soft. (Glacial Till)	TW				TW=Thinwall
				5		26		
878.6	17.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, medium to stiff. (Glacial Till)	8		15	2 1/2	
				16*				*No sample recovery.
				10		13	2	
				14		13	3	
868.6	27.0	SC	CLAYEY SAND, trace Gravel, with Sand lenses, brown, moist to 31 feet then waterbearing, medium to hard. (Glacial Till)	22		10		
				41*	▽			*No sample recovery.

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BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2001ST (cont.)**

LOCATION: N: 138453.7; E: 492046 -
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/13	SCALE: 1" = 4'

Elev. feet - 863.6	Depth - feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
			CLAYEY SAND, trace Gravel, with Sand lenses, brown, moist to 31 feet then waterbearing, medium to hard. (Glacial Till) *(continued)*	25 -		13 -		P200=29%
				20 -		24 -		
				17 -		11 -		
				7 -		12 -		
				24 -		11 -		
				24 -		10 -		
				30 -		8 -		
				20 -		9 -		
				48 -		12 -		
834.6	61.0 -			24 -		10 -		
			END OF BORING. - Water observed at 31 feet while drilling. - Boring immediately backfilled with bentonite grout. -					

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2002ST**

LOCATION: N: 138695.2; E: 492065.8
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/13	SCALE: 1" = 4'

Elev. feet 895.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
894.2	0.8	FILL	FILL: Clayey Sand, trace roots, dark brown, frozen. (Topsoil Fill)			
888.0	7.0	FILL	FILL: Clayey Sand, trace Gravel, brown, dry to moist.	25 19		
886.0	9.0	FILL	FILL: Organic Clay, black, wet.	14		
881.0	14.0	OL	ORGANIC CLAY, black, wet. (Swamp Deposit)	7 6		
877.0	18.0	CL	LEAN CLAY, brown, wet, very stiff. (Glacial Till)	18		
869.0	26.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard. (Glacial Till)	32 19	▽	
			END OF BORING. Water observed at 20 feet with 20 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2003SS**

LOCATION: N: 139002.2; E: 492115.2
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/5/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 889.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
888.6	1.0	FILL	FILL: Sandy Lean Clay, dark brown, frozen.				
882.6	7.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, trace Gravel, brown, moist.	11 6			
880.6	9.0	PT	PEAT, fibrous, black, wet. (Swamp Deposit)	6			
877.6	12.0	OL	SLIGHTLY ORGANIC CLAY, with roots, black, wet. (Swamp Deposit)	2		28	OC=3%
876.6	13.0	ML	SILT, trace roots, gray, moist, loose. (Alluvium)	8			
865.6	24.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, with occasional Lean Clay lenses, gray, moist to 15 feet then waterbearing, loose. (Glacial Outwash)	6 9	▽		
863.6	26.0	CL	LEAN CLAY, trace Gravel, gray, wet, rather stiff. (Glacial Till)	11			

END OF BORING.

Water observed at 15 feet with 15 feet of hollow-stem auger in the ground.

Water observed at 16 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

BRAUN INTERTEC

LOG OF BORING -

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2004SS**

LOCATION: N: 139232.7; E: 492117
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/5/13	SCALE: 1" = 4'

Elev. feet 887.4	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
886.7	0.7	FILL	FILL: Sandy Lean Clay, trace roots, black, frozen. (Topsoil Fill)			
		FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, trace Gravel, brown, moist.	8		
883.4	4.0	FILL	FILL: Lean Clay, trace Gravel, dark brown to black, wet.	9		
880.4	7.0	PT	PEAT, fibrous, black, wet. (Swamp Deposit)	6		
			Shells at 10 feet.	5		
875.4	12.0	ML	SILT, with Silty Sand lenses, trace roots, gray, moist, loose. (Alluvium)	8		
873.4	14.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, with Lean Clay lenses, gray, moist to 15 feet then waterbearing, loose to medium dense. (Glacial Outwash)	12	▽	
				10		
863.4	24.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, with Poorly Graded Sand and Lean Clay lenses, gray, waterbearing, medium dense. (Glacial Till)	11		
861.4	26.0		END OF BORING.			

Water observed at 15 feet with 15 feet of hollow-stem auger in the ground.

Water observed at 15 feet with 24 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:23

BRAUN℠ INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2005ST**

LOCATION: N: 139559.9; E: 492097.9
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/13	SCALE: 1" = 4'

Elev. feet 885.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	Tests or Notes
884.8	0.8	CL	LEAN CLAY, black, frozen. (Topsoil)				
		CL	LEAN CLAY, with Sand, trace Gravel, brown, wet, rather stiff. (Glacial Till)	11			
881.6	4.0						
		CH	FAT CLAY, with Silty Sand and Silt seams, brown to 12 feet then gray, wet, medium to stiff. (Glacial Till)	16			
				8			
				8			
				13			
871.6	14.0						
		CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to hard. (Glacial Till)	12		1	Switched to mud rotary drill method after 15-foot sample.
				10		1	
				12		1	
				14		1 1/2	

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:24

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2005ST (cont.)**

LOCATION: N: 139559.9; E: 492097.9
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/4/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 853.6	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	Tests or Notes
			SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to hard. (Glacial Till) *(continued)*				
			With occasional Sand lenses from 35-60 feet.	23			
				22		2 3/4	
				24			Had to re-mud rotary from 45-60 feet to be able to mud rotary down to 65 feet.
				20			
				36			
826.6	59.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense to dense. (Glacial Outwash)	24			Had to re-mud rotary from 60-65 feet to be able to mud rotary down to 70 feet.
821.6	64.0						

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:24

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2005ST (cont.)**
LOCATION: N: 139559.9; E: 492097.9
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/4/13** | SCALE: **1" = 4'**

Elev. feet 821.6	Depth feet 64.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	qp tsf	Tests or Notes
		SC	CLAYEY SAND, trace Gravel, brown and gray, wet, hard. (Glacial Till)	35			
				46			
811.6	74.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	30			
809.6	76.0		END OF BORING. Water not encountered during drilling due to mud rotary drilling. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:24

BRAUN INTERTEC

LOG OF BORING -

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2006ST**

LOCATION: N: 139744.8; E: 492105.5
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/13	SCALE: 1" = 4'

Elev. feet 886.1	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
		CL	LEAN CLAY, trace roots, black, frozen. (Topsoil)	9				
882.1	4.0	CH	FAT CLAY, with Silty Sand and Silt lenses, brown to 12 feet then gray, wet, medium to rather stiff. (Glacial Till)	8				
				9		31		P200=98% See Grain Size Accumulation Curve.
				12				
				6			3/4	
872.1	14.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather soft to rather stiff. (Glacial Till)	5			1 1/2	
				9			3/4	
				7				
857.1	29.0	SP	POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, medium dense. (Glacial Outwash)	19	▽			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:24

BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2006ST (cont.)**

LOCATION: N: 139744.8; E: 492105.5
See attached sketch.

DRILLER: M. Belch | METHOD: 3 1/4" HSA, Autohammer | DATE: **4/4/13** | SCALE: **1" = 4'**

Elev. feet 854.1	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
852.1	34.0		POORLY GRADED SAND, fine- to coarse-grained, with Gravel, gray, waterbearing, medium dense. (Glacial Outwash) *(continued)*					
		CL	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard. (Glacial Till)	28			1 1/2	
				22				
				47*				*No sample recovery.
835.1	51.0			36				
			END OF BORING.					

Water observed at 30 feet with 30 feet of hollow-stem auger in the ground.

Water observed at 33 feet with 49 1/2 feet of hollow-stem auger in the ground.

Boring immediately backfilled with bentonite grout.

(See Descriptive Terminology sheet for explanation of abbreviations)

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2020ST**

LOCATION: N: 137669.1; E: 492069.7
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 8/1/13	SCALE: 1" = 4'

Elev. feet 912.4	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
911.9	0.5	FILL	FILL: Clayey Sand, with Gravel, dark brown, moist. (Topsoil Fill)				
908.4	4.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.				
905.4	7.0	FILL	FILL: Sandy Lean Clay, trace Gravel, brown and gray, wet.	7		16	
903.4	9.0	FILL	FILL: Clayey Sand, trace Gravel, gray, wet.	11			
900.4	12.0	FILL	FILL: Silty Sand, fine- to medium-grained, trace Gravel, brown, moist.	8		15	
898.4	14.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to coarse-grained, with Gravel, brown, moist.	35			
893.4	19.0	FILL	FILL: Clayey Sand, trace Gravel, brown, wet.	18			
				7		12	P200=51%
888.4	24.0	FILL	FILL: Sandy Lean Clay, trace Gravel, brown and gray, moist to wet.	12		9	
		SM	SILTY SAND, fine- to medium-grained, trace Gravel, with Clay inclusions, brown, moist, medium dense to dense. (Glacial Till)	25			
				29			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:25

BRAUN INTERTEC

LOG OF BORING -

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2020ST (cont.)**

LOCATION: N: 137669.1; E: 492069.7
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: **8/1/13**	SCALE: **1" = 4'**

Elev. feet 880.4	Depth feet 32.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
			SILTY SAND, fine- to medium-grained, trace Gravel, with Clay inclusions, brown, moist, medium dense to dense. (Glacial Till) *(continued)*	34			
873.4	39.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, with some Gravel, brown, moist to 41 feet then waterbearing, medium dense to dense. (Glacial Outwash)	27	∇		
				24			
				44			
861.4	51.0		END OF BORING. Water observed at 41 feet with 49 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 31 feet immediately after withdrawal of auger. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:25

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2021SB**

LOCATION: N: 138953.4; E: 491892.1
See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: 8/5/13	SCALE: 1" = 4'

Elev. feet 901.8	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
901.5	0.3	FILL	FILL: Silty Sand, fine- to medium-grained, with roots, dark brown, moist. (Topsoil Fill)					
897.8	4.0	FILL	FILL: Clayey Sand, with some Gravel, dark brown, moist.	6		13		
892.8	9.0	SC	CLAYEY SAND, trace Gravel, brown, wet, rather stiff to very stiff. (Glacial Till)	9				
				24		11		
887.8	14.0	SM	SILTY SAND, fine- to medium-grained, with Silt and Clay layers and seams, brown with rust stains, moist, medium dense. (Glacial Till)	25				
				11				
884.8	17.0	CL	SANDY LEAN CLAY, with Sand layers and seams, trace Gravel, brown, wet, very stiff. (Glacial Till)	20				
870.8	31.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to stiff. (Glacial Till)	14			1 1/2	
				12			1	*Water not observed with 25 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 27 1/2 feet immediately after withdrawal of auger. Boring immediately backfilled.
				11			1	
				12			1 1/2	
			END OF BORING.*					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:25

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2022SW**
LOCATION: N: 139021.3; E: 491944.1
See attached sketch.

DRILLER: S. McLean | METHOD: 3 1/4" HSA, Autohammer | DATE: **8/5/13** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 894.4	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
894.1	0.3	SC	CLAYEY SAND, trace Gravel and roots, dark brown, moist. (Topsoil)					
		SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, moist, medium dense. (Glacial Outwash)	12				
				12		4		
887.4	7.0	ML	SILT, with Poorly Graded Sand layers and seams, brown, moist, medium dense. (Glacial Till)	11				
				14		26		P200=90%
882.4	12.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, medium to very stiff. (Glacial Till)	7			1/2	
				7			1/2	
				7			1/2	
				8			1 1/2	*Water not observed with 29 1/2 feet of hollow-stem auger in the ground. Water not observed to cave-in depth of 27 feet immediately after withdrawal of auger. Boring then backfilled.
				15			2	
				25			2 1/2	
863.4	31.0		END OF BORING.*					

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:25

BRAUN INTERTEC

LOG OF BORING

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2023SW**

LOCATION: N: 139035.4; E: 492004.5
See attached sketch.

DRILLER: S. McLean	METHOD: 3 1/4" HSA, Autohammer	DATE: 8/5/13	SCALE: 1" = 4'

Elev. feet 893.7	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	qp tsf	Tests or Notes
893.0	0.7	FILL	FILL: Sandy Lean Clay, trace Gravel and roots, dark brown, wet. (Topsoil Fill)					
889.7	4.0	FILL	FILL: Clayey Sand, trace Gravel, dark brown and brown, wet.	20		11		
886.7	7.0	SM	SILTY SAND, fine- to medium-grained, trace Gravel, brown, moist, loose. (Glacial Till)	8				
884.7	9.0	SM	SILTY SAND, fine- to medium-grained, with Gravel, brown, moist, medium dense. (Glacial Till)	19		9		P200=16%
876.7	17.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, light brown, moist to 11 feet then waterbearing, medium dense. (Glacial Outwash)	14	▽			
				12		20		P200=11%
				17				
874.7	19.0	CL	SANDY LEAN CLAY, trace Gravel, with Sand inclusions, brown, wet, stiff. (Glacial Till)	14				
869.7	24.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	27				
862.7	31.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, rather stiff to stiff. (Glacial Till)	11			1 1/2	*Water observed at 11 feet with 29 1/2 feet of hollow-stem auger in the ground.
				16			2	Boring immediately backfilled with bentonite grout.
			END OF BORING.*					

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:26

BRAUN INTERTEC

LOG OF BORING -

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2024SW**

LOCATION: N: 139142.8; E: 492030.2
See attached sketch.

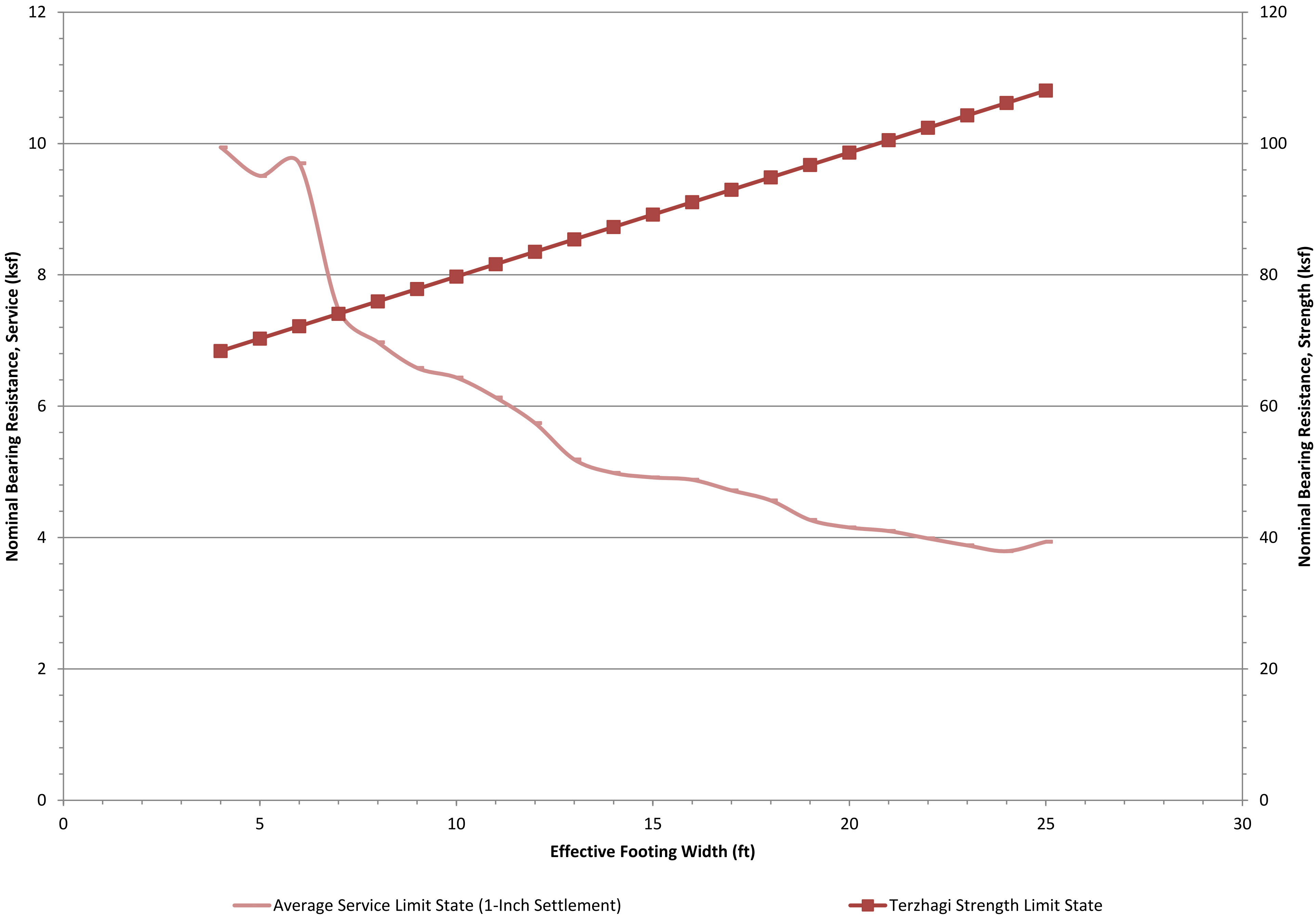
DRILLER: M. Takada | METHOD: 3 1/4" HSA, Autohammer | DATE: **8/6/13** | SCALE: **1" = 4'**

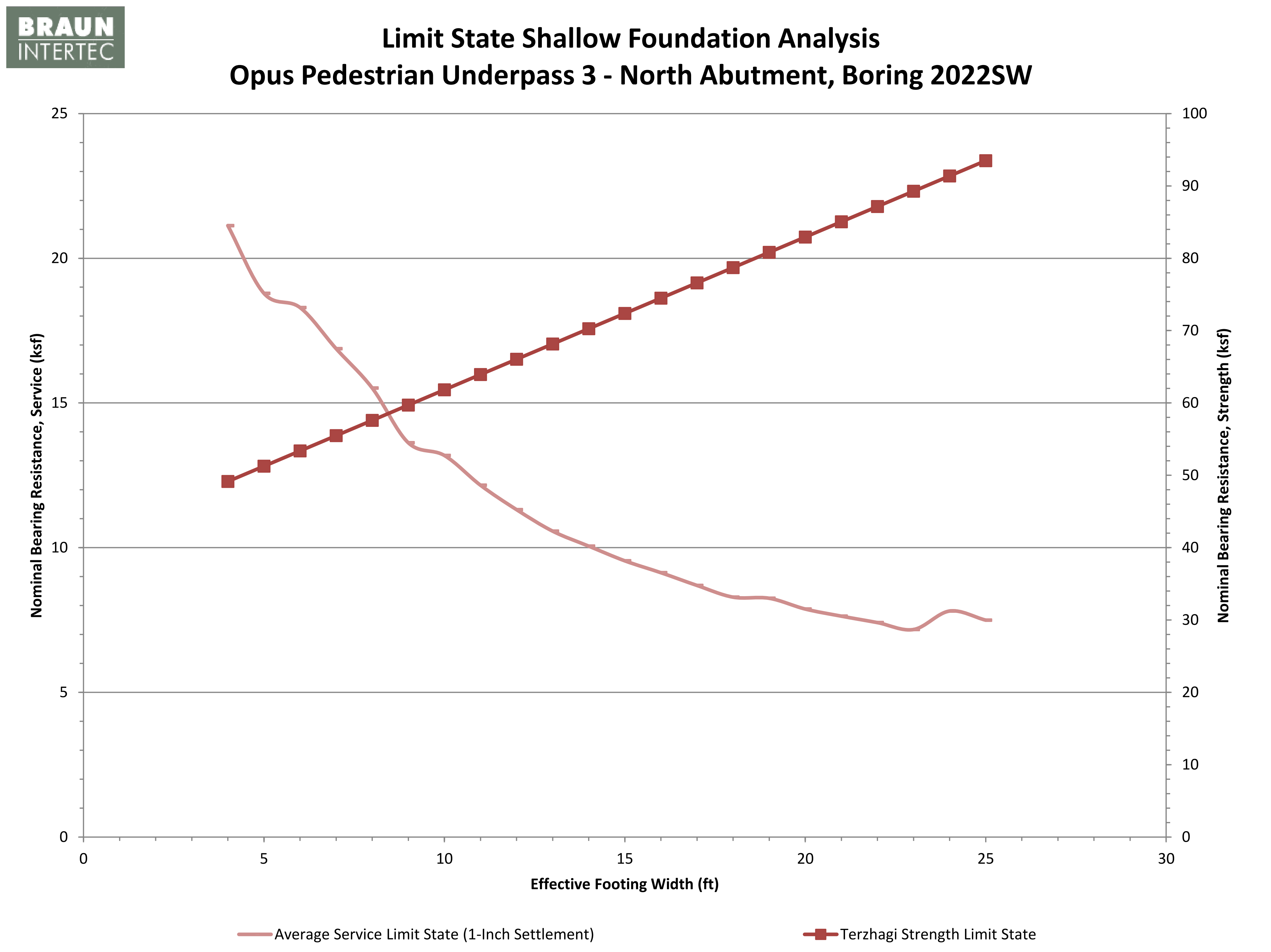
(See Descriptive Terminology sheet for explanation of abbreviations)

Elev. feet 899.3	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
898.1	1.2	FILL	FILL: Lean Clay, trace roots, dark brown, moist. (Topsoil Fill)				
890.3	9.0	FILL	FILL: Clayey Sand, slightly organic, trace Gravel, with black Clay inclusions, dark brown, moist.	4		8	OC=4%
				23			
				15		24	
887.3	12.0	FILL	FILL: Lean Clay, slightly organic, with Sand inclusions, dark gray and black, wet.	18		24	OC=4%
884.3	15.0	FILL	FILL: Clayey Sand, slightly organic, trace Gravel and roots, dark brown, wet.	14			
882.3	17.0	FILL	FILL: Lean Clay, organic, black and dark gray, wet.	14		32	OC=5%
880.3	19.0	ML	SANDY SILT, highly organic, black, wet. (Swamp Deposit)	16		52	OC=13%
877.3	22.0	CL	LEAN CLAY, gray, wet, rather stiff. (Glacial Till)	11	▽		
870.3	29.0	SP-SM	POORLY GRADED SAND with SILT, fine- to medium-grained, trace Gravel, gray, waterbearing, medium dense. (Glacial Outwash)	23			*Water observed at 21 feet with 29 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.
868.3	31.0	SP	POORLY GRADED SAND, fine- to coarse-grained, trace Gravel, brown, waterbearing, medium dense. (Glacial Outwash)	27			
			END OF BORING.*				

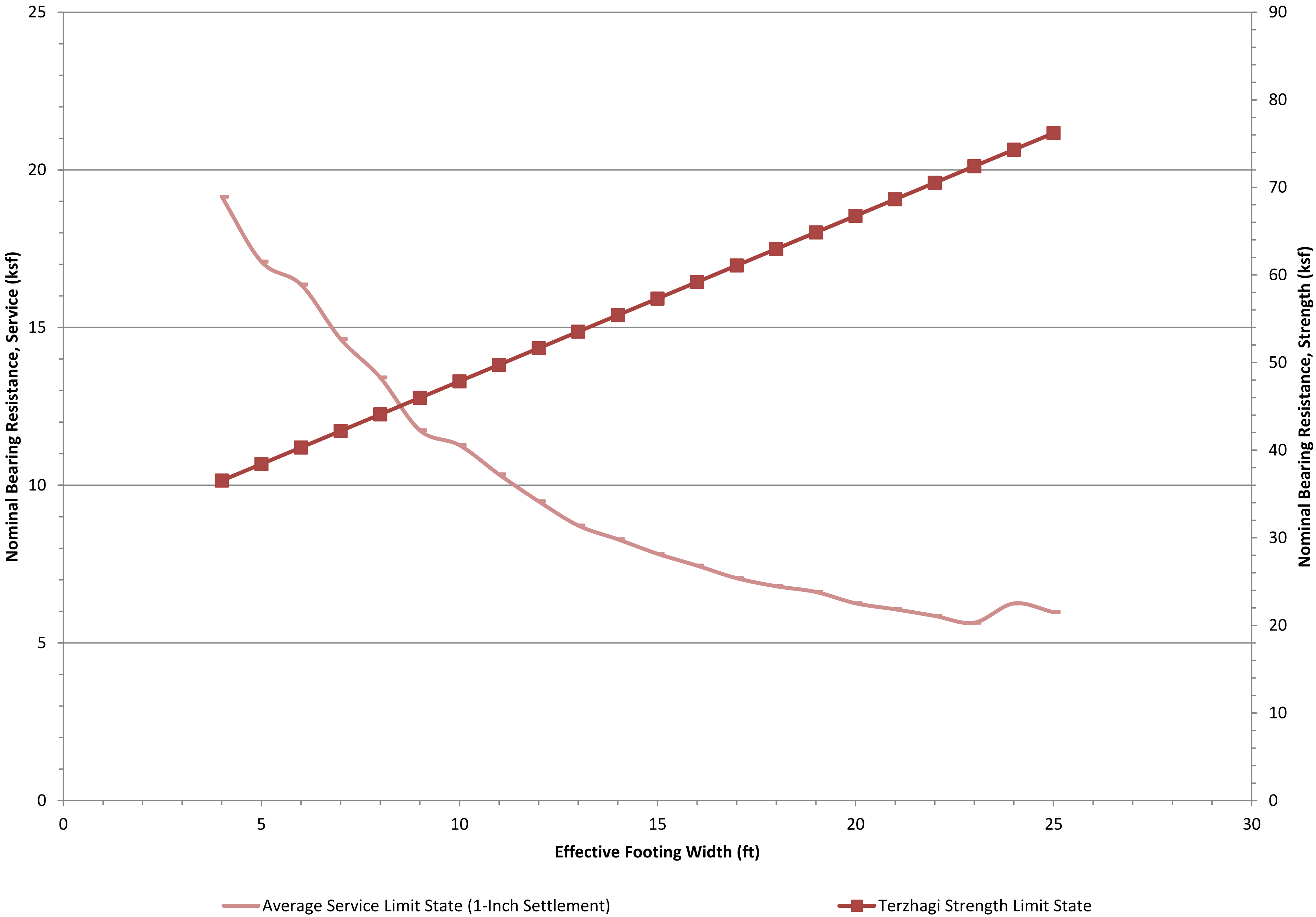
LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/1/14 10:26

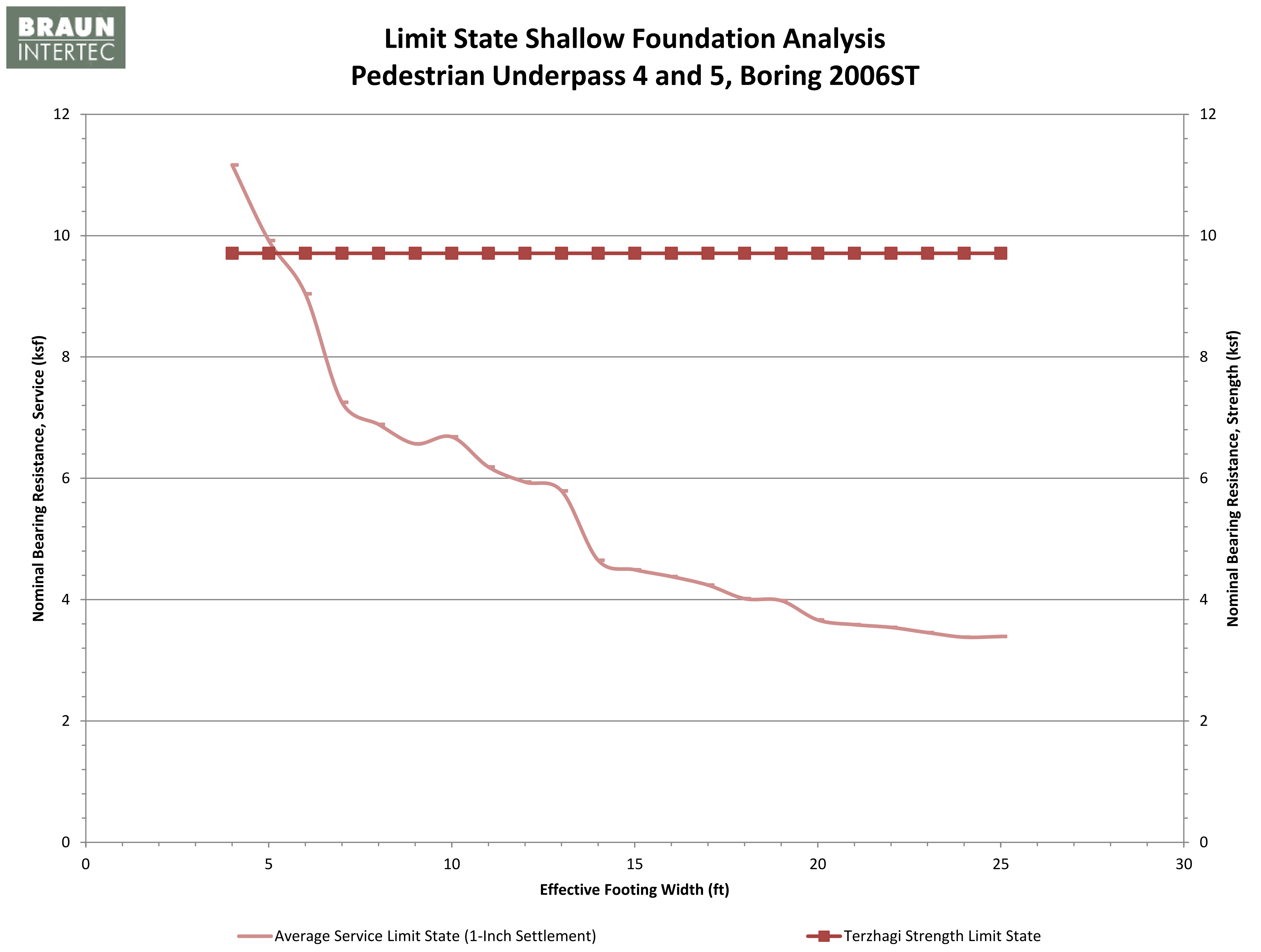
Limit State Shallow Foundation Analysis
Opus Pedestrian Underpass 1 and 2, Boring 2020ST




BRAUN INTERTEC
Limit State Shallow Foundation Analysis
Opus Pedestrian Underpass 3 - North Abutment, Boring 2022SW
Nominal Bearing Resistance, Service (ksf)
Nominal Bearing Resistance, Strength (ksf)
Effective Footing Width (ft)
0
5
10
15
20
25
30
40
50
60
70
80
90
100
Average Service Limit State (1-Inch Settlement)
Terzhagi Strength Limit State

Limit State Shallow Foundation Analysis
Pedestrian Underpass 3 - S Abutment, Boring 2023SW





BRAUN INTERTEC
Limit State Shallow Foundation Analysis
Pedestrian Underpass 4 and 5, Boring 2006ST
Nominal Bearing Resistance, Service (ksf)
Nominal Bearing Resistance, Strength (ksf)
Effective Footing Width (ft)
0
2
4
6
8
10
12
0
5
10
15
20
25
30
Average Service Limit State (1-Inch Settlement)
Terzhagi Strength Limit State

BRAUN INTERTEC

Limit State Shallow Foundation Analysis
RTW-W213, Boring 2024SW

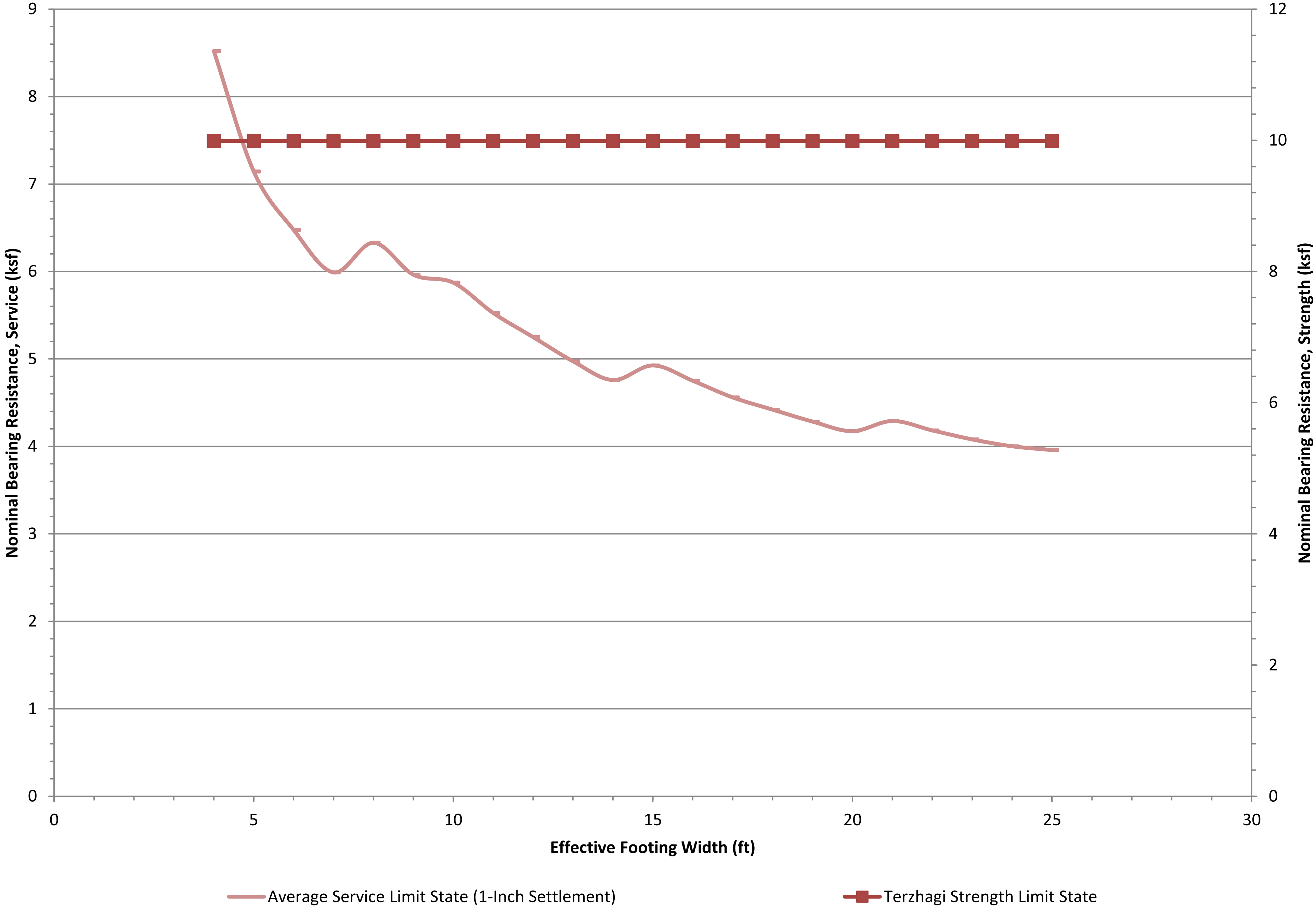


Table 5. Correlation results for sand. (Column A = Number in Table x Row B.)

A \ B	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	N bl/ft
E_o tsf	1	0.125	8	1.15	57.5	4
E_R tsf	8	1	64	6.25	312.5	22.7
p^*_L tsf	0.125	0.0156	1	0.11	5.5	0.5
q_c tsf	0.87	0.16	9	1	50	5
f_s tsf	0.0174	0.0032	0.182	0.02	1	0.1
N bl/ft	0.25	0.044	2	0.2	10	1

Table 6. Correlation results for clay. (Column A = Number in Table x Row B.)

A \ B	E_o tsf	E_R tsf	p^*_L tsf	q_c tsf	f_s tsf	S_u tsf
E_o tsf	1	0.278	14	2.5	56	100
E_R tsf	3.6	1	50	13	260	300
p^*_L tsf	0.071	0.02	1	0.2	4	7.5
q_c tsf	0.40	0.077	5	1	20	27
f_s tsf	0.079	0.0038	0.25	0.05	1	1.6
S_u tsf	0.010	0.0033	0.133	0.037	0.625	1

WALL LOADING CASE:
2' - LIVE LOAD SURCHARGE

WALL GEOMETRICS AND DATA - SPREAD FOOTING							QUANTITIES PER FOOT - SPREAD FOOTING					BASE PRESSURE KIPS/SQ. FT.	
							STRUCTURAL CONCRETE		REINFORCEMENT				
STEM HEIGHT h	STEM WIDTH a	TOE WIDTH b	FOOTING THICKNESS c	FOOTING WIDTH d	SHEAR KEY SIZE e	SHEAR KEY LOCATION f	1A43 (CU.YD.) FOOTING	3Y43 (CU.YD.) STEM	PLAIN (POUND)	EPOXY (POUND)	WALL DETAILING SCHEME ①	TOE	HEEL
5	1'-8 1/2"	1'-0"	1'-5"	3'-6"	N/A	N/A	0.187	0.296	15.38	38.16	SHORT	1.670	0.070
6	1'-9"	1'-2"	1'-5"	4'-0"	N/A	N/A	0.211	0.360	16.43	41.74	SHORT	1.820	0.090
7	1'-9 1/2"	1'-4"	1'-5"	4'-6"	N/A	N/A	0.235	0.425	19.70	45.34	SHORT	1.970	0.120
8	1'-10"	1'-6"	1'-5"	5'-0"	N/A	N/A	0.259	0.492	20.75	48.89	SHORT	2.110	0.150
9	1'-10 1/2"	1'-8"	1'-5"	5'-6"	N/A	N/A	0.283	0.561	24.13	52.69	SHORT	2.250	0.180
10	1'-11"	1'-9"	1'-5"	6'-0"	N/A	N/A	0.306	0.631	25.18	62.49	MEDIUM	2.446	0.199
11	1'-11 1/2"	2'-0"	1'-5"	6'-6"	N/A	N/A	0.331	0.703	31.28	66.85	MEDIUM	2.536	0.239
12	2'-0"	2'-3"	1'-5"	6'-9"	1'-0"	3'-10 5/8"	0.380	0.776	35.38	72.23	MEDIUM	2.758	0.156
13	2'-0 1/2"	2'-6"	1'-5"	7'-0"	1'-0"	4'-2 1/8"	0.393	0.851	40.30	76.82	MEDIUM	2.986	0.013
14	2'-1"	2'-9"	1'-6"	7'-8"	1'-0"	4'-5 3/4"	0.477	0.928	40.49	81.74	MEDIUM	3.147	0.078
15	2'-1 1/2"	3'-0"	1'-6"	8'-2"	1'-0"	4'-9 1/4"	0.506	1.006	40.10	99.57	TALL	3.239	0.111
16	2'-2"	3'-3"	1'-9"	8'-8"	1'-0"	5'-0 7/8"	0.615	1.085	41.38	105.97	TALL	3.494	0.056
17	2'-2 1/2"	3'-6"	1'-9"	9'-2"	1'-0"	5'-4 3/8"	0.649	1.166	49.02	111.90	TALL	3.586	0.089
18	2'-3"	3'-9"	1'-9"	9'-8"	1'-0"	5'-7 7/8"	0.682	1.249	50.52	129.74	TALL	3.679	0.121
19	2'-3 1/2"	4'-0"	2'-0"	10'-2"	1'-0"	5'-11 1/2"	0.810	1.333	54.26	137.41	TALL	3.935	0.066
20	2'-4"	4'-3"	2'-0"	10'-8"	1'-0"	6'-3"	0.875	1.417	61.38	165.51	TALL	4.056	0.090
21	2'-4 1/2"	4'-6"	2'-0"	11'-2"	1'-0"	6'-6 1/2"	0.916	1.504	71.34	174.30	TALL	4.151	0.122
22	2'-5"	4'-9"	2'-3"	11'-8"	1'-0"	6'-10 1/8"	1.064	1.593	65.93	183.51	TALL	4.407	0.067
23	2'-5 1/2"	5'-0"	2'-6"	12'-2"	1'-0"	7'-1 3/4"	1.221	1.683	84.82	224.49	TALL	4.663	0.012
24	2'-6"	5'-3"	2'-9"	12'-9"	1'-0"	7'-5 3/8"	1.396	1.775	94.03	234.03	TALL	4.872	0.020
25	2'-6 1/2"	5'-6"	2'-9"	13'-3"	1'-0"	7'-8 7/8"	1.449	1.868	100.13	288.16	TALL	4.967	0.052
26	2'-7"	5'-10"	3'-0"	13'-9"	1'-0"	8'-1 1/2"	1.631	1.963	102.26	299.67	TALL	5.189	0.000
27	2'-7 1/2"	6'-2"	3'-3"	14'-4"	1'-0"	8'-6 1/8"	1.832	2.059	127.34	315.84	TALL	5.364	0.000
28	2'-8"	6'-6"	3'-3"	15'-0"	1'-0"	8'-10 5/8"	1.916	2.157	140.92	394.98	TALL	5.334	0.140
29	2'-8 1/2"	6'-10"	3'-6"	15'-6"	1'-0"	9'-3 1/4"	2.123	2.257	148.00	407.90	TALL	5.558	0.077
30	---	---	---	---	---	---	---	---	---	---	---	---	---

NOTE:
EPOXY REINFORCEMENT QUANTITY ASSUMES AN EXPANSION JOINT IS USED ON BOTH PANEL ENDS. THE QUANTITY MUST BE ADJUSTED WHEN CONSTRUCTION JOINTS ARE USED. QUANTITIES ON THIS SHEET DO NOT INCLUDE RAILING. SEE RAILING SHEETS FOR RAIL REINFORCEMENT (EPOXY) AND RAIL CONCRETE (3Y46).

① SEE STANDARD PLANS 5-297.621 TO .623 FOR REINFORCING DETAILS.

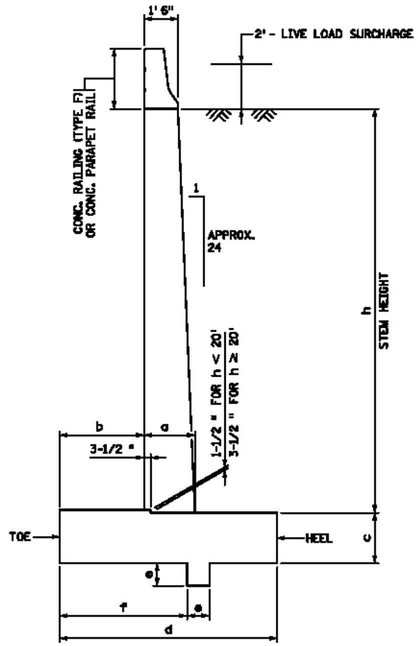
DESIGN CRITERIA

1992 A.A.S.H.T.O. DESIGN SPECIFICATIONS
DESIGN METHOD:
WORKING STRESS - STABILITY, FOUNDATIONS
LOAD FACTOR DESIGN - REINFORCED CONCRETE
f'c = 4,000 PSI
fy = 60,000 PSI

FACTOR OF SAFETY OVERTURNING: 2.0 MINIMUM
FACTOR OF SAFETY SLIDING: 1.5 MINIMUM
LOCATION OF RESULTANT: MIDDLE 1/3 OF FOOTING NEGLECTING SOIL IN FRONT OF WALL.

SEE FOUNDATION REPORT FOR ALLOWABLE BEARING PRESSURE AND COEFFICIENT OF FRICTION.

BACKFILL CHARACTERISTICS:
INTERNAL ANGLE OF FRICTION: 35°
= 33 PCF EQUIVALENT FLUID PRESSURE ACTIVE STATE
= 53 PCF EQUIVALENT FLUID PRESSURE AT REST STATE
βe = 1.0
COEFFICIENT OF FRICTION: 0.55
UNIT WEIGHT: 125 PCF



TYPICAL SECTION

REVISED:
APPROVED: MAY 31, 2006
STATE BRIDGE ENGINEER

STANDARD SHEET NO.
5-297.632 (1 OF 4)
STANDARD APPROVED:
MAY 31, 2006

TITLE:
RETAINING WALL (LIVE LOAD SURCHARGE)
SPREAD FOOTING GEOMETRY AND DATA

STATE PROJ. NO. (TH) SHEET NO. OF SHEETS

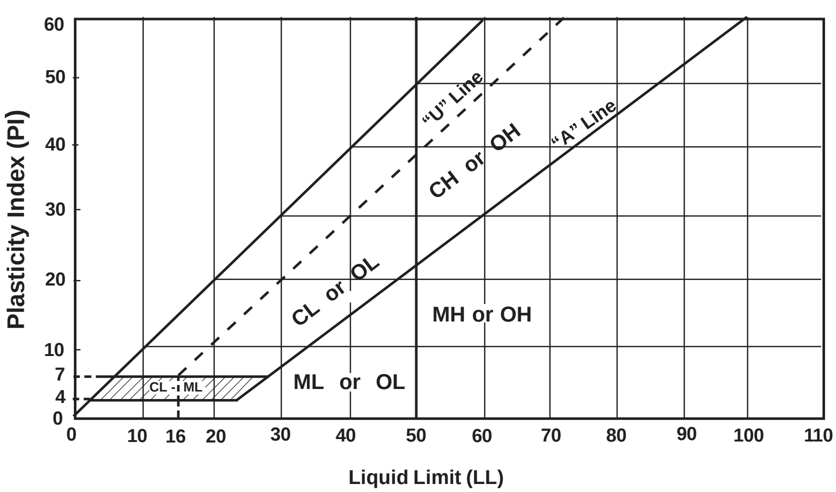
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils	Primarily organic matter, dark in color and organic odor			PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
  Coarse .... 3/4" to 3"
  Fine .... No. 4 to 3/4"
Sand
  Coarse .... No. 4 to No. 10
  Medium .... No. 10 to No. 40
  Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.

Appendix H

Opus Station

BRAUN INTERTEC
The Science You Build On.

Braun Intertec Corporation
11001 Hampshire Avenue S
Minneapolis, MN 55438

Phone: 952.995.2000
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Web: braunintertec.com

August 29, 2014 Project BL-13-00213

Mr. Don Demers
Southwest Light Rail Transit Project Office
6465 Wayzata Boulevard, Suite 500
St. Louis Park, MN 55426

Re: Geotechnical Evaluation
Proposed Opus Station Platform – 100% Design
STA 2325+92 to STA 2328+62
Southwest LRT, West Segment 2
Minnetonka, Minnesota

Dear Mr. Demers:

We are pleased to present this Geotechnical Report for the proposed Opus Station, located between STA 2325+92 and STA 2328+62 in Minnetonka, Minnesota. Details of our results and recommendations are provided in the following report.

This report is part of a larger series of reports for the west segment of the Southwest Light Rail Transit (SWLRT) project. Recommendations for the retaining walls, pedestrian underpasses, and the Overhead Contact System (OCS) will be addressed in separate reports.

A. Project Information

SWLRT is proposing to construct a light rail transit line through the cities of Hopkins, Minnetonka, and Eden Prairie, Minnesota. This Geotechnical Evaluation Report addresses the proposed Opus Station Platform, from track STA 2325+92 to STA 2328+62 in Minnetonka. The site of the proposed platform station is located east of Bren Road East and approximately 338 feet south of Bren Road West.

AA/EOE

B. Results

B.1. Exploration Logs

B.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance, laboratory tests performed on penetration test samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

B.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, penetration resistance testing performed for the project, laboratory test results, and available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

B.2. Geologic Profile

B.2.a. Summary of Borings Taken

The Southwest Light Rail Transit Project Office (SPO) requested subsurface soil and groundwater information in the area of the proposed Opus Station Platform, on two parcels of land owned by the City of Minnetonka. Two (2) standard penetration soil borings were performed in this area. The number, location, and function of the soil boring can be seen in Table 1 below.

Table 1. Soil Boring Information for Opus Station Area

Boring	Approximate Track Station	Surface Elevation	Soil Boring Function
2002SS	2325+25	895.0	Station Platform
2003SS	2328+25	889.6	Station Platform

B.2.b. Geologic Materials

A berm is present throughout much of the proposed station area. The borings were performed at the base of the berm to facilitate drill rig access, so the composition of the berm materials was not investigated.

The borings generally encountered fill soils of mix composition ranging in depths of 7 to 9 feet below the ground surface or elevations 883 and 886. The majority of the fill appears to be non-organic. However, an organic clay layer was encountered in Boring 2002SS from 7 to 9 feet below the ground surface.

Swamp deposited soils were encountered in the borings beneath the fill to depths ranging from 7 to 14 feet below the ground surface or to elevations ranging from 886 to 877 ½.

Beneath the fill and swamp deposited soils, the borings encountered native alluvium and glacially deposited soils to a termination depth of 25 feet below existing grades. The alluvium soils consisted of silt (ML) and the glacial soils consisted of poorly graded sand (SP), lean clay (CL), and sandy lean clay (CL).

Penetration resistance values recorded in the native sands ranged from 6 to 9 blows per foot (BPF), indicating the soils were loose and the native clays ranged from 11 to 32 BPF, indicating the soils were rather stiff to hard.

B.2.c. Groundwater

Groundwater was measured or estimated to be located at the depths shown below in Table 2. Corresponding groundwater elevations were determined from comparisons of the measured/estimated depths to groundwater and surface elevations, and were rounded to the highest 1/2-foot.

Table 2. Groundwater Summary

Location	Surface Elevation	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
2002SS	895.0	20	875
2003SS	889.6	15	871 ½

Seasonal and annual fluctuations of groundwater, however, should be anticipated.

Based on the information received from the project team, it is our understanding the pond located west of the proposed Opus Platform Station (to the west of Bren Road East) has a normal water level around 888.0 and a measured high water level of 892.6. It is also our understanding the wetlands north of the proposed platform station (north of Bren Road West) have a normal water level around 878.3 and a measured high water level elevation of 880.9.

C. Basis for Recommendations

C.1. Design Details

C.1.a. Proposed Construction

The proposed Opus Platform Station is approximately 270 feet in length and is located between track STA 2325+92 and STA 2328+62. The station will be lightly loaded with ramps on each end leading to an elevated slab-on-grade supported on cast-in-place footings and foundation walls. Pedestrian access to the station including ramps and/or walks, along with an associated canopy structure will be constructed as part of the station.

C.1.b. Anticipated Grade Changes

Based on the preliminary engineering plans, the top of rail elevation (from south to north) ranges from 892 to 890 with a finished station grade ranging from 893 to 891, respectively. Borings 2002SS and 2003SS were completed in the area of the proposed station at elevations 895.0 and 889.6, respectively.

C.1.c. Precautions Regarding Changed Information

We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C.2. Design and Construction Considerations

Based on the soil borings, the site appears suitable for construction of the station using shallow spread footings and ground supported slabs. Potential issues affecting the station construction are as follows:

- Organic soils were encountered beneath the fill at both boring locations and will need to be removed and replaced with engineered fill prior to construction of the station platform. The excavation depth will extend close the other observed groundwater elevations, and provisions should be made for removal any water encountered within the excavation.

- Maximum frost depth for the Southwest Light Rail Transit is assumed to be 60 inches (5 feet), therefore, a frost-free section of 5 feet should be provided below the station. To provide this frost-free section at the station location and the adjacent track segments, a subcut of 4 1/2 feet below the top of rail is anticipated. We referenced the above information from the SWLRT Guideway design criteria.

- Lean clay soils may be encountered once the subcut is complete; these soils are considered moisture sensitive and are also susceptible to disturbance from construction activities and participation. Therefore, site grading and movement on the site will be somewhat limited during wet weather conditions. Stabilization of the subgrade with gravel may be required.

D. Recommendations

Our recommendations below are for final design of the platform station based on the information provided to us within the preliminary engineering plans. We have also referenced the design guidelines use for the recently completed Central Corridor Light Rail Transit (CCLRT) construction.

D.1. Station Subgrade Preparation

D.1.a. Excavations

We recommend removing vegetation, topsoil fill, fill, and swamp deposit soils from below the proposed station area. A 5-foot zone of non-frost susceptible soil should be provided beneath the top of slab elevation (4 feet below top of rail) based on the proposed Guideway design. We expect cuts on the order of 11 to 13 feet from existing grade to reach a suitable excavation bottom. Soils encountered at anticipated subgrade elevations consist of poorly graded sand and lean clay soils and appear suitable for support of proposed fill and station construction.

The subgrade should be sloped to promote drainage to low areas where drain tile can remove any excess water. Anticipated excavation depths and bottom elevations to reach the bottom of the station Guideway section at each of the borings are shown in Table 3 below. If there is a significant raise in grade for the track or structures, additional subcutting may be required. The final profiles should be reviewed by us to verify the anticipated excavation depths.

Table 3. Excavation Depths and Bottom Elevations to Bottom of Frost-Free Zone

Location	Ground Surface Elevation	Anticipated Excavation Depth (ft)	Corresponding Bottom Elevation
2002SS	895.0	14	881
2003SS	889.6	13	876 ½

Excavation depths will vary between the borings. Portions of the excavations may also be deeper than indicated by the borings. Contractors should also be prepared to extend excavations in wet or fine-grained soils to remove disturbed bottom soils.

To provide lateral support to replacement backfill, additional required fill and the structural loads they will support, we recommend oversizing (widening) the excavations 1 foot horizontally beyond the outer edges of the station platform, for each foot the excavations extend below bottom-of-footing.

D.1.b. Surface Compaction

We recommend soils exposed in the excavation bottoms be surface compacted prior to placement of backfill and fill or structures. Surface compaction should involve at least six passes of a vibratory sheepsfoot compactor (3 foot minimum in diameter). If groundwater is present in the excavation bottom, or if the excavation bottom soils become unstable through surface compaction, surface compaction should not be performed.

D.1.c. Selecting Excavation Backfill and Additional Required Fill

D.1.c.1. Subgrade Fill

We initially recommend backfilling over wet or submerged excavation bottoms with at least 2 feet of coarse sand having less than 70 percent of the particles by weight passing a #40 sieve, and less than 10 percent of the particles passing a #200 sieve. We anticipate that this material will need to be imported.

On-site soils free of organic soil and debris can be considered for reuse as subgrade backfill and fill. The clays, however, being fine-grained, will be more difficult to compact if wet or allowed to become wet, or if spread and compacted over wet surfaces.

Imported material needed to replace excavation spoils or balance cut and fill quantities, may consist of sand, silty sand, clayey sand, sandy lean clay or lean clay. We recommend, however, that the plastic index of these materials not exceed 20.

D.1.c.2. Guideway and Platform Station Fill

Based on the proposed design sections, the Guideway will be composed of 40-inch thick layer of granular material, under a minimum of 12-inches of subballast material. We recommend specifying Guideway fill to meet the requirements of the Minnesota Department of Transportation (MnDOT) 3149.2B2 (Select Granular Borrow) for the granular material, and 3138 (Aggregate Base) for the subballast.

D.1.d. Placement and Compaction of Backfill and Fill

We recommend spreading backfill and fill in loose lifts of approximately 6 to 12 inches. We recommend compacting backfill and fill in accordance with the criteria presented below in Table 4. The relative compaction of utility backfill should be evaluated based on the structure below which it is installed, and vertical proximity to that structure.

Table 4. Material and Compaction Specification for Backfill and Fill

Material	Material Specification	Compaction Specification
Guideway Subgrade Fill	Onsite Material Free of Debris and Organic Material	100% of standard Proctor Density (ASTM D698)
Guideway Select Granular Layer	MnDOT 3149.2B2*	100% of standard Proctor Density (ASTM D698)
Guideway Subballast	MnDOT 3138	MnDOT 2211.3C

*-Select Granular Borrow Modified 10%

D.1.e. Subgrade Drainage

We recommend crowning the subgrade, so excess water entering the Guideway fill can be collected and routed away to a storm sewer. We recommend installing perforated drainpipes at the bottom of the Select Granular drainage layer, outside of the track footprint at points to which the subgrade is directed. We recommend perforated drain pipe used be placed within a Coarse Filter Aggregate material (MnDOT Specification 3149.2H) with a geotextile separation fabric separating it from the Select Granular Material.

D.2. Spread Footings

D.2.a. Embedment Depth

We recommend embedding footings and other footings associated with canopies, stoops or sidewalks 60 inches below the lowest exterior grade.

D.2.b. Subgrade Improvement

Prior to placing fill, forms or reinforcement, we recommend surface compacting the exposed subgrade. If unstable soils are encountered, they should be subcut and replaced with more favorable granular soils.

D.2.c. Net Allowable Bearing Pressure

We recommend sizing spread footings to exert a net allowable bearing pressure of 2,500 pounds per square foot (psf). This value includes a safety factor of at least 3.0 with regard to bearing capacity failure.

D.2.d. Settlement

We estimate that total and differential settlements among the footings will amount to less than one-inch and ½-inch, respectively, under the assumed loads.

D.3. Slab-On-Grade Construction

We anticipate the slab-on-grade for the station platform will be supported by the Guideway fill. We recommend using a modulus of subgrade reaction, k, of 200 pounds per square inch per inch of deflection (pci) to design the slab. Also, we recommend a minimum of 6 inches of aggregate base be provided below the platform slab. We recommend following the compaction criteria provided in Section D.1.d.

D.4. Exterior Slabs

Though not necessarily designed to accommodate dead and live load surcharges or vehicles, exterior slabs can be subjected to both. Settlement of exterior slabs on poorly compacted foundation backfill, utility backfill, and other compressible natural deposit soils or fills can also contribute to unfavorable surface drainage conditions and frost-related damage to the slabs and adjacent structures and pavements. Subgrades supporting exterior slabs should therefore consist of non-organic compacted fill or native soils. To accommodate the potential for exterior slabs bearing unanticipated traffic loads, we recommend using the compaction criteria provided in Section D.1.d. We anticipate that a majority of exterior slabs associated with station construction will be placed on the Guideway fill section. For exterior slabs not supported by the Guideway fill, we recommend a transition zone of at least 5:1 (H:V) to reduce the effects of differential frost heave away from the station.

D.5. Construction Quality Control

D.5.a. Excavation Observations

We recommend having a geotechnical engineer observe all excavations related to subgrade preparation and spread footing and slab-on-grade construction. The purpose of the observations is to evaluate the competence of the geologic materials exposed in the excavations, and the adequacy of required excavation oversizing.

D.5.b. Materials Testing

We recommend density tests be taken in excavation backfill and additional required fill placed below spread footings, slab-on-grade construction, beside foundation walls, and below pavements.

We also recommend slump, air content and strength tests of portland cement concrete.

D.5.c. Cold Weather Precautions

If site grading and construction is anticipated during cold weather, all snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on frozen subgrades. No frozen soils should be used as fill.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed on frozen subgrades. Concrete should be protected from freezing until the necessary strength is attained. Frost should not be permitted to penetrate below footings.

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were drilled with a flotation tired-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 ½ -foot intervals to termination depth. Actual sample intervals and corresponding depths are shown on the boring logs.

Penetration test boreholes that met the Minnesota Department of Health (MDH) Environmental Borehole criteria were sealed with an MDH-approved grout. Sealing records for those boreholes will be forwarded to the Minnesota Department of Health Well Management Section. Copies of the sealing records follow the Log of Boring sheets in the Appendix.

E.2. Material Classification and Testing

E.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars and returned to our facility for review and storage.

E.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM or AASHTO procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled as noted on the boring logs.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

F.3. Use of Report

This report is for the exclusive use of Southwest Light Rail Transit. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

If there are questions regarding these recommendations, please call Josh Kirk at 952.995.2222 jkirk@braunintertec.com or Ray Huber at 952.995.2260 rhuber@braunintertec.com at your convenience.

Sincerely,

BRAUN INTERTEC CORPORATION

Professional Certification:
I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

JOSHUA L. KIRK
LICENSED PROFESSIONAL ENGINEER
45005
STATE OF MINNESOTA

Joshua L. Kirk, PE
Associate-Project Engineer
License Number: 45005

Reviewed by:

FOR:

Ray A. Huber, PE
Vice President-Principal Engineer

Reviewed by:

Matthew P. Ruble, PE
Principal Engineer

Appendix:
Boring Location Sketch
Preliminary Engineering Plan and Profile Page W2-TRK-PPFL-010
Standard Penetration Borings 2002SS and 2003SS
SPT Descriptive Terminology

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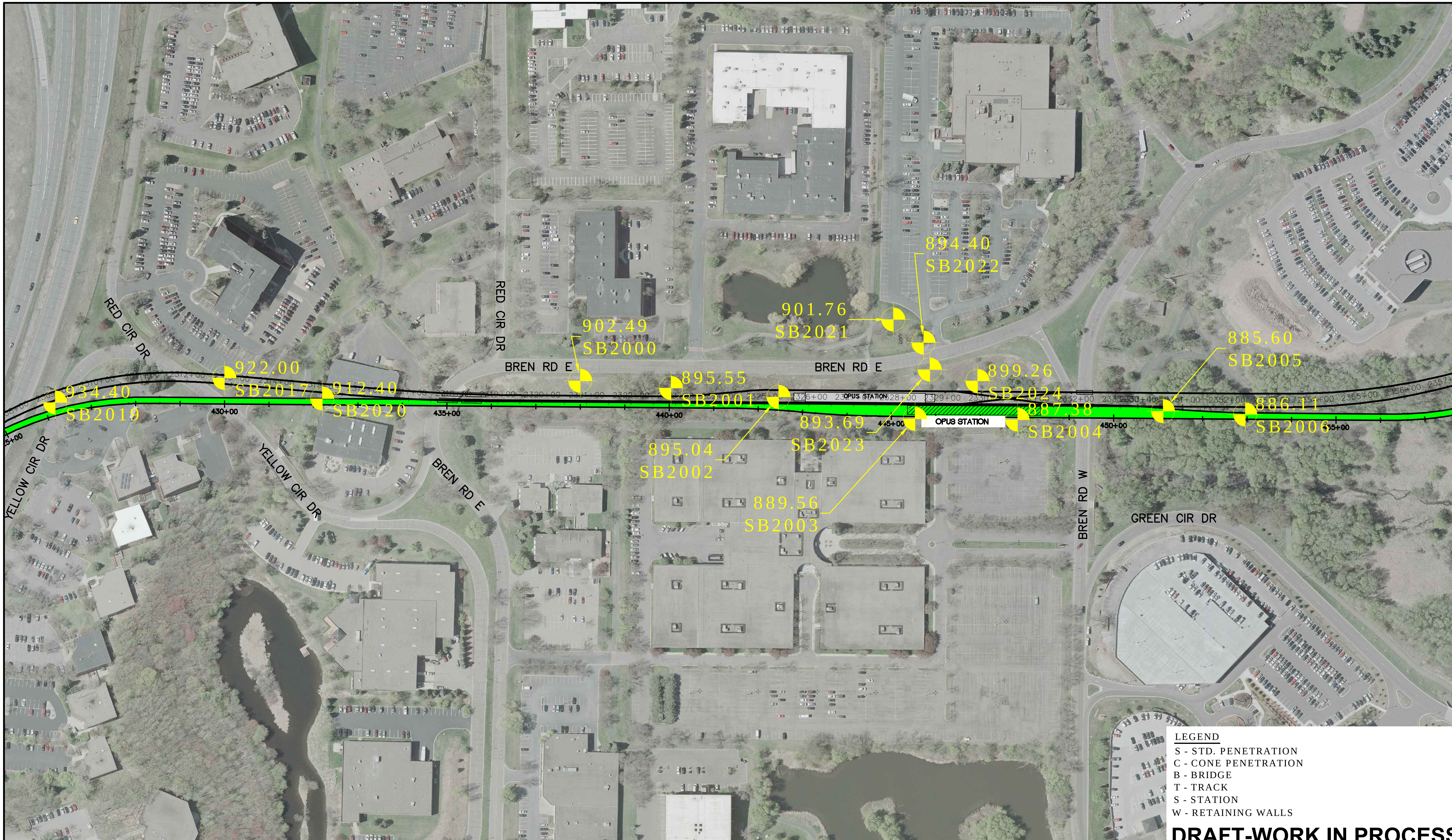
APPENDIX



LEGEND
S - STD. PENETRATION
C - CONE PENETRATION
B - BRIDGE
T - TRACK
S - STATION
W - RETAINING WALLS

DRAFT-WORK IN PROCESS

SOUTHWEST Green Line LRT Extention

SOUTHWEST LIGHT RAIL

SOIL BORINGS
SHEET 9 OF 12

IRT: N/A
REV: 0
DATE: 06/03/2014

NORTH
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METROPOLITAN COUNCIL
AECOM
SRF Consulting Group, Inc.

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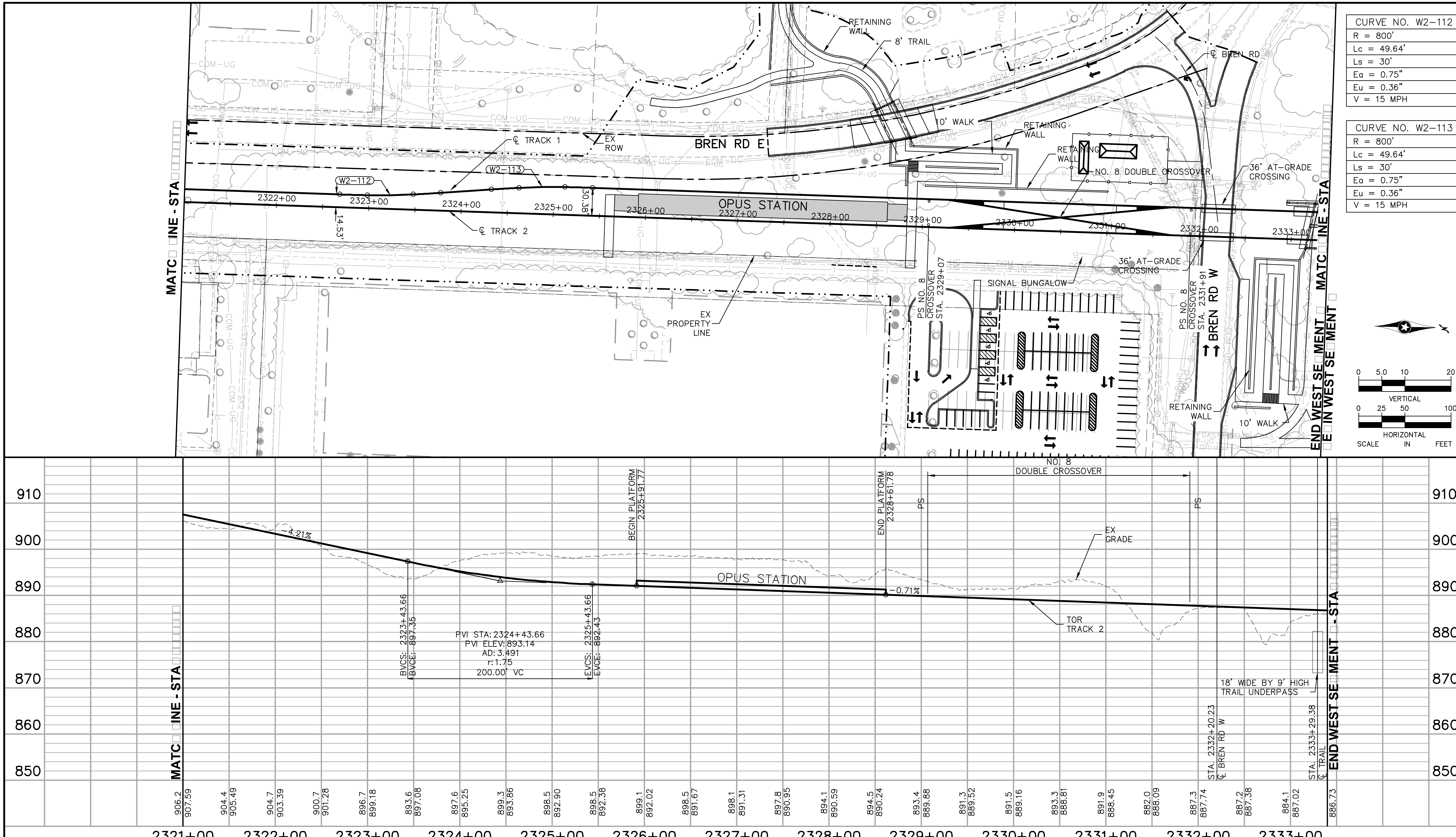

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SOUTHWEST Green Line LRT Extension

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BRAUN INTERTEC

Braun Project BL-13-00213 GEOTECHNICAL EVALUATION SWLRT Minnetonka, Minnesota	BORING: 2002SS LOCATION: N: 138695.2; E: 492065.8 See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/4/13	SCALE: 1" = 4'

Elev. feet 895.0	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
894.2	0.8	FILL	FILL: Clayey Sand, trace roots, dark brown, frozen. (Topsoil Fill)			
888.0	7.0	FILL	FILL: Clayey Sand, trace Gravel, brown, dry to moist.	25 19		
886.0	9.0	FILL	FILL: Organic Clay, black, wet.	14		
881.0	14.0	OL	ORGANIC CLAY, black, wet. (Swamp Deposit)	7 6		
877.0	18.0	CL	LEAN CLAY, brown, wet, very stiff. (Glacial Till)	18		
869.0	26.0	CL	SANDY LEAN CLAY, trace Gravel, gray, wet, very stiff to hard. (Glacial Till)	32 19	▽	
			END OF BORING. Water observed at 20 feet with 20 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.			

(See Descriptive Terminology sheet for explanation of abbreviations)

BRAUN INTERTEC

Braun Project BL-13-00213
GEOTECHNICAL EVALUATION
SWLRT
Minnetonka, Minnesota

BORING: **2003SS**
LOCATION: N: 139002.2; E: 492115.2
See attached sketch.

DRILLER: M. Belch	METHOD: 3 1/4" HSA, Autohammer	DATE: 4/5/13	SCALE: 1" = 4'

Elev. feet 889.6	Depth feet 0.0	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	MC %	Tests or Notes
888.6	1.0	FILL	FILL: Sandy Lean Clay, dark brown, frozen.				
882.6	7.0	FILL	FILL: Poorly Graded Sand with Silt, fine- to medium-grained, trace Gravel, brown, moist.	11 6			
880.6	9.0	PT	PEAT, fibrous, black, wet. (Swamp Deposit)	6			
877.6	12.0	OL	SLIGHTLY ORGANIC CLAY, with roots, black, wet. (Swamp Deposit)	2		28	OC=3%
876.6	13.0	ML	SILT, trace roots, gray, moist, loose. (Alluvium)	8			
865.6	24.0	SP	POORLY GRADED SAND, fine- to medium-grained, trace Gravel, with occasional Lean Clay lenses, gray, moist to 15 feet then waterbearing, loose. (Glacial Outwash)	6 9	▽		
863.6	26.0	CL	LEAN CLAY, trace Gravel, gray, wet, rather stiff. (Glacial Till)	11			
			END OF BORING. Water observed at 15 feet with 15 feet of hollow-stem auger in the ground. Water observed at 16 feet with 24 1/2 feet of hollow-stem auger in the ground. Boring immediately backfilled with bentonite grout.				

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\MINNEAPOLIS\2013\00213.GPJ BRAUN_V8_CURRENT.GDT 8/19/14 09:53

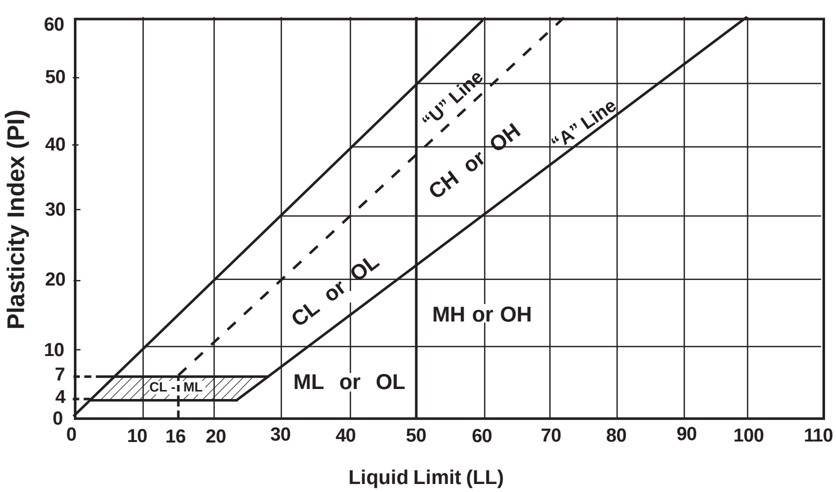
BRAUN INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification: Group Symbol	Soils Classification: Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	**Gravels** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [c]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** 5% or less fines [i]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [i]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $\quad C_c = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
   GW-GM well-graded gravel with silt
   GW-GC well-graded gravel with clay
   GP-GM poorly graded gravel with silt
   GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
   SW-SM well-graded sand with silt
   SW-SC well-graded sand with clay
   SP-SM poorly graded sand with silt
   SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	**OC**	Organic content, %
WD	Wet density, pcf	**S**	Percent of saturation, %
MC	Natural moisture content, %	**SG**	Specific gravity
LL	Liqiuid limit, %	**C**	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	**qu**	Unconfined compressive strength, psf
P200	% passing 200 sieve	**qp**	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders .... over 12"
Cobbles .... 3" to 12"
Gravel
  Coarse .... 3/4" to 3"
  Fine .... No. 4 to 3/4"
Sand
  Coarse .... No. 4 to No. 10
  Medium .... No. 10 to No. 40
  Fine .... No. 40 to No. 200
Silt .... < No. 200, PI < 4 or below "A" line
Clay .... < No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose .... 0 to 4 BPF
Loose .... 5 to 10 BPF
Medium dense .... 11 to 30 BPF
Dense .... 31 to 50 BPF
Very dense .... over 50 BPF

Consistency of Cohesive Soils

Very soft .... 0 to 1 BPF
Soft .... 2 to 3 BPF
Rather soft .... 4 to 5 BPF
Medium .... 6 to 8 BPF
Rather stiff .... 9 to 12 BPF
Stiff .... 13 to 16 BPF
Very stiff .... 17 to 30 BPF
Hard .... over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.