

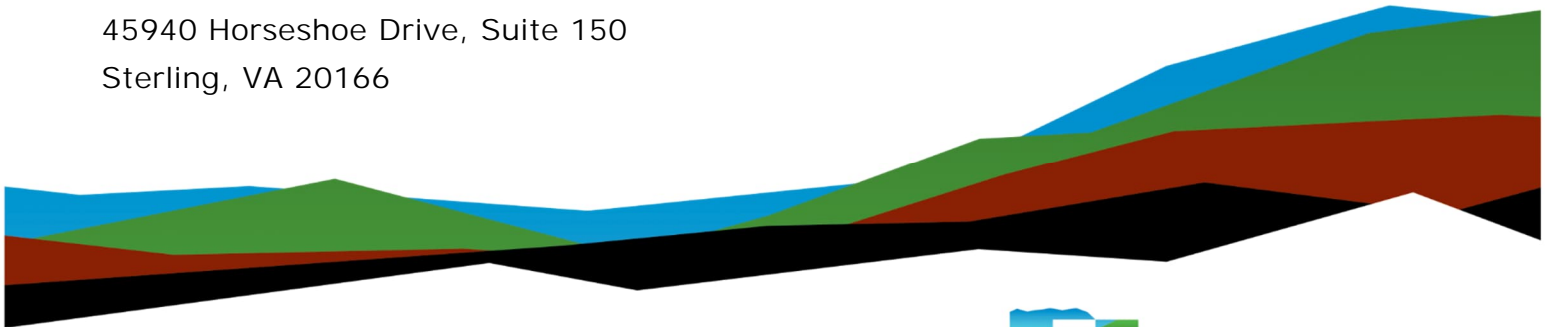
Costco Wholesale Warehouse, Lee's Summit, MO CW# 25- 0146

Geotechnical Engineering Report
Lee's Summit, MO

August 6, 2025 | Terracon Project No. 02255162

Prepared for:

Costco Wholesale Corporation
45940 Horseshoe Drive, Suite 150
Sterling, VA 20166



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August 6, 2025

Costco Wholesale Corporation
45940 Horseshoe Drive, Suite 150
Sterling, VA 20166

Attn: Steve Cross
P: (847) 498-0800
E: C_Stephencross@costco.com

Re: Geotechnical Engineering Report
Costco Wholesale Warehouse, Lee's Summit, MO CW# 25-0146
State Route 291 and Oldham Parkway
Lee's Summit, Missouri
Terracon Project No. 02255162

Dear Mr. Cross:

We have completed the scope of Geotechnical Engineering services for the referenced project in general accordance with Terracon Proposal No. P02255162 May, 25, 2025. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundations and floor slabs for the proposed project. A DRAFT Environmental Phase I Assessment was provided for the project (Project No. 02255162; report dated June 23, 2025).

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,

Terracon

Laura Wagner-Bartz, P.E.
Geotechnical Department Manager

Alex A. Goharioon

Senior Principal

Kole Berg, P.E.
Senior Consultant/Principal

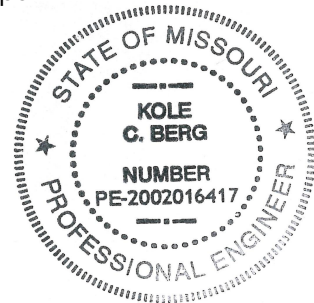


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Site Location and Exploration Plans

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Municipal Water Quality Report

Costco Asphalt Paving Specifications Section 321216

Supporting Information

Note: This report was originally delivered in a web-based format. **Blue Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the  Terracon logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

Refer to each individual Attachment for a listing of contents.

General Information

Costco Wholesale Real Estate Main Contact: Stephen Cross

Geotechnical Main Contact: Alex Goharioon

Geotechnical Engineer of Record: Kole Berg, P.E.

Project Location

CW #: 25-0146

Warehouse #: Lee's Summit, MO

Report Date: July 18, 2025

Consultant Project/Document Number: 02255162

Addendums (List): _____

Report Purpose: Preliminary Draft Final Addendum/Revision

Geotechnical Investigation Summary Checklist	Yes	No or NA	Describe / Comments	Report Section
Pre-existing Conditions / Information				
Developer provided geotechnical report (describe):	<input type="checkbox"/>	x		
Pre-existing development (describe)	<input type="checkbox"/>	x		
Foundation type (describe):	<input type="checkbox"/>	x		
Performance Issues (describe):	x		Debris in undocumented fill from demolished previous site structures. High volume change material near surface.	Pg. 4
Environmental Issues (describe)	<input type="checkbox"/>	x	See Phase I Assessment	
Site Grading Records (stripping, compaction test results, field reports, etc.)	<input type="checkbox"/>	x		
Typical Building Structural Design Criteria				
Other (describe):				
Building size (describe):				
<i>Typical wall loading</i>				
3,000 pounds per linear foot [1361 kilograms per 0.31 m] for Metal Buildings	x	<input type="checkbox"/>		Pg. 2
4,500 pounds per linear foot [2041 kilograms per 0.31 m] CMU or pre-cast	x	<input type="checkbox"/>		Pg. 2
<i>Typical column loading</i>				
120,000 pounds [54430 kilograms] in non-snow regions	<input type="checkbox"/>	x		Pg. 2
150,000 pounds [68040 kilograms] in snow regions	x	<input type="checkbox"/>		Pg. 2
Typical canopy loading: 50,000 pounds [22680 kilograms]	x	<input type="checkbox"/>		Pg. 2
1. <i>Typical floor slab loading</i>				

Geotechnical Investigation Summary Checklist	Yes	No or NA	Describe / Comments	Report Section
500 pounds per square foot [24 kPa], (psf, total)	x	<input type="checkbox"/>		Pg. 2
250 pounds per square foot [12kPa] (dead) at rack areas	x	<input type="checkbox"/>		Pg. 2
150 pounds per square foot (7.2kPa) (dead) at non-rack areas	x	<input type="checkbox"/>		Pg. 2
350 pounds per square foot (16.8kPa) (live)	x	<input type="checkbox"/>		Pg. 2
<i>Paving Design (twenty (20) year life)</i>				
Heavy Duty paving shall accommodate thirty (30) trucks per day (Traffic Index of 7.0)	x	<input type="checkbox"/>		Pg. 3
Light Duty paving shall Accommodate 6,600 cars per day (Traffic Index of 5.0)	x	<input type="checkbox"/>		Pg. 3
Performance Grade (PG) binder oil identified for local climate conditions	x	<input type="checkbox"/>		Pg. 3
<i>Site Grading Conditions/Assumptions</i>				
Deviations to Typical Criteria (list / describe):	x	<input type="checkbox"/>	Chemical stabilization of soil	Pg. 12
Design Finished Floor Elevation (FFE) (describe):	x	<input type="checkbox"/>	FFE EI 1052 (warehouse) Preliminary FFE EI 1049 (fuel canopy)	ii
Basis for FFE (assumed, per Civil) (describe):	x	<input type="checkbox"/>	Provided by MG2 on 7/3/2025	ii
Effects of change to assumed FFE (describe):	x	<input type="checkbox"/>	Changes in FFE will change excavation of debris quantities	
Maximum anticipated cuts (describe):	x	<input type="checkbox"/>	1 feet of cut within fuel center and 3 feet of cut in warehouse. Up to 8 feet of cut anticipated in parking and drive areas.	Pg. 2
Maximum anticipated fills (describe):	x	<input type="checkbox"/>	3 feet of fill at fuel center footprint and 1 feet of fill at warehouse footprint. Up to 6 feet of fill anticipated along west property boundary and in southeast corner of site.	Pg. 2
Cross sections prepared for sites that are not essentially flat	x	<input type="checkbox"/>		Exploration Results
Amount of import / export anticipated (describe):	<input type="checkbox"/>	x	Not provided	
Frost Depth (describe):	x	<input type="checkbox"/>	36 inch frost depth	Pg. 6
<i>Retaining walls</i>				
Number of walls (describe):	<input type="checkbox"/>	x		
Height / Length of walls (describe):	<input type="checkbox"/>	x		
Wall construction / type (describe):	<input type="checkbox"/>	x		
Cut / fill transition in pad (describe):	<input type="checkbox"/>	x		
Offsite Improvements (describe)	<input type="checkbox"/>	x		
<i>Fieldwork / Results</i>				
<i>Due Diligence Design Criteria</i>				
Version (describe):	<input type="checkbox"/>	<input type="checkbox"/>		
Followed Criteria?	x	<input type="checkbox"/>		Exploration and Testing Procedures

Geotechnical Investigation Summary Checklist	Yes	No or NA	Describe / Comments	Report Section
Deviations to standard investigation (describe):	x	<input type="checkbox"/>	Additional test pits to verify extent of debris in fill	Testing Procedure s
<i>Groundwater</i>				
Depth (describe):	x	<input type="checkbox"/>	1 boring encountered water at 3 feet from an abandoned pipe; groundwater was not encountered in any boring	Testing Procedure s
Perched	x	<input type="checkbox"/>	Minimal water encountered	
Expected seasonal fluctuation (describe):	x	<input type="checkbox"/>	Some fluctuation in groundwater with higher groundwater in the spring and fall typical for this climate	Pg. 9
Piezometers installed?	x	<input type="checkbox"/>	At FC-1 boring location.	i
<i>Unusual / Challenging Soils conditions encountered</i>				
Moisture-sensitive soils	x	<input type="checkbox"/>		Pg. 8
Undocumented fill	x	<input type="checkbox"/>	Fill with debris from assumed previous site demolition, including rebar, clay pipe, concrete and asphalt	Pg. 8
Unsuitable soils (require removal)	x	<input type="checkbox"/>	Remove undocumented fill	Pg. 8
Wet soils	<input type="checkbox"/>	x		
Debris	<input type="checkbox"/>	x		
Bedrock / potential non-rippable conditions	x	<input type="checkbox"/>	Sandstone bedrock anticipated to be near the fuel tank storage elevation	i
Refusal	<input type="checkbox"/>	x		
Collapsible soils	<input type="checkbox"/>	x		
Expansive soils	<input type="checkbox"/>	x	Recommend floors slabs be supported over at least 24 inches of low volume change (LVC) materials.	Pg. 13
Compressible soils	x	<input type="checkbox"/>		Pg. 8
Liquefaction	<input type="checkbox"/>	x		
Sinkholes	<input type="checkbox"/>	x		
Other (describe):	<input type="checkbox"/>	x		
<i>Potential Contamination Identified</i>				
Soil	<input type="checkbox"/>	x		
Groundwater	<input type="checkbox"/>	x		
<i>Restoration of Disturbed Areas</i>				
Backfilled with soil	x	<input type="checkbox"/>		Testing Procedure s
Backfilled with grout	<input type="checkbox"/>	x		
Other (describe):	<input type="checkbox"/>	x		
Topsoil samples collected / analyzed	x	<input type="checkbox"/>		Pg. 11

Geotechnical Investigation Summary Checklist	Yes	No or NA	Describe / Comments	Report Section
Corrosivity testing performed/addressed	x	<input type="checkbox"/>		Pg. 7
Culinary water quality testing performed	<input type="checkbox"/>	x		
Report				
Executive summary	x	<input type="checkbox"/>		i
Wet weather construction recommendations	<input type="checkbox"/>	x		
Pad winterization/pad recommendations	<input type="checkbox"/>	x		
Frost protection recommendations	<input type="checkbox"/>	x		
Design Parameters				
<i>Fill material parameters provided</i>				
Structural fill (below foundations, slabs)	x	<input type="checkbox"/>		Pg. 13
Site grading fill (below pavements, flatwork)	x	<input type="checkbox"/>		Pg. 13
Select backfill (behind truck dock walls, foundations, grade beams, etc.)	x	<input type="checkbox"/>		Pg. 13
Trench backfill	x	<input type="checkbox"/>		Pg 15
Drainage fill	x	<input type="checkbox"/>		Pg. 15
Frost resistant fill	x	<input type="checkbox"/>		Pg. 30
Slab base aggregate	x	<input type="checkbox"/>		Pg. 20
Limits of debris / unsuitable removal provided	<input type="checkbox"/>	x		
<i>Over-excavation / re-compaction required</i>				
Depth (describe):	x	<input type="checkbox"/>		
Extent (include cross-section diagram)	x	<input type="checkbox"/>		
Pad subgrade stabilization required (describe):	<input type="checkbox"/>	x		
<i>Surcharge</i>				
Height (describe):	<input type="checkbox"/>	x		
Lateral extent (describe):	<input type="checkbox"/>	x		
Estimated duration (describe):	<input type="checkbox"/>	x		
<i>Shallow Foundations</i>				
Pounds per square foot (kPa per m) allowable soil bearing pressure (describe):	x	<input type="checkbox"/>	2500 PSF following removal of fill and replacement to the bearing depth with structural fill	Pg. 18
<i>Deep Foundations</i>				
Type (describe):	<input type="checkbox"/>	x		
Options and Value Engineering Matrix provided	<input type="checkbox"/>	x		
<i>Floor Slabs</i>				
Unreinforced (>2500 pound per square foot) [>120 kPa]	<input type="checkbox"/>	<input type="checkbox"/>		Pg. 18
Reinforced (describe why)	<input type="checkbox"/>	<input type="checkbox"/>		
Subgrade modulus (pounds per square inch per inch [kPa / mm]) (describe):	<input type="checkbox"/>	<input type="checkbox"/>	150 psi/inch (supported on 24 inches of granular LVC)	Pg. 20

Geotechnical Investigation Summary Checklist	Yes	No or NA	Describe / Comments	Report Section
Base Material thickness (minimum six (6) inch [152.4 mm]) (describe):	<input type="checkbox"/>	<input type="checkbox"/>	6 inch levelling course and 18 inches of LVC	Pg. 20
<i>Seismic Conditions</i>				
Governing Building Code (IBC, UBC, other)	x	<input type="checkbox"/>		Pg. 6
Geologic Hazard Identified		x		
Proximity to earthquake fault zone(s)	<input type="checkbox"/>	x		
Proximity to seismic hazard zone(s)	<input type="checkbox"/>	x		
Potential for liquefaction	<input type="checkbox"/>	x		
Potential for lateral spreading	<input type="checkbox"/>	x		
Potential for seismic settlement	<input type="checkbox"/>	x		
Potential for slope stability/landslides	<input type="checkbox"/>	x		
Potential for ground shaking or geologic hazards	<input type="checkbox"/>	x		
<i>Retaining Walls</i>	<input type="checkbox"/>	x		
Recommended Wall Types	<input type="checkbox"/>	x		
Recommend Kleinfelder Design	<input type="checkbox"/>	x		
<i>Lateral earth pressure design values</i>				
Active:	x	<input type="checkbox"/>		Pg. 22
At-rest:	x	<input type="checkbox"/>		Pg. 22
Passive:	x	<input type="checkbox"/>		Pg. 22
Seismic:	x	<input type="checkbox"/>	Site Class C	Pg. 6
Backfill material, placement requirements	x	<input type="checkbox"/>		
Drainage requirements and cross-section drawing	<input type="checkbox"/>	x		
<i>Finger Drains</i>				
Required for frost	<input type="checkbox"/>	x		
Recommended for long term maintenance and constructability	<input type="checkbox"/>	x		
<i>Pavement</i>				
Pavement subgrade stabilization required (describe):	x	<input type="checkbox"/>		Pg. 26
Asphalt mix design specified	x	<input type="checkbox"/>		Pg. 26
Heavy and light duty pavement sections specified	x	<input type="checkbox"/>		Pg. 26
Alternative pavement sections identified	x	<input type="checkbox"/>	PG64-22	Pg. 26
Specification for offsite pavement sections included	<input type="checkbox"/>	x		
Data Gaps / Unknowns (describe):	<input type="checkbox"/>	x	.	

Executive Summary

The following is a summary of our geotechnical exploration and laboratory testing programs, as well as geotechnical considerations developed to date for this project.

General Subsurface Conditions

Topic	Discussion
Site Conditions and Historical Developments	Based on historical imagery, the site has been previously developed. It appears the most recent development at the site has been fully demolished, with the exception of a small area of concrete pavement. Additional descriptions of the site are in the Site Conditions section of this report.
Subsurface Conditions	The subsurface conditions at the project site generally consist of approximately 20 feet of native soil consisting of medium stiff to stiff fat clay overlying bedrock strata. Topsoil is present throughout the site with an average thickness of 6 inches. Areas that have been previously developed have undocumented fill typically extending 2 to 4 feet below the ground surface, with isolated areas of fill up to 8.5 feet thick. The bedrock encountered at the site consists of shale and sandstone. Further information regarding subsurface conditions is provided in the Geotechnical Characterization section of this report.
Groundwater	Groundwater was not encountered at the time of our field exploration. One boring encountered water at a depth of about 3 feet while drilling; however, this water was from an abandoned in-place pipe and not groundwater. Groundwater conditions may change due to site development, seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. A groundwater monitoring well was installed in one a boring at the proposed underground storage tanks location to monitor the water level after the field exploration is completed. Delayed groundwater readings will be provided in our final Geotechnical Engineering Report for the project.
Seismic Considerations	The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of standard penetration resistance in accordance with Section 20.4 of ASCE 7. Based on the soil conditions as described on the boring logs, it is our professional opinion that the Seismic Site Classification is C.
Liquefaction	Based on the results of our exploration, liquefaction is not expected based on the soil composition, soil density, and the relatively low level of ground motions associated with the design earthquake.



Further details regarding subsurface conditions are summarized in the Geotechnical Characterization section. A table indicating exploration locations where rock and fill materials were encountered is provided below.

Name	Latitude	Longitude	Elevation (ft) ¹	Estimate of FFE or Site Grade ²	Depth of Fill Material Encountered (ft)	Depth to Rock (ft)
B- 1	38.9023	-94.3738	1057	1052	1	17
B- 2	38.9020	-94.3738	1055	1052	—	19.5
B- 7	38.9014	-94.3752	1050	1052	—	16
B- 8	38.9017	-94.3753	1052	1052	—	17
B- 9	38.9017	-94.3755	1049	1052	—	17
B-10	38.9020	-94.3755	1052	1052	—	17
B-11	38.9024	-94.3755	1053	1052	—	15
B-12	38.9023	-94.3749	1054	1052	8.5	17
B-13	38.9023	-94.3743	1054	1052	—	18
B-14	38.9021	-94.3752	1053	1052	—	16
B-15	38.9021	-94.3746	1054	1052	—	19
B-16	38.9020	-94.3741	1054	1052	—	18
B-17	38.9019	-94.3750	1054	1052	—	17
B-18	38.9019	-94.3744	1054	1052	—	18
B-19	38.9017	-94.3746	1054	1052	—	16
B-20	38.9015	-94.3749	1052	1052	5	18
B-21	38.9016	-94.3741	1053	1052	8	19
FC-1	38.9006	-94.3729	1052	1045	—	20
FC-2	38.9004	-94.3728	1052	1046	—	21.5
FC-3	38.9005	-94.3726	1052	1044	—	22
FC-4	38.9002	-94.3726	1049	1047	—	21
P-1	38.9023	-94.3731	1053	1049	6	—
TP-1	38.9019	-94.3738	1055	1052	6	—
TP-3	38.9019	-94.3755	1051	1052	3.5	—
TP-4	38.9023	-94.3746	1054	1052	4	—
TP-6	38.9022	-94.3755	1052	1052	5	—
TP-7	38.9018	-94.3729	1053	1047	2	—
TP-8	38.9010	-94.3731	1053	1047	2.5	—
TP-9	38.9008	-94.3746	1053	1048	1.5	—
TP-10	38.9009	-94.3756	1052	1048	3	—
TP-12	38.9010	-94.3754	1057	1049	1	—
TP-13	38.9020	-94.3754	1054	1052	3.5	—
TP-14	38.9016	-94.3751	1055	1052	4	—

Name	Latitude	Longitude	Elevation (ft) ¹	Estimate of FFE or Site Grade ²	Depth of Fill Material Encountered (ft)	Depth to Rock (ft)
TP-15	38.9022	-94.3738	1056	1052	4	—
TP-16	38.9010	-94.3740	1057	1050	1	—
TP-17	38.9008	-94.3756	1054	1047	3	—
TP-18	38.9016	-94.3743	1057	1052	1.5	—
TP-19	38.9012	-94.3741	1058	1050	3	—

Further details regarding subsurface conditions will be summarized in the [Geotechnical Characterization](#) section of this Geotechnical Engineering Report.

Geotechnical Considerations

The soils encountered at the site appear suitable for construction of the planned Costco project, provided improvements or corrections of the conditions discussed herein. We have identified existing undocumented fill and expansive clays as a geotechnical condition that may impact the proposed design and construction. This will require particular attention in project planning, design and during construction and are discussed in greater detail in the following sections and are discussed in greater detail in the [Geotechnical Overview](#) section of this report.

Design and Construction Recommendations

Topic	Discussion
Earthwork	Earthwork is anticipated to include demolition, clearing and grubbing, excavations, and engineered fill placement. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements. Recommendations for earthwork are provided in the Earthwork Section of this report.



Topic	Discussion
Warehouse Recommendations	<p>The project includes a roughly 162,000 square-foot (sf) Costco building planned to be built in the northwest portion of the site. The building will be slab-on-grade (non-basement) with loading docks.</p> <p>It is our opinion that a shallow foundation system will be suitable to support the proposed warehouse. Based on the conditions encountered, a maximum allowable soil bearing pressure of 2,500 pounds per square foot (psf) can be used for foundation design when bearing on stiff, native clay soils or structural fill. Some localized overexcavation of lower strength clays and replacement with structural fill may be required to achieve this bearing pressure. If a higher allowable bearing pressure is required, a ground improvement system could be installed to support the shallow foundations. Recommendations for foundations are presented in the Shallow Foundations section of this report.</p> <p>A slab-on-grade floor slab can be used for the proposed Costco Warehouse building. We recommend that the floor slab be constructed on a minimum 6-inch-thick aggregate base course layer placed over at least 18 inches of compacted LVC structural fill. The combined aggregate base course and structural fill layers should result in a minimum 24-inch LVC zone to mitigate effects of the potentially expansive clay subgrades. It should be noted that the subgrade and 6-inch-thick layer of base course materials are not designed to support heavy construction equipment (such as scrapers and haul trucks). Consequently, construction equipment could degrade the subgrade. It is the contractor's responsibility to maintain the integrity of the subgrade during construction activities. We understand that Costco Wholesale has determined that vapor barriers are not to be used in construction of Costco Wholesale structures due to adverse effects on concrete curing and performance. Recommendations for slabs are presented in the Floor Slabs and Exterior Slabs section of this report.</p>
Fuel Facility Recommendations	<p>One fuel facility is located at the southeast end of the site and is planned to include three, 40,000-gallon underground storage tanks, buried at depths of about 18 feet below existing site grades.</p> <ul style="list-style-type: none"> ■ Proposed grading for fuel facility was provided at the time of this Executive Summary and indicated site grades in paving areas ranging from El 1044 to El 1050. Based on conversation with the project team, we understand the proposed fuel facility will be at or near existing site grades. Groundwater was not encountered during drilling and delayed water levels indicated no groundwater present. ■ Temporary dewatering of the underground storage tank (UST) excavations may be required due to water infiltration due to rainfall or surface water runoff; water runoff should be directed

Topic	Discussion
	<p>away from excavations. We anticipate that dewatering may be accomplished with filtered sumps, and pumps.</p> <ul style="list-style-type: none"> ■ ■ Excavations on the order of 20± feet will be required for underground storage tank installation. Consideration should be given to temporary shoring for the excavations for the USTs. Based on overburden soil type and groundwater condition within the area of fuel facility, we anticipate that the excavation will be in Type B Soil, which requires all simple slope excavations 20 feet or less in depth having a maximum allowable slope of 1:1 (horizontal : vertical). However, the Contractor is ultimately responsible for choosing means and methods for excavation support and for determining safe slopes for temporary excavations during construction. ■ ■ Excavation into bedrock consisting of sandstone with some shale seams is anticipated. We anticipate excavators equipped with jack-hammer attachments may be required to complete excavations within the bedrock. However, the Contractor should ultimately determine the appropriate means and methods. ■ All excavations should be performed in accordance with OSHA 29 CRF, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local, and/or state regulations. The Contractor should be ultimately responsible for choosing means and methods for excavation support. Recommendations for foundations are presented in the Shallow Foundations section of this report.
Lateral Earth Pressures	Structures with unbalanced backfill levels on opposite sides, such as truck loading docks, should be designed for earth pressures presented in the Lateral Earth Pressures section of this report.
Pavements	Recommended pavement thicknesses, in general accordance with Costco Asphalt Paving Specifications dated August 2024, include 4 inches of asphalt over 8 inches of aggregate base course in light-duty parking areas and 6 inches of asphalt over 8 inches of aggregate base course in heavy-duty drive lanes and loading areas. Additional pavement section alternatives and discussion are presented Pavements section of the report.
Stormwater Management Basins	Two below-grade stormwater management basins are anticipated to be constructed on the site. Lab infiltration tests were performed in the areas of the proposed stormwater management basins instead of field infiltration testing. Test results are provided in the Stormwater Management Basins section of this report.

Design Parameters

Shallow Foundations: Existing undocumented fill is not suitable bearing material and should be removed from the foundation bearing zones and replaced with compacted Structural Fill. More detailed design information will be provided in the Shallow Foundations section of our Geotechnical Engineering Report.

Item	Description
Maximum Net Allowable Bearing Pressure	Warehouse and Fuel Center 2,500 psf bearing on stiff native clays soils or Structural Fill OR >3,000 psf bearing on a ground improvement system
Ultimate Passive Resistance ¹ (equivalent fluid pressures)	290 pcf (Structural Fill)
Sliding Resistance ²	0.30 (Concrete on medium stiff to stiff clay) 0.45 (Concrete on Structural Fill)
Minimum Embedment below Finished Grade ³	Exterior footings: 36 inches Interior footings in unheated areas: 36 inches Interior footings in heated areas: 18 inches
Estimated Total Settlement from Structural Loads ²	about 1 inch
Estimated Differential Settlement ^{2, 4}	About 1/2 of total settlement

1. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure.
2. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
3. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
4. Differential settlements are as measured over a span of 50 feet. Larger foundation footprints will likely require reduced net allowable soil bearing pressures to reduce risk for potential settlement.

Concrete Slabs:

Item	Description
Building Floor Slab-on-Grade (without Reinforcement)	6 inches PCC over 6 inches aggregate base course ¹ overlying 18 inches structural fill (LVC)

Item	Description
Exterior Concrete Slab	6 inches PCC over 6 inches aggregate base course ¹ overlying 18 inches structural fill (LVC)
Fuel Facility Concrete Slab	6 inches PCC over 6 inches aggregate base course ¹ overlying 18 inches structural fill (LVC)
Estimated Modulus of Subgrade Reaction ²	150 pounds per square inch per inch (psi/in) for point loads

1. All materials should meet the current Missouri Department of Transportation (MoDOT) Standard Specifications for Highway Construction.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in Earthwork, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

Lateral Earth Pressures: Structures with unbalanced backfill levels on opposite sides, such as truck loading docks should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained.

Earth Pressure Condition ¹	Coefficient for Backfill Type ^{2,3,7}	Surcharge Pressure ⁴ p ₁ (psf)	Equivalent Fluid Unit Weight (pcf) ^{2,5}	
			Unsaturated ⁶	Submerged ⁶
Active (K _a)	Granular - 0.31	(0.31)S	40	80
	Clay - 0.42	(0.42)S	50	85
At-Rest (K _o)	Granular - 0.47	(0.47)S	60	90
	Clay - 0.58	(0.58)S	70	95
Passive (K _p)	Granular - 3.3	---	420	290
	Clay - 2.4	---	290	200

Earth Pressure Condition ¹	Coefficient for Backfill Type ^{2,3,7}	Surcharge Pressure ⁴ p ₁ (psf)	Equivalent Fluid Unit Weight (pcf) ^{2,5}	
			Unsaturated ⁶	Submerged ⁶

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, with a maximum unit weight of 120 pcf for granular soils.
3. Uniform surcharge, where S is surcharge pressure.
4. Loading from heavy compaction equipment is not included.
5. "Unsaturated" conditions are recommended when drainage behind walls is incorporated into the design. "Submerged" conditions are recommended when drainage behind walls is not incorporated into the design.
6. Backfill placed against structures should consist of granular soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.
7. Footings, floor slabs, pavements, or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

Stormwater Management Basins

Two stormwater management basins are anticipated to be constructed on the site. Based on local experience, laboratory permeability tests were conducted instead of field infiltration testing to estimate infiltration rates. Test results are as follows:

Test Location	Soil Strata	Approximate Depth of Test (Feet) ¹	Average Lab Measured Infiltration Rate (in./hour)
SB-1	Fat Clay	5-6.8	0.00044
SB-2	Fat Clay	10-11.4	0.00101
SB-3	Fat Clay	Results Pending	Results Pending
SB-4	Fat Clay	10-12	0.00014

1. Below Existing Site Grades. Infiltration rate tests were completed near the proposed bottom of stormwater management basins.

Pavements

The subgrades for rigid and flexible pavement systems are anticipated to consist of native clay or compacted General Fill placed above these materials. Undocumented fill material should be removed prior to placing pavement aggregate base course. Following

removal of undocumented fill and prior to placement of additional general fill, the entire pavement area should be proofrolled with a minimum 20-ton tandem-axle dump truck to aid in delineating areas of soft or otherwise unsuitable soil. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Unstable areas should be overexcavated to more competent material and replaced with compacted Structural Fill. Excessively wet or dry materials should either be removed, or moisture conditioned and recompacted.

A California Bearing Ratio (CBR) of 2.0 was used for the subgrade for the asphaltic concrete (AC) pavement designs. The value was based on our expectation of the quality of the subgrade as prescribed by the [Site Preparation](#) conditions and [Fill Material and Placement](#) outlined in the Earthwork section of this Executive Summary. A modulus of subgrade reaction of 120 pounds per cubic inch (pci) was used for the Portland cement concrete (PCC) pavement designs. If cuts and fills greater than 3 feet from existing grade within the parking areas are planned for the site, Terracon should be notified immediately to evaluate the potential impacts grade changes may have on the geotechnical design considerations and assess whether our recommendations remain valid or require modifications.

Recommended pavement thicknesses, in general accordance with *Costco Asphalt Paving Specifications* dated August 2024, are presented in the table below. The Pavements section of our Geotechnical Engineering Report will address the design of pavement systems.

Traffic patterns and anticipated loading conditions were based on "Section 9" of the "Costco Wholesale Development Requirements", Version 2024. An 18-kip equivalent single-axle load (ESAL) of 7,159 for standard duty parking areas and 121,010 for heavy duty areas was used based on a 20-year design life and the following Costco design requirements:

- Heavy Duty Pavements: ESALS of 121,010
- Standard Duty Pavements: ESALS of 7,159

Pavement Type	Material	Layer Thickness (inches)	
		Standard Duty	Heavy Duty
Flexible	Asphaltic Surface Course ¹ Superpave Surface – PG64-22	2	2
	Asphaltic Binder Course ¹ Superpave Surface – PG64-22	2	2
	Aggregate Base Course (MoDOT Type 5) ^{2, 3}	8	8
	Approved Proofrolled Soil Subgrade	12	12

Pavement Type	Material	Layer Thickness (inches)	
		Standard Duty	Heavy Duty
Rigid	Portland Cement Concrete ^{1, 2}	5	8
	Aggregate Base Course (MoDOT Type 5) ^{2, 3}	8	8
	Approved Proofrolled Soil Subgrade	12	12

1. Refer to *Costco Asphalt Paving Specifications, Section 321216*, dated August 2024.
2. All materials should meet the current Missouri Department of Transportation (MoDOT) Standard Specifications for Highways and Bridges. Portland Cement concrete pavements should meet MoDOT specifications, using a 28-day compressive strength of 4,000 psi and ¾-inch coarse aggregate.
3. Aggregate base courses should meet the fill materials described in the [Earthwork](#) section.

This Executive Summary Report should be used in conjunction with this geotechnical engineering report. The final report must be read in its entirety for a comprehensive understanding of the items contained herein. The [General Comments](#) section of this report should be read for an understanding of report limitations.

Introduction

This report presents the results of our subsurface exploration and Geotechnical Engineering services performed for the proposed Costco Wholesale Warehouse to be located at State Route 291 and Oldham Parkway in Lee's Summit, Missouri. The purpose of these services was to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and rock conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Demolition considerations
- Dewatering considerations
- Foundation design and construction
- Floor slab design and construction
- Lateral earth pressure
- Pavement design and construction
- Stormwater pond considerations
- Frost considerations

The geotechnical engineering Scope of Services for this project included the advancement of 21 test borings, 19 test pits, laboratory testing, engineering analysis, and preparation of this report. The soil borings and test pits were advanced to varying depths depending on their purpose, in general accordance with the "Costco Wholesale Development Requirements, Version 2024", last dated October 31, 2024.

Drawings showing the site and boring locations are shown on the [Site Location](#) and [Exploration Plan](#), respectively. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration are included on the boring logs and/or as separate graphs in the [Exploration Results](#) section.

Project Description

Our initial understanding of the project was provided in our proposal and was discussed during project planning. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	<p>The following information was provided by Costco and the project team:</p> <ul style="list-style-type: none"> ■ "Site Layout Plan C200", prepared by CEC Civile & Environmental Consultants, LLC Companies, dated July 3, 2025 ■ "Costco Wholesale Development Requirements, Version 2024", last dated October 31, 2024
Project Description	<ul style="list-style-type: none"> ■ Construction of a new, single-story, slab-on-grade Costco Wholesale Warehouse, fuel station, and pavements. ■ Two detention ponds are planned to be constructed in the southern portion of the site, adjacent to the proposed fuel facility location and in the northwestern portion of the site. ■ In addition, all existing structures/slabs will be removed, and mass grading of the roughly 27-acre site and construction of public improvements are planned.
Proposed Structures	<p>The project includes a roughly 162,000 square-foot (sf) Costco building planned to be built in the northeast portion of the site. The building will be slab-on-grade (non-basement) with loading docks.</p> <p>One fuel facility is located at the south end of the site and is planned to include three, 40,000-gallon underground storage tanks, buried at depths of about 18 feet below existing site grades.</p> <p>Two stormwater management basins are planned, with one located at the southeast end of the site and one located on the northwest end.</p>
Building Construction	<ul style="list-style-type: none"> ■ The Costco Warehouse is anticipated to be constructed with structural masonry or pre-cast concrete perimeter bearing walls with structural steel framing. ■ The Fuel Facility Canopy will be supported on steel columns on either shallow spread footings or drilled piers. Fuel storage will be provided by three 40,000-gallon underground storage tanks.
Finished Floor Elevation	<p>The Costco Warehouse is currently planned to have a finished floor elevation (FFE) of approximately 1052 feet.</p>
Maximum Loads ¹	<p>Costco Warehouse:</p> <ul style="list-style-type: none"> ■ Columns: 120 to 150 kips ■ Walls: 3 to 4.5 kips per linear foot (klf) ■ Floor slabs: 500 pounds per square foot (psf) (Total) and 350 psf (Live) <p>Fuel Facility Canopy:</p> <ul style="list-style-type: none"> ■ Axial Compression: 50 kips ■ Axial Uplift: 10 kips ■ Maximum Moment: 100 kip-feet <p>Light poles:</p> <ul style="list-style-type: none"> ■ Axial Compression: 10 kips
Allowable Settlements ¹	<p>Costco Warehouse and Fuel Facility shall not exceed the following settlements:</p>

Item	Description
	<ul style="list-style-type: none"> ■ Total: 1 inch ■ Differential: ½ inch over 50 feet
Grading/Slopes	<p>Based on provided site plans, we understand cuts and fills on the order of about 2 to 10 feet will be required to achieve final site grades.</p> <p>Based on provided site plans, we understand the site is primarily a fill site.</p> <ul style="list-style-type: none"> ■ The proposed warehouse is anticipated to have fill on the order of 3 to feet with an approximate new fill depth 5 feet. ■ Parking areas are anticipated to have fills on the order of about 1 to 8 feet ■ The fuel station is anticipated to have fill on the order of about 0 to 2 feet. ■ Minor cuts on the order of about 1 to 2 feet are anticipated in the drive lane areas on the southeast side of the site.
Below-Grade Structures	<p>Truck loading dock walls up to approximately 4 feet high are anticipated at the southeast building corner.</p> <p>Underground storage tanks are planned for the fuel facility. Depth of the proposed fuel tanks were not provided; however, we do not expect excavations for the proposed tanks to exceed 20 feet below ground surface.</p>
Free-Standing Retaining Walls	No retaining walls are planned.
Pavements ¹	<p>Both rigid (concrete) and flexible (asphalt) pavement sections are planned for the site. The pavement design period is 20 years for the following anticipated traffic conditions:</p> <ul style="list-style-type: none"> ■ Heavy Duty Pavements: 30 trucks per day (Traffic Index of 7.0), Equivalent Single Axle Load (ESAL) of 121,010 ■ Light Duty Pavements: 6,600 cars per day (Traffic Index of 5.0), ESAL of 7,159

1. Based on the "Costco Wholesale Development Requirements, Version 2024", dated October 31, 2024.

Terracon should be notified if any of the above information is inconsistent with the planned construction, especially the grading limits, as modifications to our recommendations may be necessary.

Site Conditions

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	<p>The project is located at State Route 291 and Oldham Parkway in Lee's Summit, Missouri.</p> <p>The 23.85-acre property includes a 22.22-acre Costco Parcel, 2.1 acres of detention ponds, and a 1.63-acre outlot.</p> <p>Latitude/Longitude (approximate): 38.9019, -94.3748 See Site Location</p>
Existing Improvements	<p>The site was previously occupied by an industrial facility. Oldham Road and 291 Highway are present along the north and west borders of the site; a railroad is present along the east site border. An undeveloped lot is present south of the site.</p>
Current Ground Cover	<p>Some concrete pads and/or drives are present. The remainder of the site is covered with grass and trees.</p>
Existing Topography	<p>The site is relatively flat within the proposed warehouse location, with existing surface grades ranging from El 1056 to 1050. Outside the planned warehouse footprint, the site slopes down gradually to the southeast to a low elevation of 1040. Boring depths have been estimated in part with this information and improved topographic information should be provided if available.</p>

We also collected photographs at the time of our field exploration program. Representative photos are provided in our [Photography Log](#).

Geotechnical Characterization

We have developed a general characterization of the subsurface conditions based upon our review of the subsurface exploration, laboratory data, geologic setting and our understanding of the project. This characterization, termed GeoModel, forms the basis of our geotechnical evaluation. Conditions observed at each exploration point are indicated on the individual logs. The individual logs can be found in the [Exploration Results](#) and the GeoModel can be found in the [Figures](#) attachment of this report.

As part of our analyses, we identified the following model layers within the subsurface profile. For a more detailed view of the model layer depths at each boring location, refer to the GeoModel.

Model Layer	Layer Name	General Description
1	Fill	Clay, with varying amounts of debris and organics
2	Clay	Lean to fat clay, medium stiff to stiff
3	Sandstone	Sandstone, highly weathered, with shale

Summary of Subsurface Conditions

The subsurface conditions at the project site generally consist of approximately 20 feet of native soil consisting of medium to stiff to stiff clay overlying bedrock strata. Areas that have been previously developed have undocumented fill typically extending 2 to 4 feet below the ground surface, with isolated areas of fill up to 8.5 feet thick

An approximately 1- to 4-foot thick layer of topsoil fill was encountered over lean to fat clay in some borings and test pits on the site. The topsoil fill layer was primarily encountered in borings on the northwest corner of the site. The layer was typically observed at surface grade to approximately 3 to 4 feet below existing site grades.

An approximately 1- to 5-foot thick layer of undocumented fill material with varying amounts of gravel and homogenous clay was encountered in borings surrounding a demolished structure on site within the proposed warehouse footprint. B-21 had a thicker layer that extended to a depth of about 8 feet below site grades.

Bedrock on the site varied in depth from approximately 16 to 20 feet below existing site grades, with a highly weathered shale zone. No rock coring was performed.

Groundwater Observations

Groundwater was encountered at a depth of 3 feet below existing site grades during and after the time of our field exploration. Groundwater conditions may change due to site development, seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. A permanent groundwater monitoring well was installed to monitor the water level after the field exploration was completed.

Borings were advanced in the dry using hollow-stem auger drilling techniques drilling technique that allow short term groundwater observations to be made while drilling. Groundwater seepage was not encountered within the maximum drilling depth at the time of our field exploration. Groundwater conditions may be different at the time of construction. Mapping by the Natural Resources Conservation Service (NRCS) indicates a seasonal high groundwater level within 30 inches of ground surface. Groundwater conditions may change due to seasonal variations in rainfall, runoff, and other conditions not apparent at the time of drilling. Long-term groundwater monitoring was outside the scope of services for this project.

Geologic Hazards

Highly plastic, fat clay soils are present on this site. Such soils are commonly referred to as "expansive" or "swelling" soils because they expand or swell as their moisture contents increase. However, these soils also "contract" or "shrink" as their moisture

contents decrease. Since the “active” zone in the project area (i.e., the zone where the soils typically shrink and swell with seasonal moisture fluctuations) is limited to about 2 feet below grade, these soils are generally considered suitable for support of foundations that bear below frost depth of 3 feet. However, a placement of a layer of low volume change (LVC) material below grade-supported floor slabs is typically recommended to help reduce the amount of future subgrade volume change that could result in movement and damage to grade-supported floor slabs.

Seismic Site Class

The seismic design requirements for buildings and other structures are based on Seismic Design Category. Site Classification is required to determine the Seismic Design Category for a structure. The Site Classification is based on the upper 100 feet of the site profile defined by a weighted average value of either shear wave velocity, standard penetration resistance, or undrained shear strength in accordance with Section 20.4 of ASCE 7 and the International Building Code (IBC). Based on the soil/bedrock properties observed at the site and as described on the exploration logs and results, our professional opinion is that a Seismic Site Classification of C can be considered for the project. Subsurface explorations at this site were extended to a maximum depth of 25 feet. The site properties below the boring depth to 100 feet were estimated based on our experience and knowledge of geologic conditions of the general area. Additional deeper borings or geophysical testing may be performed to confirm the conditions below the current boring depth.

Liquefaction

Based on the results of our exploration, liquefaction is not expected based on the soil composition, soil density, and the relatively low level of ground motions associated with the design earthquake.

Percolation/Infiltration

Stormwater Management Basins

Two below-grade stormwater management basins are anticipated to be constructed on the site. Laboratory permeability tests were performed on soil samples collected in the areas of the proposed stormwater management basins. These test results are as follows:

Test Location	Soil Strata	Approximate Depth of Test (Feet) ¹	Average Laboratory Permeability Rate (in./hour)
SB-1	Fat Clay	5-6.8	0.00044
SB-2	Fat Clay	10-11.4	0.00101
SB-3	Fat Clay	5-6.8	0.00003
SB-4	Fat Clay	10-12	0.00014

1. Below Existing Site Grades. Permeability rate tests were completed near the proposed bottom of stormwater management basins.

Based on the results of the permeability tests , stormwater management basins should be designed for retention of stormwater.

Corrosivity

The table below lists the results of laboratory soluble sulfate, soluble chloride, electrical resistivity, and pH testing. The values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

Corrosivity Test Results Summary

Boring	Sample Depth (feet)	Soil Description	Soluble Sulfate (%)	Soluble Chloride (%)	Electrical Resistivity (Ω -cm)	pH
FC-3	3-5	CH	0.014	-	890	6.83
B-6	3-5	CL	0.004	0.004	900	6.75

These test results are provided to assist in determining the type and degree of corrosion protection that may be required. For protection against corrosion to buried metals, Terracon recommends that an experienced corrosion engineer be retained to design a suitable corrosion protection system for underground metal structures or components.

Imported fill materials may have significantly different properties than the site materials noted above and should be evaluated if expected to be in contact with metals used for construction.

Geotechnical Overview

The soils encountered at the site appear suitable for construction of the planned Costco project, provided the improvements or corrections of the conditions discussed herein are implemented. We have identified existing undocumented fill, organic material in soil, and expansive clay soils as geotechnical conditions that may impact the proposed design and construction. These conditions will require particular attention in project planning, design and during construction and are discussed in greater detail in the following sections.

The recommendations contained in this report are based upon the results of field and laboratory testing (presented in the [Exploration Results](#)), engineering analyses, and our current understanding of the proposed project. The [General Comments](#) section provides an understanding of the report limitations.

Existing Fill

Existing undocumented fill and construction debris was generally encountered to depths of about 4 feet below existing site grades, with isolated areas of fill extending to depths of about 8.5 feet below existing site grades. Existing fill was most likely placed during the previous development of the site. The existing fill encountered at our exploration points was highly variable in composition and density, and portions of the site likely contain fill that was not compacted for use under proposed buildings. Based on our soil borings and test pits, we anticipate existing fill will impact the proposed construction of the warehouse foundations and slabs as well as pavements. Existing fill could extend to greater depths, particularly within the area of the former buildings. It is our opinion that existing fill were encountered during construction should be removed and replaced with properly compacted Engineered Fill.

We do not possess any information regarding whether the former demolition required removal of buildings and structures or if fill was placed under the observation of a geotechnical engineer; therefore, the fill is considered "undocumented." Undocumented fill can present a greater than normal risk of post-construction movement of foundations, slabs and other site improvements supported on or above these materials. Consequently, it is our opinion existing fill on the site should not be relied upon for support of foundations and interior/exterior concrete slabs, and where encountered, should be removed from the building footprint, foundation bearing zones, and from below exterior slab/rigid concrete bearing zones down to native soil. The foundation bearing zone is defined as the area below 2/3H:1V lines extending downward and outward from edge of footing/slab.

Expansive Clays

Subsurface soil conditions at the site consist of clays with variable plasticity. Clays with high plasticity (Fat Clays) have the potential to shrink and swell with seasonal fluctuations in the soil moisture content. For this reason, we recommend that at least the upper 24 inches of the subgrade materials below the bottom of the floor slab consist of Structural Fill (composed of low volume change (LVC) material) as defined in the [Fill Material Types](#) section. Preliminary lab data suggests that only limited amounts of material that would meet the Structural Fill criteria are present on-site, and it would not be practical to separate these soils during grading. Therefore, the use of imported Structural Fill materials should be anticipated.

Alternatively, chemical admixtures can be incorporated into the on-site soils to reduce their volume change susceptibility and create Structural Fill. Refer to the [Soil Stabilization](#) section for additional details.

Earthwork

Earthwork is anticipated to include demolition, clearing and grubbing, excavations, engineered fill placement, and potentially chemical stabilization. The following sections provide recommendations for use in the preparation of specifications for the work. Recommendations include critical quality criteria, as necessary, to render the site in the state considered in our geotechnical engineering evaluation for foundations, floor slabs, and pavements.

Warehouse: Proposed grading for the site indicates fill on the order for 3 to 7 feet will be required to achieve finished floor elevation in the area of the proposed warehouse. Subsurface conditions encountered in the area of the proposed warehouse generally consisted of approximately 5 to 8 feet of existing fill over lean clay followed by a thin layer of till over weathered bedrock. The existing fill encountered at our exploration points was highly variable in composition and density, and portions of the site likely contain fill that was not compacted for use under proposed buildings. Existing fill on the site generally included areas composed of fat clay, lean to fat clay, lean clay, sand and gravel. Based on results of our laboratory testing we anticipate most of the existing fill on the site will be suitable for reuse as General Fill. Upon completion of removal and replacement/recompaction of existing fill, new fill should be placed to achieve final finished grade as discussed in this report.

Fuel Facility: Based on provided site grading plans, we understand minor fill (up to 2 feet) is planned to develop final grades in the proposed fuel facility area, and excavations are anticipated to depths up to about 20 feet to construct the proposed underground storage tanks. Subsurface conditions in the proposed fuel facility area

generally consisted of fat clays to depths of about 20 to 22 feet below existing site grades, and weathered bedrock (shale and/or sandstone) is present below the clays. Groundwater was not encountered in our exploratory borings during drilling, and delayed water levels indicated no groundwater present. Excavations for the USTs will likely encounter fat clays, highly weathered shale and sandstone, and no groundwater.

Pavements: Pavement on the site are generally anticipated to require approximately 1 to 6 feet of fill with isolated areas on the southeast side of the site requiring 1 to 6 feet of cut to achieve finished grade. Subsurface conditions in the pavement areas varied across the site but generally consisted of existing fill over lean clay. We recommend removal of existing fill soils. However, even with the recommended construction procedures, there is inherent risk for Costco that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following appropriate recommendations. Costco must be willing to accept the risk associated with constructing pavements over the undocumented fill to take advantage of the cost benefit associated with keeping undocumented fill in place.

If Costco elects to construct pavements on existing fill, the following protocol should be followed to reduce this risk. After demolition of the existing structures and pavement materials and prior to placement of additional fill, the entire pavement area should be proofrolled with heavy, rubber tire construction equipment, to aid in delineating areas of soft or otherwise unsuitable soil. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Unstable areas should be overexcavated to more competent material and replaced with compacted Engineered Fill. Excessively wet or dry materials should either be removed, or moisture conditioned and recompacted.

Demolition

The proposed building will be constructed within the footprint of the previous developments. Previous demolition activities appear to have left some construction materials on-site, including rebar, asphalt, clay piping, and potentially other miscellaneous debris.

Where existing construction debris or materials are encountered outside of the proposed warehouse footprint and at least 5 feet beyond the outer edge of foundations and conflict with proposed utilities and pavements, they should be removed to a depth of at least 2 feet below the affected utility or design pavement subgrade elevation. If utility piping is abandoned in-place, the pipes should be properly plugged and/or filled with grout.

Site Preparation

Prior to placing fill, existing vegetation, topsoil, and root mats should be removed from lawn/landscaped areas of the site. Complete stripping of the topsoil to approximately 4-inches to 18inches below ground surface should be performed in the proposed building and pavement areas.

Mature trees are located within or near the footprint of some of the proposed warehouse, which will require removal at the onset of construction. Tree root systems can remove substantial moisture from surrounding soils. Where trees are removed, the full root ball and all associated dry and desiccated soils should be removed. The soil materials which contain less than 5 percent organics can be reused as engineered fill provided the material is moisture conditioned and properly compacted.

Organic soils with organic contents greater than 3 percent should be removed from the building and fuel facility areas and greater than 5 percent removed from pavement areas and not used as fill in these areas. The organic soils removed during site preparation could be used in landscaped areas.

The results of the organic contents for selected samples are shown in the table below.

Organic Content Summary

Location	Site Area	Sample Depth (feet)	Organic Content (%)
TP-1	Warehouse	0-0.5	3.6
TP-4	Warehouse	0.5-1.0	4.8
TP-7	Parking	1-1.5	4.8
TP-1	Fuel Facility	0.5-1.1	5.6

Although no evidence of underground facilities (such as septic tanks, cesspools, basements, and utilities) was observed during the exploration and site reconnaissance, such features could be encountered during construction. If underground facilities are encountered, such features should be removed, and the excavation thoroughly cleaned prior to backfill placement and/or construction.

Subgrade Preparation

After completion of excavation for new foundations and the removal of unsuitable existing fill and topsoil, and prior to placement of fill or construction of foundations, floor slabs or pavements the soil subgrades should be proofrolled with at least six passes in

perpendicular directions using a minimum 20-ton tandem-axle dump truck in open areas; or a minimum 1-ton self-propelled vibratory roller or large vibratory plate compacted in trenches or confined excavations. Subgrade preparation and proofrolling should be performed under the observation of the Geotechnical Engineer.

Areas that deflect excessively during the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Unstable areas should be overexcavated to more competent material and replaced with compacted Structural Fill or Engineered Fill depending on the location of the fill placement. Excessively wet or dry materials may either be removed, or moisture conditioned and recompacted. Once subgrades have been properly prepared, Structural Fill may be placed in controlled lifts to achieve design foundation and slab subgrade elevations.

Existing Fill

As noted in [Geotechnical Characterization](#), borings B-12, B-20, and B-21 encountered previously placed fill to depths ranging from about 5 to 8 feet. We have no records to indicate the degree of control, and consequently, the fill is considered unreliable for support of foundation loads. Support of pavements on or above existing fill soils is discussed in this report. However, even with the recommended construction procedures, inherent risk exists for the owner that compressible fill or unsuitable material, within or buried by the fill will, not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following the recommendations contained in this report.

If the owner elects to construct pavements on the existing fill, the following protocol should be followed. Once the planned pavement subgrade elevation has been reached, the entire pavement area should be proofrolled. Areas of soft or otherwise unsuitable material should be undercut and replaced with either new structural fill or suitable, existing on site materials.

Excavation

We anticipate that excavations for the proposed construction can generally be accomplished with conventional excavation equipment (e.g. backhoes, scrapers, and tracked end-loaders). The bottom of excavations should be thoroughly cleaned of loose and/or soft soil and disturbed material prior to backfill placement and/or construction.

Soil Stabilization

Describe why stabilization may be needed. Methods of subgrade improvement, as described below, could include scarification, moisture conditioning and recompaction, removal of unstable materials and replacement with granular fill (with or without

geosynthetics), and chemical stabilization. The appropriate method of improvement, if required, would be dependent on factors such as schedule, weather, the size of area to be stabilized, and the nature of the instability. More detailed recommendations can be provided during construction as the need for subgrade stabilization occurs. Performing site grading operations during warm seasons and dry periods would help reduce the amount of subgrade stabilization required.

If the exposed subgrade is unstable during proofrolling operations, it could be stabilized using one of the methods outlined below.

Chemical Modification - Improvement of subgrades with portland cement or lime could be considered for improving unstable soils. Chemical modification should be performed by a pre-qualified contractor having experience with successfully stabilizing subgrades in the project area on similar sized projects with similar soil conditions. Results of chemical analysis of the additive materials should be provided to the geotechnical engineer prior to use. The hazards of chemicals blowing across the site or onto adjacent property should also be considered. Additional testing would be needed to develop specific recommendations to improve subgrade stability by blending chemicals with the site soils. Additional testing could include, but not be limited to, determining the most suitable stabilizing agent, the optimum amounts required, the presence of sulfates in the soil, and freeze-thaw durability of the subgrade.

Further evaluation of the need and recommendations for subgrade stabilization can be provided during construction as the geotechnical conditions are exposed.

Fill Material Types

Fill required to achieve design grade should be classified as Structural Fill and Engineered Fill. Structural Fill consists of low volume change (LVC) material and should be used within 24 inches of the bottom of floor slabs. Engineered Fill is material used in deeper fill areas below the building area, as fill below the pavements, and to achieve grade outside of these areas.

Reuse of On-Site Soil: Excavated on-site soil may be selectively reused as fill. Material property requirements for on-site soil for use as engineered fill are noted in the table below:

Fill Type ¹	USCS Classification	Acceptable Location for Placement ²
Native Fat Clays and/or Lean to Fat Clays (LL \geq 45 and/or PI \geq 23)	CH, CL/CH	At depths greater than 24 inches below the bottom of floor slabs Below pavements

Fill Type ¹	USCS Classification	Acceptable Location for Placement ²
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1. Based on subsurface exploration. Actual material suitability should be determined in the field at time of construction.
2. Based on subsurface exploration, actual material suitability should be determined in the field at time of construction.

Imported Fill Materials: Imported fill materials should meet the following material property requirements. Regardless of its source, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.

Fill Type ¹	USCS Classification	Acceptable Location for Placement
Structural Fill – Low Volume Change (LVC)	GM ² or CL (LL<45 and PI<23)	All locations and elevations, except where free-draining material is required
Crushed Stone ³	GW, GP, SW, SP	Where free-draining material is required

1. Structural fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade.
2. MoDOT Type 5 or an approved alternate gradation of crushed limestone aggregate
3. Free-draining granular materials with less than 5 percent fines (material passing the #200 sieve), such as ASTM C33 Size No. 57 aggregate or an approved alternate gradation.

Fill Placement and Compaction Requirements

Structural fill, engineered fill, and general fill should meet the following compaction requirements.

Location	Minimum Compaction Requirements for Granular Soil ¹	Minimum Compaction Requirements for Cohesive Soil ²	Water Content Range ^{2, 3}	Compaction Testing Frequency per Lift ^{4, 5}
Under Buildings and Structures	95%	95% ²	-2% to +4%	1 per 10,000 SF
Beneath Pavements and Walkways	95%	95% ²	-2% to +4%	1 per 15,000 SF

Location	Minimum Compaction Requirements for Granular Soil ¹	Minimum Compaction Requirements for Cohesive Soil ²	Water Content Range ^{2, 3}	Compaction Testing Frequency per Lift ^{4, 5}
Utility Trench Backfill	95%	95% ²	-2% to +4%	1 per 150 LF
Lawns or Unimproved Areas	90%	92% ²	-2% to +4%	1 per 20,000 SF

1. Maximum density and optimum water content as determined by the Modified Proctor test (ASTM D1557, Method).
2. Standard Proctor test (ASTM D698). High plasticity cohesive fill should not be compacted to more than 100% of standard Proctor maximum dry density.
3. Low plasticity cohesive: -2% to +3% of optimum
 High plasticity cohesive: 0 to +4% of optimum
 Granular: -3% to +3% of optimum
4. SF – Square feet
5. LF – Linear feet

Terracon should be retained during site earthwork to perform the necessary testing and observations during the installation of ground improvements, excavations, subgrade preparation, placement and compaction of controlled fills, backfilling of excavations to the planned subgrades, and construction of other associated design features.

Utility Trench Backfill

Any soft or unsuitable materials encountered at the bottom of utility trench excavations should be removed and replaced with structural fill or bedding material in accordance with public works specifications for the utility to be supported. This recommendation is particularly applicable to utility work requiring grade control and/or in areas where subsequent grade raising could cause settlement in the subgrade supporting the utility. Trench excavation should not be conducted below a downward 1:1 projection from existing foundations without engineering review of shoring requirements and geotechnical observation during construction.

On-site materials are considered suitable for backfill of utility and pipe trenches from 1 foot above the top of the pipe to the final ground surface, provided the material is free of organic matter and deleterious substances.

Trench backfill should be mechanically placed and compacted as discussed earlier in this report. Compaction of initial lifts should be accomplished with hand-operated tampers or other lightweight compactors. Where trenches are placed beneath slabs or footings, the backfill should satisfy the gradation and expansion index requirements of engineered fill

discussed in this report. Flooding or jetting for placement and compaction of backfill is not recommended.

For low permeability subgrades, utility trenches are a common source of water infiltration and migration. Utility trenches penetrating beneath the building should be effectively sealed to restrict water intrusion and flow through the trenches, which could migrate below the building. The trench should provide an effective trench plug that extends at least 5 feet from the face of the building exterior. The plug material should consist of cementitious flowable fill or low permeability clay. The trench plug material should be placed to surround the utility line. If used, the clay trench plug material should be placed and compacted to comply with the water content and compaction recommendations for structural fill stated previously in this report.

Grading and Drainage

All grades must provide effective drainage away from the building during and after construction and should be maintained throughout the life of the structure. Water retained next to the building can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from the building.

Exposed ground should be sloped and maintained at a minimum 5% away from the building for at least 10 feet beyond the perimeter of the building. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After building construction and landscaping have been completed, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted, as necessary, as part of the structure's maintenance program. Where paving or flatwork abuts the structure, a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations for the proposed structure are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of grade-supported improvements such as floor slabs and pavements. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over or adjacent to construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the

materials should be scarified, moisture conditioned, and recompacted prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety or the contractor's activities; such responsibility shall neither be implied nor inferred.

Excavations or other activities resulting in ground disturbance have the potential to affect adjoining properties and structures. Our scope of services does not include reviewing available final grading information or considering potential temporary grading performed by the contractor for potential effects such as ground movement beyond the project limits. A preconstruction/ precondition survey should be conducted to document nearby property/infrastructure prior to any site development activity. Excavation or ground disturbance activities adjacent or near property lines should be monitored or instrumented for potential ground movements that could negatively affect adjoining property and/or structures.

Construction Observation and Testing

The earthwork efforts should be observed by the Geotechnical Engineer (or others under their direction). Observation should include documentation of adequate removal of surficial materials (vegetation, topsoil, and pavements), evaluation and remediation of existing fill materials, as well as proofrolling and mitigation of unsuitable areas delineated by the proofroll.

Each lift of compacted fill should be tested, evaluated, and reworked, as necessary, as recommended by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency stated in the table in the Fill Placement and Compaction section.

In areas of foundation excavations, the bearing subgrade should be evaluated by the Geotechnical Engineer. If unanticipated conditions are observed, the Geotechnical Engineer should be contacted to discuss mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer's evaluation of subsurface conditions, including assessing variations and associated design changes.

Shallow Foundations

If the site has been prepared in accordance with the requirements noted in [Earthwork](#), the following design parameters are applicable for shallow foundations.

Design Parameters – Compressive Loads

Item	Description	
Maximum Net Allowable Bearing Pressure	Warehouse and Fuel Center	2,500 psf bearing on stiff native clay soils or compacted Structural Fill OR >3,000 psf bearing on a ground improvement system
Ultimate Passive Resistance ¹ (equivalent fluid pressures)	290 pcf (native soils or fill that is compacted as recommended in this report)	
Sliding Resistance ²	0.30 (Concrete on medium stiff to stiff clay) 0.45 (Concrete on Structural Fill)	
Minimum Embedment below Finished Grade ³	Exterior footings:	36 inches
	Interior footings in unheated areas:	36 inches
	Interior footings in heated areas:	18 inches
Estimated Total Settlement from Structural Loads ²	about 1 inch	
Estimated Differential Settlement ^{2, 4}	About 1/2 of total settlement	

1. Use of passive earth pressures require the sides of the excavation for the spread footing foundation to be nearly vertical and the concrete placed neat against these vertical faces or that the footing forms be removed and compacted structural fill be placed against the vertical footing face. Assumes no hydrostatic pressure.
2. Can be used to compute sliding resistance where foundations are placed on suitable soil/materials. Frictional resistance for granular materials is dependent on the bearing pressure which may vary due to load combinations. For fine-grained materials, lateral resistance using cohesion should not exceed ½ the dead load.
3. Embedment necessary to minimize the effects of frost and/or seasonal water content variations. For sloping ground, maintain depth below the lowest adjacent exterior grade within 5 horizontal feet of the structure.
4. Differential settlements are as measured over a span of 50 feet. Larger foundation footprints will likely require reduced net allowable soil bearing pressures to reduce risk for potential settlement.

Design Parameters – Overturning and Uplift Loads

Shallow foundations subjected to overturning loads should be proportioned such that the resultant eccentricity is maintained in the center-third of the foundation (e.g., $e < b/6$, where b is the foundation width). This requirement is intended to keep the entire foundation area in compression during the extreme lateral/overturning load event. Foundation oversizing may be required to satisfy this condition.

Uplift resistance of spread footings can be developed from the effective weight of the footing and the overlying soils with consideration to the IBC basic load combinations.

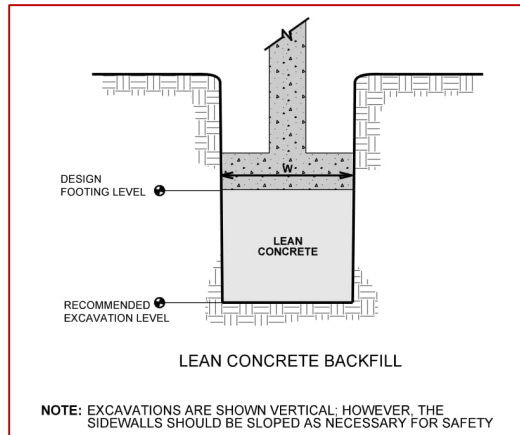
Item	Description
Soil Moist Unit Weight	120 pcf
Soil weight included in uplift resistance	Soil included within the prism extending up from the top perimeter of the footing at an angle of 45 degrees from vertical to ground surface

1. Effective (or buoyant) unit weight should be used for soil above the foundation level and below a water level.

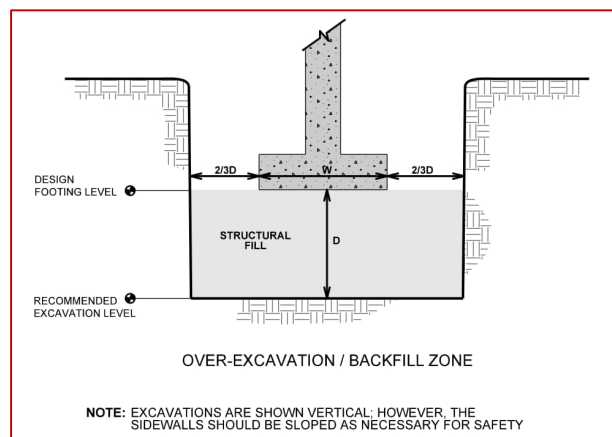
Foundation Construction Considerations

As noted in [Earthwork](#), the footing excavations should be evaluated under the observation of the Geotechnical Engineer. The base of all foundation excavations should be free of water and loose soil, prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance. Care should be taken to prevent wetting or drying of the bearing materials during construction. Excessively wet or dry material or any loose/disturbed material in the bottom of the footing excavations should be removed/reconditioned before foundation concrete is placed.

If unsuitable bearing soils are observed at the base of the planned footing excavation, the excavation should be extended deeper to suitable soils, and the footings could bear directly on these soils at the lower level or on lean concrete or Structural Fill placed in the excavations. Overexcavation for lean concrete replacement is illustrated on the sketch below.



Overexcavation for Structural Fill placement below footings should be conducted as shown below. The overexcavation should be backfilled up to the footing base elevation with Structural Fill placed as recommended in the [Earthwork](#) section of this report.



Floor Slabs and Exterior Slabs

Design parameters for floor slabs assume the requirements for [Earthwork](#) have been followed. Specific attention should be given to positive drainage away from the structure and positive drainage of the aggregate base beneath the floor slab.

Item	Description
Building Floor Slab-on-Grade (without Reinforcement)	6 inches PCC over 6 inches aggregate base course ¹ overlying 18 inches structural fill.
Building Floor Slab-on-Grade (without Reinforcement)	6 inches PCC over 6 inches aggregate base course ¹ overlying 18 inches structural fill (LVC).

Item	Description
Exterior Concrete Slab	6 inches PCC over 6 inches aggregate base course ¹ overlying 18 inches structural fill (LVC).
Fuel Facility Concrete Slab	6 inches PCC over 6 inches aggregate base course ¹ overlying 18 inches structural fill (LVC).
Estimated Modulus of Subgrade Reaction ³	150 pounds per square inch per inch (psi/in) for point loads

1. All materials should meet the current Missouri Department of Transportation (MoDOT) Standard Specifications for Highway Construction.
2. Modulus of subgrade reaction is an estimated value based upon our experience with the subgrade condition, the requirements noted in Earthwork, and the floor slab support as noted in this table. It is provided for point loads. For large area loads the modulus of subgrade reaction would be lower.

Saw-cut contraction joints should be placed in the slab to help control the location and extent of cracking. For additional recommendations, refer to the ACI Design Manual. Joints or cracks should be sealed with a waterproof, non-extruding compressible compound specifically recommended for heavy duty concrete pavement and wet environments.

Where floor slabs are tied to perimeter walls or turn-down slabs to meet structural or other construction objectives, our experience indicates differential movement between the walls and slabs will likely be observed in adjacent slab expansion joints or floor slab cracks beyond the length of the structural dowels. The Structural Engineer should account for potential differential settlement through use of sufficient control joints, appropriate reinforcing or other means.

Settlement of floor slabs supported on existing fill materials cannot be accurately predicted but could be larger than normal and result in some cracking. Mitigation measures, as noted in Existing Fill within [Earthwork](#), are critical to the performance of floor slabs. In addition to the mitigation measures, the floor slab can be stiffened by adding steel reinforcement, grade beams, and/or post-tensioned elements.

Floor Slab Construction Considerations

Finished subgrade, within and for at least 10 feet beyond the floor slab, should be protected from traffic, rutting, or other disturbance and maintained in a relatively moist condition until floor slabs are constructed. If the subgrade should become damaged or desiccated prior to construction of floor slabs, the affected material should be removed, and structural fill should be added to replace the resulting excavation. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab support course.

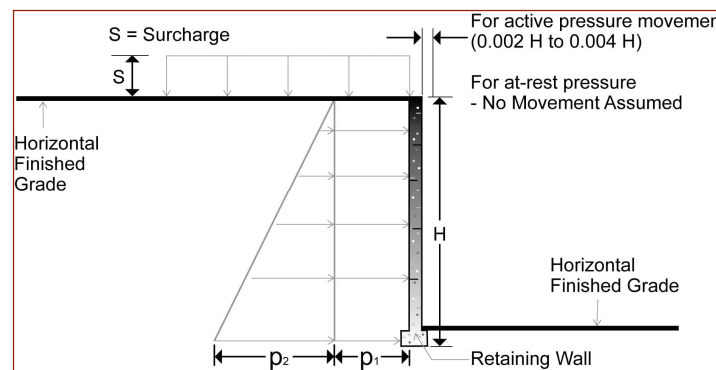
We understand that Costco Wholesale has determined that vapor barriers are not to be used in construction of Costco Wholesale structures due to adverse effects on concrete curing and performance. Therefore, we have provided construction recommendations that do not include installation of a moisture barrier with the understanding that there will be an increased risk for adverse moisture issues.

The Geotechnical Engineer should observe the condition of the floor slab subgrades immediately prior to placement of the floor slab support course, reinforcing steel, and concrete. Attention should be paid to high traffic areas that were rutted and disturbed earlier, and to areas where backfilled trenches are located.

Lateral Earth Pressures

Design Parameters

Structures with unbalanced backfill levels on opposite sides, such as truck loading docks, should be designed for earth pressures at least equal to values indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction, and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown in the diagram below. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement and is commonly used for basement walls, loading dock walls, or other walls restrained at the top. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls (unless stated).



Lateral Earth Pressure Design Parameters

Earth Pressure Condition ¹	Coefficient for Backfill Type ^{2,3,7}	Surcharge Pressure ⁴ p ₁ (psf)	Equivalent Fluid Pressures (psf) ^{2,5}	
			Unsaturated ⁵	Submerged ⁵
Active (K _a)	Granular - 0.31	(0.31)S	40	80
	Clay - 0.42	(0.42)S	50	85
At-Rest (K _o)	Granular - 0.47	(0.47)S	60	90
	Clay - 0.58	(0.58)S	70	95
Passive (K _p)	Granular - 3.3	---	420	290
	Clay - 2.4	---	290	200

1. For active earth pressure, wall must rotate about base, with top lateral movements 0.002 H to 0.004 H, where H is wall height. For passive earth pressure, wall must move horizontally to mobilize resistance.
2. Uniform, horizontal backfill, with a maximum unit weight of 120 pcf for clay soils and 130 pcf for granular soils.
3. Granular material backfill phi = 32 degrees (minimum); Clay soil phi = 24 degrees (minimum)
4. Uniform surcharge, where S is surcharge pressure.
5. Loading from heavy compaction equipment is not included. To achieve "Drained" conditions, follow guidelines in Subsurface Drainage for Below-Grade Walls below. "Undrained" conditions are recommended when drainage behind walls is not incorporated into the design.

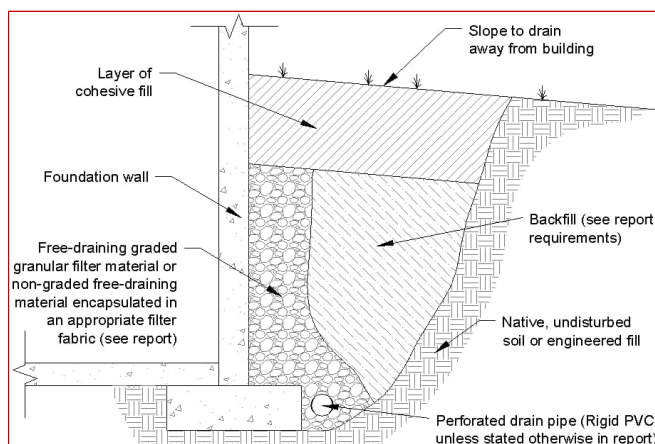
Backfill placed against structures should consist of granular soils or low plasticity cohesive soils. For the granular values to be valid, the granular backfill must extend out and up from the base of the wall at an angle of at least 45 degrees from vertical for the active case.

Footings, floor slabs, or other loads bearing on backfill behind walls may have a significant influence on the lateral earth pressure. Placing footings within wall backfill and in the zone of active soil influence on the wall should be avoided unless structural analyses indicate the wall can safely withstand the increased pressure.

The lateral earth pressure recommendations given in this section are applicable to the design of rigid retaining walls subject to slight rotation, such as cantilever, or gravity type concrete walls. These recommendations are not applicable to the design of modular block - geogrid reinforced backfill walls (also termed MSE walls). Recommendations covering these types of wall systems are beyond the scope of services for this assignment. However, we would be pleased to develop a proposal for evaluation and design of such wall systems upon request.

Subsurface Drainage for Below-Grade Walls

A perforated rigid plastic drain line installed behind the base of dock walls that extend below adjacent grade is recommended to prevent hydrostatic loading on the walls. The invert of a drain line around a below-grade building area should be placed near foundation bearing level. The drain line should be sloped to provide positive gravity drainage to daylight or to a sump pit and pump. The drain line should be surrounded by clean, free-draining granular material having less than 5% passing the No. 200 sieve, such as ASTM C 33, Size No. 57 aggregate. The free-draining aggregate should be encapsulated in a filter fabric. The granular fill should extend to within 2 feet of final grade, where it should be capped with compacted cohesive fill to reduce infiltration of surface water into the drain system.



As an alternative to free-draining granular fill, a prefabricated drainage structure may be used. A prefabricated drainage structure is a plastic drainage core or mesh which is covered with filter fabric to prevent soil intrusion and is fastened to the wall prior to placing backfill.

Fuel Facility

Based on the borings completed for the proposed underground storage tanks and fuel facility, we recommend the canopy structure be supported on shallow foundations that are designed and constructed as recommended in the [Shallow Foundations](#) section of this report.

As noted in the [Project Description](#) section, there will be three fuel UST's within the UST field. As stated in the [Fill Material Types](#) section of this report, the natural soils encountered near the ground surface in the planned UST field may be suitable for reuse as Engineered Fill, but weathered shale and sandstone fragments would not.

The UST bedding and backfill should consist of Structural Fill or "pea gravel" with a maximum particle size of ½-inch and contain no more than 5% of material passing the No. 8 sieve, unless otherwise specified by the tank manufacturer. We recommend the UST bedding and backfill material be separated from surrounding soils with a geotextile filter fabric. The fabric will reduce the potential for particle migration, while maintaining subsurface drainage. Particle migration could result in development of concentrated point loads on the tanks, loss of support below the tanks, and/or propagate upward resulting in loss of support for adjacent utility lines or the surficial concrete slabs.

Based on conditions encountered in the borings, significant seepage is generally not expected in excavations for this project (e.g., for footing construction and utility installation). If seepage is encountered in excavations during construction, the contractor is responsible for designing, implementing, and maintaining appropriate dewatering methods to control seepage and facilitate construction. In our experience, dewatering of excavations in clay soils can typically be accomplished using sump pits and pumps. Once the settlement monitoring is completed, the excess Structural Fill or pea gravel can then be removed to the tank subgrade elevation, the Deadman anchors and tanks can be set, and the excavation backfilled as recommended in the [Fill Placement and Compaction Requirements](#) section of this report. Care should be exercised when excavating the Structural Fill or pea gravel to not disturb the filter fabric. Considering tank manufacturers typically require a minimum of 18 inches of bedding for wet-set construction, we do not expect this will be a significant logistic concern.

The benefits of pre-loading are that it will reconsolidate the disturbed subgrade soils, provide a more uniform bearing surface, and reduce the potential net settlement from the complete UST system.

All excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, "Excavations" and its appendices, and in accordance with any applicable local and/or state regulations. Based on soil type and groundwater condition within the area of fuel facility, it is recommended that the excavation should follow OSHA excavation procedures for Type B Soil, which requires all simple slope excavations 20 feet or less in depth having a maximum allowable slope of 1 horizontal to 1 vertical (horizontal : vertical). The Contractor should be ultimately responsible for choosing means and methods for excavation support.

Light Poles

Light poles are expected to be installed in landscaped and pavement areas using relatively shallow 18 to 24-inch diameter drilled shafts. The soil surrounding the pole foundations is expected to consist of compacted General Fill. The foundation embedment

for light poles is typically controlled by lateral loads from wind and ice rather than axial capacity. The pole foundations embedment should be designed assuming unconstrained conditions (e.g., no contribution from the surrounding pavements). The response of foundations to lateral loads is not only dependent upon the soil material's horizontal subgrade reaction, but also on the pole/shaft actual cross-sectional features, effective length, and stiffness. An analysis is usually performed to provide a maximum lateral load that results in some limiting amount of top of shaft deflection or to a specified maximum yield moment resistance of the shaft. Based on previous experience on Costco projects with similar soil conditions, we expect the light pole foundations will require a minimum embedment of around 8 to 10 feet. We would be pleased to provide a site-specific evaluation of the light pole foundations using a simplistic analysis, such as Brom's Method, if the design shear and moments for the light poles are provided.

Pavements

Subgrade Preparation

Pavements on existing fill materials may be considered; however, even with the recommended construction procedures, there is inherent risk for Costco that compressible fill or unsuitable material, within or buried by the fill, will not be discovered. This risk of unforeseen conditions cannot be eliminated without completely removing the existing fill but can be reduced by following appropriate recommendations. Costco must be willing to accept the risk associated with constructing pavements over the undocumented fill to take advantage of the cost benefit associated with keeping undocumented fill in place.

If Costco elects to construct pavements on existing fill, the following protocol should be followed to reduce this risk. Once the planned grading has been completed, the entire area should be proofrolled with heavy, rubber tire construction equipment (a 20-ton tandem-axle dump truck or equivalent), to aid in delineating areas of soft or otherwise unsuitable soil. Areas excessively deflecting under the proofroll should be delineated and subsequently addressed by the Geotechnical Engineer. Unstable areas should be overexcavated to more competent material and replaced with compacted Structural Fill or Engineered Fill. Excessively wet or dry materials should either be removed, or moisture conditioned and recompacted.

On most project sites, the site grading is accomplished relatively early in the construction phase. Fills are placed and compacted in a uniform manner. However, as construction proceeds, excavations are made into these areas, rainfall and surface water saturates some areas, heavy traffic from concrete trucks and other delivery vehicles disturbs the subgrade and many surface irregularities are filled in with loose soils to improve trafficability temporarily. As a result, the pavement subgrades, initially

prepared early in the project, should be carefully evaluated as the time for pavement construction approaches.

We recommend the moisture content and density of the top 12 inches of the subgrade be evaluated and the pavement subgrades be compacted within two days prior to commencement of actual paving operations. Areas not in compliance with the required ranges of moisture or density should be moisture conditioned and recompacted. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. If a significant precipitation event occurs after the evaluation or if the surface becomes disturbed, the subgrade should be reviewed by qualified personnel immediately prior to paving. The subgrade should be in its finished form at the time of the final review.

After compaction and repairing subgrade deficiencies, the entire subgrade should be scarified and developed as recommended in the [Earthwork](#) section of this report to provide a uniform subgrade for pavement construction. Areas that appear severely desiccated following site stripping may require further undercutting and moisture conditioning.

Pavement Design Parameters

The subgrades for rigid and flexible pavement systems are anticipated to consist of native soils, existing fill that has been evaluated by the Geotechnical Engineer, or compacted Engineered Fill placed above these materials. A California Bearing Ratio (CBR) of 2.0 was used for the subgrade for the asphaltic concrete (AC) pavement designs. The value was based on two CBR tests completed in the lab on bulk sample obtained from borings during our field exploration and our expectation of the quality of the subgrade as prescribed in [Earthwork](#) section of this Report. A modulus of subgrade reaction of 120 pounds per cubic inch (pci) was used for the portland cement concrete (PCC) pavement designs.

Traffic patterns and anticipated loading conditions were based on "Section 9" of the "Costco Wholesale Development Requirements", Version 2024. An 18-kip equivalent single-axle load (ESAL) of 7,159 for standard duty parking areas and 121,010 for heavy duty areas was used based on a 20-year design life and the following Costco design requirements:

- Heavy Duty Pavements: ESALS of 121,010
- Standard Duty Pavements: ESALS of 7,159

Pavement Section Thicknesses

Recommended pavement thicknesses, in general accordance with *Costco Asphalt Paving Specifications* dated August 2024, are presented in the table below.

Pavement Type	Material	Layer Thickness (inches)	
		Standard Duty	Heavy Duty
Flexible	Asphaltic Surface Course ¹ Superpave Surface – PG64-22	2	2
	Asphaltic Binder Course ¹ Superpave Surface – PG64-22	2	4
	Aggregate Base Course (MoDOT Type 5) ^{2,3}	8	8
	Approved Proofrolled Soil Subgrade ³	12	12
Rigid	Portland Cement Concrete ^{1, 2}	5	5
	Aggregate Base Course (MoDOT Type 5) ^{2, 3}	8	8
	Approved Proofrolled Soil Subgrade	12	12

1. Refer to *Costco Asphalt Paving Specifications, Section 321216*, dated August 2024.
2. All materials should meet the current Missouri Department of Transportation (MoDOT) Standard Specifications for Highways and Bridges. Portland Cement concrete pavements should meet MoDOT specifications, using a 28-day compressive strength of 4,000 psi and ¾-inch coarse aggregate.
3. Aggregate base course materials should consist of Structural Fill described in the [Earthwork](#) section.

Areas for parking of heavy vehicles, concentrated turn areas, and start/stop maneuvers could require thicker pavement sections. Edge restraints (i.e. concrete curbs or aggregate shoulders) should be planned along curves and areas of maneuvering vehicles.

Proper joint spacing will be required to prevent excessive slab curling and shrinkage cracking. Joints should be sealed to prevent entry of foreign material and doweled where necessary for load transfer. PCC pavement details for joint spacing, joint reinforcement, and joint sealing should be prepared in accordance with ACI 330 and ACI 325.

Where practical, we recommend early-entry cutting of crack-control joints in PCC pavements. Cutting of the concrete in its "green" state typically reduces the potential for micro-cracking of the pavements prior to the crack control joints being formed, compared to cutting the joints after the concrete has fully set. Micro-cracking of

pavements may lead to crack formation in locations other than the sawed joints, and/or reduction of fatigue life of the pavement.

Openings in pavements, such as decorative landscaped areas, are sources for water infiltration into surrounding pavement systems. Water can collect in the islands and migrate into the surrounding subgrade soils thereby degrading support of the pavement. Islands with raised concrete curbs, irrigated foliage, and low permeability near-surface soils are particular areas of concern. The civil design for the pavements with these conditions should include features to restrict or collect and discharge excess water from the islands. Examples of features are edge drains connected to the stormwater collection system, longitudinal subdrains, or other suitable outlets and impermeable barriers preventing lateral migration of water such as a cutoff wall installed to a depth below the pavement structure.

Pavement Drainage

Pavements should be sloped to provide rapid drainage of surface water. Water allowed to pond on or adjacent to the pavements could saturate the subgrade and contribute to premature pavement deterioration. In addition, the pavement subgrade should be graded to provide positive drainage within the granular base section. Appropriate sub-drainage or connection to a suitable daylight outlet should be provided to remove water from the granular subbase.

Pavement Maintenance

The pavement sections represent minimum recommended thicknesses and, as such, periodic upkeep should be anticipated. Preventive maintenance should be planned and provided for through an on-going pavement management program. Maintenance activities are intended to slow the rate of pavement deterioration and to preserve the pavement investment. Pavement care consists of both localized (e.g., crack and joint sealing and patching) and global maintenance (e.g., surface sealing). Additional engineering consultation is recommended to determine the type and extent of a cost-effective program. Even with periodic maintenance, some movements and related cracking may still occur, and repairs may be required.

Pavement performance is affected by its surroundings. In addition to providing preventive maintenance, the civil engineer should consider the following recommendations in the design and layout of pavements:

- Final grade adjacent to paved areas should slope down from the edges at a minimum 2%.
- Subgrade and pavement surfaces should have a minimum 2% slope to promote proper surface drainage.

- Install pavement drainage systems surrounding areas anticipated for frequent wetting.
- Install joint sealant and seal cracks immediately.
- Seal all landscaped areas in or adjacent to pavements to reduce moisture migration to subgrade soils.
- Place compacted, low permeability backfill against the exterior side of curb and gutter.
- Place curb, gutter and/or sidewalk directly on clay subgrade soils rather than on unbound granular base course materials.

Frost Considerations

The soils on this site are frost susceptible, and small amounts of water can affect the performance of the slabs on-grade, sidewalks. Exterior slabs should be anticipated to heave during winter months. If frost action needs to be eliminated in critical areas, we recommend the use of non-frost susceptible (NFS) fill or structural slabs (for instance, structural stoops in front of building doors). Placement of NFS material in large areas may not be feasible; however, the following recommendations are provided to help reduce potential frost heave:

- Provide surface drainage away from the building and slabs, and toward the site drainage system.
- Install drains around the perimeter of the building, stoops, below exterior slabs and connect them to the site drainage system.
- Grade clayey subgrades so groundwater potentially perched in overlying fill or aggregate base, slope toward a site drainage system.
- Place NFS fill as backfill beneath slabs critical to the project.
- Place a 3 horizontal to 1 vertical (3H:1V) transition zone between NFS fill and other soils.

As an alternative to extending NFS fill to the full frost depth, consideration can be made to placing extruded polystyrene or cellular concrete under a buffer of at least 2 feet of NFS material.

General Comments

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the

Geotechnical Engineer, where noted in this report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our Scope of Services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third-party beneficiaries intended. Any third-party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

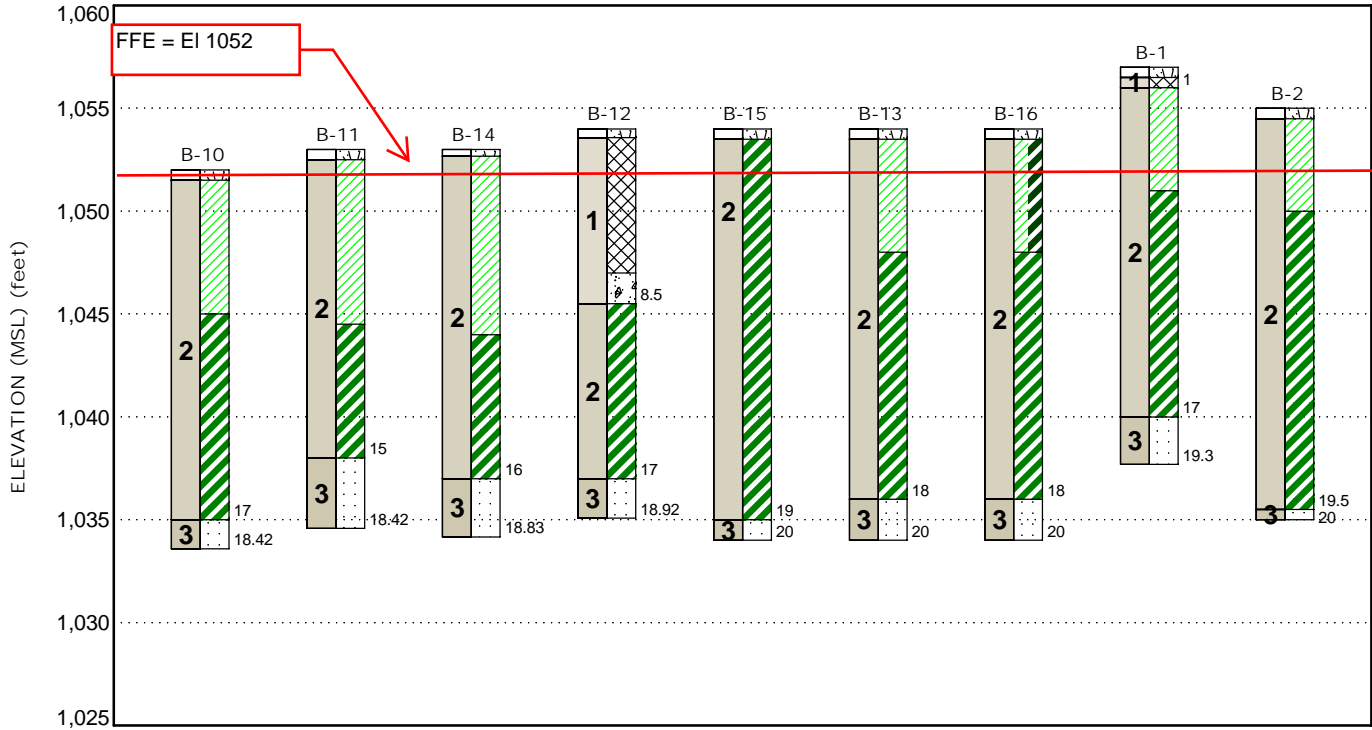
Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly affect excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety and cost estimating including excavation support and dewatering requirements/design are the responsibility of others. Construction and site development have the potential to affect adjacent properties. Such impacts can include damages due to vibration, modification of groundwater/surface water flow during construction, foundation movement due to undermining or subsidence from excavation, as well as noise or air quality concerns. Evaluation of these items on nearby properties are commonly associated with contractor means and methods and are not addressed in this report. The owner and contractor should consider a preconstruction/precondition survey of surrounding development. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

Figures

Contents:

GeoModel (7)

GeoModel - Warehouse (North Half)



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend	
1	FILL	clay, with varying amounts of debris and organics	Topsoil	Fill
2	CLAY	lean to fat clay, medium stiff to stiff	Lean Clay	Fat Clay
3	SANDSTONE	sandstone, highly weathered, with shale	Sandstone	Concrete
			Lean Clay/Fat Clay	

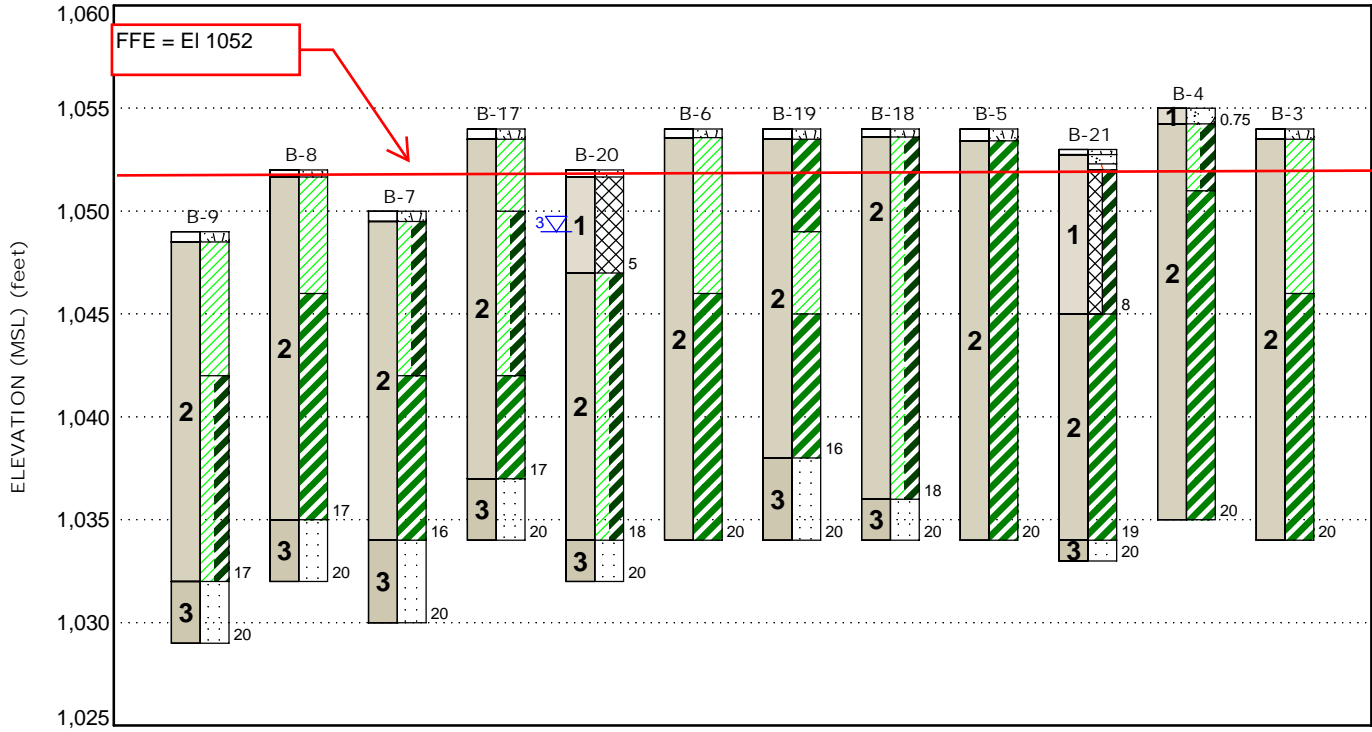
First Water Observation

NOTES:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

GeoModel - Warehouse (South Half)



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend	
1	FILL	clay, with varying amounts of debris and organics	Topsoil	Lean Clay
2	CLAY	lean to fat clay, medium stiff to stiff	Fat Clay	Concrete
3	SANDSTONE	sandstone, highly weathered, with shale	Lean Clay/Fat Clay	Sandstone
			Fill	Aggregate Base Course

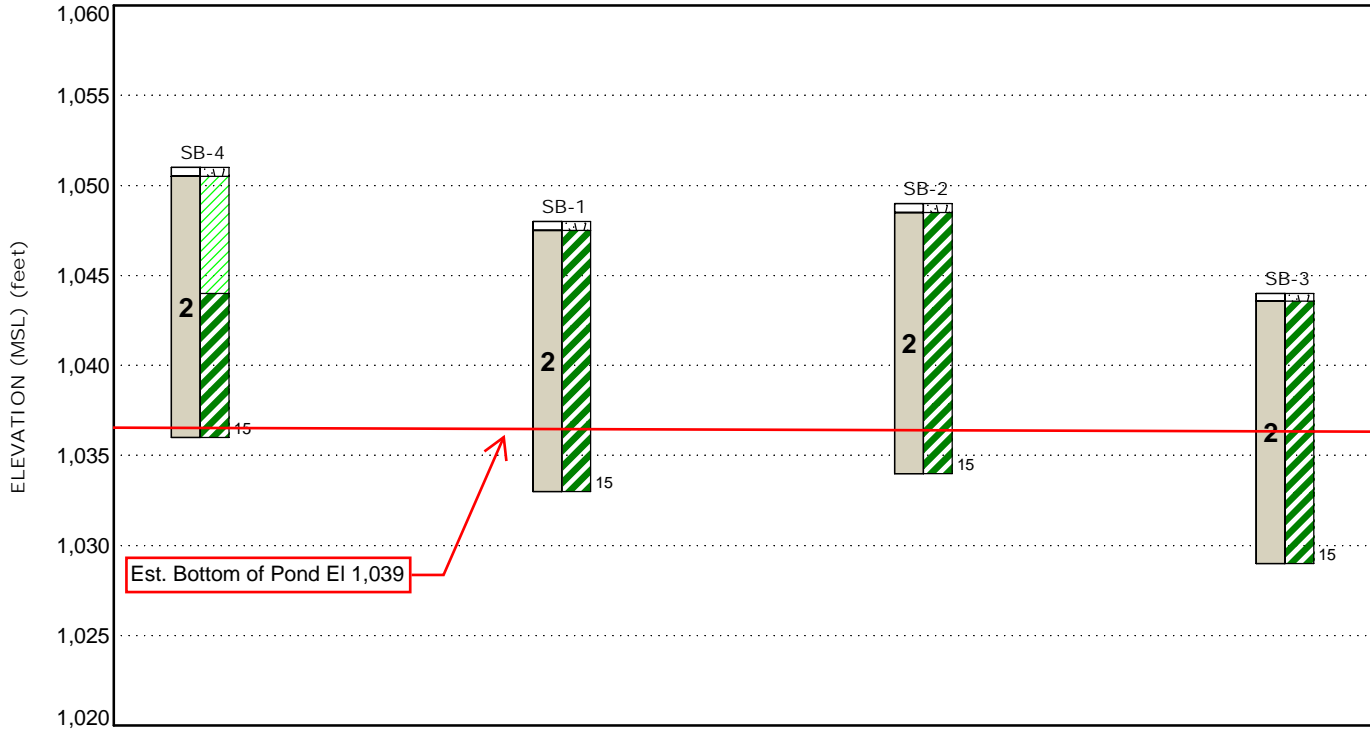
First Water Observation

NOTES:




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Groundwater levels are temporal. The levels shown are representative of the date and time of our exploration. Significant changes are possible over time. Water levels shown are as measured during and/or after drilling. In some cases, boring advancement methods mask the presence/absence of groundwater. See individual logs for details.

GeoModel - Stormwater Basin



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend	
1	FILL	clay, with varying amounts of debris and organics	 Topsoil	 Fat Clay
2	CLAY	lean to fat clay, medium stiff to stiff	 Lean Clay	
3	SANDSTONE	sandstone, highly weathered, with shale		

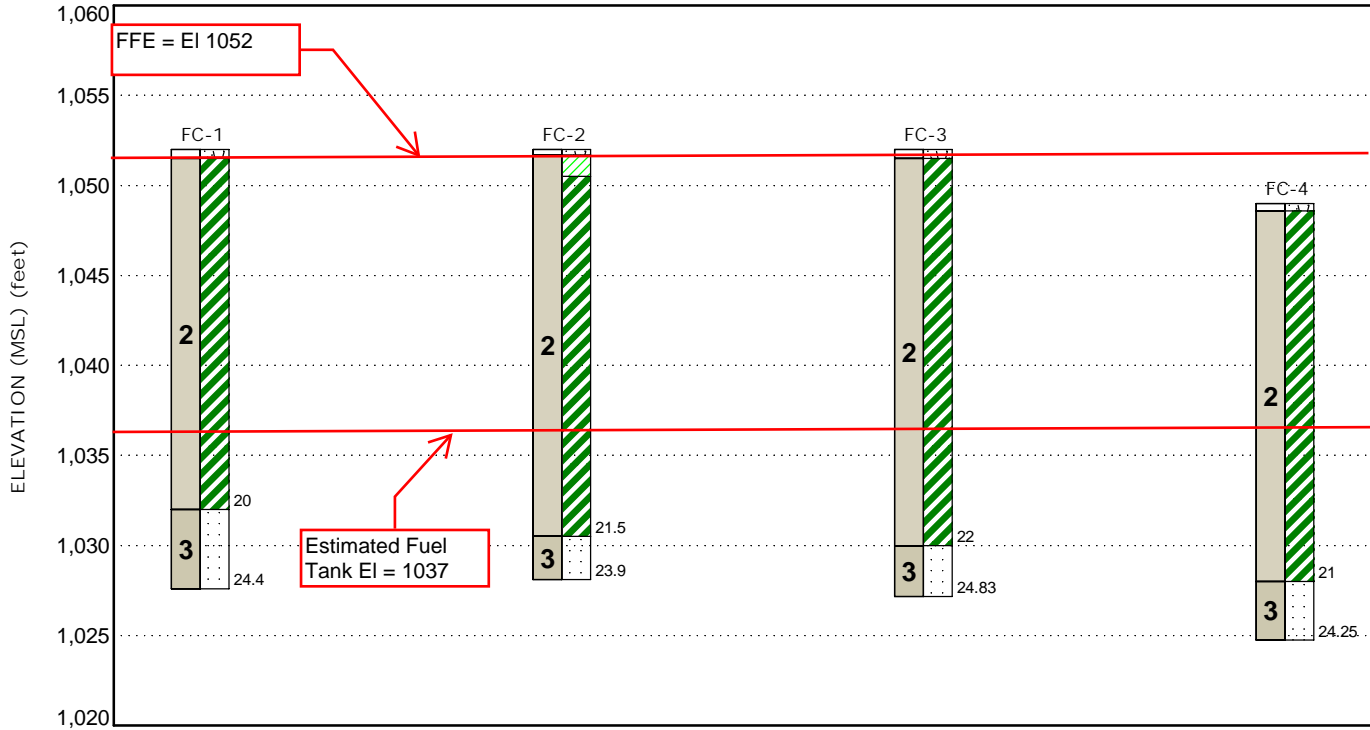
 First Water Observation

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NOTES:

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GeoModel - Fuel Facility



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend	
1	FILL	clay, with varying amounts of debris and organics	Topsoil	Fat Clay
2	CLAY	lean to fat clay, medium stiff to stiff	Sandstone	Lean Clay
3	SANDSTONE	sandstone, highly weathered, with shale		

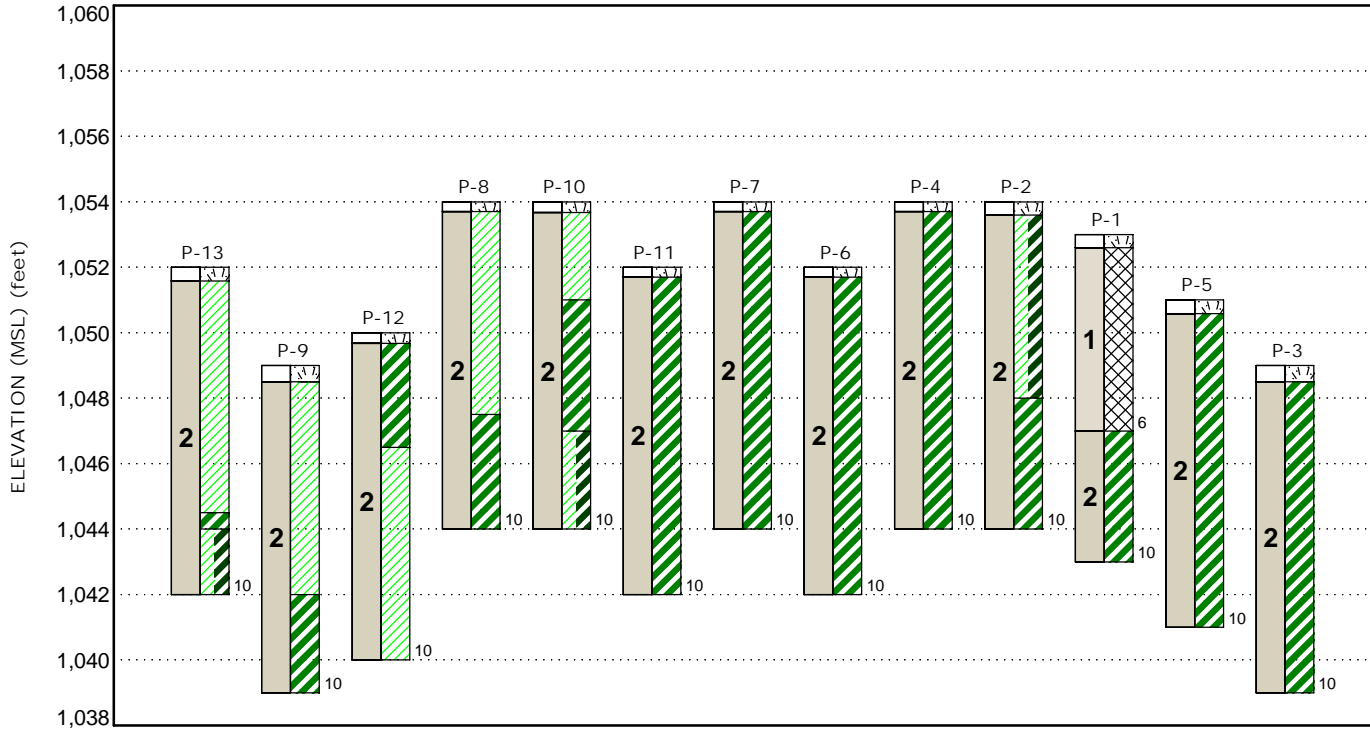
First Water Observation

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GeoModel - Parking



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend	
1	FILL	clay, with varying amounts of debris and organics	Topsoil	Fill
2	CLAY	lean to fat clay, medium stiff to stiff	Fat Clay	Lean Clay/Fat Clay
3	SANDSTONE	sandstone, highly weathered, with shale	Lean Clay	

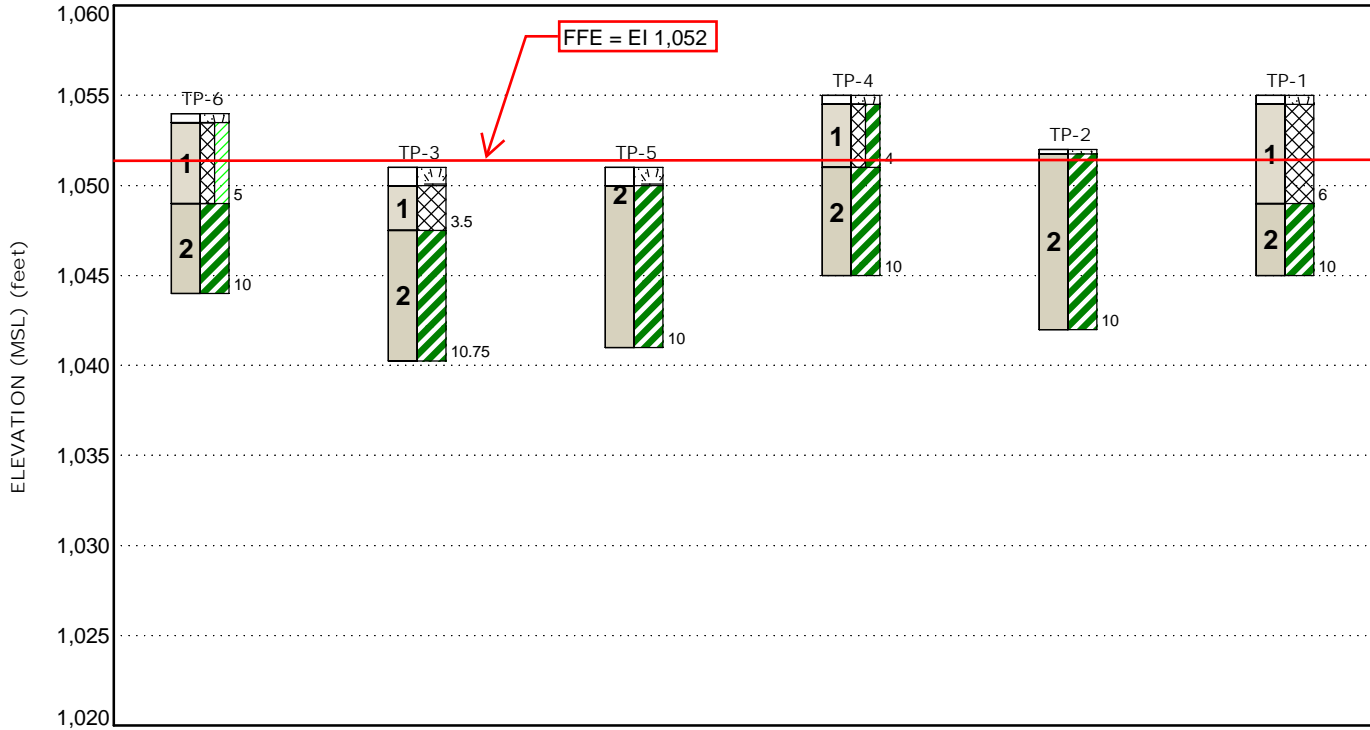
First Water Observation

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GeoModel - Test Pits (Warehouse)



This is not a cross section. This is intended to display the Geotechnical Model only. See individual logs for more detailed conditions.

Model Layer	Layer Name	General Description	Legend	
1	FILL	clay, with varying amounts of debris and organics	Topsoil	Fill
2	CLAY	lean to fat clay, medium stiff to stiff	Fat Clay	Lean Clay
3	SANDSTONE	sandstone, highly weathered, with shale		

First Water Observation

NOTES:

Layering shown on this figure has been developed by the geotechnical engineer for purposes of modeling the subsurface conditions as required for the subsequent geotechnical engineering for this project. Numbers adjacent to soil column indicate depth below ground surface.

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Geotechnical Engineering Report

Costco Wholesale Warehouse, Lee's Summit, MO CW# 25-0146 | Lee's Summit, Missouri

August 6, 2025 | Terracon Project No. 02255162



Attachments

Exploration and Testing Procedures

Field Exploration

The preliminary subsurface exploration program included the advancement of soil borings and test pits completed between June 18 through June 27, 2025. Boring locations and their associated depths are summarized below.

Number of Borings	Approximate Boring Depth (feet)	Location
21	20	Warehouse Building
24	24 to 25	Fuel Facility
13	10	Pavement
4	15	Stormwater Management
Number of Test Pits	Approximate Boring Depth (feet)	Location
19	10	Across the project site

Boring Layout and Elevations: Terracon personnel provided the boring layout using handheld GPS equipment (estimated horizontal accuracy of about ± 10 feet) and referencing existing site features. Approximate ground surface elevations were obtained by interpolation from the were estimated using Google Earth. If elevations and a more precise boring layout are desired, we recommend borings be surveyed.

Subsurface Exploration Procedures: We advanced the borings with a track-mounted, rotary drill rig using continuous flight augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. For borings in the fuel center, samples were obtained at 2.5 feet intervals prior to boring completion or rock coring, as applicable. the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge was pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split-barrel sampling procedure, a standard 2-inch outer diameter split-barrel sampling spoon was driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the SPT resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. Ring-lined, split-barrel sampling procedures are similar to standard split spoon sampling procedure; however, blow counts are typically recorded for 6-inch intervals for a total of 12 inches of penetration. We observed and recorded groundwater levels during drilling and sampling.

For safety purposes, all borings were backfilled with auger cuttings after their completion.

We also observed the boreholes while drilling and at the completion of drilling for the presence of groundwater. The groundwater levels are shown on the attached boring logs.

Test pits were dug from 7 to 10 feet below existing site grades. An excavator was used to excavate soil and grab samples were collected for the first 18-inches in 6-inch intervals.

The sampling depths, penetration distances, and other sampling information was recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a Geotechnical Engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs included visual classifications of the materials observed during drilling and our interpretation of the subsurface conditions between samples. Final boring logs were prepared from the field logs. The final boring logs represent the Geotechnical Engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

The project engineer reviewed the field data and assigned laboratory tests. The laboratory testing program included the following types of tests:

- Moisture Content
- Dry Unit Weight
- Unconfined Compression
- Atterberg Limits
- Moisture Density Relationship (Proctor)
- California Bearing Ratio (CBR)
- Topsoil testing
- Infiltration testing

The laboratory testing program often included examination of soil samples by an engineer. Based on the results of our field and laboratory programs, we described and classified the soil samples in accordance with the Unified Soil Classification System.

Photography Log



Site Photo 1 – Test Pit 1



Site Photo 2 – Test Pit 2



Site Photo 3 – Test Pit 3



Site Photo 4 – Test Pit 4



Site Photo 5 – Test Pit 5



Site Photo 6 – Test Pit 6



Site Photo 7 – Test Pit 7



Site Photo 8 – Test Pit 8



Site Photo 9 – Test Pit 9



Site Photo 10 – Test Pit 10



Site Photo 11 – Test Pit 11



Site Photo 12 – Test Pit 12



Site Photo 13 – Test Pit 13



Site Photo 14 – Test Pit 14



Site Photo 15 – Test Pit 15



Site Photo 16 – Test Pit 16



Site Photo 17 – Test Pit 17



Site Photo 18 – Test Pit 18



Site Photo 19 – Test Pit 19

Site Location and Exploration Plans

Contents:

- Site Location Plan
- Exploration Plan with Aerial Image (NW)
- Exploration Plan with Aerial Image (SE)
- Exploration Plan with Project Overlay
- Cross Section Location Plan

Note: All attachments are one page unless noted above.

Site Location

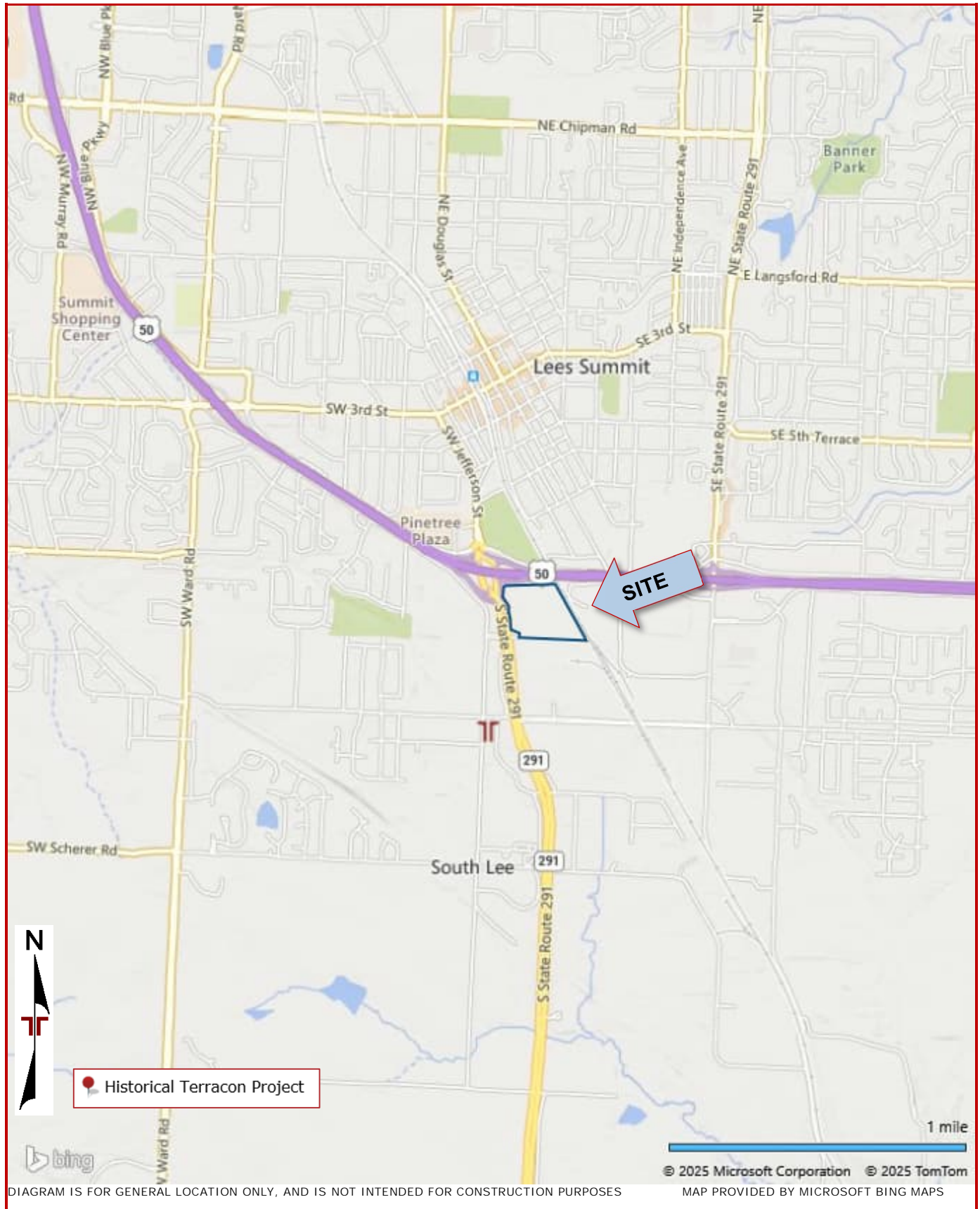


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

MAP PROVIDED BY MICROSOFT BING MAPS

Exploration Plan with Aerial Image (NW)

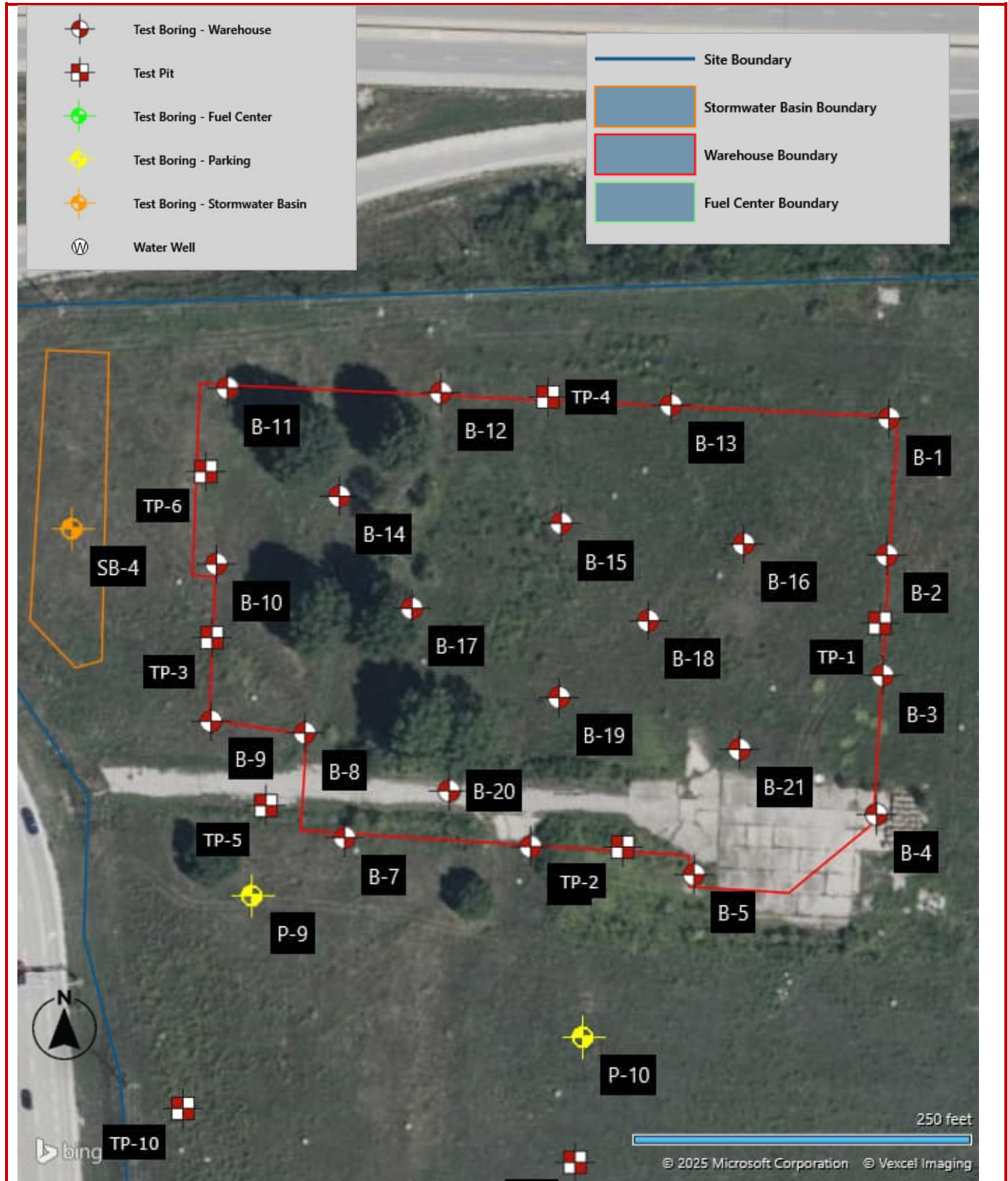
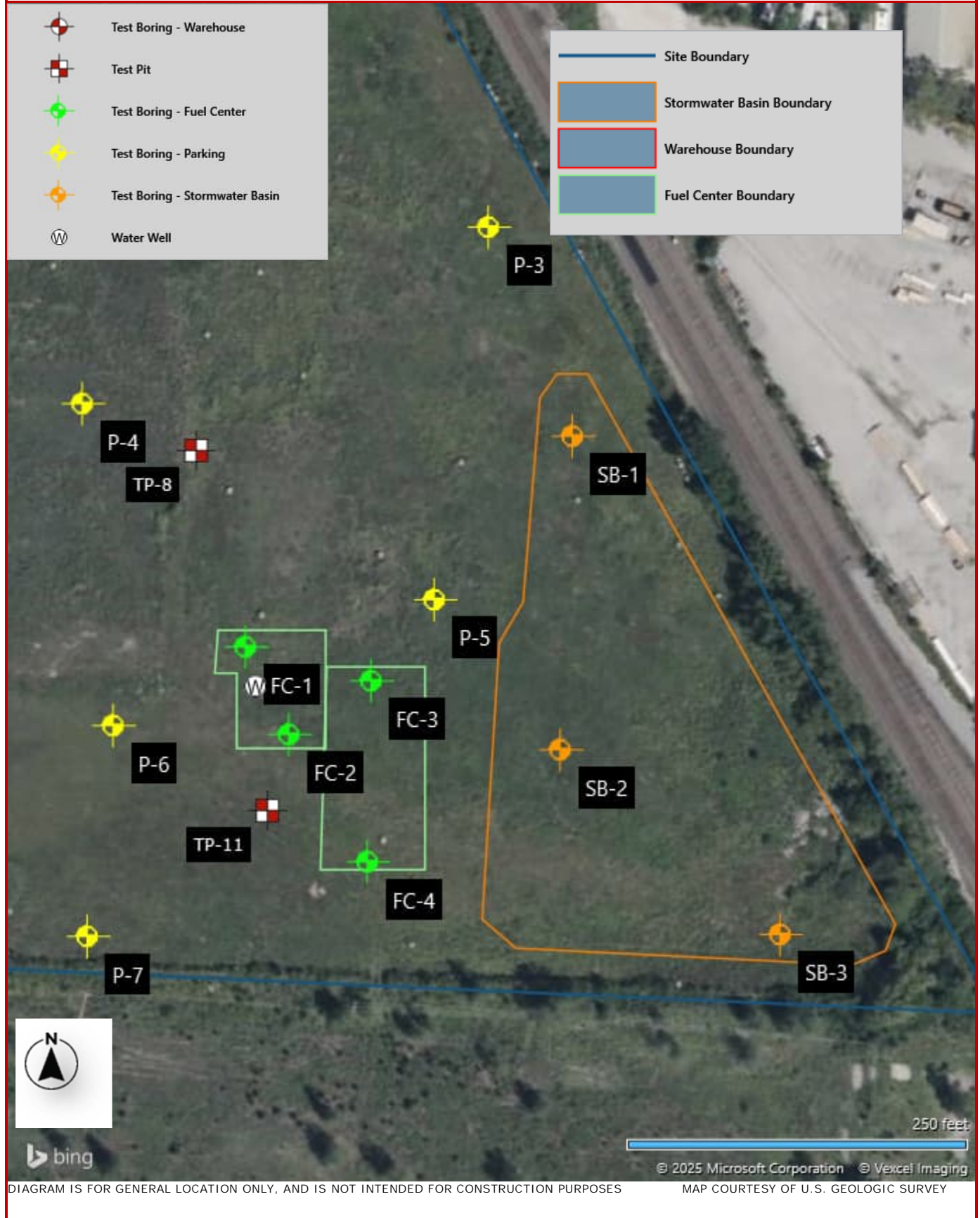


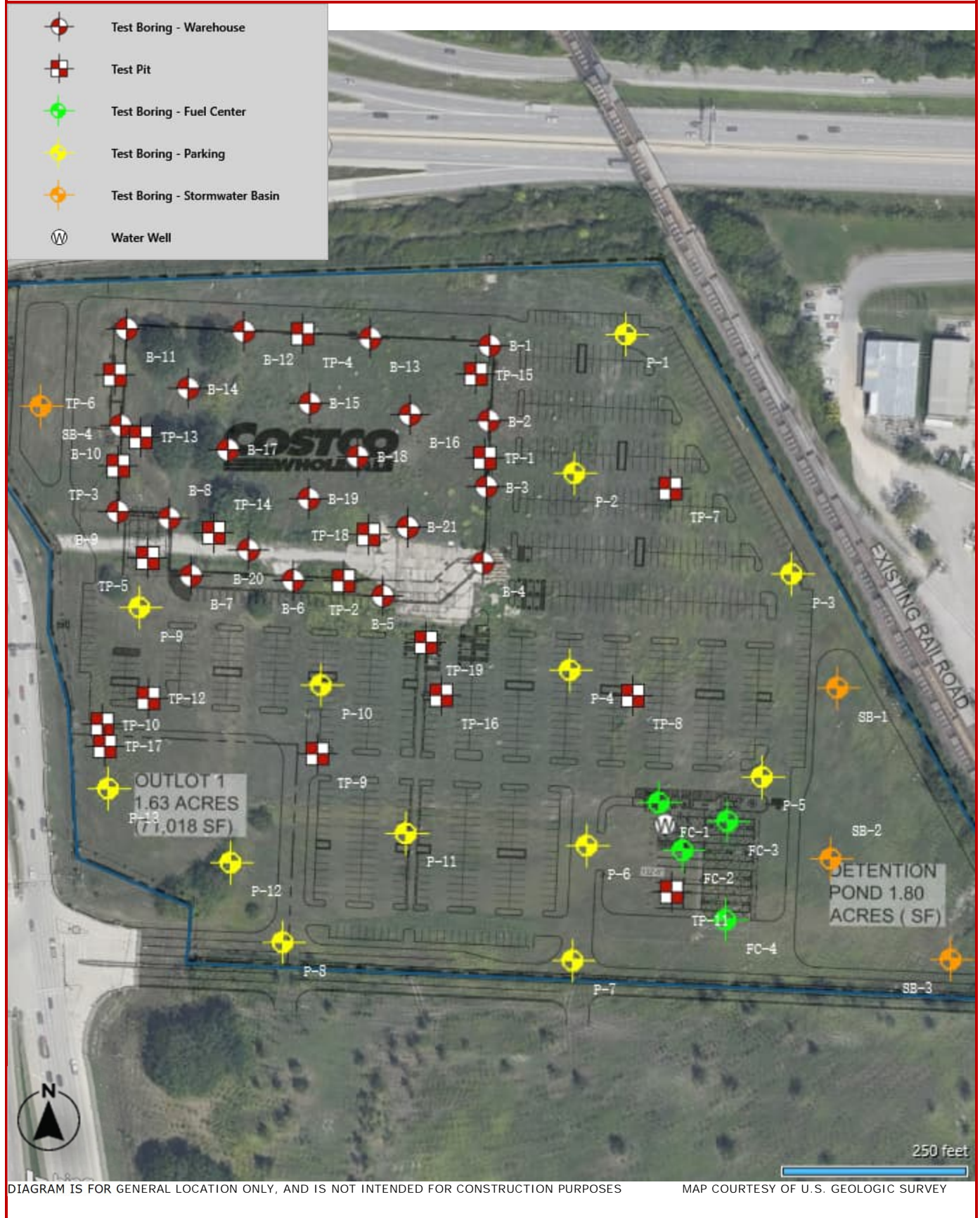
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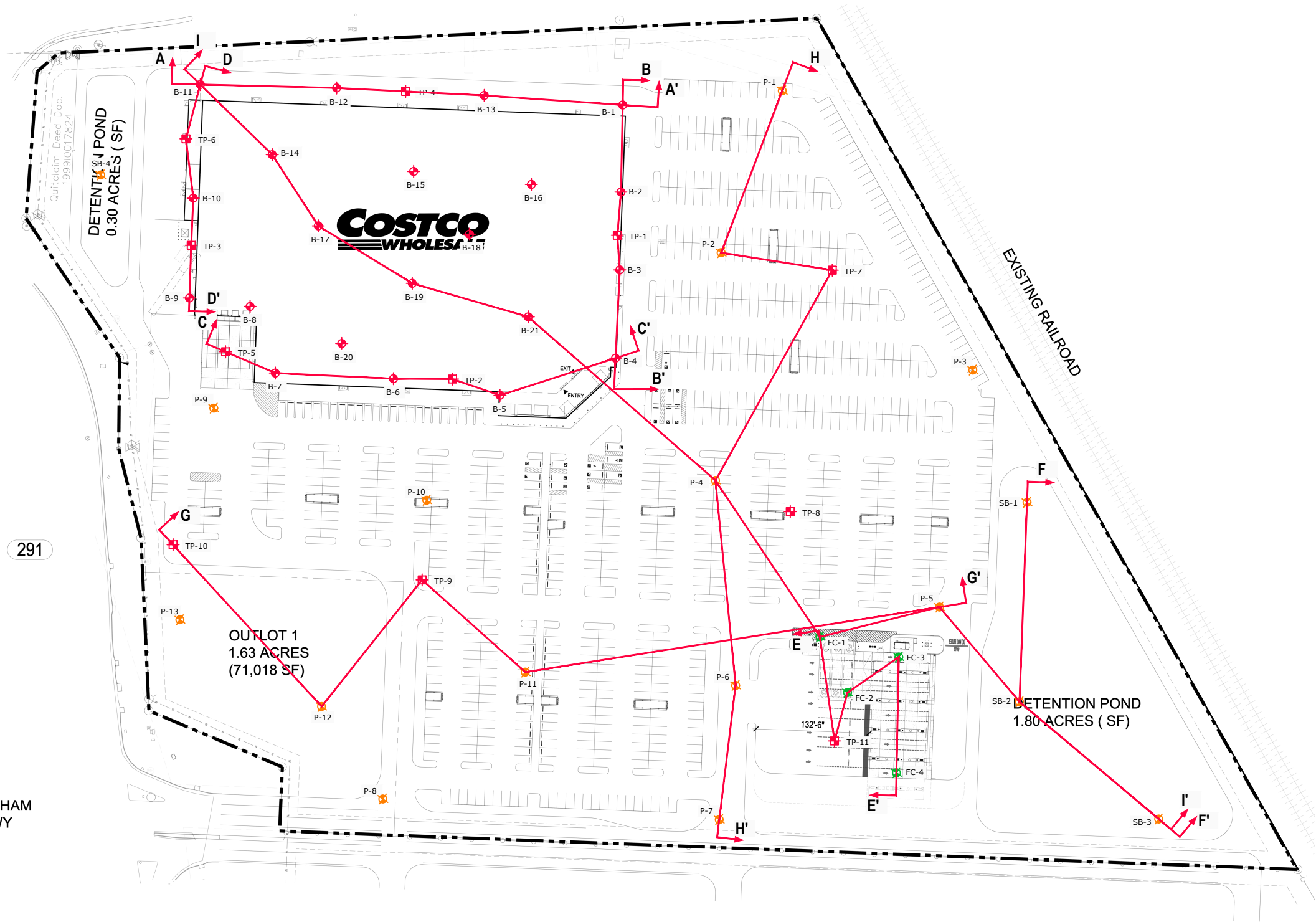
MAP COURTESY OF U.S. GEOLOGIC SURVEY

Exploration Plan with Aerial Image (SE)



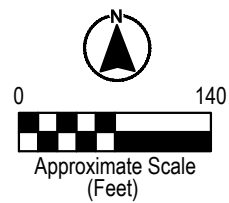
Exploration Plan with Site Plan Overlay





NOTES:

- SEE CROSS SECTION PLAN FOR ORIENTATION OF SOIL PROFILE.
- WHILE INDIVIDUAL TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS ON THE DATES SHOWN, IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.
- THE SUBSURFACE CONDITIONS SHOWN ON THESE PROFILES ARE NOT WARRANTED BUT ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND ENGINEERING JUDGEMENTS.



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Project Mgr:	LWB	Project No.	02255162
Drawn By:	RLW	Scale:	AS SHOWN
Checked By:	LWB/MRF	File No.	02255162-1
Approved By:	LWB	Date:	JULY 2025



15620 W 113th St
(913) 492-7777
Lenexa, KS 66219

CROSS SECTION DIAGRAM
COSTCO WHOLESALE WAREHOUSE LEE'S SUMMIT, MO CW# 25-0146
COSTCO WHOLESALE CORPORATION
STATE ROUTE 291 AND OLDHAM PARKWAY
LEE'S SUMMIT, MO

EXHIBIT
1

Exploration and Laboratory Results

Contents:

Cross Sections (9 pages)

Boring Logs (B-1 through B-21, P-1 through P-13, FC-1 through FC-4, SW-1 through SW-4, TP-1 through TP-19)

Atterberg Limits (2 pages)

Grain Size Distribution (1 pages)

Moisture Density Relationship

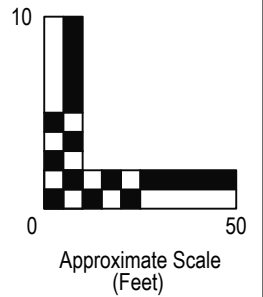
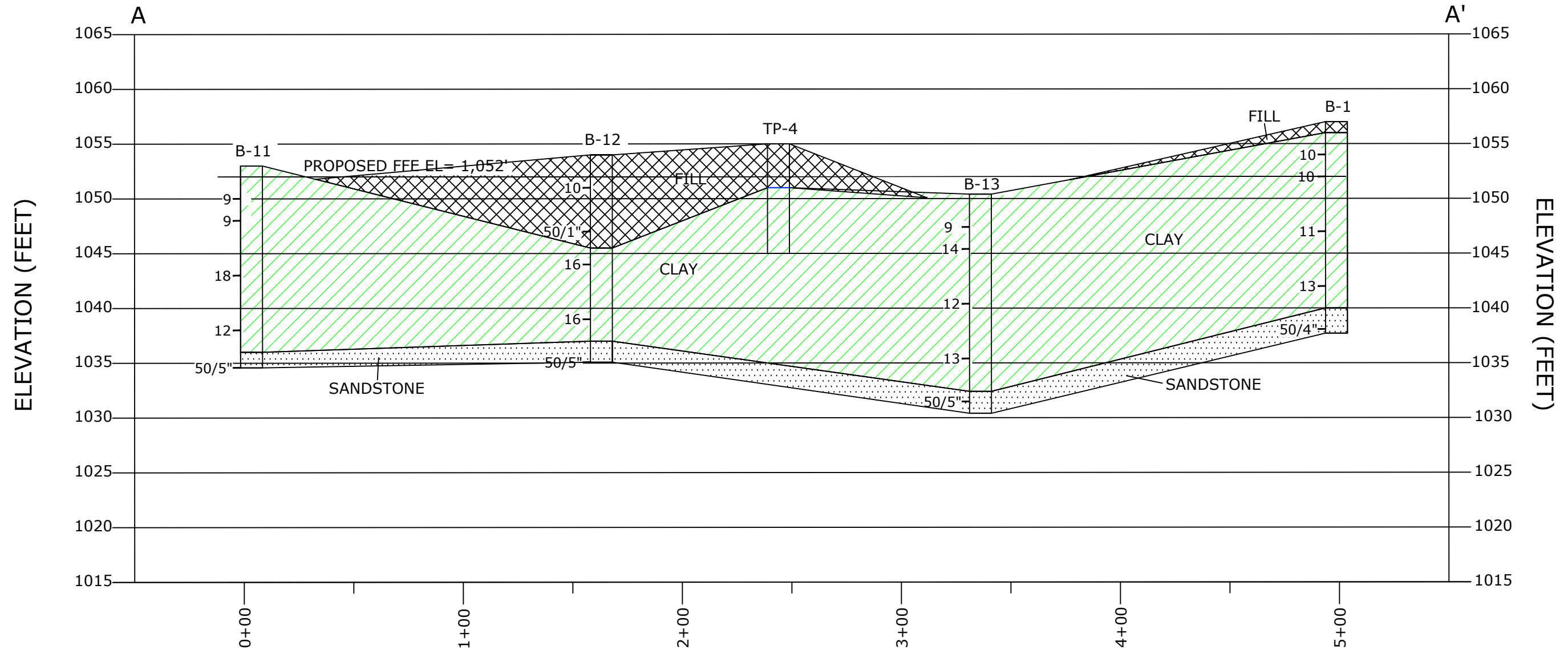
CBR Results (2 pages)

Corrosion Results

Infiltration Results (4 pages)

Note: All attachments are one page unless noted above.

SUBSURFACE PROFILE CROSS SECTION A-A'

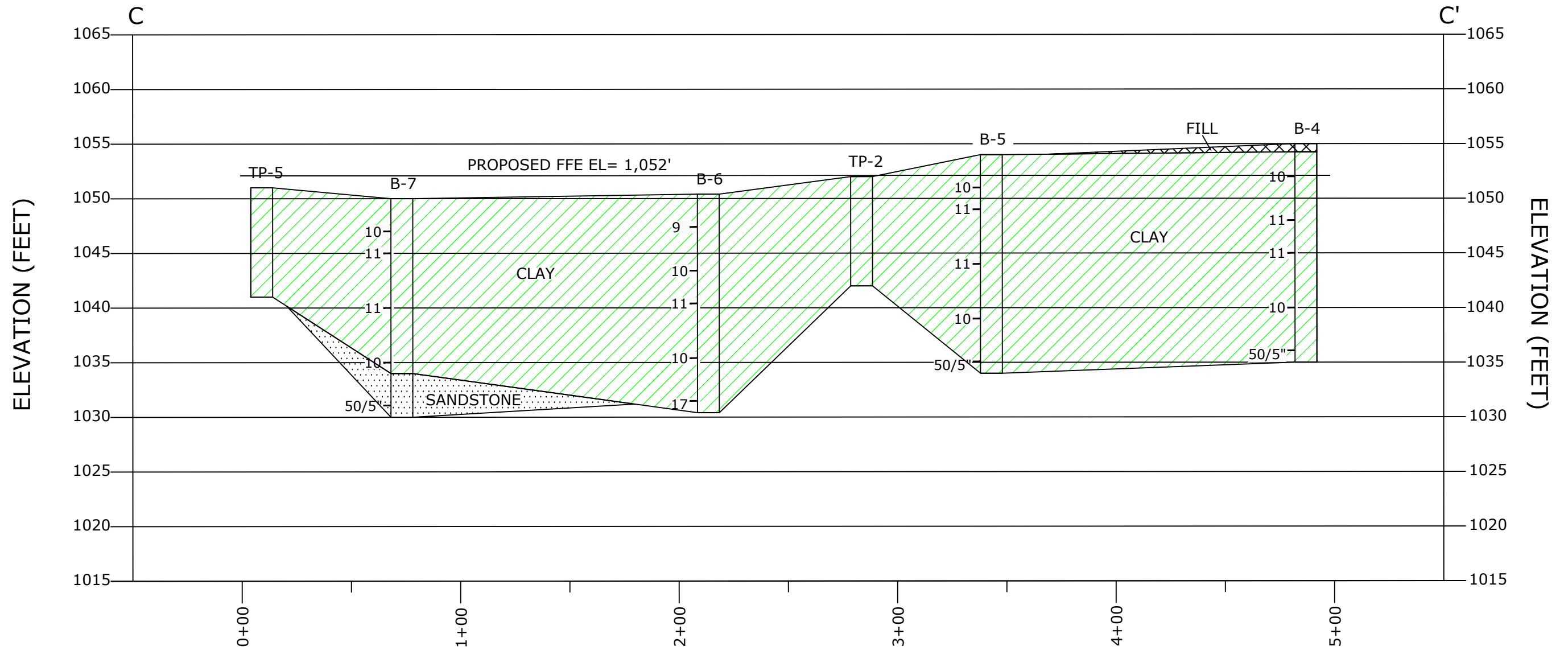


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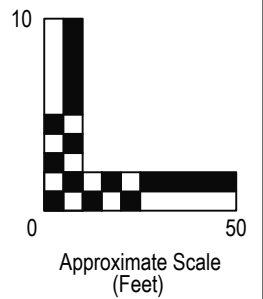
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Drawn By:	RLW	Scale:	AS SHOWN			
Checked By:	LWB/MRF	File No.:	02255162-2			
Approved By:	LWB	Date:	JULY 2025			
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SUBSURFACE PROFILE CROSS SECTION C-C'



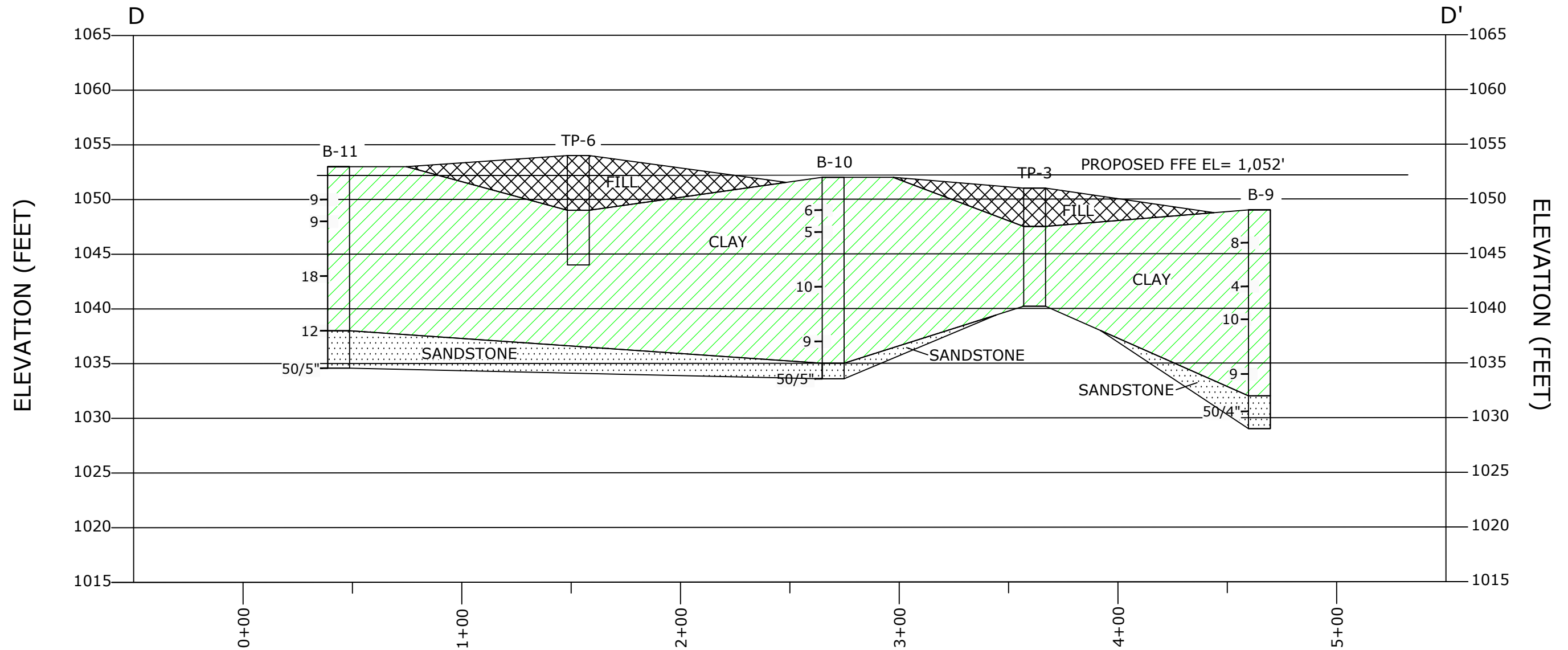
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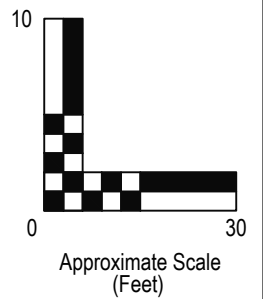
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Drawn By:	RLW	Scale:	AS SHOWN		15620 W 113th St (913) 492-7777 Lenexa, KS 66219	4
Checked By:	LWB/MRF	File No.:	02255162-2			
Approved By:	LWB	Date:	JULY 2025			

SUBSURFACE PROFILE CROSS SECTION D-D'



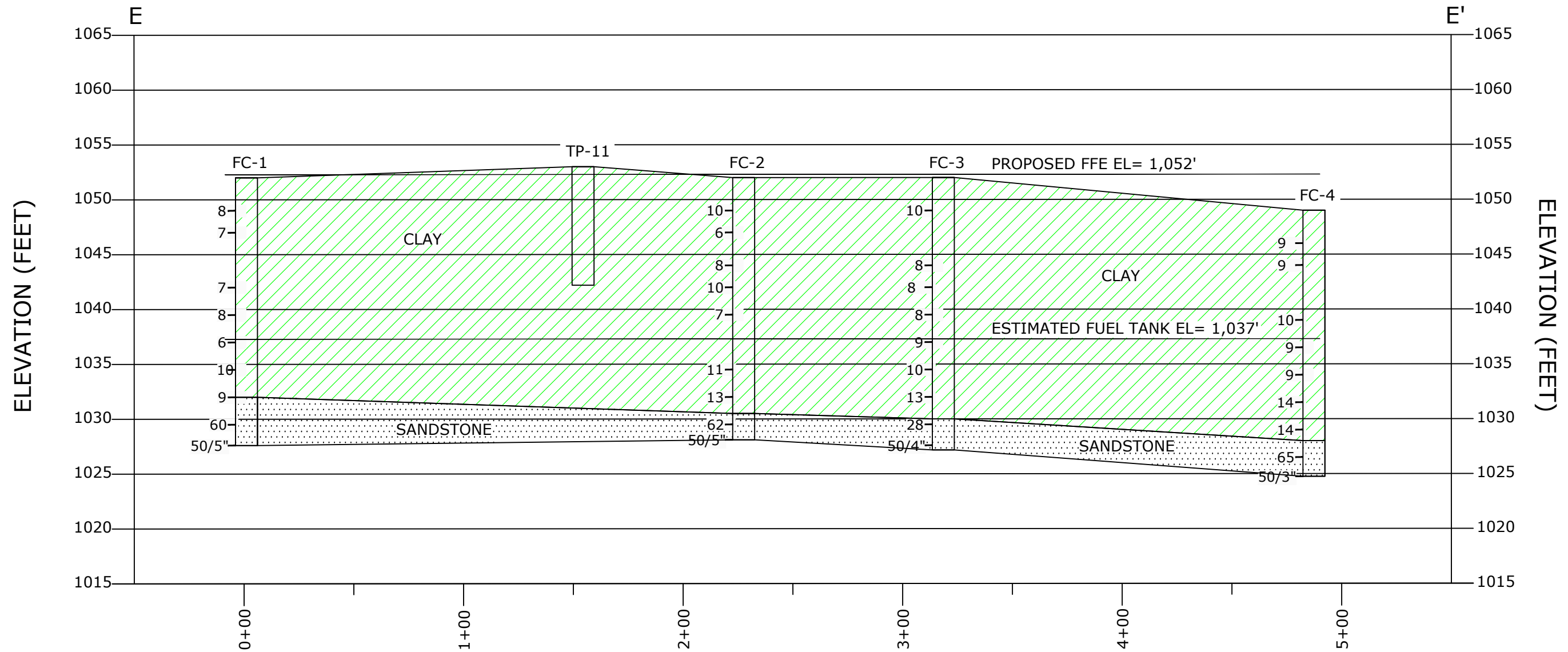
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Drawn By:	RLW	Scale:	AS SHOWN			
Checked By:	LWB/MRF	File No.:	02255162-2			
Approved By:	LWB	Date:	JULY 2025			
				15620 W 113th St (913) 492-7777	Lenexa, KS 66219	

SUBSURFACE PROFILE CROSS SECTION E-E'

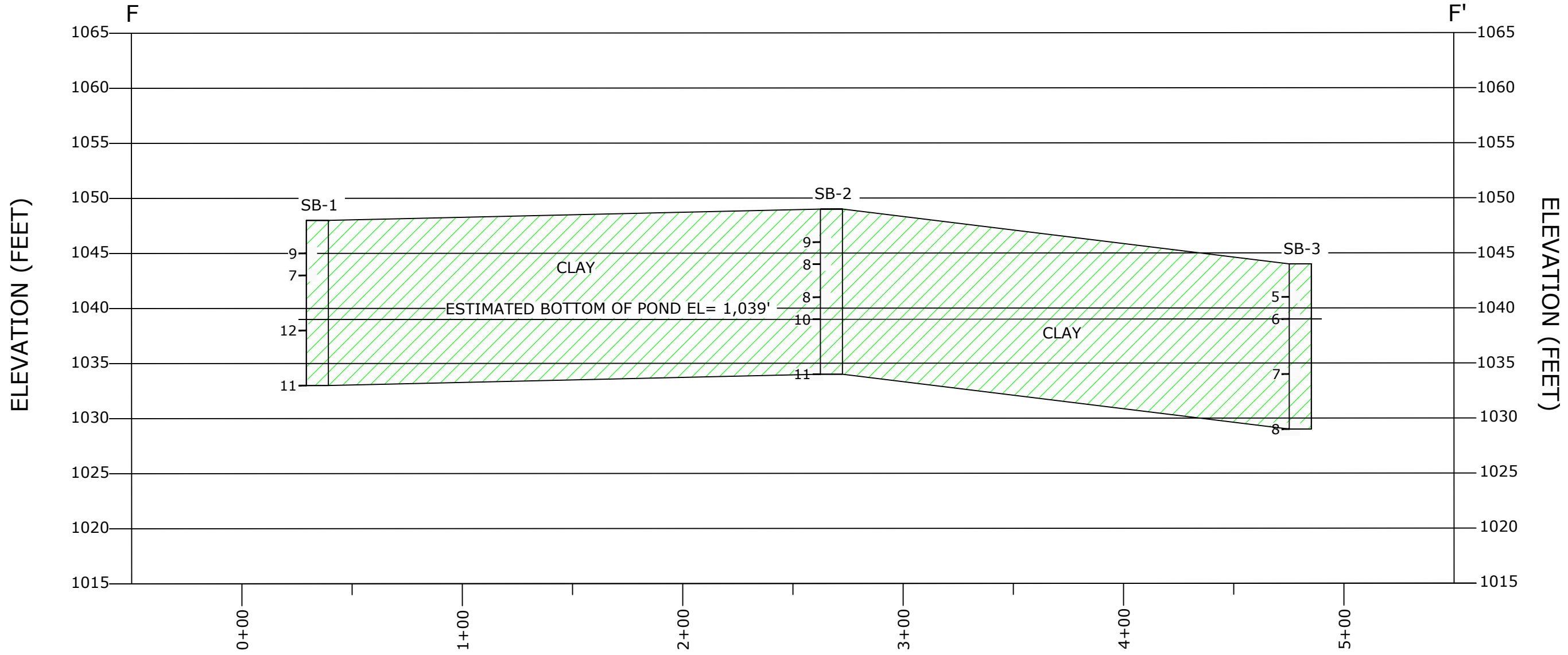


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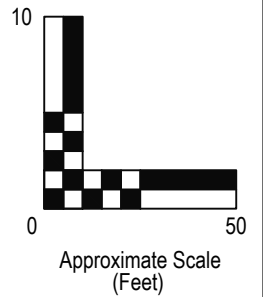
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Project Mngr: LWB	Project No. 02255162		GEOTECHNICAL INVESTIGATION	EXHIBIT
Drawn By: RLW	Scale: AS SHOWN		Terracon	COSTCO WHOLESALE WAREHOUSE LEE'S SUMMIT, MO CW# 25-0146
Checked By: LWB/MRF	File No. 02255162-2	15620 W 113th St (913) 492-7777	COSTCO WHOLESALE CORPORATION	
Approved By: LWB	Date: JULY 2025	Lenexa, KS 66219	STATE ROUTE 291 AND OLDHAM PARKWAY	
			LEE'S SUMMIT, MO	

SUBSURFACE PROFILE CROSS SECTION F-F'

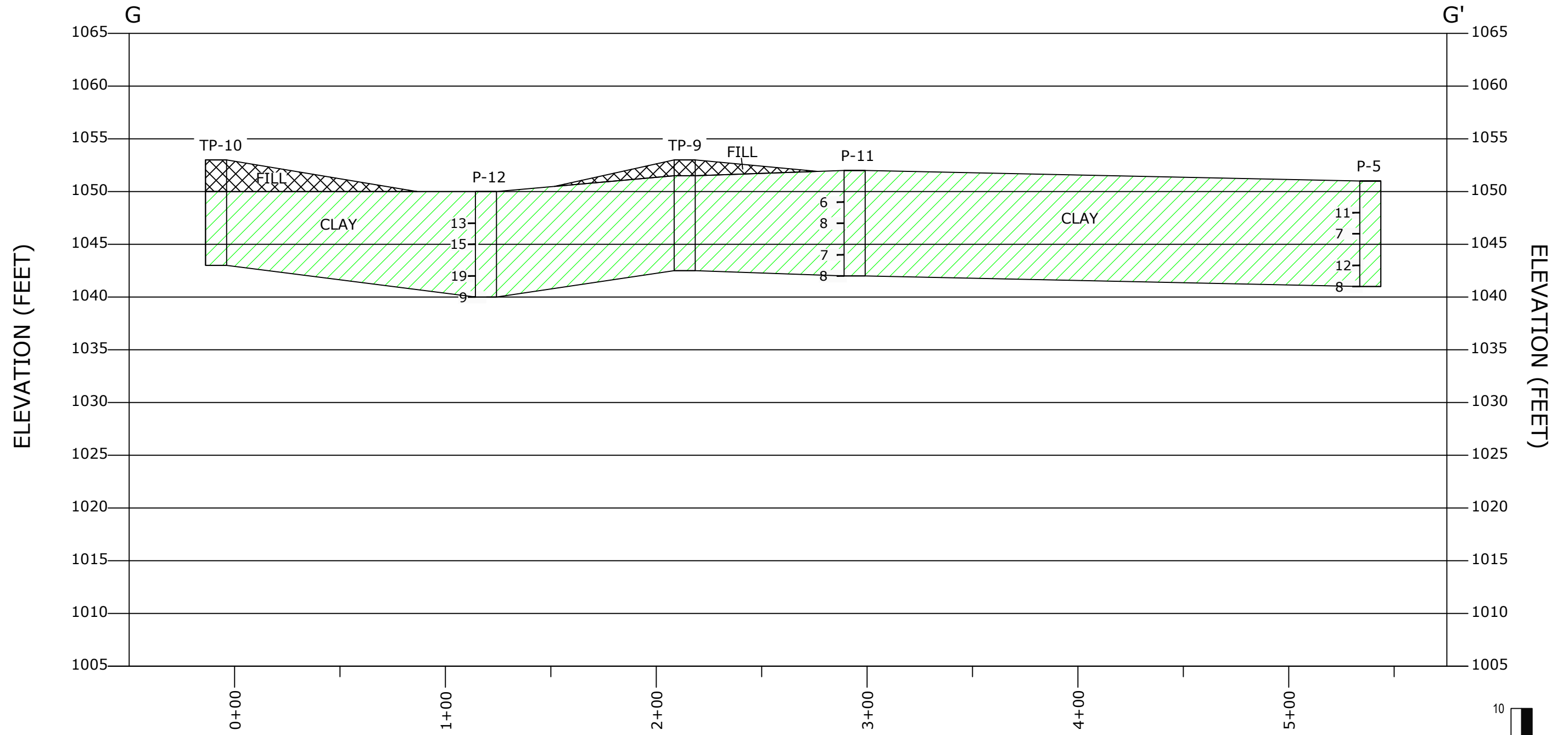


- NOTES:**
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Drawn By:	RLW	Scale:	AS SHOWN		15620 W 113th St Lenexa, KS 66219 (913) 492-7777	7
Checked By:	LWB/MRF	File No.:	02255162-2			
Approved By:	LWB	Date:	JULY 2025			

SUBSURFACE PROFILE CROSS SECTION G-G'

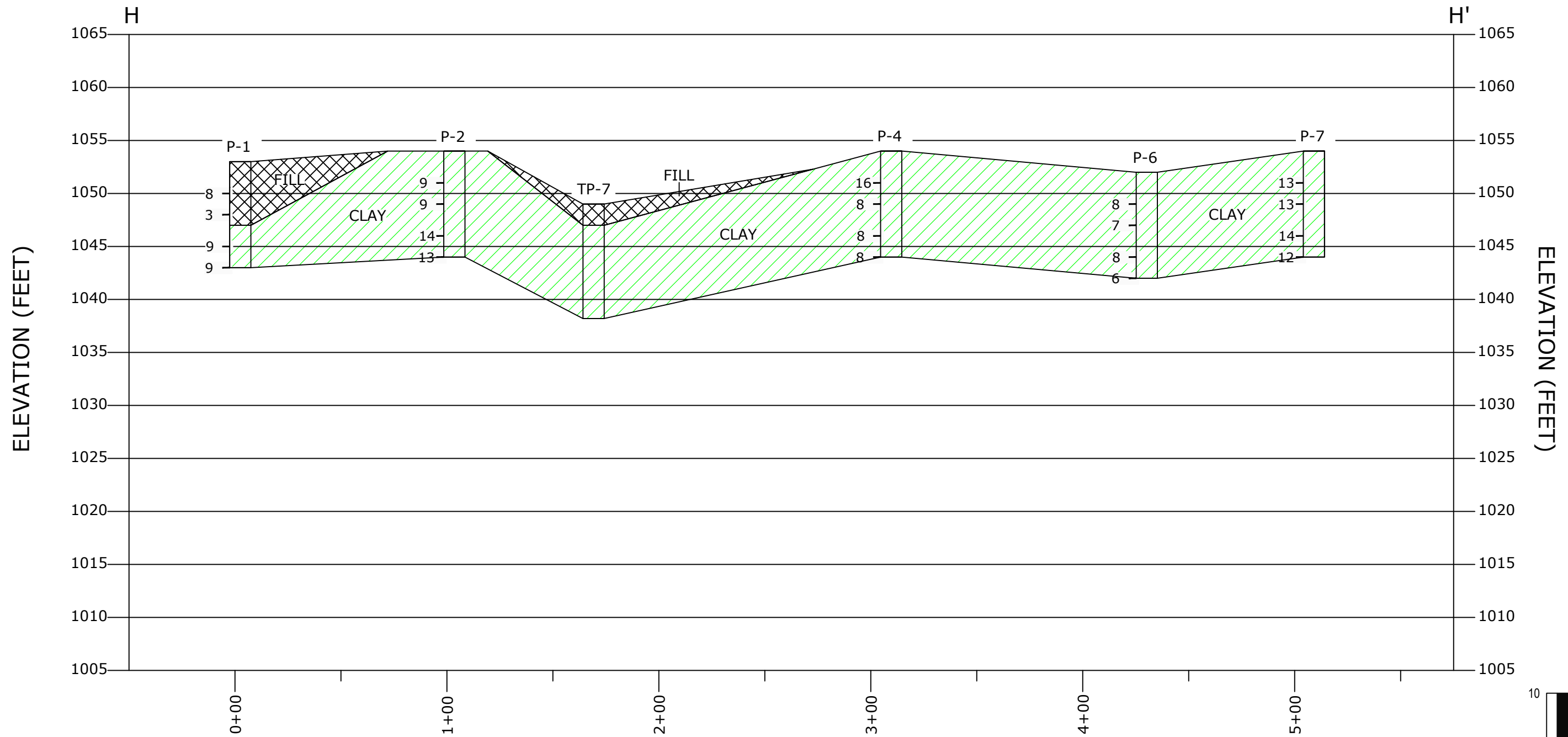


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- SEE CROSS SECTION PLAN FOR ORIENTATION OF SOIL PROFILE.
- WHILE INDIVIDUAL TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS ON THE DATES SHOWN, IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.
- THE SUBSURFACE CONDITIONS SHOWN ON THESE PROFILES ARE NOT WARRANTED BUT ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND ENGINEERING JUDGEMENTS.

Project Mngr:	LWB	Project No.:	02255162	<p style="font-size: small;">15620 W 113th St (913) 492-7777</p> <p style="font-size: x-small;">Lenexa, KS 66219</p>	GEOTECHNICAL INVESTIGATION COSTCO WHOLESALE WAREHOUSE LEE'S SUMMIT, MO CW# 25-0146 COSTCO WHOLESALE CORPORATION STATE ROUTE 291 AND OLDHAM PARKWAY LEE'S SUMMIT, MO	EXHIBIT 8
Drawn By:	RLW	Scale:	AS SHOWN			
Checked By:	LWB/MRF	File No.:	02255162-2			
Approved By:	LWB	Date:	JULY 2025			

SUBSURFACE PROFILE CROSS SECTION H-H'

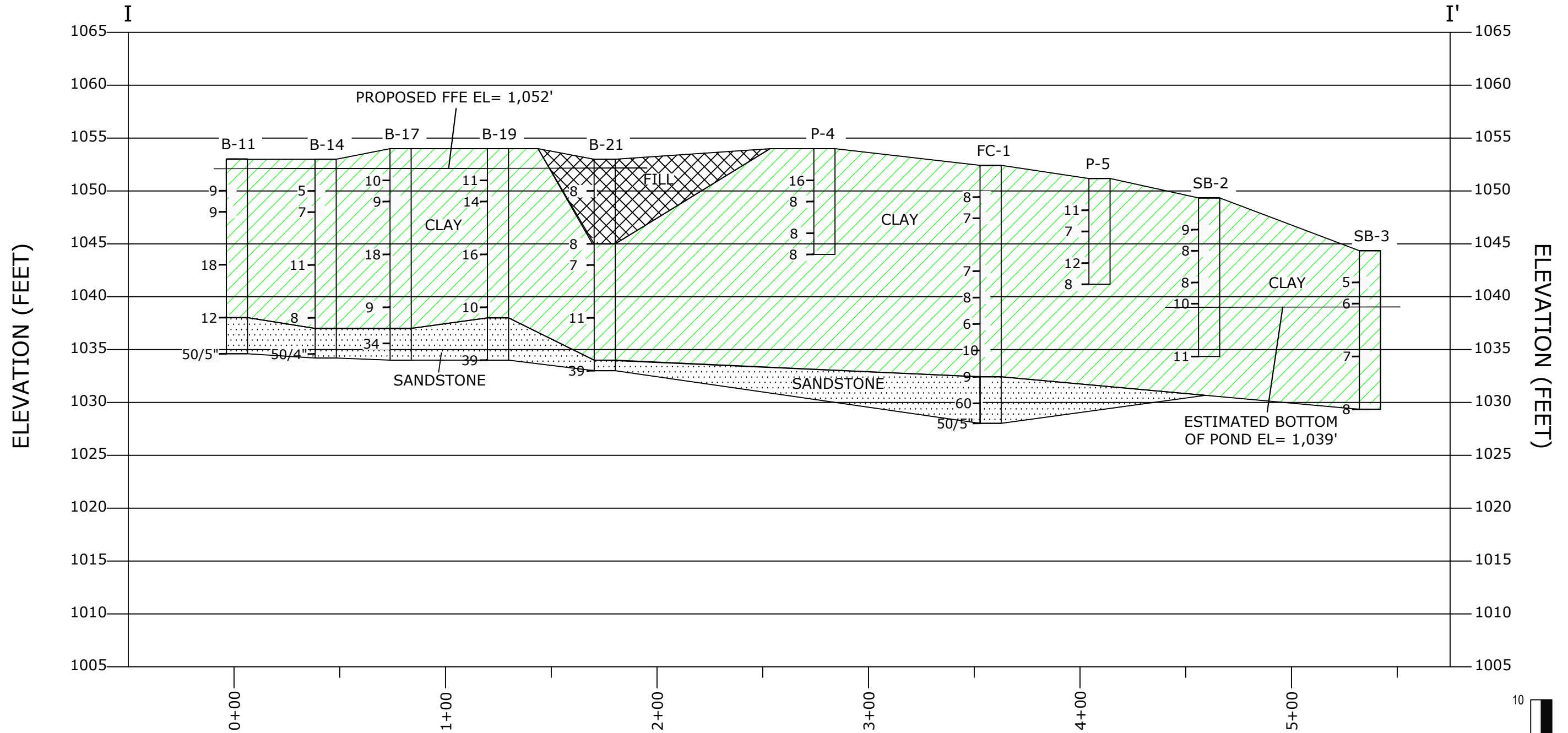


NOTES:

- SEE CROSS SECTION PLAN FOR ORIENTATION OF SOIL PROFILE.
- WHILE INDIVIDUAL TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS ON THE DATES SHOWN, IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.
- THE SUBSURFACE CONDITIONS SHOWN ON THESE PROFILES ARE NOT WARRANTED BUT ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND ENGINEERING JUDGEMENTS.

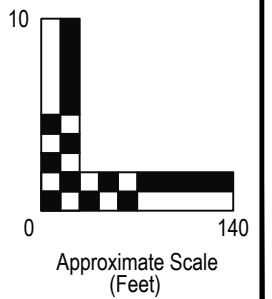
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="font-size: small;">Project Mgr:</td><td>LWB</td></tr> <tr><td style="font-size: small;">Drawn By:</td><td>RLW</td></tr> <tr><td style="font-size: small;">Checked By:</td><td>LWB/MRF</td></tr> <tr><td style="font-size: small;">Approved By:</td><td>LWB</td></tr> </table>	Project Mgr:	LWB	Drawn By:	RLW	Checked By:	LWB/MRF	Approved By:	LWB	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td style="font-size: small;">Project No.:</td><td>02255162</td></tr> <tr><td style="font-size: small;">Scale:</td><td>AS SHOWN</td></tr> <tr><td style="font-size: small;">File No.:</td><td>02255162-2</td></tr> <tr><td style="font-size: small;">Date:</td><td>JULY 2025</td></tr> </table>	Project No.:	02255162	Scale:	AS SHOWN	File No.:	02255162-2	Date:	JULY 2025	<p style="font-size: x-small;">15620 W 113th St (913) 492-7777</p> <p style="font-size: x-small;">Lenexa, KS 66219</p>	<p style="font-weight: bold; font-size: small;">GEOTECHNICAL INVESTIGATION</p> <p style="font-size: x-small;">COSTCO WHOLESALE WAREHOUSE LEE'S SUMMIT, MO CW# 25-0146 COSTCO WHOLESALE CORPORATION STATE ROUTE 291 AND OLDHAM PARKWAY LEE'S SUMMIT, MO</p>	<p style="font-weight: bold; font-size: small;">EXHIBIT</p> <p style="font-size: x-small;">9</p>
Project Mgr:	LWB																			
Drawn By:	RLW																			
Checked By:	LWB/MRF																			
Approved By:	LWB																			
Project No.:	02255162																			
Scale:	AS SHOWN																			
File No.:	02255162-2																			
Date:	JULY 2025																			

SUBSURFACE PROFILE CROSS SECTION I-I'



NOTES:

- SEE CROSS SECTION PLAN FOR ORIENTATION OF SOIL PROFILE.
- WHILE INDIVIDUAL TEST BORING RECORDS ARE CONSIDERED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT THE RESPECTIVE BORING LOCATIONS ON THE DATES SHOWN, IT IS NOT WARRANTED THAT THEY ARE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.
- THE SUBSURFACE CONDITIONS SHOWN ON THESE PROFILES ARE NOT WARRANTED BUT ARE ESTIMATED BASED ON ACCEPTED SOIL ENGINEERING PRINCIPLES AND ENGINEERING JUDGEMENTS.



Project Mgr:	LWB	Project No.:	02255162		GEOTECHNICAL INVESTIGATION COSTCO WHOLESALE WAREHOUSE LEE'S SUMMIT, MO CW# 25-0146 COSTCO WHOLESALE CORPORATION STATE ROUTE 291 AND OLDHAM PARKWAY LEE'S SUMMIT, MO	EXHIBIT
Drawn By:	RLW	Scale:	AS SHOWN		15620 W 113th St Lenexa, KS 66219 (913) 492-7777	10
Checked By:	LWB/MRF	File No.:	02255162-2			
Approved By:	LWB	Date:	JULY 2025			

Boring Log No. B-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9023° Longitude: -94.3738° Depth (Ft.) Approximate Elevation: 1057 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 5" ROOT ZONE	1056.5									
1		1.0 FILL - LEAN CLAY , dark brown and gray LEAN CLAY (CL) , light brown and gray, stiff	1056			3-3-7 N=10			18.4			
						4-5-5 N=10						
		6.0 FAT CLAY (CH) , light brown and gray, stiff	1051			4-4-7 N=11			26.4			
2							UC	0.30	0.4	23.4	102	
						4-6-7 N=13			23.7			
		17.0 SANDSTONE , light brown and gray, highly weathered, weathered shale	1040									
3		19.3 Refusal at 19.3 Feet	1037.7			25-50/4"						

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-23-2025

Boring Completed
 06-23-2025

Boring Log No. B-2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9020° Longitude: -94.3738° Depth (Ft.) Approximate Elevation: 1055 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE 1054.5										
2		LEAN CLAY (CL) , light brown and gray, stiff			X	3-3-6 N=9			20.7			
					X	3-4-5 N=9			21.4			
		5.0 FAT CLAY (CH) , light brown and gray, medium stiff to stiff 1050	5						28.2			
					X	2-3-3 N=6			24.7			
					X	4-4-7 N=11			24.1			
		19.5 1035.5			X	7-35-50/5"			25.4			
3		20.0 SANDSTONE , light brown and gray, highly weathered, weathered shale 1035 Boring Terminated at 20 Feet	20									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-23-2025
Boring Completed
 06-23-2025

Boring Log No. B-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9018° Longitude: -94.3738° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE 1053.5										
		LEAN CLAY (CL) , light brown and gray, medium stiff to stiff	5		X	2-3-4 N=7			27.0			
									22.1			
		8.0 FAT CLAY (CH) , light brown and gray, stiff 1046			X	3-4-7 N=11			22.3			
					X	2-4-5 N=9			26.3			
					X	4-5-8 N=13			23.0			
					X	5-6-11 N=17			22.8			
		20.0 Boring Terminated at 20 Feet 1034	20									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-23-2025
Boring Completed
 06-23-2025

Boring Log No. B-4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9015° Longitude: -94.3738°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
1	CONCRETE	Approximate Elevation: 1055 (Ft.)	0.8									
	LEAN CLAY/FAT CLAY, dark brown with gray, medium stiff		1054.25			1-4-5 N=9			28.3			
	FAT CLAY, brown with gray, stiff to very stiff		1051				UC		23.1			
2	light brown with gray		5			2-4-6 N=10			23.7			
			10			3-5-6 N=11						
			15			2-4-6 N=10						
			20			6-6-11 N=17			23.1			
		Boring Terminated at 20 Feet	1035									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-27-2025
Boring Completed
 06-27-2025

Boring Log No. B-5

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9014° Longitude: -94.3743° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		6" ROOT ZONE	0.6									
		FAT CLAY (CH) , light brown with gray, stiff	1053.42									
					X	2-4-6 N=10			22.6			
					X	3-5-6 N=11			24.2			
			5						27.3		66-17-49	
					X	2-5-6 N=11			26.0			
					X	2-4-6 N=10						
			10									
					X	2-4-6 N=10						
			15									
					X	50/5"			25.7			
			20									
		Boring Terminated at 20 Feet	20.0									
			1034									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-27-2025</p> <p>Boring Completed 06-27-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. B-6

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9014° Longitude: -94.3747° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.4 5" ROOT ZONE 1053.58										
	[Hatched Pattern]	LEAN CLAY (CL) , dark brown with gray, medium stiff to stiff	5	X		1-4-5 N=9			28.7			
									26.8			
		8.0 FAT CLAY (CH) , light brown with gray, stiff to very stiff 1046		X		2-4-6 N=10			28.3			
	[Hatched Pattern]		10	X		3-5-6 N=11			21.5		54-21-33	
2	[Hatched Pattern]			X		2-4-6 N=10			26.8			
		20.0 Boring Terminated at 20 Feet 1034	20	X		6-6-11 N=17			23.9			

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p> <p>Notes</p>	<p>Water Level Observations Water not encountered.</p> <p>Advancement Method</p> <p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p> <p>Logged by MR</p> <p>Boring Started 06-27-2025</p> <p>Boring Completed 06-27-2025</p>
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Boring Log No. B-7

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9014° Longitude: -94.3752° Depth (Ft.) Approximate Elevation: 1050 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE , with gravel	1049.5									
		LEAN CLAY/FAT CLAY (CL/CH) , dark brown with gray, stiff										
			5			2-4-6 N=10			20.2			
						3-5-6 N=11			25.4			
							UC	2.68	14.8	22.4	106	49-17-32
2		FAT CLAY (CH) , light brown with gray, stiff	8.0									
			10			2-5-6 N=11						
			15			2-4-6 N=10						
3		SANDSTONE , light brown with gray, highly weathered	16.0									
			20			50/5"						
		Boring Terminated at 20 Feet	20									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-27-2025
Boring Completed
 06-27-2025

Boring Log No. B-8

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9017° Longitude: -94.3753° Depth (Ft.) Approximate Elevation: 1052 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2	4" ROOT ZONE		0.3									
	LEAN CLAY (CL), dark brown, soft to medium stiff		1051.67			1-3-3 N=6			28.4			
			5			1-2-1 N=3			35.1			
	FAT CLAY (CH), brown to gray, stiff		1046	6.0					27.5			
			10			2-5-6 N=11						
3	SANDSTONE, light brown to gray, highly weathered, with weathered shale		1035			2-5-5 N=10			27.8			
			15			10-9-36 N=45						
	Boring Terminated at 20 Feet		1032			20						

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (if any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-26-2025
Boring Completed
 06-26-2025

Boring Log No. B-9

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9017° Longitude: -94.3755°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		Depth (Ft.) Approximate Elevation: 1049 (Ft.)										
	0.5	6" ROOT ZONE	1048.5									
2	0.5	LEAN CLAY (CL) , dark brown with gray, medium stiff			X	2-3-5 N=8			18.9			
	5								25.5			
	7.0	LEAN CLAY/FAT CLAY (CL/CH) , light brown with gray, soft	1042		X	1-2-2 N=4			20.7			
	10	stiff			X	3-6-4 N=10			28.6			
3	15	stiff			X	3-4-5 N=9			19.9			
	17.0	SANDSTONE , light brown with gray, highly weathered	1032		X	34-50/4"						
	20.0	Boring Terminated at 20 Feet	1029									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-27-2025
Boring Completed
 06-27-2025

Boring Log No. B-10

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9020° Longitude: -94.3755°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		Depth (Ft.) Approximate Elevation: 1052 (Ft.)										
		0.5 6" ROOT ZONE	1051.5									
		LEAN CLAY (CL) , dark brown to gray, medium stiff			X	2-2-4 N=6			24.6			
					X	2-2-3 N=5			27.3		45-28-17	
			5									
		7.0 FAT CLAY (CH) , brown to gray, stiff	1045		X	3-5-5 N=10			25.7			
2									22.2			
		light brown to gray										
					X	2-3-6 N=9			27.1			
			15									
		17.0 SANDSTONE , light brown to gray, highly weathered, with weathered shale	1035									
3					X	50/5"						
		18.9 Refusal at 18.92 Feet	1033.08									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-26-2025




Boring Completed
 06-26-2025

Boring Log No. B-11

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9024° Longitude: -94.3755° Depth (Ft.) Approximate Elevation: 1053 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		6" ROOT ZONE	0.5									
2		LEAN CLAY (CL) , dark brown to gray, stiff			X	4-4-5 N=9			20.5			
					X	4-4-5 N=9			20.0			
						UC	4.48	2.1	15.9	107		
		FAT CLAY (CH) , brown to light gray, very stiff	8.5		X	5-8-10 N=18			15.8		54-21-33	
						X	4-5-7 N=12					
		SANDSTONE , light brown, completely weathered, with weathered clayey shale	15.0		X	4-5-7 N=12						
3						X	50/5"					
		Refusal at 18.92 Feet	18.9									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-26-2025</p> <p>Boring Completed 06-26-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. B-12

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9023° Longitude: -94.3749° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.4 5" ROOT ZONE 1053.58										
1		FILL - LEAN CLAY , dark brown to gray				3-4-6 N=10			24.6			
									26.5			
		7.0 FILL - CONCRETE , brown to light gray 1047				2-50/1"			23.1			
2		FAT CLAY (CH) , brown to gray, very stiff				3-7-9 N=16			21.3			
									24.2	67-25-42		
		17.0 SANDSTONE , light brown, highly weathered, with weathered shale 1037				4-6-10 N=16						
3		SANDSTONE , light brown, highly weathered, with weathered shale				50/5"						
		18.9 Refusal at 18.92 Feet 1035.08										

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-26-2025

Boring Completed
 06-26-2025

Boring Log No. B-13

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9023° Longitude: -94.3743° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE 1053.5										
		LEAN CLAY (CL) , brown and gray, stiff			X	3-3-6 N=9						
			5		X	5-7-7 N=14						
		6.0 FAT CLAY (CH) , light brown and gray, stiff 1048			X	3-5-7 N=12						
2			10				UC	1.08	3.2	25.6	99	
			15		X	5-6-7 N=13						
		18.0 SANDSTONE , light brown and gray, highly weathered, with shale 1036			X	10-50/5"						
3		20.0 Boring Terminated at 20 Feet 1034	20									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-24-2025
Boring Completed
 06-24-2025

Boring Log No. B-14

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9021° Longitude: -94.3752° Depth (Ft.) Approximate Elevation: 1053 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2		4" ROOT ZONE LEAN CLAY (CL) , dark brown to gray, medium stiff	0.3									
			1052.67	5	X	1-3-2 N=5			29.2			
				5	X	1-3-4 N=7			28.3			
				5					27.6			
			9.0		X	3-4-7 N=11			21.6	53-21-32		
3		FAT CLAY (CH) , brown to gray, stiff	1044									
			16.0	15	X	2-4-4 N=8						
			1037									
		SANDSTONE , light brown to gray, highly weathered, with shale	1034.17									
		Refusal at 18.83 Feet	18.8		X	50/4"						

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-26-2025
Boring Completed
 06-26-2025

Boring Log No. B-15

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9021° Longitude: -94.3746° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE 1053.5										
2		FAT CLAY (CH) , brown and gray, stiff - color change to light brown and gray at 4 feet	5		X	2-4-5 N=9			18.3		51-22-29	
			10		X	5-6-7 N=13						
			15		X	3-3-5 N=8						
			19.0		X	3-5-5 N=10						
3		19.0 1035 SANDSTONE , light brown and gray, highly weathered, with shale 20.0 1034	20		X	4-22-50/4"						
		Boring Terminated at 20 Feet										

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-24-2025
Boring Completed
 06-24-2025

Boring Log No. B-16

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9020° Longitude: -94.3741° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE 1053.5										
		LEAN TO FAT CLAY (CL/CH) , brown and gray, medium stiff				2-2-3 N=5						
			5			2-2-3 N=5						
		6.0 FAT CLAY (CH) , light brown and gray, stiff 1048				4-4-7 N=11						
2			10						24.7			
			15			4-5-7 N=12						
		18.0 SANDSTONE , light brown and gray, highly weathered, with shale 1036				9-50/5"						
3			20									
		Boring Terminated at 20 Feet 1034										

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-24-2025

Boring Completed
 06-24-2025

Boring Log No. B-17

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9019° Longitude: -94.3750° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2		0.5 6" ROOT ZONE LEAN CLAY (CL) , dark brown and gray, stiff	1053.5			5-6-4 N=10			19.1			
		4.0 LEAN TO FAT CLAY (CL/CH) , dark gray and brown, stiff to very stiff	1050			3-3-6 N=9						
		12.0 FAT CLAY (CH) , light brown and gray, stiff	1042			5-8-10 N=18						
		17.0 SANDSTONE , light brown and gray, highly weathered, with shale	1037			3-3-6 N=9						
3		20.0 Boring Terminated at 20 Feet	1034			7-11-23 N=34						

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-24-2025
Boring Completed
 06-24-2025

Boring Log No. B-18

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9019° Longitude: -94.3744° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.4 5" ROOT ZONE 1053.6										
2		LEAN TO FAT CLAY (CL/CH) , brown and gray, stiff 4' - color change to light brown and gray	5		X	4-6-7 N=13						
			5				UC	2.33	2.2	17.1	102	42-20-22
			10		X	3-5-5 N=10						
			10		X	3-4-5 N=9						
			15		X	5-5-7 N=12						
3		SANDSTONE , light brown and gray, weathered shale	18.0 1036 20.0 1034		X	17-42-50/2"						
		Boring Terminated at 20 Feet	20									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-24-2025
Boring Completed
 06-24-2025

Boring Log No. B-19

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9017° Longitude: -94.3746° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		6" ROOT ZONE	0.5									
2		FAT CLAY (CH) , dark brown with gray, stiff	1053.5									
					X	3-4-7 N=11			27.3			
					X	3-6-8 N=14			21.7		69-23-46	
					X	6-6-10 N=16			18.5		37-16-21	
		LEAN CLAY (CL) , dark brown with gray, very stiff	5.0									
		FAT CLAY (CH) , light brown with gray, stiff	9.0									
			1045									
			10.0									
			15.0									
			16.0									
		SANDSTONE , light brown with gray	16.0									
3			1038									
			20.0									
		Boring Terminated at 20 Feet	1034									
			20									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-27-2025</p> <p>Boring Completed 06-27-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. B-20

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9015° Longitude: -94.3749°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		Depth (Ft.) Approximate Elevation: 1052 (Ft.)										
	0.3	CONCRETE , with asphalt	1051.67									
1	5.0	FILL - LEAN CLAY , dark brown with greenish gray, abandoned pipe with water	1047	▽	X	1-3-2 N=5			26.6			
					X	2-5-3 N=8			30.2			
		LEAN CLAY/FAT CLAY (CL/CH) , brown with gray, stiff	5		■				21.6		48-19-29	
2					X	2-3-5 N=8			24.8			
					X	3-2-6 N=8			29.7			
3	18.0	SANDSTONE , light brown with gray	1034		X	50/5"						
	20.0	Boring Terminated at 20 Feet	1032									
			20									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 ▽ While drilling

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-27-2025
Boring Completed
 06-27-2025

Boring Log No. B-21

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9016° Longitude: -94.3741°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
1		Depth (Ft.) Approximate Elevation: 1053 (Ft.) 0.3 3" ROOT ZONE 1052.75 0.7 5" CONCRETE 1052.3 1.0 4" AGGREGATE BASE COURSE 1052 FILL - LEAN TO FAT CLAY (CL/CH) , brown and gray	5		X	2-3-5 N=8			22.1			
			8.0		X	2-3-5 N=8						
			10		X	3-3-4 N=7						
			15		X	4-4-7 N=11						
2		FAT CLAY (CH) , light brown and gray, medium stiff to stiff 8.0 1045	19.0		X	7-9-30 N=39						
3		SANDSTONE , light brown and gray, clayey 19.0 1034 20.0 1033	20									
		Boring Terminated at 20 Feet										

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-24-2025
Boring Completed
 06-24-2025

Boring Log No. FC-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9006° Longitude: -94.3729° Depth (Ft.) Approximate Elevation: 1052 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	
							Test Type	Compressive Strength (tsf)	Strain (%)				
		0.5 6" ROOT ZONE	1051.5										
2		FAT CLAY (CH) , dark gray and brown, medium stiff to stiff											
		3' - color change to light brown and gray											
					5								
							3-4-4 N=8				24.4		
							2-2-5 N=7				27.2		
								UC	2.54	14.8	22.3	105	
					10								
							3-4-3 N=7				23.0		
					3-3-5 N=8				26.3				
					2-3-3 N=6				27.7				
			15										
					2-4-6 N=10				25.0				
					3-4-5 N=9				28.8				
			20										
3		SANDSTONE , light brown and gray, highly weathered, weathered shale											
							11-24-36 N=60						
			24.4			23-50/5"							
		Refusal at 24.4 Feet	1027.6										

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-23-2025
Boring Completed
 06-23-2025

Boring Log No. FC-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9005° Longitude: -94.3726° Depth (Ft.) Approximate Elevation: 1052 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	
							Test Type	Compressive Strength (tsf)	Strain (%)				
		0.5 6" ROOT ZONE 1051.5											
2		LEAN CLAY (CL) , dark brown and gray, medium stiff to stiff 7.5' - color change to light brown and gray				3-4-6 N=10			26.6		47-17-30		
									24.8				
								3-3-5 N=8			25.5		
								2-3-5 N=8			22.0		
								3-3-5 N=8			25.5		
								2-4-5 N=9			27.0		
								3-5-5 N=10			25.4		
								4-6-7 N=13			23.2		
								6-9-19 N=28			23.6		
								17-38-50/4"					
3		SANDSTONE , light brown and gray, highly weathered 22.0 1030 24.8 1027.17											

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by TC</p> <p>Boring Started 06-20-2025</p> <p>Boring Completed 06-20-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. FC-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9005° Longitude: -94.3726°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		Depth (Ft.) Approximate Elevation: 1052 (Ft.) Refusal at 24.83 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by TC</p> <p>Boring Started 06-20-2025</p> <p>Boring Completed 06-20-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. FC-4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9002° Longitude: -94.3726° Depth (Ft.) Approximate Elevation: 1049 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	
							Test Type	Compressive Strength (tsf)	Strain (%)				
		0.4 5" ROOT ZONE 1048.58											
2		FAT CLAY (CH) , dark brown and gray, stiff color change to light brown and gray				2-3-6 N=9							
						3-3-6 N=9			24.3				
											22.6		
								3-4-6 N=10			23.5		
								3-3-6 N=9			26.4	71-23-48	
								3-3-6 N=9			23.0		
								4-5-9 N=14			24.0		
								4-6-8 N=14			24.2		
3		SANDSTONE , light brown and gray, highly weathered, with residual shale	21.0			22-30-35 N=65			21.6				
			24.3			39-50/3"							
		Refusal at 24.25 Feet 1024.75											

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 TC

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-20-2025

Boring Completed
 06-20-2025

Boring Log No. P-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9023° Longitude: -94.3731° Depth (Ft.) Approximate Elevation: 1053 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.4 5" ROOT ZONE 1052.6										
1		FILL - FAT CLAY , dark brown and gray	5	X		3-3-5 N=8			30.0			
		6.0 1047				2-1-2 N=3			18.0			
2		FAT CLAY (CH) , light brown and gray, stiff	10	X		3-4-5 N=9			22.0			
		10.0 1043				3-3-6 N=9			22.2			
		Boring Terminated at 10 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-23-2025</p> <p>Boring Completed 06-23-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9018° Longitude: -94.3734° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.4	1053.6									
	5" ROOT ZONE											
	LEAN TO FAT CLAY (CL/CH), dark brown and gray, stiff											
2	FAT CLAY (CH), light brown and gray, stiff											
		6.0	1048			2-3-6 N=9			26.9		75-23-52	
						3-4-5 N=9			26.1			
						4-6-8 N=14			20.9			
						5-6-7 N=13			24.3			
		10.0	1044									
		Boring Terminated at 10 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9015° Longitude: -94.3723° Depth (Ft.) Approximate Elevation: 1049 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE	1048.5									
2		FAT CLAY (CH) , dark brown and gray, medium stiff to stiff light brown and gray	5		X	4-3-5 N=8			27.1	62-19-43		
					X	2-2-5 N=7		25.0				
					X	4-3-5 N=8		22.2				
					X	3-4-5 N=9		21.8				
		Boring Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-23-2025</p> <p>Boring Completed 06-23-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9011° Longitude: -94.3734° Depth (Ft.) _____ Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.3 - 1053.7 4" ROOT ZONE										
2		FAT CLAY (CH) , brown, stiff to very stiff brown and gray	5		X	6-7-9 N=16			22.5			
					X	3-4-4 N=8			26.6			
					X	3-3-5 N=8			21.8			
					X	4-4-4 N=8			25.7			
		10.0 - 1044 Boring Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by TC</p> <p>Boring Started 06-19-2025</p> <p>Boring Completed 06-19-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-5

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9007° Longitude: -94.3725°	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		Depth (Ft.) Approximate Elevation: 1051 (Ft.)										
		0.4 1050.58										
2		FAT CLAY (CH) , dark brown and gray, medium stiff to stiff			X	3-4-7 N=11			22.3			
			5		X	2-3-4 N=7			25.6			
		6' - color change to light brown and gray			X	4-5-7 N=12			29.8			
					X	3-4-4 N=8			25.2			
		10.0 1041	10									
		Boring Terminated at 10 Feet										

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55 LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-23-2025
Boring Completed
 06-23-2025

Boring Log No. P-6

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9004° Longitude: -94.3733° Depth (Ft.) Approximate Elevation: 1052 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2		0.3 - 1051.7 4" ROOT ZONE										
		FAT CLAY (CH) , brown and gray, medium stiff to stiff			X	2-4-4 N=8			27.7			
			5		X	3-3-4 N=7			26.3			
					X	3-3-5 N=8			24.8			
		10.0 - 1042		10		X	2-3-3 N=6			29.8		
		Boring Terminated at 10 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by TC</p> <p>Boring Started 06-19-2025</p> <p>Boring Completed 06-19-2025</p>
		<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>

Boring Log No. P-7

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9000° Longitude: -94.3734° Depth (Ft.) _____ Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2		4" ROOT ZONE FAT CLAY (CH) , brown, stiff 1.5' color change to brown and gray	0.3									
		1053.7			X	3-5-8 N=13			22.1	76-25-51		
		5			X	4-6-7 N=13			20.4			
		10			X	5-7-7 N=14			19.7			
		1044			X	4-6-6 N=12			21.0			
		Boring Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55 LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by TC</p> <p>Boring Started 06-19-2025</p> <p>Boring Completed 06-19-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-8

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9001° Longitude: -94.3747° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2		0.3 - 1053.7 6" ROOT ZONE										
		LEAN CLAY (CL) , brown, stiff										
		3-4-5 N=9						28.7				
		3-5-8 N=13						21.9				
		6.5 - 1047.5 FAT CLAY (CH) , brown, stiff to very stiff										
						5-7-10 N=17						
						3-5-5 N=10						
		10.0 - 1044 Boring Terminated at 10 Feet	10									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 MR

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-19-2025
Boring Completed
 06-19-2025

Boring Log No. P-9

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9013° Longitude: -94.3754° Depth (Ft.) Approximate Elevation: 1049 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	
							Test Type	Compressive Strength (tsf)	Strain (%)				
		0.5 6" ROOT ZONE	1048.5										
2		LEAN CLAY (CL) , dark brown with gray, stiff			X	2-4-6 N=10			17.2				
					X	2-5-10 N=15			22.0				
					X	2-5-7 N=12			27.6				
					X	2-5-7 N=12			25.1				
		7.0 FAT CLAY (CH) , dark brown with gray, stiff	1042										
		10.0 Boring Terminated at 10 Feet	1039										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p> <p>Notes</p>	<p>Water Level Observations Water not encountered.</p> <p>Advancement Method</p> <p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p> <p>Logged by MR</p> <p>Boring Started 06-27-2025</p> <p>Boring Completed 06-27-2025</p>
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Boring Log No. P-10

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9010° Longitude: -94.3746° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2	0.3 - 1053.67	4" ROOT ZONE										
	1.0 - 1051	LEAN CLAY (CL) , dark brown with gray, medium stiff			X	2-3-4 N=7			27.3			
	3.0 - 1051	FAT CLAY (CH) , brown and gray, stiff			X	2-4-5 N=9			27.4			
	7.0 - 1047	LEAN CLAY/FAT CLAY (CL/CH) , brown and gray, stiff			X	2-3-5 N=8			21.1		42-18-24	
	10.0 - 1044	LEAN CLAY/FAT CLAY (CL/CH) , brown and gray, stiff			X	2-3-5 N=8			24.5			
		Boring Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-27-2025</p> <p>Boring Completed 06-27-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-11

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9005° Longitude: -94.3741° Depth (Ft.) Approximate Elevation: 1052 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
2		4" ROOT ZONE FAT CLAY (CH) , brown and gray, medium stiff	0.3 — 1051.7			2-3-3 N=6			24.0			
			5			2-4-4 N=8			23.0			
			7.5			2-3-4 N=7			29.1			
			9.5			3-3-5 N=8			23.8			
		Boring Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by TC</p> <p>Boring Started 06-19-2025</p> <p>Boring Completed 06-19-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-12

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9004° Longitude: -94.3750° Depth (Ft.) Approximate Elevation: 1050 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.3 1049.67										
	4" ROOT ZONE											
	FAT CLAY (CH) , brown, stiff											
		3.5 1046.5				3-6-7 N=13			24.4			
			5			3-6-9 N=15			23.3			
						7-9-10 N=19			19.0			
						4-4-5 N=9			25.2			
		10.0 1040	10									
		Boring Terminated at 10 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by TC</p> <p>Boring Started 06-19-2025</p> <p>Boring Completed 06-19-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. P-13

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9007° Longitude: -94.3756° Depth (Ft.) Approximate Elevation: 1052 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.4 5" ROOT ZONE 1051.58										
2		LEAN CLAY (CL) , dark brown with gray, stiff 3' - color change to light brown and gray				2-5-5 N=10			21.4	44-22-22		
						2-4-8 N=12		21.7				
						2-4-6 N=10		28.3				
						4-4-5 N=9		24.4				
		7.5 1044.5 8.0 FAT CLAY (CH) , dark brown with gray, stiff 1044 LEAN CLAY/FAT CLAY (CL/CH) , brown to dark brown, stiff, with gray										
		10.0 1042 Boring Terminated at 10 Feet	10									

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Drill Rig
 CME-55LC

Hammer Type
 Automatic

Driller
 LN

Notes

Advancement Method

Logged by
 TC

Abandonment Method
 Boring backfilled with auger cuttings upon completion.

Boring Started
 06-27-2025
Boring Completed
 06-27-2025

Boring Log No. SB-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9010° Longitude: -94.3721° Depth (Ft.) Approximate Elevation: 1048 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI	
							Test Type	Compressive Strength (tsf)	Strain (%)				
		0.5 6" ROOT ZONE	1047.5										
2		FAT CLAY (CH) , light gray and brown, stiff			X	3-4-5 N=9				24.1			
			3' - color change to dark brown and gray			X	2-3-4 N=7				22.9		
			5										
			6' - color change to light brown and gray			X	3-5-7 N=12				24.8		60-23-37
			10					UC	2.93	15	21.5	106	
		15.0	1033		X	3-5-6 N=11			24.1				
		Boring Terminated at 15 Feet	15										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-20-2025</p> <p>Boring Completed 06-20-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. SB-2

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9004° Longitude: -94.3721° Depth (Ft.) Approximate Elevation: 1049 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI		
							Test Type	Compressive Strength (tsf)	Strain (%)					
		0.5 6" ROOT ZONE	1048.5											
2		6' - color change to light gray and brown			X	3-4-5 N=9				25.5				
					X	2-3-5 N=8				28.4				
					X	3-3-5 N=8					25.5			
					X	4-4-6 N=10					24.0			
									UC	2.35	15	23.5	102	
							X	3-5-6 N=11				25.1		61-20-41
		Boring Terminated at 15 Feet	15											

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-20-2025</p> <p>Boring Completed 06-20-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. SB-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9000° Longitude: -94.3716° Depth (Ft.) Approximate Elevation: 1044 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.4 5" ROOT ZONE 1043.58										
2		FAT CLAY (CH) , dark brown and gray, medium stiff color change to light brown and gray	5		X	2-1-4 N=5			27.1		56-22-34	
			5		X	2-2-4 N=6			28.7			
			10		X	2-3-4 N=7			22.7			
			10	UC	1.68	3.1	28.1	97				
		15.0 Boring Terminated at 15 Feet 1029	15		X	2-3-5 N=8			25.9			

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-20-2025</p> <p>Boring Completed 06-20-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Boring Log No. SB-4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9021° Longitude: -94.3759° Depth (Ft.) Approximate Elevation: 1051 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE	1050.5									
		LEAN CLAY (CL) , dark brown with gray, stiff			X	3-4-6 N=10			22.7			
					X	3-3-6 N=9			25.3			
			5				UC	2.90	2	17.0	104	48-19-29
		7.0 FAT CLAY (CH) , brown with gray, stiff	1044		X	2-5-6 N=11			30.5			
2									9.1			
					X	3-4-5 N=9			25.0			
		Boring Terminated at 15 Feet	1036									
			15									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig CME-55LC</p> <p>Hammer Type Automatic</p> <p>Driller LN</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Logged by MR</p> <p>Boring Started 06-27-2025</p> <p>Boring Completed 06-27-2025</p>
	<p>Abandonment Method Boring backfilled with auger cuttings upon completion.</p>	

Test Pit Log No. TP-1

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9019° Longitude: -94.3738° Depth (Ft.) Approximate Elevation: 1055 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE 1054.5								17.5		
1		FAT CLAY WITH SAND (CH) , brown and gray, fines			 					27.3		
		6.0 1049	5							25.5		
2		FAT CLAY (CH) , gray										
		10.0 1045	10									
		Test Pit Terminated at 10 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Operator</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-3

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9019° Longitude: -94.3755° Depth (Ft.) Approximate Elevation: 1051 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		12" ROOT ZONE , Topsoil	1.0							24.1		
		FILL - LEAN CLAY , dark brown and gray	1050							23.9		
1		asphalt layer								23.5		
		3.5 buried clay pipe fragments	1047.5									
2		FAT CLAY (CH) , dark brown and gray		5								
			10									
		Test Pit Terminated at 10.75 Feet	10.8									
			1040.25									



<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Operator</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-4

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9023° Longitude: -94.3746° Depth (Ft.) Approximate Elevation: 1055 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE	1054.5							23.8		
1		FILL - FAT CLAY (CH) , dark brown sandy, tan, with fines	4.0		 					24.8		
2		FAT CLAY (CH) , medium to high plasticity, gray	10.0							25.8		
		Test Pit Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Operator</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-5

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9015° Longitude: -94.3754° Depth (Ft.) Approximate Elevation: 1051 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		12" ROOT ZONE	1.0	1050	☞ ☞ ☞					17.0 20.1 20.4		
2		FAT CLAY (CH) , brownish gray dark brown	5	1041	☞							
		Test Pit Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p> <p>Abandonment Method</p>	<p>Operator</p> <p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-6

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9022° Longitude: -94.3755° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE	1053.5							20.4		
1		FILL - LEAN CLAY (CL) , brown and gray								23.6		
		5.0	1049							21.3		
2		FAT CLAY (CH) , brown and gray										
		10.0	1044									
		Test Pit Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Operator</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-7

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9018° Longitude: -94.3729° Depth (Ft.) Approximate Elevation: 1049 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		0.5 6" ROOT ZONE	1048.5							23.4		
1		FILL - FAT CLAY (CH) , dark brown, gravels								23.2		
		2.0 1.5' - color change to brown and gray	1047							27.3		
2		FAT CLAY (CH) , dark brown 4' - color change to gray										
		10.8 Test Pit Terminated at 10.75 Feet	1038.25									







<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Operator</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-8

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9010° Longitude: -94.3731° Depth (Ft.) Approximate Elevation: 1052 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
1		0.3 - 1051.75 3" ROOT ZONE FILL - POORLY GRADED SAND WITH CLAY AND GRAVEL , gray, cobbles			 				5.3 4.6 9.8			
2		2.5 - 1049.5 FAT CLAY (CH) , black and dark brown 6' - color change from black to gray 8' - red staining	5									
		10.0 - 1042 Test Pit Terminated at 10 Feet	10									

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p> <p>Abandonment Method</p>	<p>Operator</p> <p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-9

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9008° Longitude: -94.3746° Depth (Ft.) Approximate Elevation: 1053 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		12" ROOT ZONE										
		1.0 1052								15.5		
1		FILL - POORLY GRADED SAND WITH CLAY AND GRAVEL , brownish gray	1.5 1051.5							11.0		
		FAT CLAY (CH) , brown								16.4		
2												
		10.5 1042.5	10									
		Test Pit Terminated at 10.5 Feet										

See [Exploration and Testing Procedures](#) for a description of field and laboratory procedures used and additional data (If any).
 See [Supporting Information](#) for explanation of symbols and abbreviations.
 Elevation Reference: Elevations were interpolated from Google Earth.

Water Level Observations
 Water not encountered.

Excavator
 Trackhoe

Operator

Notes





Advancement Method

Logged by
 MLR

Abandonment Method







Test Pit Started
 06-18-2025
Test Pit Completed
 06-18-2025

Test Pit Log No. TP-10

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9009° Longitude: -94.3756° Depth (Ft.) Approximate Elevation: 1053 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		12" ROOT ZONE	1.0	1052	☞ ☞ ☞					10.7 12.4 20.4		
1		FILL - FAT CLAY , dark brown with red										
		3.0 asphalt layer	3.0	1050								
2		FAT CLAY (CH) , dark brown with red										
		Test Pit Terminated at 10 Feet	10.0	1043								



<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Operator</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Test Pit Log No. TP-11

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9003° Longitude: -94.3729° Depth (Ft.) Approximate Elevation: 1053 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		12" ROOT ZONE										
	1.5	1051.5		  					27.1 22.7 23.4		73-28-45	
2		FAT CLAY (CH) , brown 2' - color change from brown to reddish brown 9' - color change to reddish gray	5									
	10.0	1043	10									
		Test Pit Terminated at 10 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Excavator Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Operator</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Test Pit Started 06-18-2025</p> <p>Test Pit Completed 06-18-2025</p>

Boring Log No. TP-12

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9010° Longitude: 94.3754° Depth (Ft.) Approximate Elevation: 1057 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		12" ROOT ZONE	1.0									
2		FAT CLAY (CH) , dark brown to light brown 9' - color change to black	10.0									
		Boring Terminated at 10 Feet	10									

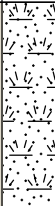


<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Driller</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>

Boring Log No. TP-13

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9020° Longitude: 94.3754° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
1		FILL - POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC) , gray	1.0									
		FILL - FAT CLAY (CH) , dark brown	3.5									
2		FAT CLAY (CH) , dark brown	10.0	5								
	Boring Terminated at 10 Feet		10.0	10								




<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).</p> <p>See Supporting Information for explanation of symbols and abbreviations.</p> <p>Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Driller</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>

Boring Log No. TP-14

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9016° Longitude: 94.3751° Depth (Ft.) Approximate Elevation: 1055 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits
							Test Type	Compressive Strength (tsf)	Strain (%)			LL-PL-PI
1		FILL - TOPSOIL	4.0	1051								
2		LEAN CLAY (CL) , brown and gray	7.0	1048								
		FAT CLAY (CH) , brown and gray	8.0	1047								
Boring Terminated at 8 Feet												

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p> <p>Abandonment Method</p>	<p>Driller</p> <p>Logged by MLR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>

Boring Log No. TP-15

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9022° Longitude: 94.3738° Depth (Ft.) Approximate Elevation: 1056 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		18" ROOT ZONE										
1		FILL - LEAN CLAY (CL) , brown	1.5 1054.5									
2		FAT CLAY (CH) , gray and brown dense and waxy	4.0 1052 5 10 10.0 1046									
		Boring Terminated at 10 Feet										




<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Driller</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>

Boring Log No. TP-17

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9008° Longitude: 94.3756° Depth (Ft.) Approximate Elevation: 1054 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
1		FILL - 36" ROOT ZONE , dark brown to brown, asphalt fragments	3.0									
2		FAT CLAY (CH) , brown moderately weathered	12.0									
		Boring Terminated at 23 Feet										

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Driller</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>

Boring Log No. TP-18

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9016° Longitude: 94.3743° Depth (Ft.) Approximate Elevation: 1057 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
		12" ROOT ZONE										
		1.0 1056										
1		1.5 FILL - , plastic and concrete fragments	1055.5									
2		FAT CLAY (CH) , brown										
		10.0 1047	10									
		Boring Terminated at 10 Feet										

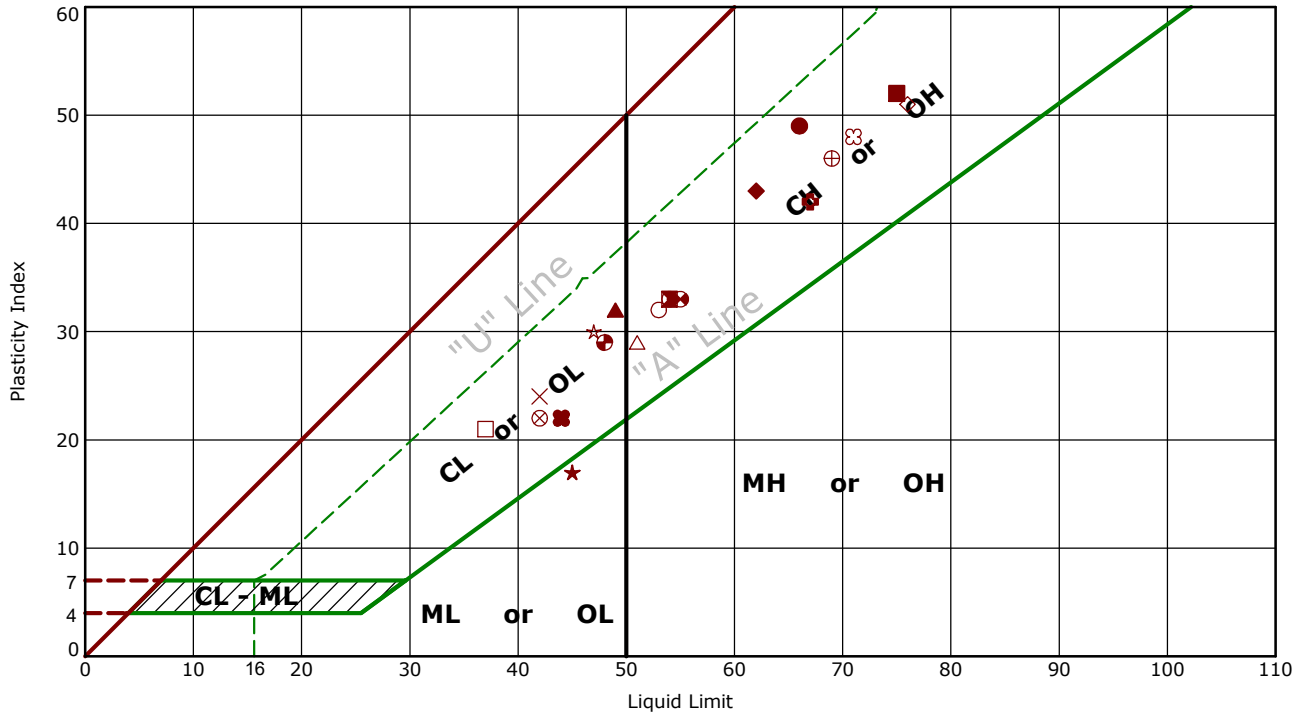
<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p>	<p>Driller</p>
	<p>Abandonment Method</p>	<p>Logged by MLR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>

Boring Log No. TP-19

Model Layer	Graphic Log	Location: See Exploration Plan Latitude: 38.9012° Longitude: 94.3741° Depth (Ft.) Approximate Elevation: 1058 (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Strength Test			Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits LL-PL-PI
							Test Type	Compressive Strength (tsf)	Strain (%)			
1		FILL - POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC)	3.0									
2		LEAN CLAY (CL) , brown to gray	5.0									
		FAT CLAY (CH) , brown and gray	7.0	5								
Boring Terminated at 7 Feet												

<p>See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations. Elevation Reference: Elevations were interpolated from Google Earth.</p>	<p>Water Level Observations Water not encountered.</p>	<p>Drill Rig Trackhoe</p>
<p>Notes</p>	<p>Advancement Method</p> <p>Abandonment Method</p>	<p>Driller</p> <p>Logged by MLR</p> <p>Boring Started 06-24-2025</p> <p>Boring Completed 06-24-2025</p>

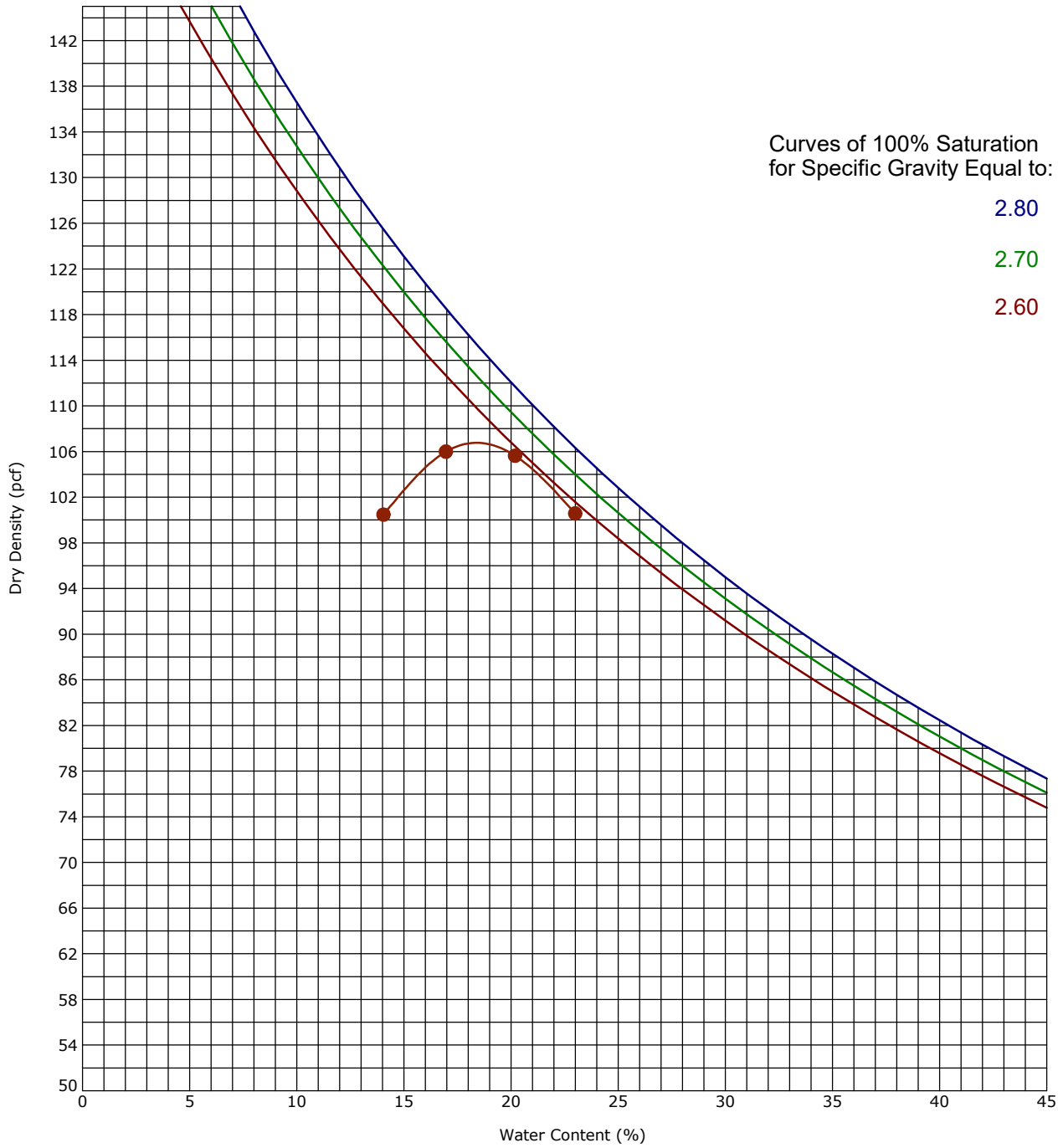
Atterberg Limit Results ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-5	6 - 8	66	17	49		CL	Lean Clay
⊠	B-6	8.5 - 10	54	21	33		CH	Fat Clay
▲	B-7	6 - 8	49	17	32		CL	Lean Clay
★	B-10	3.5 - 5	45	28	17		CL	Lean Clay
⊙	B-11	8.5 - 10	54	21	33		CH	Fat Clay
⊕	B-12	13.5 - 15	67	25	42		CH	Fat Clay
○	B-14	8.5 - 10	53	21	32		CH	Fat Clay
△	B-15	3 - 5	51	22	29		CH	Fat Clay
⊗	B-18	3 - 5	42	20	22		CL	Lean Clay
⊕	B-19	3.5 - 5	69	23	46		CH	Fat Clay
□	B-19	6.5 - 8	37	16	21		CL	Lean Clay
⊕	B-19	8 - 10	55	22	33		CH	Fat Clay
⊕	B-20	5 - 7	48	19	29		CL	Lean Clay
★	FC-3	1.5 - 3	47	17	30		CL	Lean Clay
⊗	FC-4	11 - 12.5	71	23	48		CH	Fat Clay
■	P-2	1.5 - 3	75	23	52		CH	Fat Clay
◆	P-3	1.5 - 3	62	19	43		CH	Fat Clay
◇	P-7	1.5 - 3	76	25	51		51	Fat Clay
×	P-10	6.5 - 8	42	18	24		CL	Lean Clay
⊕	P-13	1.5 - 3	44	22	22		CL	Lean Clay

Moisture-Density Relationship

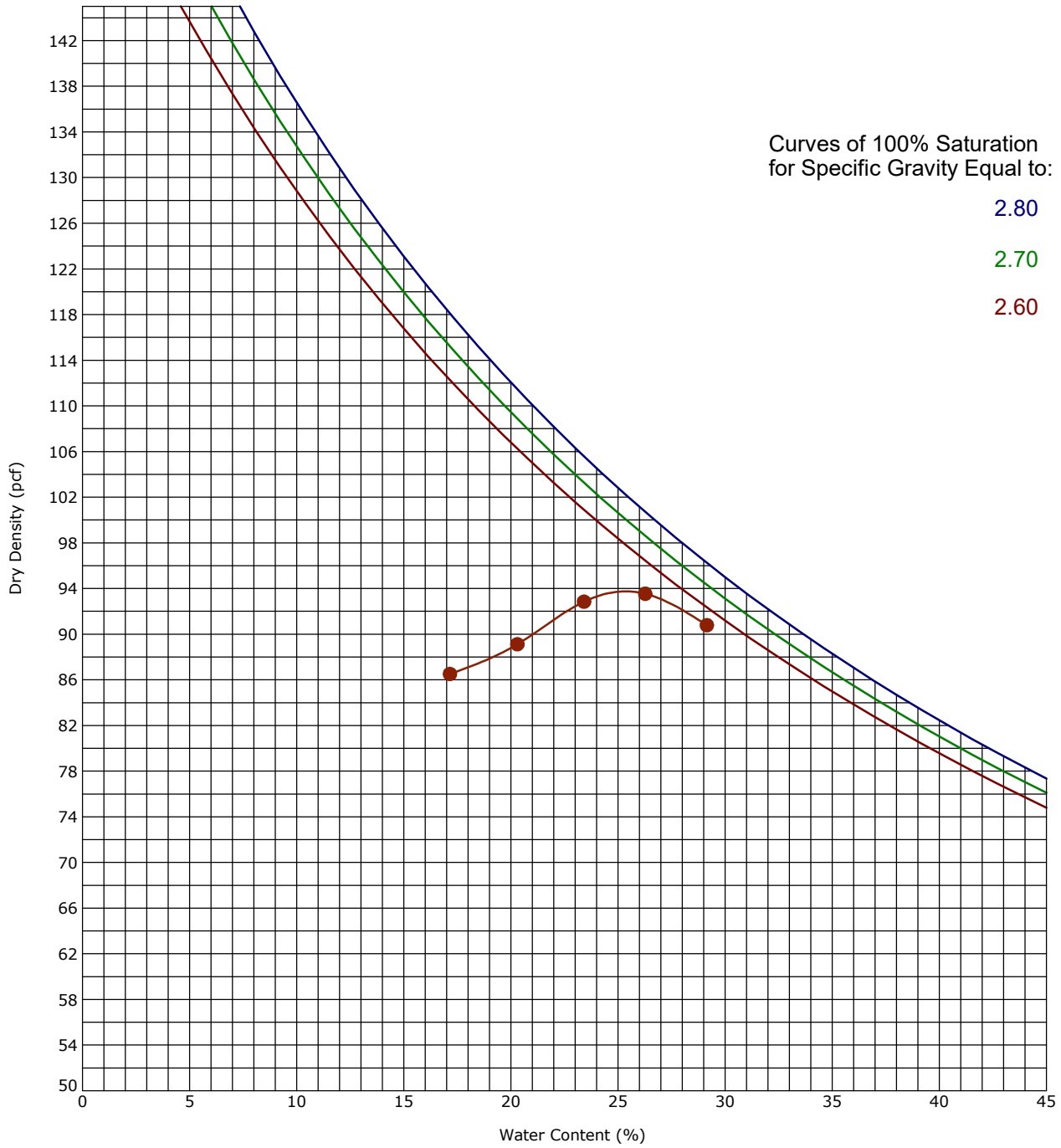
ASTM D698-Method A



Boring ID		Depth (Ft)		Description of Materials			
TP-5		0 - 0.5					
Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
90	0.0				ASTM D698-Method A	106.8	18.3

Moisture-Density Relationship

ASTM D698-Method A



Boring ID		Depth (Ft)		Description of Materials				
TP-11		0 - 0.5		SANDY FAT CLAY(CH)				
Fines (%)	Fraction > mm size	LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)	
60	0.0	73	28	45	ASTM D698-Method A	93.7	25.4	

California Bearing Ratio of Laboratory-Compacted Soils



Report Number: 02255162
Service Date: 07/03/25
Report Date: 03/11/16
Task:

15620 W.113th Street
Lenexa, Kansas 66219
Ph. 913.492.7777; Fx 913.492.7443

Client

Project

Costco Wholesale Warehouse-CW #25-0146

Project No. 02255162

SAMPLE INFORMATION

Sample Number:	<u>4</u>	Proctor Method:	<u>ASTM D698 - Method A</u>
Boring Number:	<u>TP-11 #465</u>	Maximum Dry Density (pcf):	<u>93.4</u>
Sample Location:	<u>Test Pit #11</u>	Optimum Moisture:	<u>25.4</u>
Depth:	<u>3.0-5.0</u>	Liquid Limit:	<u>73</u>
Material Description:	<u>Fat Clay (CH) Dark Brown</u>	Plasticity Index:	<u>45</u>

CBR TEST DATA

CBR Value at 0.100 inch 2.7
CBR Value at 0.200 inch 2.2

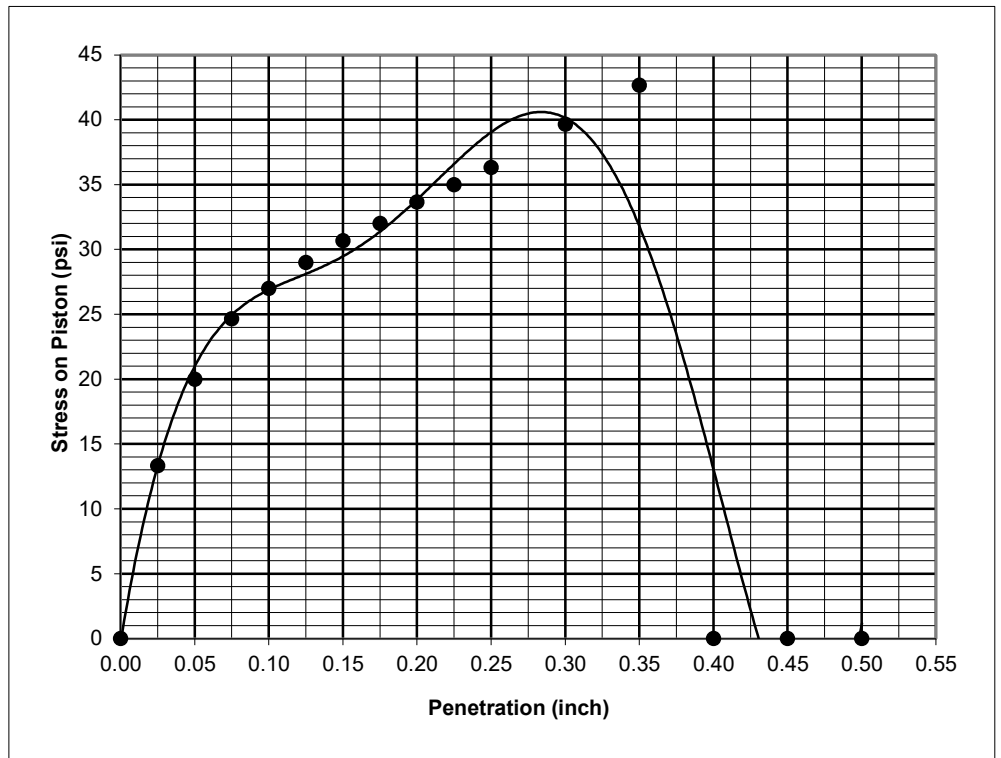
Surcharge Weight (lbs) 10
Soaking Condition Soaked
Length of Soaking (hours) 96
Swell (%) 2.4

DENSITY DATA

Dry Density Before Soaking (pcf) 89.3
Compaction of Proctor (%) 95.6

MOISTURE DATA

Before Compaction (%) 25.8
After Compaction (%) 25.2
Top 1" After Soaking (%) 32.0
Average After Soaking (%) 28.4



Comments:

Test Methods: ASTM D1883

Services:

Terracon Rep:
Reported To:
Contractor:

Started:
Finished:

Report Distribution

Reviewed by: _____

California Bearing Ratio of Laboratory-Compacted Soils



Report Number: 02255162
Service Date: 07/03/25
Report Date: 03/11/16
Task:

15620 W.113th Street
Lenexa, Kansas 66219
Ph. 913.492.7777; Fx 913.492.7443

Client

Project

Costco Wholesale Warehouse-CW #25-0146

Project No. 02255162

SAMPLE INFORMATION

Sample Number: 4
Boring Number: TP-5 #466
Sample Location: Test Pit #5
Depth: 1.5-3.5
Material Description: Lean to Fat Clay, (CL/CH) Light Yellow/Reddish Brown

Proctor Method: ASTM D698 - Method A
Maximum Dry Density (pcf): 106.3
Optimum Moisture: 18.4
Liquid Limit: 51
Plasticity Index: 30

CBR TEST DATA

CBR Value at 0.100 inch 2.0
CBR Value at 0.200 inch 1.9

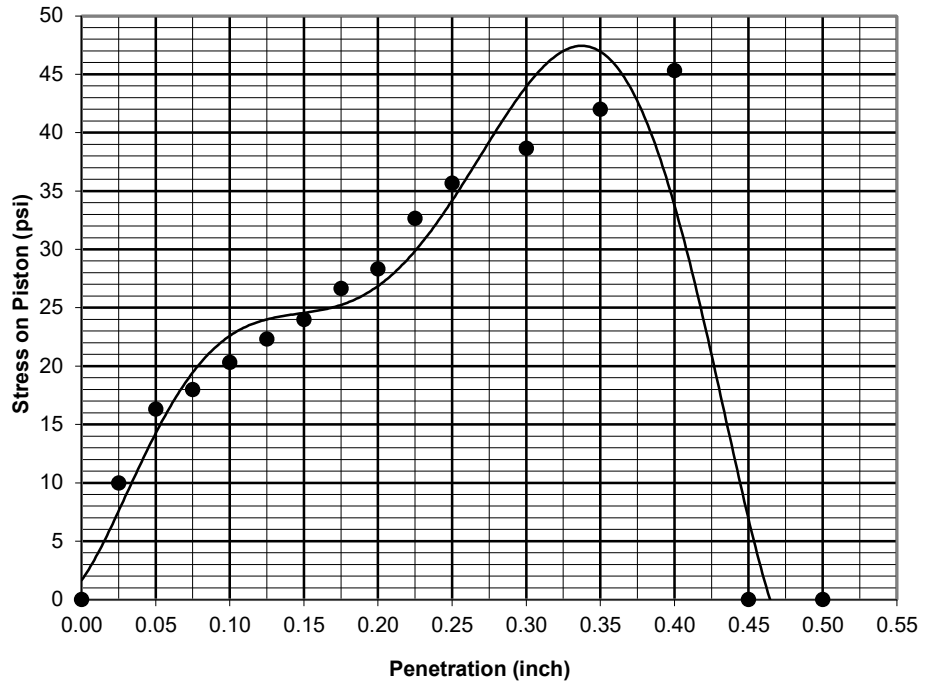
Surcharge Weight (lbs) 10
Soaking Condition Soaked
Length of Soaking (hours) 96
Swell (%) 2.3

DENSITY DATA

Dry Density Before Soaking (pcf) 101.4
Compaction of Proctor (%) 95.4

MOISTURE DATA

Before Compaction (%) 18.7
After Compaction (%) 18.9
Top 1" After Soaking (%) 27.5
Average After Soaking (%) 14.3



Comments:

Test Methods: ASTM D1883

Services:

Terracon Rep:
Reported To:
Contractor:

Started:
Finished:

Report Distribution

Reviewed by: _____



2640 12th Street SW Cedar Rapids, IA 52404

CHEMICAL LABORATORY TEST REPORT

Project Number: 02255162

Report Date: 8/5/2025

Project Name: Costco Wholesale Warehouse - Lee's Summit, MO #CW 25-0146

Client: *Confidential*

Sample Submitted By: Terracon-Lenexa

Lab No.: 06-Cedar Rapids

Results of Corrosivity Analysis

<i>Sample ID:</i>	B-6	FC-3		
<i>Sample Number:</i>	S-2	S-2		
<i>Sample Depth (ft.):</i>	3.0' - 5.0'	3.0' - 5.0'		
Ox/Red Potential [ORP] ASTM G200 (mV)	+708	+730		
pH Determination ASTM G51	6.75	6.83		
Total Salts AWWA 2520B (mg/kg)	220	522		
Water Soluble Chloride AASHTO T291A (mg/kg)	37	NIL		
Water Soluble Sulfates AASHTO T290B (mg/kg)	44	140		
Electrical Resistivity ASTM G57 (ohms*cm)	900	890		
Presence of Sulfides, AWWA 4500-S.A.4c	NIL	NIL		

The tests were performed in general accordance with applicable ASTM, AASHTO or AWWA standards. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

Analyzed by: Christalyn Thjorne

**MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS
USING A FLEXIBLE WALL PERMEAMETER
ASTM D 5084 - 16, METHOD C
FLUID: DEAIRED DISTILLED WATER WITH 0.01 M CaCL2**

DATE: 7/10/2025
 PROJECT NUMBER: 02255162
 PROJECT NAME: Costco Wholesale Warehouse
 LOCATION: #CW 25-0146
 SAMPLE ID: SB-1_ST-3_5.0-6.8 feet
 SAMPLE DESCRIPTION: FAT CLAY (CH), gray brown
 LL: 77 PL: 26



15620 W. 113th Street
 Lenexa, Kansas 66219
 (913) 492-7777

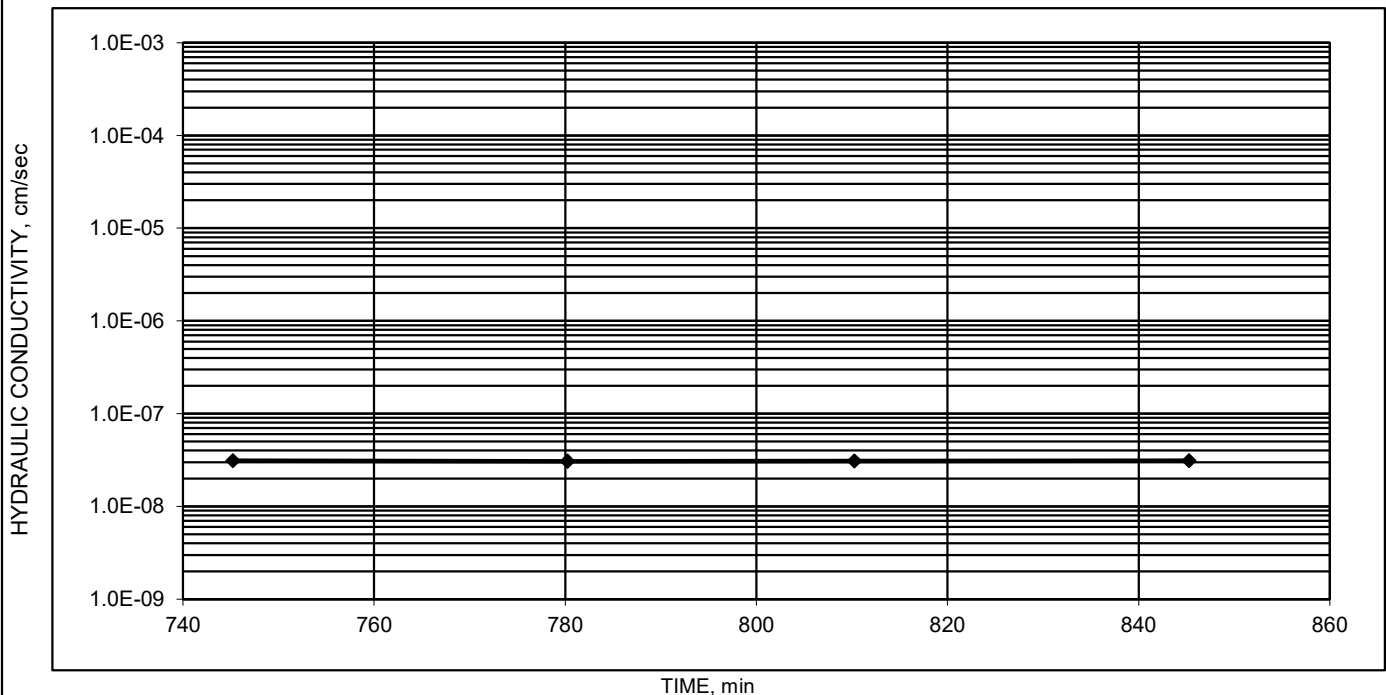
SAMPLE DATA

	INITIAL	FINAL	ADDITIONAL DATA	
Moisture %:	29.0	31.2	Sample Recompact?	NO
Wet Unit Weight, pcf	122.4	121.3	Maximum Dry Density, pcf:	NA
Dry Unit Weight, pcf	94.8	92.4	Optimum Moisture Content, %:	NA
Height, in.	2.96	3.01	Compaction, %:	NA
Diameter, in.	2.84	2.87	Over Optimum Moisture Content, %:	NA
Saturation, %:	98.2	99.7	Specific Gravity:	2.8
Void Ratio	0.82	0.86	SG Assumed or Tested	ASSUMED
Porosity	0.45	0.46	B-Value Parameter After Saturation:	98

PERMEATION DATA

Elapsed Time (min.)	Cell Pressure (psi)	Bottom Pressure (psi)	Top Pressure (psi)	Cell Volume (ml)	Bottom Volume (ml)	Top Volume (ml)	In Flow (ml/min.)	Out Flow (ml/min.)	Flow Ratio	Pressure Diff. (psi)	Gradient	k Value cm/sec
745	66.16	62.61	61.62	0.516	0.287	-0.780	0.00066	0.00076	1.15	0.98	9.2	3.1E-08
780	66.14	62.60	61.62	0.565	0.315	-0.802	0.00078	0.00061	0.78	0.98	9.2	3.1E-08
810	66.15	62.60	61.62	0.594	0.339	-0.820	0.00073	0.00066	0.90	0.98	9.1	3.1E-08
845	66.15	62.61	61.62	0.630	0.368	-0.841	0.00080	0.00061	0.77	0.98	9.2	3.1E-08

HYDRAULIC CONDUCTIVITY (k20), CM/SEC : **3.1E-08**



**MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS
 USING A FLEXIBLE WALL PERMEAMETER
 ASTM D 5084 - 16, METHOD C
 FLUID: DEAIRED DISTILLED WATER WITH 0.01 M CaCL2**

DATE: 7/10/2025
 PROJECT NUMBER: 02255162
 PROJECT NAME: Costco Wholesale Warehouse
 LOCATION: #CW 25-0146
 SAMPLE ID: SB-2_ST-5_10.0-11.4 feet
 SAMPLE DESCRIPTION: FAT CLAY (CH), gray brown
 LL: 52 PL: 18



15620 W. 113th Street
 Lenexa, Kansas 66219
 (913) 492-7777

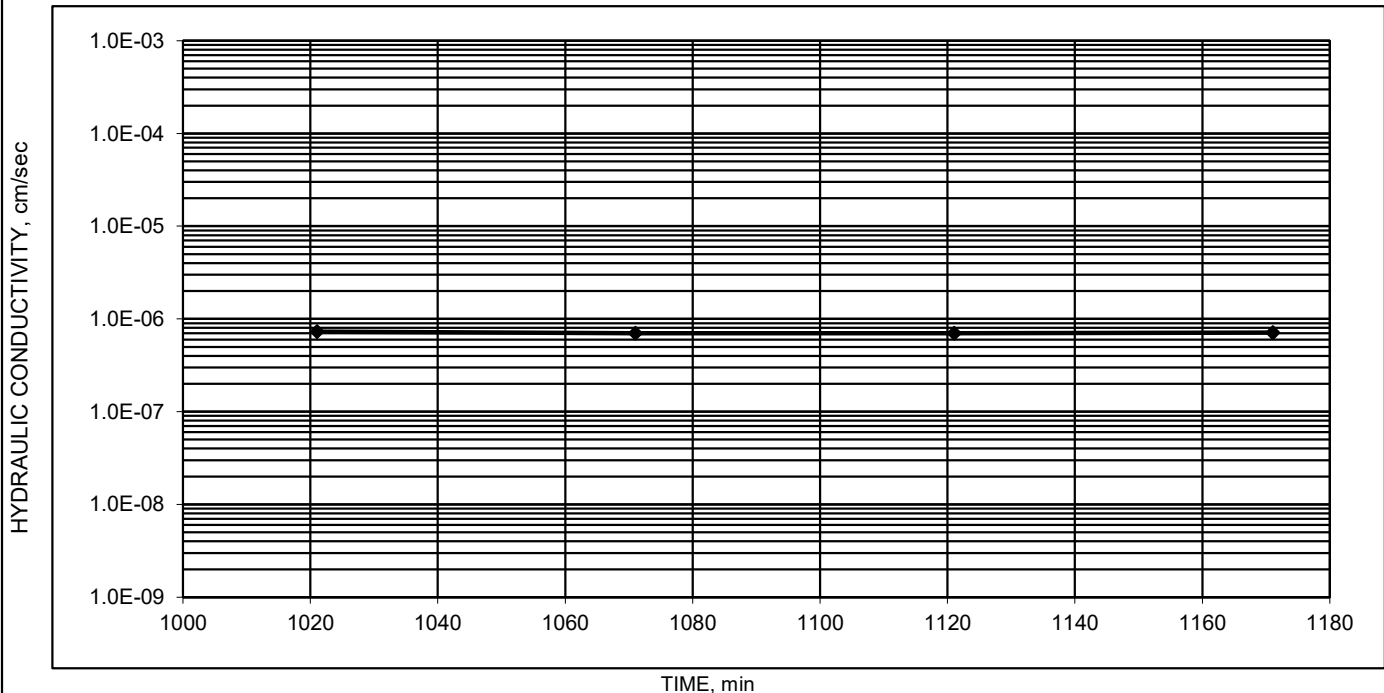
SAMPLE DATA

	INITIAL	FINAL	ADDITIONAL DATA	
Moisture %:	22.5	22.7	Sample Recompact?	NO
Wet Unit Weight, pcf	130.0	128.7	Maximum Dry Density, pcf:	NA
Dry Unit Weight, pcf	106.1	104.9	Optimum Moisture Content, %:	NA
Height, in.	2.96	2.95	Compaction, %:	NA
Diameter, in.	2.75	2.77	Over Optimum Moisture Content, %:	NA
Saturation, %:	100.4	98.3	Specific Gravity:	2.8
Void Ratio	0.62	0.64	SG Assumed or Tested	ASSUMED
Porosity	0.38	0.39	B-Value Parameter After Saturation:	99

PERMEATION DATA

Elapsed Time (min.)	Cell Pressure (psi)	Bottom Pressure (psi)	Top Pressure (psi)	Cell Volume (ml)	Bottom Volume (ml)	Top Volume (ml)	In Flow (ml/min.)	Out Flow (ml/min.)	Flow Ratio	Pressure Diff. (psi)	Gradient	k Value cm/sec
1021	64.02	60.51	-0.26	6.964	17.512	-24.723	0.01491	0.01552	1.04	0.97	9.1	7.3E-07
1071	64.01	60.51	-0.26	7.046	18.251	-25.478	0.01450	0.01498	1.03	0.97	9.1	7.0E-07
1121	64.02	60.51	-0.27	7.116	18.974	-26.226	0.01447	0.01511	1.04	0.98	9.2	7.0E-07
1171	64.01	60.47	-0.26	7.172	19.688	-26.964	0.01397	0.01465	1.05	0.94	8.8	7.1E-07

HYDRAULIC CONDUCTIVITY (k20), CM/SEC : **7.1E-07**



**MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS
USING A FLEXIBLE WALL PERMEAMETER
ASTM D 5084 - 16, METHOD C**

FLUID: DEAIRED DISTILLED WATER WITH 0.01 M CaCL2

DATE: 7/21/2025
 PROJECT NUMBER: 02255162
 PROJECT NAME: Costco Wholesale Warehouse
 LOCATION: #CW 25-0146
 SAMPLE ID: SB-3_ST-3_5.0-6.8 feet
 SAMPLE DESCRIPTION: FAT CLAY (CH), gray brown
 LL: 56 PL: 19



15620 W. 113th Street
 Lenexa, Kansas 66219
 (913) 492-7777

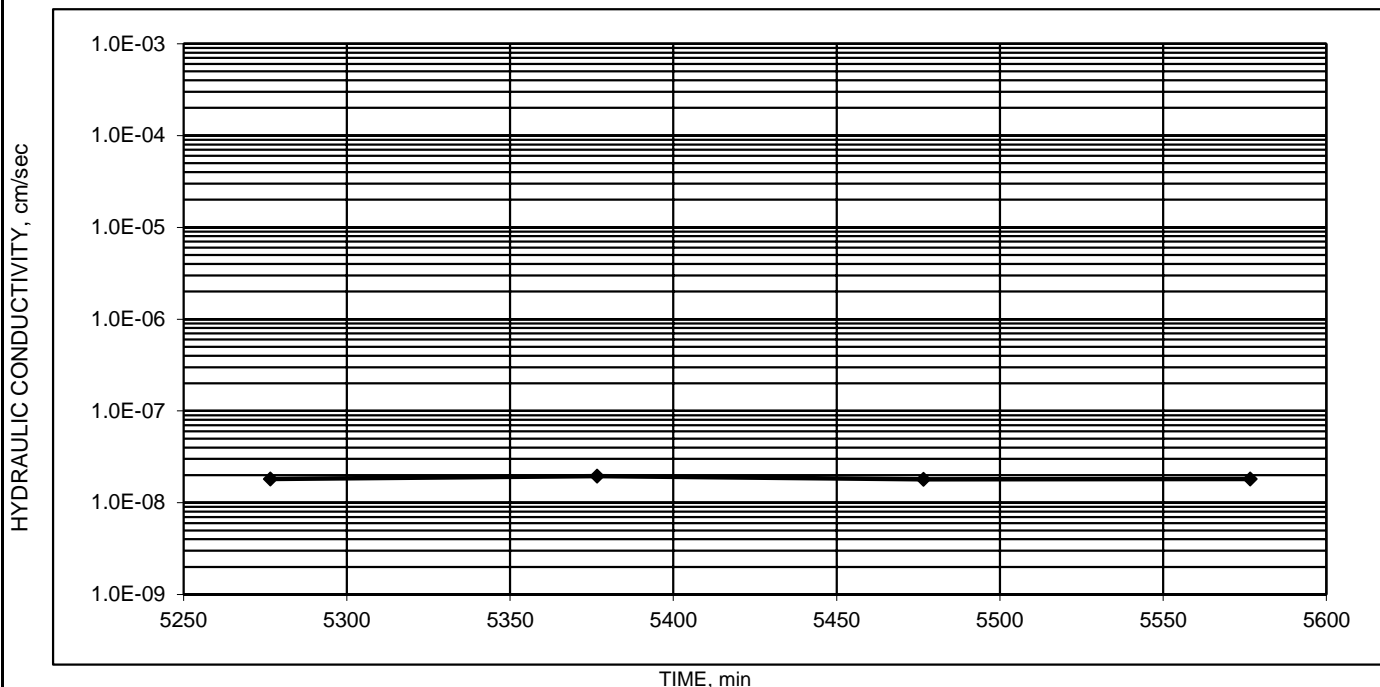
SAMPLE DATA

	INITIAL	FINAL	ADDITIONAL DATA	
Moisture %:	21.4	22.3	Sample Recompacted?	NO
Wet Unit Weight, pcf	130.0	129.1	Maximum Dry Density, pcf:	NA
Dry Unit Weight, pcf	107.1	105.6	Optimum Moisture Content, %:	NA
Height, in.	2.95	2.99	Compaction, %:	NA
Diameter, in.	2.84	2.85	Over Optimum Moisture Content, %:	NA
Saturation, %:	97.7	98.2	Specific Gravity:	2.8
Void Ratio	0.60	0.63	SG Assumed or Tested	ASSUMED
Porosity	0.38	0.38	B-Value Parameter After Saturation:	99

PERMEATION DATA

Elapsed Time (min.)	Cell Pressure (psi)	Bottom Pressure (psi)	Top Pressure (psi)	Cell Volume (ml)	Bottom Volume (ml)	Top Volume (ml)	In Flow (ml/min.)	Out Flow (ml/min.)	Flow Ratio	Pressure Diff. (psi)	Gradient	k Value cm/sec
5277	64.21	60.60	59.66	0.836	10.868	-10.850	0.00047	0.00036	0.77	0.99	9.3	1.8E-08
5377	64.19	60.60	59.65	0.865	10.921	-10.882	0.00049	0.00039	0.79	0.99	9.2	1.9E-08
5477	64.19	60.60	59.65	0.880	10.965	-10.923	0.00038	0.00043	1.12	0.99	9.3	1.8E-08
5577	64.19	60.60	59.65	0.882	11.013	-10.966	0.00039	0.00043	1.10	0.99	9.3	1.8E-08

HYDRAULIC CONDUCTIVITY (k20), CM/SEC : **1.8E-08**



**MEASUREMENT OF HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS
USING A FLEXIBLE WALL PERMEAMETER
ASTM D 5084 - 16, METHOD C
FLUID: DEAIRED DISTILLED WATER WITH 0.01 M CaCL2**

DATE: 7/10/2025
PROJECT NUMBER: 02255162
PROJECT NAME: Costco Wholesale Warehouse
LOCATION: #CW 25-0146
SAMPLE ID: SB-4_ST-5_10.0-12.0 feet
SAMPLE DESCRIPTION: FAT CLAY (CH), brown



15620 W. 113th Street
Lenexa, Kansas 66219
(913) 492-7777

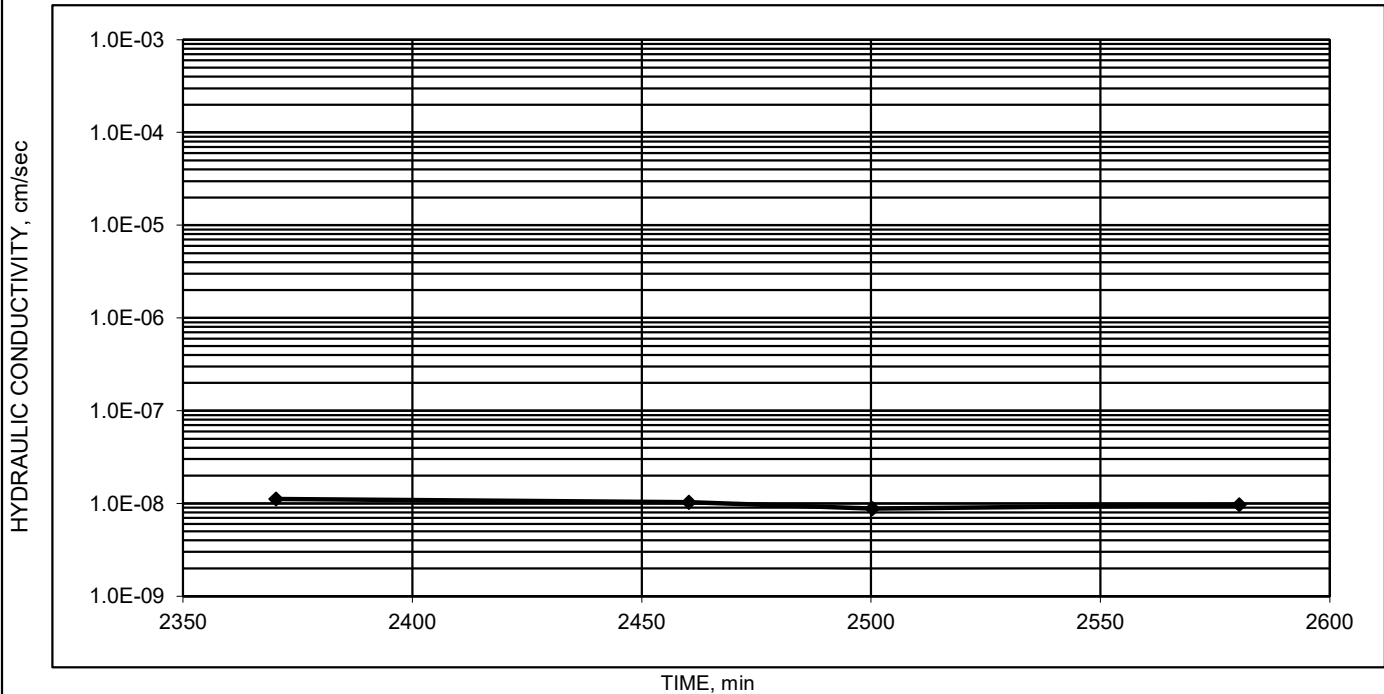
SAMPLE DATA

	INITIAL	FINAL	ADDITIONAL DATA	
Moisture %:	28.0	29.2	Sample Recompact?	NO
Wet Unit Weight, pcf	123.7	123.3	Maximum Dry Density, pcf:	NA
Dry Unit Weight, pcf	96.6	95.5	Optimum Moisture Content, %:	NA
Height, in.	2.96	2.98	Compaction, %:	NA
Diameter, in.	2.86	2.87	Over Optimum Moisture Content, %:	NA
Saturation, %:	98.3	99.8	Specific Gravity:	2.8
Void Ratio	0.79	0.81	SG Assumed or Tested	ASSUMED
Porosity	0.44	0.45	B-Value Parameter After Saturation:	97

PERMEATION DATA

Elapsed Time (min.)	Cell Pressure (psi)	Bottom Pressure (psi)	Top Pressure (psi)	Cell Volume (ml)	Bottom Volume (ml)	Top Volume (ml)	In Flow (ml/min.)	Out Flow (ml/min.)	Flow Ratio	Pressure Diff. (psi)	Gradient	k Value cm/sec
2370	65.30	60.85	59.79	0.848	0.336	-0.490	0.00025	0.00026	1.04	0.99	9.3	1.1E-08
2460	65.30	60.84	59.79	0.908	0.363	-0.488	0.00024	0.00023	0.99	0.98	9.2	1.0E-08
2500	65.30	60.86	59.80	0.929	0.373	-0.492	0.00019	0.00021	1.08	0.99	9.2	8.8E-09
2580	65.29	60.85	59.79	0.946	0.389	-0.506	0.00024	0.00020	0.82	0.99	9.3	9.7E-09

HYDRAULIC CONDUCTIVITY (k20), CM/SEC : **1.0E-08**



Municipal Water Quality Report

Contents:

2025 Annual Water Quality Report - City of Lee's Summit (8 pages)

Note: All attachments are one page unless noted above.



"I am honored to present the 2025 Water Quality Report on behalf of Lee's Summit Water Utilities. I've got the privilege of leading a team deeply committed to protecting public health and delivering high-quality water and sewer services to our growing community. This report reflects our regulatory compliance and shared commitment to service excellence, public trust and long-term infrastructure stewardship."

- Director of Water Utilities Jeffrey Thorn

Director's Message >



demonstrate that your drinking water surpasses the water quality standards established by the U.S. Environmental Protection Agency.



What is a Water Quality Report?

Where does your water come from?

Why are there contaminants in my water?

Per- and Polyfluoroalkyl Substances (PFAS)

The utility's top priority is protecting public health and the quality of drinking water. Lee's Summit is taking a proactive approach by educating residents about emerging contaminants like PFAS.



What is being done about PFAS?

What is LS Water Utilities doing about PFAS?

What should I do about PFAS now?

Additional information

Per- and polyfluoroalkyl substances (PFAS) are chemicals found in many everyday items, including firefighting foam, non-stick pans, raincoats, food wrappers and shampoo. These chemicals are a growing concern because they may be harmful to human health and linger in the environment forever. This means if they get into our water sources they could impact our drinking water for years to come.

Health Precautions

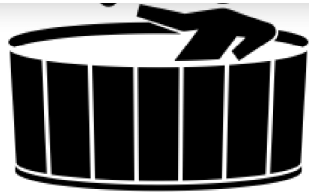
Some people may be more vulnerable to contaminants in drinking water than the general population. This includes those with:

- Weakened immune system due to chemotherapy, organ transplants, HIV/AIDS or other conditions.
- Age-related vulnerabilities (elderly).
- Infant immune systems still under development.

If you fall into one of these categories, talk to your doctor about any concerns regarding drinking water. For more information on contaminants and potential health effects or to receive a copy of guidelines, contact the EPA's Safe Drinking Water Hotline at 1.800.426.4791.

Drop by Drop

For reference, here's how these amounts compare to everyday items:



**Part Per Million
(PPM)**

One Drop in a
Hot Tub = One PPM



**Part Per Billion
(PPB)**

One Drop in an Olympic
Size Swimming Pool =
One PPB



**Part Per Trillion
(PPT)**

One Drop in a
Six-Acre Lake =
One PPT

The Water Details

Disinfection Byproducts

Substance (unit of measure)	Monitoring Period	Sample Point	MCL (MRDL)	MCLG (MRDLG)	LRAA	Range Low-High	Typical Source
Haloacetic Acids [HAA5] (ppb)	2024	DBPDUAL-01	60	0	14	8.96 - 23.2	A byproduct of drinking water disinfection
Haloacetic Acids [HAA5] (ppb)	2024	DBPDUAL-02	60	0	12	4.58 - 16.6	A byproduct of drinking water disinfection
Haloacetic Acids [HAA5] (ppb)	2024	DBPDUAL-03	60	0	11	4.95 - 15.1	A byproduct of drinking water disinfection
Haloacetic Acids [HAA5] (ppb)	2024	DBPDUAL-04	60	0	9	4.77 - 14.3	A byproduct of drinking water disinfection
TTHMs [Total Trihalomethanes] (ppb)	2024	DBPDUAL-01	80	0	8	5.89 - 13.5	A byproduct of drinking water disinfection
TTHMs [Total Trihalomethanes] (ppb)	2024	DBPDUAL-02	80	0	6	1.33 - 8.61	A byproduct of drinking water disinfection



TTHMs [Total Trihalomethanes] (ppb)	2024	DBPDUAL-04	80	0	6	1.37 - 7.92	A byproduct of drinking water disinfection
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Lead and Copper

Substance (unit of measure)	Sample Period	Violation	90% Tile	Range Low - High	AL	Sites Over AL	Typical Source
Copper (ppm)	2021 - 2023	No	0.006	0.00127 - 0.00919	1.3	0	Corrosion of household plumbing systems
Lead (ppb)	2021 - 2023	No	0	0	15	0	Corrosion of household plumbing systems

Microbiological

Substance (unit of measure)	MCLG [MRDLG]	Violation	Result	MCL [MRDL]	Typical Source
Coliform (total coliform rule)	0	No	In the month of August, .96% of samples returned as positive	Treatment Technique Trigger	Naturally present in the environment

Unregulated Contaminant Monitoring Rule (UCMR)

Substance (unit of measure)	Collection Date of HV	Highest Value	Range of Sampled Result(s)	Unit
Lithium (total)	10/14/2024	56.7	26.4 - 56.7	UG/L
Perfluorobutanoic Acid	07/11/2024	0.00566	0.00566	UG/L

Violations and Health Effects Information

During the 2024 calendar year, we had the below-noted violations(s) of drinking water regulations.

Compliance Period	Type	Reason for Violation
5/1/24 - 5/31/2024	E. Coli	Monitoring, Routine, Minor (RTCR)



If present, lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. Lee's Summit PWS is responsible for providing high quality drinking water and removing water system owned and controlled lead pipes, but cannot control the variety of materials used in plumbing components in your home. You share the responsibility for protecting yourself and your family from the lead in your home plumbing. You can take responsibility by identifying and removing lead materials in the portion of the service line you own, within your home plumbing, and taking steps to reduce your family's risk. Before drinking tap water, flush your pipes for several minutes by running your tap, taking a shower, doing laundry or a load of dishes. You can also use a filter certified by an American National Standards Institute accredited certifier to reduce lead in drinking water. Information on lead in drinking water, testing methods and steps you can take to minimize exposure is available at the [United States Environmental Protection Agency](https://www.epa.gov/lead).

Service line inventory is required and can be requested from Lee's Summit Water Utilities. [View your Service line](#).

Reseller Regulated Contaminants

Substance (unit of measure)	Year Sampled	Violation	MCL [MRDL]	MCLG [MRDLG]	Independence Water		Kansas City Water		Typical Source
					Highest Detected	Range Low- High	Highest Detected	Range Low- High	
Atrazine (ppb)	2024	No	3	3			2.67	0 -2.67	Runoff from herbicide used on row crops
Barium (ppm)	2024	No	2	2	0.0438	0.0438	0.0242	0.0242	Discharge of drilling wastes; discharge from metal refineries; erosion of natural deposits
Fluoride (ppm)	2024	No	4	4	0.23	0.23	0.746	0.746	Natural deposits; water additive which



									strong teeth
Nitrate - Nitrite (ppm)	2024	No	10	10	0.384	0.384	2.59	2.59	Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits
Selenium (ppb)	2024	No	50	50	-	-	2.56	2.56	Erosion of natural deposits

Disinfection Byproducts

Substance (unit of measure)	Sample Point	Year Sampled	Violation	MCL [MRDL]	MCLG [MRDLG]	Independence Water		Kansas Cit Water	
						Highest LRAA	Range Low-High	Highest LRAA	Rar Lo Hi
Haloacetic Acids [HAA5] (ppb)	DBPDUAL-01	2024	No	60	0			14	9.7 18
Haloacetic Acids [HAA5] (ppb)	DBPDUAL-02	2024	No	60	0			14	8.6 20
Haloacetic Acids [HAA5] (ppb)	DBPDUAL-03	2024	No	60	0	4	3.51 - 4.92		
Haloacetic Acids [HAA5] (ppb)	DBPDUAL-04	2024	No	60	0	5	2.75 - 6.95	15	9.9 19
Haloacetic Acids [HAA5] (ppb)	DBPDUAL-05	2024	No	60	0			14	9.3 20
Haloacetic Acids [HAA5] (ppb)	DBPDUAL-06	2024	No	60	0			14	9.9 19
Haloacetic Acids [HAA5] (ppb)	DBPDUAL-15	2024	No	60	0			14	10. 19



Trihalomethanes] (ppb)	01								13
TTHMs [Total Trihalomethanes] (ppb)	DBPDUAL-02	2024	No	80	0			10	5.4 12
TTHMs [Total Trihalomethanes] (ppb)	DBPDUAL-03	2024	No	80	0	3	1.26 - 6.08		
TTHMs [Total Trihalomethanes] (ppb)	DBPDUAL-04	2024	No	80	0	4	1.09 - 6.69	10	5.4 13
TTHMs [Total Trihalomethanes] (ppb)	DBPDUAL-05	2024	No	80	0			10	5.3 13
TTHMs [Total Trihalomethanes] (ppb)	DBPDUAL-06	2024	No	80	0			10	5.3 13
TTHMs [Total Trihalomethanes] (ppb)	DBPDUAL-15	2024	No	80	0			9	4.4 13

Reseller Violations and Health Effects Information

			Independence Water	Kansas City Water
Substance (unit of measure)	Year Sampled	Violation	Range Low-High	Range Low-High
Hardness, Total (as CAC03)	2021	No	123	123

Reseller Violations and Health Effects Information

During the 2024 calendar year, the water system(s) that we purchase water from had the below-noted violation(s) of drinking water regulations.

Water System	Type	Category	Analyte	Compliance Period

Costco Asphalt Paving Specifications Section

Contents:

Costco Warehouse Master Specifications – Section 321216 – Asphalt Paving (13 pages)

Note: All attachments are one page unless noted above.

SECTION 321216 - ASPHALT PAVING**PART 1 - GENERAL**

1.1 RELATED DOCUMENTS

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

1.2 SCOPE

- A. Onsite paving shall conform to the following requirements; deviations shall only be allowed with written approval from Costco Construction. The asphalt binder oil shall be Performance Grade (PG) asphalt binder as specified herein. The PG binder oil grade shall be verified with the Geotechnical Report for the project.
- B. This work shall consist of dense, fine graded, hot, plant-mixed asphalt concrete to produce a very smooth, uniform completed surface that is free from cracks, rock pockets and aggregate segregation, providing "void free" appearance and texture. When approved to be placed in multiple lifts, any additional costs shall be the responsibility of the contractor with no additional compensation from the owner.
- C. Bidding documents shall include the Contractors proposed Asphalt Mixture Design sheets. (Refer to Mix Design Submittal Checklist sheet at the end of this section). Designs will be for HMA to be placed for each of the uses anticipated on each project; patching, base, leveling, and / or surface course. Each asphalt supplier shall be required to submit its own mix design submittal.
- D. Hot Mix Asphalt (HMA) shall be manufactured from a state approved / certified HMA manufacturing facility. Work consists of one or more courses of HMA constructed on a prepared foundation. The asphalt concrete consists of a mixture of aggregates and specified type and grade of asphalt binder. The manufacturing facility shall be capable of producing HMA in accordance with the following requirements and all applicable local agency specifications on an ongoing and consistent basis.
- E. Ensuring uniform material is produced and selecting the vendor for these asphalt projects will require timely submittal of documents and qualifications to the satisfaction of the Owner. Contractor / material supplier shall demonstrate the existence of the following documents:
1. Approved vendor certificate for the state where work is being done,
 2. Quality Control manual for material production over-site and testing measures being performed both at the asphalt plant as well as on the job site, and
 3. List / Organizational Chart showing personnel responsible for use of equipment and actions of the crew on the grade while paving and compacting asphalt.
- F. HMA Mix Designs shall be performed by qualified personnel with proven past experience and successes in the mix design and quality control of asphalt production. Resumes of the signing 'individual-in-charge' may be required by the Owner and shall be supplied if requested. The design shall meet the following requirements in this section and be less than 12-months old. However, the mix design method used shall be the Contractors option, as stated previously, based on various methods which currently exist around the nation. A completed design shall require submittal of documentation as detailed, requested by the Owner in order for the producer to demonstrate knowledge of design and production.
- G. Calibrated equipment and qualified personnel must be accessible at all times during the construction of this HMA. The Contractor shall provide the necessary equipment, materials,

and labor to complete the job acceptable to the Owner. Variations in the size and amount of equipment will depend on the size of the area being paved.

- H. It is imperative that all documents list a 'Person-in-Charge' who is responsible for the oversight of the previously listed activities. This individual will be the point of contact for the Owner and they shall work with the Owner to ensure timely project completion and specification compliance. This individual shall be knowledgeable in all aspects of asphalt design, production, and installation and shall be an employee of the company holding the contract with the Owner, even if the HMA is being produced and supplied by a separate vendor.

1.3 DEFINITIONS

- A. Nominal Maximum Aggregate Size (NMAS) is one sieve size larger than the first sieve to retain more than 10 percent.
- B. Maximum Size of Aggregate (MSA) is the smallest sieve size through which 100 percent of aggregate sample particles pass.
- C. Asphalt Concrete (AC) Pavement Section is the structural component of the flexible pavement constructed with hot-mix asphalt (HMA). The AC pavement section shall consist of at least two (2) courses; a Surface Course and an underlying Base Course.
- D. Surface Course - The surface / wearing course shall be installed uniformly, to all finished lines and grades, smooth, durable, skid-resistant, impervious thus protecting lower layers, and stable. Workmanship of the finished surface course shall be of the highest industry standards possible prior to acceptance by the Owner. The surface course shall be built with a 3/8 inch or 1/2 inch nominal HMA mix in accordance with the standard specifications. The surface course shall have a minimum compacted thickness of at least 1-1/2 inch, and a minimum thickness of 1-3/4 inch is preferred in cold weather conditions. In no case, shall the surface course thickness be less than 3-times the nominal maximum aggregate size (NMAS), unless approved by the Owner.
- E. Leveling Course - The leveling course is used for the location of the parking area that requires placement of a variable thickness of HMA to 'true up' the lot prior to placement of the surface course. The leveling course should have NMAS no greater than that of the surface course.
- F. Base Course - The lower base course of the pavement structure (below the surface and leveling courses) shall be built with a 1/2 inch or 3/4 inch nominal HMA mix in accordance with the standard specification. The base course shall have a minimum compacted thickness of at least 1-1/2 inch, and a minimum thickness of 1-3/4 inch is preferred in cold weather conditions. In no case, shall the base course thickness be less than 3-times the nominal maximum aggregate size (NMAS), unless approved by the Owner. Base courses shall not be allowed to remain exposed (without the surface course placed over it) for an extended period of time, unless approved by the engineer. If the base course is allowed to remain uncovered for an extended period of time, the minimum compacted thickness should be increased to 2.0 inches.
- G. Tacking / Priming - The process of applying one coat of emulsified asphalt to all horizontal and vertical surfaces of either an existing pavement for an overlay or between lifts while building an improved or new structure (tacking), or upon the aggregate base (priming).
- H. Binder replacement is the percentage of binder oil included in the HMA mix that is contributed from RAP and is expressed as a percent of the total binder content in the mix.

- I. Lot (and Sub-Lots) - A lot is equal to the quantity of paving placed in a single working day with one HMA mix. When more than 750 tons of Asphalt are placed in one day, the Lot will be divided into two (2) equally sized sub-lots.

1.4 ACTION SUBMITTALS

- A. Job-Mix Design (JMD): For every paving project, the contractor shall submit a mix design, per these specifications, and optional alternative value engineered mix design in accordance with Section 321216.3 "Asphalt Modifications to Include Value Engineering to Costco", for review by the Costco's Geotechnical Engineer of Record at the time of the bid and at least 30 days prior to the scheduled production and lay down of the asphalt mix. Job Mix Designs should demonstrate proposed mixes are capable of complying with the requirements of these specifications. Once the Engineer has reviewed that the Asphalt Mix complies with the design intent and specifications or made comments on how it does not comply, they will forward mix designs to the CPM for final selection. The costs associated with developing Job-Mix Designs until one is accepted by the Owner shall be at the Contractor's expense with no additional compensation.
 - 1. The design mix submittal shall meet the following criteria:
 - a. Mix Design shall be based on either the Superpave or Marshall methods per the Asphalt Institute Manual Series No. 2 (MS-2) current edition.
 - b. Name/type/identification of mix.
 - c. Source and grade of asphalt binder and modifiers.
 - d. Source and description of aggregates and mineral fillers.
 - e. Gradation and bulk specific gravity of each aggregate bin size.
 - f. The percentage of each bin size used in the Job Mix Design, the combined aggregate gradation and the combined aggregate bulk specific gravities.
 - g. Reclaimed Asphalt Pavement (RAP) quality, gradation, asphalt content, and maximum theoretical (and/or effective) specific gravity of the fine and course RAP.
 - h. Aggregate quality test results for all aggregates.
 - i. Plotted mix property curves showing the following mix properties at least four asphalt binder contents: unit weight and bulk specific gravity, maximum theoretical specific gravity, percent of air voids, percent void filled (VFA), and percent voids in mineral aggregates (VMA).
 - j. Recommended asphalt content recommended for the JMD, which shall result in a mix meeting all properties specified herein at the percent air voids shown in table.
 - k. The submittal shall list the following mix properties at the JMD recommended asphalt binder content:
 - 1) Bulk Specific Gravity, Gmb
 - 2) Maximum Theoretical Specific Gravity, Gmm
 - 3) Mix Air Voids at Optimum Asphalt Content
 - 4) Voids Filled with Asphalt (VFA) percent
 - 5) Voids in Mineral Aggregate (VMA)
 - 6) Mixing Temperature Ranges
 - 7) Compaction Temperature Ranges
 - 8) Dust to Asphalt Ratio
 - 9) Compaction Energy (Gyrations or Blows)
 - 10) Optimum Oil Content, percent.
 - 11) Stability, lbs.
 - 12) Flow, 0.01 in.
- B. Pre-Paving Meeting. Prior to proceeding with paving of the Costco site, a Pre-Paving Meeting shall be held with the General Contractor and his paving subcontractor(s), and all field testing and inspection personnel to review and discuss the Paving Plan, including methods, procedures and equipment relating to the paving, and Costco's expectations for the final pavement surface smoothness. At a minimum defining paving pulls, testing locations for laboratory (AC, gradation, and volumetrics) and field (in-place longitudinal joint and mat density), temperature

measurements with SEEK InfraRed camera as documentation, thickness, and yield checks. Everything shall be performed and reported daily. Find more details within this specification.

- C. Paving Plan. At least 14 days prior to the Pre-Paving Meeting, the Contractor shall submit the asphalt paving plan. As minimum, the plan shall include the following:
 - 1. Paving direction.
 - 2. Location of longitudinal joints.
 - 3. Start time and end time for each paving day.
 - 4. Equipment to be used in paving operations.
- D. Contractor's Quality Control Plan including testing of the mixture proposed to be used on the project shall be submitted to the Owner prior to acceptance of the proposed mix design.
 - 1. See Part 3 for test strip requirements.
- E. Independent Testing Laboratory (ITL). At least 30 days prior to the scheduled production, the contractor shall submit an independent testing laboratory (ITL) for contractor's quality control purpose for review and approval by the Owner. The minimum criteria of the ITL are as follows:
 - 1. Possess the equipment and resources to perform all the required asphalt materials testing procedure.
 - 2. Possess accreditation or certification for State DOT, AASHTO, City, or County

1.5 WARRANTY

- A. The contractor shall provide the owner with a two-year warranty after date of acceptance, for the asphalt paving. Warranty shall cover defects related to the product, and the installation of the paving.

1.6 PROJECT CONDITIONS

- A. Weather Limitations:
 - 1. Apply prime and/or tack coats when ambient temperature is above 40 degrees F, and when temperature has been above 35 degrees F for 12 hours immediately prior to application. Do not apply when surface is wet, contains excess moisture, during rain, or when frozen.
 - 2. Asphalt pavement shall be placed only when the air temperature is 40 degrees F and rising for base lifts and 50 degrees F for surface lifts, where possible.
- B. Cold Weather Paving: Cold weather paving condition applies when the ambient air temperatures during paving is expected to be 50 degrees F or less. Under this condition, the following practices shall be required:
 - 1. Cold weather paving shall only be conducted at the discretion of the engineer, and when allowed shall be completed in accordance with the Cold Weather Paving provisions outlined in the Costco Development Requirements.
 - 2. Review the Cold Weather Asphalt Paving document by Murphy Pavement Technology, Inc., and incorporate additional equipment and/or measures as necessary to help achieve the required quality pavement.
 - See Section 321216B "Cold Weather Asphalt Paving Exhibit".
 - 3. Ensure that hot mix asphalt is delivered to the Site at the highest allowable temperature.
 - 4. Adjust paving and compaction operations to achieve optimum density in a shorter time period. At a minimum, the Contractor shall provide separate breakdown and finish rollers, and include sufficient crews for each piece of equipment, so they can be operated simultaneously.
 - 5. Utilize PAVECOOL/PAVETOOL <http://www.dot.state.mn.us/app/pavecool/> (or similar program) to evaluate the effect of the ambient temperatures and wind conditions on the AC mix for placement and compaction. Provide daily analysis sheet prior to paving.

6. Verify the minimum mixing and compaction temperatures for the AC mix and corresponding binder oil and terminate compaction operations once the AC mix has cooled to the minimum compaction temperature. In no instance shall the AC deform, deflect or crack during rolling and compaction operations.
7. Watch mix temperatures, insulate trucks/trailers, increase the number of rollers, decrease production rates and paving speeds, and cut joints as recommended in the Cold Weather Paving document.
8. If the asphalt pavement is to be placed on an aggregate base, the base must be solidly compacted at or below optimum moisture, and not be frozen.
9. Hand-worked areas should be avoided during cold weather conditions, if possible.

C. Traffic Control:

1. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required. Traffic control equipment shall be in good condition. Erect lighted barrel or scissor type barricades, using caution tape or ribbon or other suitable means to prohibit vehicular and pedestrian traffic from entering the work area while work is being performed.

PART 2 - PRODUCTS

2.1 ASPHALT CONCRETE

- A. Asphalt Binder: Asphalt binder shall be Performance Grade (PG) binder oil per ASTM D 6373. The PG binder grade shall be determined based on the Federal Highway Administration's LTPPBind program version 3.1 or the most recent version, to provide the following:
 1. The high-end temperature rating shall be the grade with 98 percent reliability,
 2. The low-end temperature rating shall be the grade with a minimum 90 percent reliability,
 3. The PG binder grade requirement may be superseded by the project Geotechnical Report.
 4. When the mixture contains 20 percent or less RAP, the PG binder grade determined by the previous steps 1 through 3 shall be used.
 5. When the mixture contains greater than 20 percent to 30 percent RAP, the required PG binder grade shall be one grade softer on both high and low temperatures than the PG binder grade determined by previous steps 1 through 3. For example, if PG 58-28 is required by LTPPBind then PG 52-34 is required for high RAP mixtures.
- B. Hot Mix Asphalt (HMA): Provide a plant-mixed dense, fine-graded, hot-mix asphalt designed in accordance with the procedures outlined as follows:
 1. Provide a dense fine-graded mix design and as produced complying with the gradation table 2.1 below:

Table 2.1 Aggregate Gradation

Maximum Size of Aggregate (inch)	1	¾	½
Nominal Maximum Aggregate Size (inch)	¾	½	¾
Pavement Section Application	Base Course Only	Base or Surface Courses	Surface Courses Only
U.S. Sieve Size	Percent Passing	Percent Passing	Percent Passing
1"	100	100	100
¾"	90 -100	100	100
½"	Maximum 90	90 - 100	100
¾"	-	Maximum 90	90-100
#4	Minimum 40		Maximum 90

#8		Minimum 40	Minimum 40
#200	3-6	3-6	3-7

2. Provide hot-mix asphalt for onsite paving meeting properties showing in Table 2.2 and the following criteria:
 - a. Coarse aggregate angularity (ASTM D5821): 75 percent of coarse aggregate portion should have at least one fractured face
 - b. L.A. Wear (ASTM C535 or C131): Coarse aggregate portion should have a maximum of 35 percent loss.
 - c. Flat and elongated pieces, 5:1 ratio (ASTM D 4791): 10 percent maximum
 - d. Soundness (sodium sulfate, ASTM C 88): 16 percent maximum loss with five cycles.
 - e. Fine aggregate angularity (AASHTO T304): 40 percent minimum
 - f. Plasticity Index (ASTM D 4318): 0 or non-plastic
 - g. Sand equivalent (ASTM D 2419): 40 percent minimum
 - h. Natural sand content: 20 percent maximum
 - i. Clay lumps and friable particles (ASTM C142): 2 percent maximum.
 - j. Maximum RAP content 30 percent for base course and 30 percent for surface course.
 - k. Recycled asphalt shingles (RAS) shall not be allowed.
 - l. Design binder content is selected at 3.5 percent air voids (per Table 2.2).
 - m. Minimum Tensile Strength Ratio (TSR) is 80 percent.
3. All aggregate quality requirements by the State agency where the asphalt is being installed shall be met for the intended use (base, intermediate, and/or surface course) or the current Costco Requirements outlined herein, whichever is more stringent.

Table 2.2 HMA Property Criteria

Pavement Section	Base Course		Surface or Base Course		Surface Course	
	Super-pave	Marshall	Superpave	Marshall	Super-pave	Marshall
Nominal Maximum Size of Aggregate (NMSA)	3/4 inch		1/2 inch		3/8 inch	
Mix Design Method	Super-pave	Marshall	Superpave	Marshall	Super-pave	Marshall
Test Method	AASHTO M323	ASTM D5581	AASHTO M323	ASTM D6926	AASHTO M323	ASTM D6926
Compaction Energy	N _{des} = 50 Gyration	50 Blows per side	N _{des} = 50 Gyration	50 Blows per side	N _{des} = 50 Gyration	50 Blows per side
Mold size, inch	6	4	6	4	6	4
Design Air Voids, %	3.5	3.5	3.5	3.5	3.5	3.5
VMA, %	13.0 min.	13.0 min.	14.0 min.	14.0 min.	15.0 min.	15.0 min.
VFA, %	70 to 80	70 to 80	70 to 80	70 to 80	70 to 80	70 to 80
AC Content (%)	5.0 to 6.0	5.0 to 6.0	5.5 to 6.5	5.5 to 6.5	6.0 to 7.0	6.0 to 7.0
Dust Proportion	0.7 - 1.3	0.7 - 1.3	0.7 - 1.3	0.7 - 1.3	0.7 - 1.3	0.7 - 1.3
Hamburg Wheel Tracker ²	Max. 10 mm at 20,000 passes		Max. 10 mm at 20,000 passes		Max. 10 mm at 20,000 passes	
Stability, lbs.		1,500 min.		1,500 min.		1,500 min.
Flow, 0.01 in.		8 to 16		8 to 16		8 to 16

- C. Reclaimed Asphalt Pavement (RAP): RAP shall consist of the material obtained from highways, streets, or asphalt parking lots by crushing, milling, or planing existing asphalt concrete pavements. This material shall be transported to the asphalt concrete production facility yard

and processed through an appropriate crusher so that the resulting material will contain no particles larger than the maximum aggregate size of the asphalt concrete mixture in which it will be used. All RAP shall be processed across a maximum of a 5/8-inch screen. The material shall be stockpiled on a free draining base and kept separate from virgin aggregates, dirt, vegetation or rubbish. The material contained in the RAP stockpiles shall have a reasonably uniform gradation from fine to coarse and shall be protected from accumulation of excessive moisture and shall not be contaminated by foreign materials. The use of RAP will be permitted provided that the end product is in conformance with the approved job-mix formula and that the RAP proportions meet the maximum requirements for the appropriate pavement section course. When RAP is used in the mix design, the following recommendations shall be observed:

1. The gradation of the aggregate in the RAP should be used in calculation of the mix gradation and fractured faces. Fine aggregate angularity, sand equivalent and flat and elongated particles shall not be measured for the RAP aggregate.
2. The percentage of asphalt in the RAP shall be considered when determining the optimum asphalt content. The maximum binder replacement from RAP is 30 percent for surface course and 30 percent for base course.
3. Asphalt content of the total mixture for mix batching shall include virgin and reclaimed asphalt binder. The asphalt binder in the RAP shall be considered as part of the trial mix binder content.
4. The specific gravity of the virgin binder shall be used as the specific gravity of the binder in the RAP for mixture design.
5. The bulk specific gravity of the aggregate in the RAP shall be determined and used as the bulk specific gravity of the RAP aggregate for calculation purposes. The bulk specific gravity of the RAP shall be determined by the following steps:
 - a. Determine the maximum theoretical specific gravity (G_{mm}) of the RAP by ASTM D 2041.
 - b. Determine the asphalt content of the RAP (P_b) by extraction following ASTM D 2172.
 - c. Calculate the effective specific gravity (G_{se}) of the RAP from the G_{mm} and the RAP asphalt content (P_b).
 - d. Determine the absorption of the coarse aggregate from the RAP extraction.
 - e. Determine the bulk specific gravity of the RAP aggregate (G_{sb}) by the table 2.3. See Exhibit 321216.2 "Determination of Reclaimed Asphalt Pavement (RAP) Aggregate Bulk (Dry) Specific Gravity (G_{sb})", at the end of this Section, which includes an example of calculation for high absorption aggregates.

Table 2.3 Bulk Specific Gravity of RAP Aggregate

Absorption of the RAP coarse aggregate	Absorption Category	Bulk specific gravity of RAP aggregate
>1.5%	High	G _{sb} = G _{se} - 0.1
≤ 1.5%	Low	G _{sb} = G _{se} - 0.05

6. Use mixing and compaction temperatures for intended asphalt binder grade.

2.2 TACK COAT AND PRIME COAT

- A. Tack coat shall be SS-1, SS-1h, CSS-1 or CSS-1h diluted with an equal amount of water, or agency acceptable product.
- B. Prime coat shall be MS-2, CMS-2, or HFMS-2s.
- C. Tack coat and Prime Coat shall comply with AASHTO M140 or M208.

2.3 BITUMINOUS STRIP BETWEEN CONCRETE AND ASPHALT PAVEMENT

- A. Bituminous Strip at Flush Connections between Concrete Pavement and Asphalt Pavement: Hot asphalt joint sealing compound consisting of polymer-modified bitumen strip, with a disposable interleaving, for sealing joints between asphalt pavement and concrete pavement.
1. Approved Product: DensoBand by Denso North America; Southfield, MI, phone (248) 350-7500; www.densona.com.
 - a. Thickness: 0.59 inch.
 - b. Width: 1.77 inches.
 - c. Length: Manufacturer's standard roll.
 2. Primer: Denso Primer D.
 - a. Application of primer is required. No exception.

PART 3 - EXECUTION

3.1 AGGREGATE BASE

- A. Dense graded mixture of natural or crushed gravel or stone, and natural or crushed sand, ASTM D 2940, with at least 90 percent passing a 1-1/2 inch sieve and not more than 12 percent passing a No. 200 sieve.
1. When thickness of compacted base is 8 inches or less, place materials in a single layer.
 2. When thickness of compacted base exceeds 8 inches, place materials in equal layers, with no layer more than 8 inches thick or less than 4 inches thick when compacted.
- B. Aggregate base shall be compacted to the thickness indicated on the paving drawing at near optimum moisture and to at least 95 percent of ASTM D 1557 maximum dry density.

3.2 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared sub-grade is ready to receive paving.
1. Sweep loose granular particles, dust from surface of unbound-aggregate base course or previous AC lift.
 2. Remove any water from the existing surface.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions.
- C. Tack Coat: Dilute the emulsion with equal parts of water. Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sy and allow to cure.
1. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillage and clean affected surfaces.
 2. Prohibit traffic from traversing tack-coated area.
 3. Apply tack coat only to area to be paved during that work day.

3.3 HOT-MIX ASPHALT PLACEMENT

- A. Machine place hot-mix asphalt mix on prepared base surface, spread uniformly, and strike off.
- B. Regulate paver machine speed to obtain a smooth (tight-mat), continuous surface free of pulls, bumps and tears in asphalt-paving mat.
1. The HMA pavement section shall be constructed with two (2) or more courses or lifts.
 2. HMA mix shall be placed in accordance with the limitation outlined in Table 3.1 below.
 3. Spread and compact asphalt mix with the temperature range specified on the approved Job Mix Design Submittal.

- 4. Begin applying mix along centerline of crown and along the high side of one-way slopes, unless otherwise indicated.

Table 3.1 HMA Placement Lift Limitation

Lift Limitation	AC Pavement Section		
		Base Course	Surface Course
Minimum number of lift		1	1
Minimum compacted lift thickness	Inch	1.5	1.5
	Ratio of NMAS	3	3
Maximum compacted lift thickness	Inch	4	3

- C. Place paving in consecutive strips not less than twelve feet wide, except where infill edge strips of a lesser width are required. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course.
- D. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of the mix. Place each course to required grade, cross section and thickness, when compacted.
- E. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material from forming "high" spots. Fill depressions with hot-mix asphalt and prevent segregation of the mix; use suitable hand tools to smooth surface.
- F. Where shown on the plans or directed by the Owner, install bituminous strip at connections between asphalt pavement and concrete pavement to improve adhesion and reduce water intrusion. Install bituminous strip in accordance to manufacturer's installation instructions and as follows:
 - 1. Prior to installing bituminous strip, prepare surfaces in accordance to manufacturer's installation instructions. Apply required primer to clean and dry vertical surfaces of joints. Allow primer to dry to a tack consistency.
 - 2. Lay the strip along the length of the joint and remove the interleaving paper. Heat the inside surface of the strip material and place it against the vertical surface of the joint. Firmly press into place.
 - 3. Ensure that the hot asphalt is placed up tight to the bituminous strip to allow for the bond/fuse to occur between materials.

3.4 JOINTS

- A. Surface course longitudinal joints shall run with the traffic pattern. Therefore, pulling across the driving lanes shall not be allowed unless express permission is given by the Owner. Detail and submit to the Owner a paving plan on the site plan sheet prior to placement of asphalt.
- B. The entire parking lot surface course shall be paved on the same day. The timing and process should be discussed with and approved by the Owner before proceeding with the work. Work in such a manner as to not unduly limit parking or access to the site by customers or employees. Maintain access to at least 50 percent of usable parking spaces during paving all the time.
- C. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat.
 - 2. Offset longitudinal joints in successive courses a minimum of six inches.

3. Offset transverse joints in successive courses a minimum of 24 inches.
4. Construct transverse joints by bulkhead method or sawed vertical face method as described in Asphalt Institute's "The Asphalt Handbook".
5. Construct cold longitudinal joints by saw cuttings straight and true edge. Tack coat the longitudinal joint.
6. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement, and complete compaction to the specified density before the minimum compaction temperature specified in the JMD is reached.

3.5 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. In areas inaccessible by rollers, compact hot-mix paving with a hot, hand tampers or vibratory-plate compactors. Complete compaction before mix temperature cools to less than the minimum temperature specified in the approved Job Mix Design Submittal.
 1. As required, the paving contractor shall complete a Roll Pattern (i.e. Test Pattern) to determine the size and type of equipment required, as well as, the corresponding number of passes with each to meet compaction and smoothness requirements.
- B. Breakdown Rolling: Accomplish breakdown (or initial) rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated smoothness, crown and grade. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and re-rolling to required elevations and density.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still within the approved Job Mix Design specified compaction temperature range. Continue rolling until hot-mix asphalt course has been uniformly compacted to the required density.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.
- F. Repairs: Remove paved areas that are defective, contaminated with foreign materials, or rejected due to surface coarseness or smoothness. Remove paving course over area affected and replace with new, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until paving has adequately cooled. Repair all damaged areas.
- H. Density: Compare density of in-place materials for each lot and subplot against ASTM D 2041 maximum specific gravity for the mix. Minimum acceptable density of in-place material shall be: the average density of 93.0 to 97.0 percent of the theoretical maximum density determined by ASTM D 2041.
- I. Surface course longitudinal joints shall be measured 6 inches from the joint, centered upon core or density gauge, and shall meet the mat density requirements minus 2.0 percent as a minimum, but no less than 90.0 percent of the maximum theoretical specific gravity, per ASTM D 2041.

- J. Base and leveling course longitudinal joint density shall be between 95 and 102 percent of maximum achievable individually, with an average of 98 percent on any given day. Base and leveling installation of asphalt shall meet local DOT specifications for in-place density measurement.

3.6 FINISHED PAVEMENT SURFACES

- A. Examine finished surface and verify "tight-mat" finish per Costco's requirements and expectations, and verify conformance with Owner, or owner's representative. Open graded (porous) finished surfaces or areas with rock pockets or segregated material will not be accepted.
- B. The completed asphalt pavement surface shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, irregularities, rock pockets, coarse aggregate and roller marks. Areas of handwork at joints and miscellaneous structures shall match the smooth surface texture of all other areas of new pavement.
- C. Finished paved surface shall be uniform, clean and smooth, with no ponding, pooling or "birdbaths". Paved surfaces containing "birdbaths" will not be accepted and will be replaced and/or repaired by the Contractor, at no additional cost to the Owner. Patching will not be acceptable.

3.7 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated with the following tolerances:
 1. Aggregate Base Course: Plus or minus 1/2 inch.
 2. Asphalt Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a ten (10') foot straight edge applied transversely or longitudinally to paved areas:
 1. Aggregate Base Course: 1/4 inch.
 2. Asphalt Surface Course: 1/8 inch.
- C. Final pavement surface (roughness) acceptance shall be by the Owner or the Owner's representative.

3.8 FIELD QUALITY ASSURANCE

- A. Quality Assurance Asphalt Paving Test Strip:
 1. Developer/Contractor Testing: As required by Costco, provide a sample (20-feet by 100-foot minimum test strip) of asphalt paving for review and approval by Costco or Costco's representative.
 - a. Coordinate location of field testing, cores and mix samples (for lab analysis) with Architect and Costco PM.
 2. Approval and acceptance by Costco shall be required prior to proceeding with paving of remainder of site.
 3. Any testing and inspection completed by Costco shall be considered independent of any Quality Control Testing required by the Developer/Contractor or their paving contractor to show conformance with all of the requirements outlined in this section.
- B. Testing Agency:

1. The contractor shall be responsible for coordinating paving activities with the owner's testing agency to allow field inspection and testing in conformance with these specifications.
 2. The testing agency shall prepare daily test reports, and state in each report whether the tested work complies with the specified requirements.
 3. Any additional testing required to verify compliance of corrected work shall be at the contractor's expense.
- C. Thickness: In-place compacted thickness of hot-mix asphalt will be determined in accordance with ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course shall be tested for compliance with smoothness tolerances, and shall include a "visual" inspection of the asphalt pavement surface by the Owner or the Owner's representative.
- E. Quality Assurance Testing: For the purpose of Quality Assurance Testing and Acceptance Evaluation, the HMA paving work shall be divided into lots and sub-lots, as defined in Section 1.3. With a Lot understood to be equal to the quantity of paving completed in one working day.
1. For each lot, a sample of HMA will be obtained in accordance with ASTM D 3665 random sampling procedure by the Owner's testing agency and following mix properties determined:
 - a. Asphalt Binder Content, ASTM D 2172 or D 6307.
 - b. Aggregate Gradation, ASTM C 136 and C 117.
 - c. Maximum Specific Gravity, ASTM D 2041. (Mandatory 2-hour cure time before testing for QC and QA)
 2. For the first lot of the project and every third lot thereafter, the following additional properties shall be determined:
 - a. Air Voids, percent.
 - b. Voids Filled, percent.
 - c. Voids in Mineral Aggregate, percent.
 3. One location within each lot shall be randomly selected using ASTM D 3665 procedures for density testing. Two cores shall be obtained at each location and their density determined in accordance with ASTM D 3665a and their thicknesses determined in accordance with ASTM D 3549. The density and thickness for each location shall be the average of the two core samples. The compaction of each subplot shall be the percentage of the average density for the subplot compared to the maximum density of the sample lot determined in accordance with ASTM D 2041.
- F. Acceptance Evaluation:
1. The HMA paving for a lot is acceptable if the AC mix properties are consistent with the approved JMF and meet the criteria shown in Table 3.2.

Table 3.2 HMA Acceptance Criteria

Quality Characteristics		Requirements
Gradation (% passing):	Sieve Size	
	3/4" or greater	JMF ^a ± 5
	1/2"	JMF ^a ± 5
	3/8"	JMF ^a ± 5
	No. 4	JMF ^a ± 5
	No. 8	JMF ^a ± 5
	No. 30	JMF ^a ± 3
	No. 200	JMF ^a ± 1.5
Asphalt binder content (%)		JMF ^a ± 0.3

Air Voids ^c (%)		2.5 - 4.5
Minimum VMA ^d (%)	Mix NMAS	
	3/4"	13.0
	1/2"	14.0
	3/8"	15.0
Dust Proportion		0.7 - 1.3
Compaction (% of theoretical maximum density)		92 - 97 ^b

Note:

- a. JMF = Job Mix Formula, the value is from the approved mix design submittal.
- b. Payment reduction applies if compaction is outside the requirements, see the following paragraph.
- c. Mix design shall target 3.5 percent air voids and maintain an air void running average of 3.5 percent during production.
- d. VMA deviation of more than 0.5 below the minimum requirement requires corrective measures and immediate shut-down of paving operations until the issues with AC mix production is resolved.

G. Payment Reduction:

- 1. Any average in-place density measured for surface course mixtures that is less than required for the day will result in a reduction in HMA pay equal to the following table 3.3. After reaching the 30 percent reduction mark the pavement shall be removed and replaced by the Contractor or at owner permission, left in place with no compensation due the Contractor.

Table 3.3 Pay Factor

Pay Factor (%)	In-place Density as Percent of Maximum Theoretical Specific Gravity, Gmm (%)	Pay Factor (%)	In-place Density as Percent of Maximum Theoretical Specific Gravity, Gmm (%)
100	> 93	89.0	91.4
99.5	92.9	88.0	91.3
99.0	92.8	87.0	91.2
98.5	92.7	86.0	91.1
98.0	92.6	85.0	91.0
97.5	92.5	83.5	90.9
97.0	92.4	82.0	90.8
96.5	92.3	80.5	90.7
96.0	92.2	79.0	90.6
95.5	92.1	77.5	90.5
95.0	92.0	76.0	90.4
94.0	91.9	74.5	90.3
93.0	91.8	73.0	90.2
92.0	91.7	71.5	90.1
91.0	91.6	70.0	90.0
90.0	91.5	0	<90.0

H. Removal and Replacement:

- 1. Remove and replace, or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements, at no additional cost to the Owner.

- I. Quality Control Testing and Inspection:
1. The Contractor shall at his own expense perform quality control testing and inspection as necessary for the Contractor to control operations to provide HMA paving meeting the requirements of these specifications.
 2. The Contractor shall be responsible to obtain cores at his own expense, for each lot, each paving lift, and each separate phase of paving work.
 3. The Contractor shall provide the Owner's testing agency split samples (i.e. additional cores) for independent testing. Payment reduction shall be calculated based on the available core test results.
 4. The Contractor shall be solely responsible for patching and repairing the core hole location.
 5. Testing and inspection by the Owner shall not relieve the Contractor of responsibility to control the work quality and performance.

END OF SECTION 321216

Supporting Information

Contents:








General Notes

Rock Classification Notes

Unified Soil Classification System

Note: All attachments are one page unless noted above.

General Notes

Sampling	Water Level	Field Tests
 Grab Sample  Shelby Tube  Split Spoon	 Water Initially Encountered  Water Level After a Specified Period of Time  Water Level After a Specified Period of Time  Cave In Encountered Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	N Standard Penetration Test Resistance (Blows/Ft.) (HP) Hand Penetrometer (T) Torvane (DCP) Dynamic Cone Penetrometer UC Unconfined Compressive Strength (PID) Photo-Ionization Detector (OVA) Organic Vapor Analyzer

Descriptive Soil Classification

Soil classification as noted on the soil boring logs is based Unified Soil Classification System. Where sufficient laboratory data exist to classify the soils consistent with ASTM D2487 "Classification of Soils for Engineering Purposes" this procedure is used. ASTM D2488 "Description and Identification of Soils (Visual-Manual Procedure)" is also used to classify the soils, particularly where insufficient laboratory data exist to classify the soils in accordance with ASTM D2487. In addition to USCS classification, coarse grained soils are classified on the basis of their in-place relative density, and fine-grained soils are classified on the basis of their consistency. See "Strength Terms" table below for details. The ASTM standards noted above are for reference to methodology in general. In some cases, variations to methods are applied as a result of local practice or professional judgment.

Location And Elevation Notes

Exploration point locations as shown on the Exploration Plan and as noted on the soil boring logs in the form of Latitude and Longitude are approximate. See Exploration and Testing Procedures in the report for the methods used to locate the exploration points for this project. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

Strength Terms

Strength Terms						
Relative Density of Coarse-Grained Soils <small>(More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance</small>		Consistency of Fine-Grained Soils <small>(50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance</small>			Bedrock	
Relative Density	Standard Penetration or N-Value (Blows/Ft.)	Consistency	Unconfined Compressive Strength Qu (tsf)	Standard Penetration or N-Value (Blows/Ft.)	Standard Penetration or N-Value (Blows/Ft.)	Consistency
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1	< 20	Weathered
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4	20 - 29	Firm
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	5 - 8	30 - 49	Medium Hard
Dense	30 - 50	Stiff	1.00 to 2.00	9 - 15	50 - 79	Hard
Very Dense	> 50	Very Stiff	2.00 to 4.00	16 - 30	>79	Very Hard
		Hard	> 4.00	> 30		

Relevance of Exploration and Laboratory Test Results

Exploration/field results and/or laboratory test data contained within this document are intended for application to the project as described in this document. Use of such exploration/field results and/or laboratory test data should not be used independently of this document.

Rock Classification Notes

WEATHERING	
Term	Description
Fresh	Mineral crystals appear bright; show no discoloration. Features show little or now staining on surfaces. Discoloration does not extend into intact rock.
Slightly weathered	Rock generally fresh except along fractures. Some fractures stained and discoloration may extend <0.5 inches into rock.
Moderately weathered	Significant portions of rock are dull and discolored. Rock may be significantly weaker than in fresh state near fractures. Soil zones of limited extent may occur along some fractures.
Highly weathered	Rock dull and discolored throughout. Majority of rock mass is significantly weaker and has decomposed and/or disintegrated; isolated zones of stronger rock and/or soil may occur throughout.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The rock mass or fabric is still evident and largely intact. Isolated zones of stronger rock may occur locally.

STRENGTH OR HARDNESS		
Description	Field Identification	Uniaxial Compressive Strength, psi
Extremely strong	Can only be chipped with geological hammer. Rock rings on hammer blows. Cannot be scratched with a sharp pick. Hand specimens require several hard hammer blows to break.	>36,000
Very strong	Several blows of a geological hammer to fracture. Cannot be scratched with a 20d common steel nail. Can be scratched with a geologist's pick only with difficulty.	15,000-36,000
Strong	More than one blow of a geological hammer needed to fracture. Can be scratched with a 20d nail or geologist's pick. Gouges or grooves to ¼ inch deep can be excavated by a hard blow of a geologist's pick. Hand specimens can be detached by a moderate blow.	7,500-15,000
Medium strong	One blow of geological hammer needed to fracture. Can be distinctly scratched with 20d nail. Can be grooved or gouged 1/16 in. deep by firm pressure with a geologist's pick point. Can be fractured with single firm blow of geological hammer. Can be excavated in small chips (about 1-in. maximum size) by hard blows of the point of a geologist's pick;	3,500-7,500
Weak	Shallow indent by firm blow with geological hammer point. Can be gouged or grooved readily with geologist's pick point. Can be excavated in pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.	700-3,500
Very weak	Crumbles under firm blow with geological hammer point. Can be excavated readily with the point of a geologist's pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.	150-700

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		Bedding Spacing (May Include Foliation or Banding)	
Description	Spacing	Description	Spacing
Intensely fractured	< 2.5 inches	Laminated	< ½-inch
Highly fractured	2.5 – 8 inches	Very thin	½ – 2 inches
Moderately fractured	8 inches to 2 feet	Thin	2 inches – 1 foot
Slightly fractured	2 to 6.5 feet	Medium	1 – 3 feet
Very slightly fractured	> 6.5 feet	Thick	3 – 10 feet
		Massive	> 10 feet

ROCK QUALITY DESIGNATION (RQD) ¹	
Description	RQD Value (%)
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification	
				Group Symbol	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: Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3$ ^E	GW	Well-graded gravel ^F
		Gravels with Fines: More than 12% fines ^C	$Cu < 4$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	GP	Poorly graded gravel ^F
			Fines classify as ML or MH	GM	Silty gravel ^{F, G, H}
		Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Fines classify as CL or CH	GC
	$Cu \geq 6$ and $1 \leq Cc \leq 3$ ^E			SW	Well-graded sand ^I
	Sands with Fines: More than 12% fines ^D		$Cu < 6$ and/or $[Cc < 1$ or $Cc > 3.0]$ ^E	SP	Poorly graded sand ^I
			Fines classify as ML or MH	SM	Silty sand ^{G, H, I}
	Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	PI > 7 and plots above "A" line ^J	CL
PI < 4 or plots below "A" line ^J				ML	Silt ^{K, L, M}
Organic:			$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$	OL	Organic clay ^{K, L, M, N} Organic silt ^{K, L, M, O}
			Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above "A" line
PI plots below "A" line		MH			Elastic silt ^{K, L, M}
Organic:		$\frac{LL \text{ oven dried}}{LL \text{ not dried}} < 0.75$		OH	Organic clay ^{K, L, M, P} Organic silt ^{K, L, M, Q}
		Highly organic soils:		Primarily organic matter, dark in color, and organic odor	

^A Based on the material passing the 3-inch (75-mm) sieve.

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C 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.

^D 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.

^E $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

^M If soil contains $\geq 30\%$ 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.

