GEOTECHNICAL DATA REPORT

FINAL

TWP SEGMENT A PRV & METER PIPE & VAULT & CHEMICAL BUILDING

THORNTON, COLORADO

FEBRUARY 2023

Engineering from the ground down

2750 S Wadsworth Blvd, Suite D-200
Denver, Colorado 80227
303.625.9502
www.LithosEng.com

February 10, 2023
Project No. 21207

Carollo Engineers
390 Interlocken Crescent, Ste 800
Broomfield, Colorado 80021

Attention: Mr. Bart Giles, PE
Senior Infrastructure Engineer

Regarding: Geotechnical Data Report- Final
TWP Segment A PRV & Meter Pipe & Vault & Chemical Building
Thornton, Colorado

Mr. Giles,

The following Geotechnical Data Report presents data collected for the Thornton Water Project (TWP) Segment A PRV & Meter Pipe & Vault & Chemical Building. This study was conducted in general accordance with the Task Order between Lithos Engineering and Carollo Engineers dated January 28, 2022. This report contains the results of our subsurface investigation concerning the structures for this project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,
Lithos Engineering

Alex Warren, EI
Staff Engineer

Derek Magnuson, PG, CEG
Project Geologist

Steve Kuehr PE
Senior Consultant

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APPENDICES

1 INTRODUCTION

Carollo Engineers (Carollo) retained Lithos Engineering (Lithos) to provide geotechnical engineering services for the TWP Segment A PRV & Meter Pipe & Vault & Chemical Building (Project). The City of Thornton (City) will construct a new Chemical Building in between Colorado Boulevard and the South Platte River in Thornton, Colorado. Two vaults will also be constructed in the same vicinity along the alignment of a pipeline designed by others.

The purpose of this report is to document subsurface conditions identified by Lithos during geotechnical exploration for the Project. The Geotechnical Design Memorandum (GDM) by Lithos, provided under separate cover, will provide geotechnical recommendations for design and construction of the project.

1.1 Project Description

Based on correspondence with Carollo regarding the Chemical Building and review of 95 percent design drawings for the vaults prepared by Carollo, we understand the Project will include the following facilities at locations noted on Figure 1:

- A new Chemical Building with a footprint of approximately 30 feet by 45 feet and a finish floor elevation approximately 3 feet below the existing ground surface (bgs). The Chemical Building will be designed to include tanks of various sizes.
- A chemical injection manhole with a circular footprint approximately 11 feet in diameter. The manhole will be approximately 13 feet deep.
- A pressure reducing vault with a footprint of approximately 20 feet by 35 feet. The vault will be approximately 18 feet deep, with a finish floor elevation of 5,068.75 feet and a 3 to 5-foot thick mat slab.

1.2 Site Description

The project site for the Chemical Building and vaults is located southeast of the intersection of E 88th Avenue and Colorado Boulevard. The site is bounded to the east and south by the South Platte River and the Thornton Gravel Ponds, respectively. The site for the Chemical Building is currently used as materials stockpile storage for the City of Thornton and has an elevation of approximately 5,095 feet. The vaults will be constructed in a relatively flat field in a park above the South Platte River with an elevation of approximately 5,082 feet. Based on our review of historical aerial imagery available on Historic Aerials (historicaerials.com), the Project site existed as undeveloped land and materials storage in the earliest image dating back to 1956 and has changed since then with more development. The following list summarizes our review of aerial imagery for the subject site:

- Aerial imagery from 1956 indicates the site of the proposed Chemical Building existed as a small storage site with structures and materials, and the site of the proposed vaults was undeveloped land. The South Platte River is located east of the site and structures for the water treatment plant and the road for Colorado Boulevard exist west of the site.
- Aerial imagery from 1971 shows further development of the water treatment plant, with the site of the proposed Chemical Building still serving as storage. The site of the vaults is undeveloped land.
- Aerial imagery from 1991 indicates the most development occurred during this time. The site of the Chemical Building shows an expanded materials storage site across the street from the water

treatment plant. One of the gravel ponds exists south of this site. The site of the vaults is undeveloped land, however a parking lot and trail were constructed on either side as part of the Platte River Trailhead Park.

- Aerial imagery from 1993 to 2019 indicates no further development occurred at the site and exists in its present state.

2 GEOTECHNICAL INVESTIGATION

Lithos conducted a subsurface investigation at the project site on January 24 and 25, 2022, and on November 16, 2022. The geotechnical investigation included geotechnical drilling, a subsequent geotechnical laboratory testing program, and field testing of hydraulic conductivity (slug testing). Subsurface conditions encountered during the investigation are discussed in Section 3.

2.1 Subsurface Investigation

Lithos completed five geotechnical borings to investigate the general subsurface conditions for the Project site (Figure 1). The geotechnical borings include CHM-1, CHM-2, and CHM-3 for the Chemical Building, and VLT-1 and VLT-2 for the PRV and chemical injection manhole. Borings were advanced to depths of 39.4 to 75.0 feet below existing ground surface (bgs).

Lithos subcontracted Vine Laboratories, Inc. from Commerce City, Colorado to drill four borings utilizing a CME 55 truck mounted drilling rig in January 2022. Lithos subcontracted Elite Drilling Services to drill one boring utilizing a Mobile 48X track mounted drilling rig on November 16, 2022. Drilling and sampling procedures were conducted in general accordance with ASTM D1586 – *Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils*, ASTM D3550 – *Standard Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils*. Continuous-flight, hollow-stem augers were used to advance borings below the existing ground surface to the maximum depth of exploration. During advance of the augers, Modified California or Split Spoon samples (2.0-inch, 1.4-inch inner diameter) were obtained at 5-foot intervals. The number of blows by a 140-pound hammer falling 30-inches required for 12 inches of sampler penetration (recorded in 6-inch increments) are presented on the boring logs (Appendix A). For the January 2022 borings, a photoionization detector (PID) was used on collected samples in conjunction with soil odor observations.

2.2 Geotechnical Laboratory Testing

A geotechnical laboratory testing program was developed by Lithos and performed by Martinez Associates on representative samples collected during the subsurface investigation. The geotechnical laboratory testing results are presented in Appendix B. Geotechnical laboratory tests were conducted in general accordance with local practice. If field characterized soil and bedrock descriptions differed from results indicated by laboratory classification testing, the boring logs presented in Appendix A were amended to reflect laboratory testing results.

2.3 Corrosion Laboratory Testing

A corrosion laboratory testing program was developed by Lithos and performed by Project X Corrosion Engineering on representative samples collected during the subsurface investigation. The corrosion laboratory testing results are presented in Appendix C. Corrosion laboratory tests were conducted in general accordance with associated standards presented in the table below.

Table 1 – Lab Testing Summary

Geotechnical and Corrosion Laboratory Testing	
Test	**Standard**
Chloride	ASTM D4327
pH	ASTM G51
Redox Potential	ASTM G200
Sulfate-Water Soluble	ASTM D4327
Sulfide	SM 4500-D
Resistivity	ASTM G187
Ammonium	ASTM D6919
Nitrate	ASTM D4327

2.4 Hydraulic Conductivity Testing

Slug tests were conducted in accordance with ASTM D4044 to estimate the hydraulic properties of the aquifer in the groundwater monitoring well by creating a sudden change in water level and measuring the response using a submerged transducer. The falling-head slug test, or slug-in test, was performed by inserting a solid slug instrument into the well, rapidly raising the water level and recording the falling water level until it reached equilibrium. The rising-head slug test, or slug-out test, was performed once equilibrium was reached by removing the solid slug instrument from the well, rapidly lowering the water level, and recording the rising water level until it reached equilibrium. The measured responses were analyzed according to Bouwer and Rice (1976) to determine the hydraulic conductivity of the aquifer. Table 2 below presents the hydraulic conductivity results of the slug tests conducted the monitoring well installed in Boring VLT-1.

Table 2 – Hydraulic Conductivity Results

Slug Test Results						
Boring	**Hydraulic Conductivity in cm/sec**					
	Slug In 1	Slug In 2	Slug In 3	Slug Out 1	Slug Out 2	Slug Out 3
VLT-1	2.8×10^{-3}	3.2×10^{-3}	3.2×10^{-3}	4.2×10^{-3}	3.2×10^{-3}	4.6×10^{-3}

3 SUBSURFACE CONDITIONS

Subsurface conditions were assessed based on the findings of the geotechnical investigation described in the previous section. Soil and rock descriptions noted on the boring logs and below are in general accordance with ASTM D2487 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and D2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. Boring logs and a supplementary boring log key explaining boring log details are provided in Appendix A.

3.1 Regional Geology

Geologic mapping of the greater Denver area by Trimble and Machette (1979) indicates the Project area is underlain by Holocene Post-Piney Creek and Piney Creek alluvium and Paleocene and Upper Cretaceous Denver Formation. The alluvium is described as gravel, sand, silt, and clay of modern stream flood plains

and older terraces. The Denver Formation is described as claystone, siltstone, sandstone, and conglomerate composed of altered andesitic debris.

3.2 Subsurface Conditions

Primary materials encountered during the subsurface investigation include fill, coarse alluvium, fine alluvium, and bedrock.

3.2.1 Fill

Fill was encountered in all borings at the existing ground surface or beneath asphalt pavement and extended to depths of 3 to 27 feet bgs. Based on input from the City of Thornton, we understand the fill at the chemical building site was placed as levee material. Near the vaults, the fill is likely related to the development of the parking lot and trails. Records of fill placement observation and associated materials testing have not been provided for our review and as such, the fill should be considered uncontrolled. Encountered fill was classified as the following in accordance with USCS:

- Sandy Lean Clay (CL) with varying gravel content
- Lean Clay with Sand (CL)
- Sandy Fat Clay (CH)
- Clayey Sand (SC) with varying gravel content
- Silty, Clayey Sand (SC-SM)
- Silty Sand (SM)
- Poorly Graded Sand with Silt and Gravel (SP-SM)

Fill was primarily comprised of varying amounts of clay and sand, and occasional silt and fine gravel. Blow counts in fill ranged from 6 to 29 blows per foot of sampler penetration indicating a relative consistency of medium stiff to very stiff for cohesive material, and a relative density of loose to medium dense for granular material. Cobble-size particles were suspected in the fill during drilling based on the auger behavior. Fill was further described as dark brown to gray and moist.

3.2.2 Coarse Alluvium

Coarse alluvium was encountered in all borings below fill and extended to depths of 28 feet bgs in the vault borings and the depths of exploration in the Chemical Building borings. Encountered coarse alluvium was classified as the following in accordance with USCS:

- Silty Sand (SM)
- Clayey Sand (SC) with gravel
- Well-Graded Sand (SW) with varying gravel content
- Well-Graded Sand with Silt (SW-SM) and varying gravel content
- Poorly Graded Sand (SP) with varying gravel content
- Poorly Graded Sand with Silt (SP-SM) and varying gravel content
- Poorly Graded Sand with Clay and gravel (SP-SC)

Coarse alluvium was comprised of fine to coarse sand with varying amounts of silt, clay, and gravel. Blow counts in the coarse alluvium ranged from 4 to 64 blows per foot of sampler penetration indicating a relative density of very loose to very dense. Cobble-size particles were suspected in the coarse alluvium during drilling based on the auger behavior. The coarse alluvium was further described as olive and moist to wet.

3.2.3 Fine Alluvium

Fine alluvium was encountered in Borings CHM-1 and VLT-1 layered between the coarse alluvium and extended to depths of 14 and 32 feet bgs. Encountered fine alluvium was classified as the following in accordance with USCS:

- Sandy Lean Clay (CL)
- Sandy Silt (ML)

Fine alluvium was comprised of clay and silt with varying amounts of sand. Blow counts in the fine alluvium ranged from 4 to 30 blows per foot of sampler penetration indicating a relative consistency of stiff for the cohesive material, and a relative density of very loose to medium dense for the granular material. The fine alluvium was further described as olive to yellowish brown and wet.

3.2.4 Bedrock

Sandstone, siltstone, and claystone bedrock of the Denver Formation was encountered in Borings CHM-3, VLT-1, and VLT-2 below the coarse alluvium and extended to the depths of exploration in each boring. The bedrock was generally very soft to soft, fresh, and dark greenish/blueish gray, with varying amounts of fine sand and clay.

Three swell tests were performed on samples of bedrock from Boring CHM-3 and VLT-2. The samples exhibited swells of 2.1 to 5.2 percent under inundation pressures of 500 psf, indicating a low to high swell potential in accordance with CAGE (1996) criteria. The swell pressures ranged from 4,000 to 17,560 psf.

3.2.5 Groundwater

Groundwater was encountered in all borings during the subsurface investigation and measured at depths ranging from 13.8 to 20.8 feet bgs. A temporary monitoring well was installed in Boring VLT-1. Groundwater was recorded at the time of drilling and subsequently monitored after drilling operations. Table 3 below presents groundwater fluctuations in the monitoring well as measured at the time of drilling and subsequent monitoring.

Fluctuations in groundwater levels may occur due to variations in the water level of nearby drainages, precipitation, seasonal moisture variations, temperature, future site development and other factors not evident at the time that these measurements were made.

Table 3 – Groundwater Monitoring Readings

Groundwater Depth [ft.][1]				
Boring	**Date**			
	1/25/22 (Drilling)	2/14/22	3/25/22	5/11/22
VLT-1	13.8	10.6	10.8	10.2

[1] Depth as measured below the ground surface

3.2.6 PID Readings

A photoionization detector (PID) with a 10.6 eV lamp was used on collected samples during the January 2022 subsurface investigation to detect the presence of volatile organic compounds (VOCs) while in the field. The PID readings are noted on the boring logs in Appendix A. Additionally, the field representative

smelled the samples to detect the presence of odors that may indicate VOCs, and in some instances when no odor was detected, the representative made notes indicating as such rather than using the PID.

Samples collected from Borings CHM-1 and CHM-2 had PID readings ranging from 2 to 33 parts per million (ppm). Samples collected from Borings VLT-1 and VLT-2 had PID readings ranging from less than 2 to 88 ppm.

4 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principals; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from exploratory borings and geotechnical laboratory testing. The boring logs presented in this report only depict the subsurface conditions at the actual boring and locations. Subsurface conditions are typically variable, both laterally and vertically, and the nature and extent of the subsurface variations across the site may not become evident until construction. The boundaries between different soil types and bedrock presented in this report are approximate and may be abrupt or gradational. Groundwater levels may vary with time, precipitation, and changes to the hydrogeological conditions at or surrounding the project site.

An environmental assessment was not included in Lithos Engineering scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, Lithos Engineering recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

REFERENCES

- ASTM Standards, ASTM International, West Conshohocken, PA (2012).
- Bouwer, H. and R.C. Rice, 1976, A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.
- AECOM, September 3, 2021, Plan & Profile STA 285+00 to End, TWP Seg A, Phase 2, Project No. 12-777H5, Sheet No. PP29.
- Colorado Association of Geotechnical Engineers (CAGE), 1996, Guideline for slab performance risk evaluation and residential basement floor system recommendations, Guideline 1.
- Historic Aerials, 2022, Historic Aerial Image Viewer Web Application, accessed online on February 22 at https://www.historicaerials.com/viewer.
- Trimble, D.E. and M.N. Machette, 1979, Geologic Map of the greater Denver area, front range urban corridor, Colorado, US Geological Miscellaneous Investigations Series Map I-856-H, scale 1:100,000.

Historic Aerials Reviewed Images	
1956	1993
1964	1999
1971	2009
1991	2019

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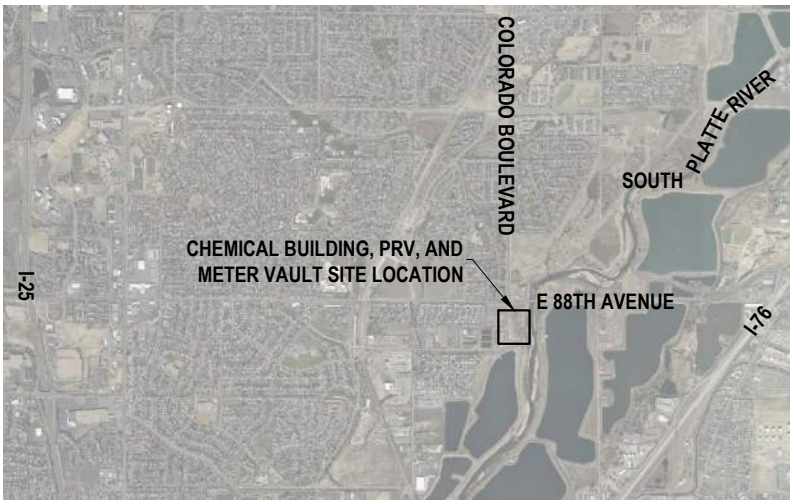
FIGURES



LEGEND:

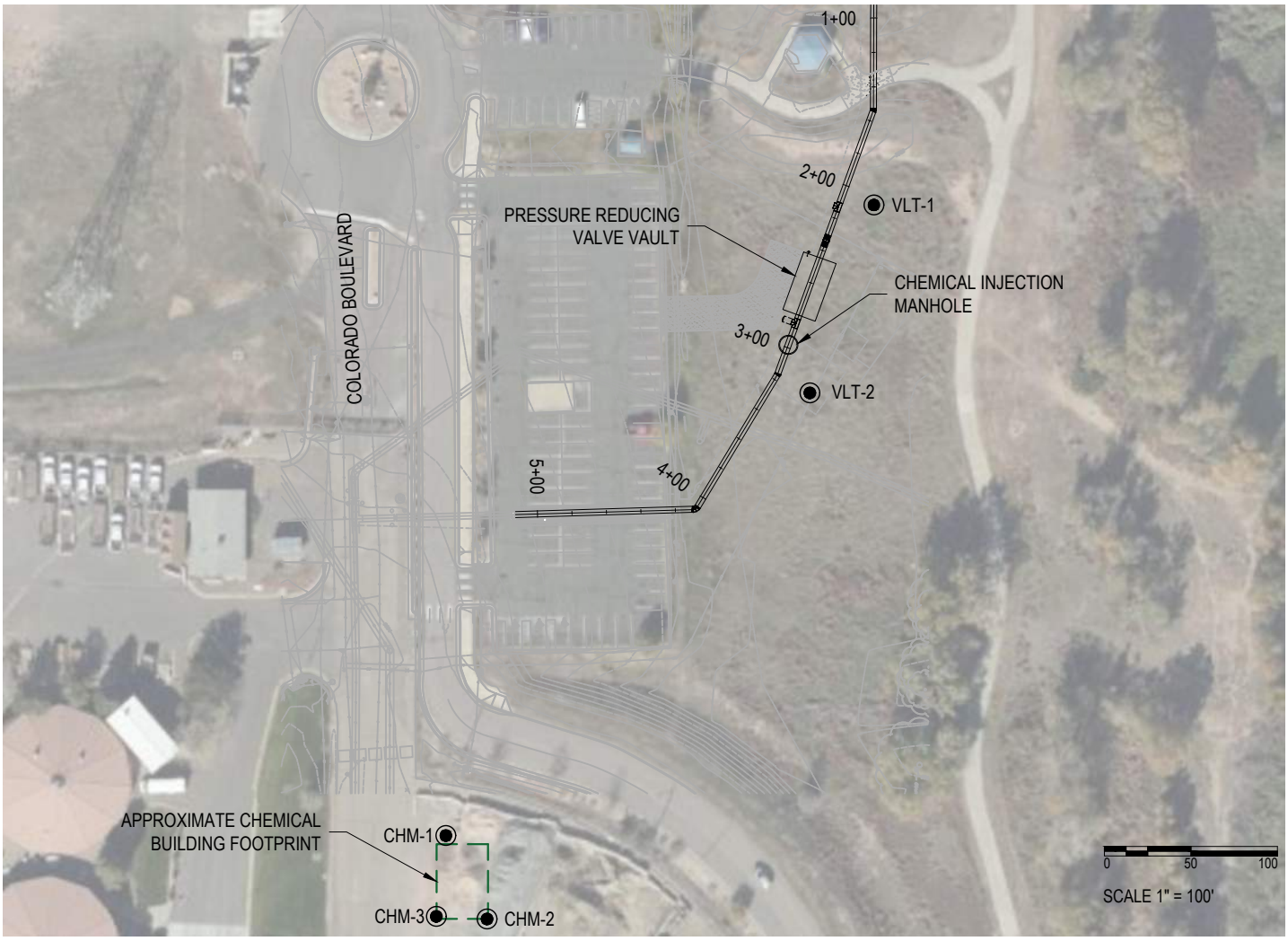
VLT-X ◉ APPROXIMATE VAULT BORING LOCATION

CHM-X ◉ APPROXIMATE CHEMICAL BUILDING BORING LOCATION

— — — APPROXIMATE CHEMICAL BUILDING FOOTPRINT

N

SITE VICINITY MAP



BORING LOCATIONS

LITHOS ENGINEERING
2750 S WADSWORTH BLVD, SUITE D-200
DENVER, COLORADO 80227
303.625.9502

PROJECT TITLE: CHEMICAL BUILDING, PRV, & METER VAULT THORNTON WATER PROJECT

DRAWING TITLE: SITE VICINITY AND BORING LOCATIONS

OWNER: City of Thornton

CLIENT: carollo

PROJECT NO.:	21207	DRAWN BY:	JP
LOCATION:	THORNTON, CO	DESIGNED BY:	DF
DATE:	02/2023	CHECKED BY:	DM

FIGURE NUMBER: 1

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APPENDIX – A

Standard Geotechnical Drilling Keys and Boring Logs

BORING LOG KEY

STANDARD GEOTECHNICAL DRILLING

Soil Classifications:

Clear Square Sieve Openings — U.S. Standard Series Sieve Sizes

12"	3"	3/4"	4	10	40	200

Boulders	Cobbles	Gravel		Sand			Silts and Clays
		Coarse	Fine	Coarse	Medium	Fine	

300mm	75mm	19mm	4.75mm	2.0mm	0.42mm	0.075mm

Gradation Estimates by Field Observation	
Description	**Quantity (%)**
Trace	<5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	> 50

Relative Density or Consistency of Non-cohesive and Cohesive Soils			
Non-cohesive Soils		**Cohesive Soils**	
Classification	**Blows per 12 in**	**Classification**	**Blows per 12 in**
Very Loose	0 to 4	Very Soft	0 to 2
Loose	5 to 10	Soft	3 to 4
Medium Dense	11-30	Medium Stiff	5 to 8
		Stiff	9 to 15
Dense	31 to 50	Very Stiff	16 to 30
Very Dense	>50	Hard	>30

Color: Sample colors are in general accordance with basic brown, red, yellow, and gray combinations

Description of Moisture	
Description	**Criteria**
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil below the groundwater table

Plasticity	
Description	**Criteria**
Nonplastic	A $\frac{1}{8}$" diameter thread cannot be rolled
Low	A $\frac{1}{8}$" in diameter thread can be rolled with difficulty; a lump cannot be formed at a moisture lower than the plastic limit
Medium	A $\frac{1}{8}$" in diameter thread can be rolled easily; a crumbly lump can be formed at a moisture lower than the plastic limit
High	A $\frac{1}{8}$" in diameter thread can be rolled very easily; a lump can be formed at a moisture lower than the plastic limit

Description of Odor	
Description	**Criteria**
No Organic Odor	Organic odor is not present
Trace Organic Odor	Mild organic odor; mixture of soil and organics
Strong Organic Odor	Prominent organic odor; sample is primarily organic

Cementation	
Description	Criteria
Weak	Crumbles with light finger pressure
Moderate	Crumbles with considerable finger pressure
Strong	Will not crumble with finger pressure

Rock Descriptions:

Weathering	
Description	**Criteria**
Fresh	No visible sign of rock material weathering: perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration of rock material on discontinuity surfaces.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly Weathered	More than half of the rock material is decompsed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

Texture	
Description	**Criteria**
Very Fine Grained	Grains not individually visible to the unaided eye
Fine Grained	Grains barely visible to the unaided eye, up to $\frac{1}{16}$" diameter
Medium Grained	Grain diameter between $\frac{1}{16}$" and $\frac{3}{16}$"
Coarse Grained	Grains diameter between $\frac{3}{16}$" and $\frac{1}{4}$"
Very Coarse Grained	Grains larger than $\frac{1}{4}$" in diameter

Field Hardness	
Description	**Criteria**
Very Hard	Cannot be scratched with a knife or sharp pick.
Hard	Can be scratched with a knife or pick only with difficulty
Medium	Can be gouged $\frac{1}{16}$" deep by firm pressure on knife or pick point
Soft	Can be grooved or gouged readily with knife or pick point
Very Soft	Can be carved with knife and scratched readily by fingernail

Geologic Interpretation:

A ***Geologic Interpretation*** of encountered soil and bedrock units is provided for each specific ***Visual Material Description***. Examples of geologic interpretations for soil that may be presented include: FILL, ALLUVIUM, AEOLIAN, AND GLACIAL TILL, AND RESIDUUM. Rock geologic interpretations are referenced based on a combination of field classifications and applicable geologic maps.

Sample Graphics and Descriptions:

California Barrel Sampler: Barrel sampler loaded with sample liners and driven to collect a relatively representative and intact specimen of soil or weak rock.

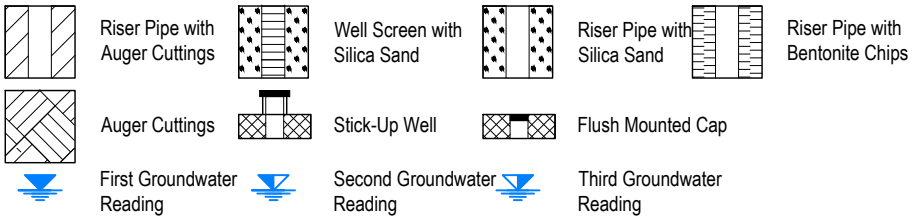
Split-Spoon Sampler: Split-barrel sampler driven in accordance with ASTM D1586 used to provide visual material descriptions and collect a disturbed specimen.

Shelby Tube Sampler: Thin wall tube hydraulically pushed into the subsurface to collect a representative and intact specimen of soil.

Bulk Sample: Bulk or bagged sample taken from auger cuttings.

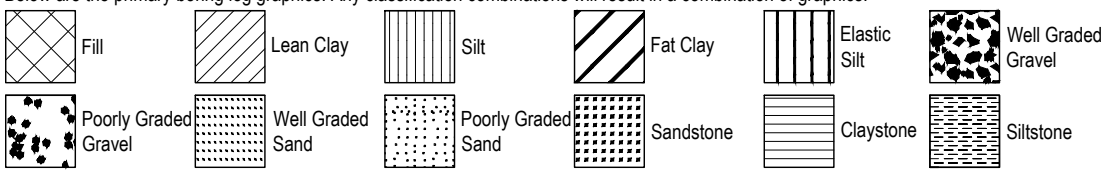
Continuous Sampler: A 5-foot long sampler barrel that is driven to collect a continuous 5-foot run of cohesive and non-cohesive soil.

Groundwater Monitoring Well Graphics:



Boring Graphics:

Below are the primary boring log graphics. Any classification combinations will result in a combination of graphics.



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BORING: CHM-1

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/24/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Modified California
Sampler Diameter(s): 2.0-inches

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Boring Location: 39.853567, -104.940072
Boring Elevation: 5,094' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**ASPHALT PAVEMENT- 4" thick**												
							0.3 ft.												
			8 8	10			**FILL** Sandy LEAN CLAY (CL), some fine to coarse sand, few coarse gravel, very stiff, dark brown, moist, maximum particle size 2.5-inches, PID=33 ppm.												
			3 6	10							0.03								
	5090		3 8	10			2.5' - Silty, clayey SAND (SC-SM), mostly sand, some silty clay, loose, olive to dark brown, moist, PID=7 ppm.							35.5	28	7			
5							4' - As above except dark gray, olive yellow, dark brown, moist, PID=10 ppm.												
	5085		4 6	10			Sandy LEAN CLAY (CL), little fine to coarse sand, trace fine to coarse gravel, stiff, dark gray, PID=5 ppm.												
10							11.0 ft.												
							COARSE ALLUVIUM Cobbles and gravel inferred based on drilling action at 11'.												
	5080		6 8	10			Well-graded SAND (SW), mostly fine to coarse sand, few fine to coarse gravel, trace silt, medium dense, pale olive, moist, maximum particle size 1.0-inches, PID=9 ppm.												
15																			
	5075		10 17	12			As above except some fine to coarse gravel, wet, maximum particle size 2.0-inches, PID=3 ppm.	(20.0 ft.)				39.5	55.8	4.7					
20																			
	5070		12 18	12			As above except maximum particle size 1.0-inch, PID=2 ppm.												
25							24.8 ft.												
							FINE ALLUVIUM Sandy SILT (ML), some fine sand, medium dense, olive yellow, wet.												
	5065		6 6	12			Sandy LEAN CLAY (CL), some fine sand, stiff, yellowish												
30																			

Sampling Data | Visual Material Description | Laboratory Testing Results (In-Situ States | INDEX DATA | Strength & Compressibility)

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/24/22	0-days	20.0-feet

BORING: CHM-1

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/24/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Modified California
Sampler Diameter(s): 2.0-inches

LITHOS ENGINEERING

Boring Location: 39.853567, -104.940072
Boring Elevation: 5,094' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results: In-Situ States: Moisture Content (%)	In-Situ States: Dry Unit Weight (pcf)	In-Situ States: Water Soluble Sulfates (%)	INDEX DATA: Gravel Content (%)	INDEX DATA: Sand Content (%)	INDEX DATA: Fines Content (%)	INDEX DATA: Liquid Limit (%)	INDEX DATA: Plasticity Index (%)	Strength & Compressibility: UCS (psf)	Strength & Compressibility: Swell Pressure (psf)	Strength & Compressibility: Swell Percent (%)
30							brown, wet, PID= 3 ppm.												
							32.0 ft.												
							COARSE ALLUVIUM Cobbles and gravel inferred based on drilling action at 32'.												
35	5060		18 28	12			Poorly graded SAND with silt and gravel (SP-SM), mostly fine to coarse sand, little fine to coarse gravel, few silt, dense, pale olive, wet, maximum particle size 2.0-inches, PID=6 ppm.												
							Cobbles and gravel inferred based on drilling action at 37'.												
	5055		11 12	4			As above except trace gravel, medium dense, PID=2 ppm.												
40							40.0 ft.												
							END OF EXPLORATION												
45	5050																		
50	5045																		
55	5040																		
60	5035																		

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/24/22	0-days	20.0-feet

BORING: CHM-2

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/24/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Modified California
Sampler Diameter(s): 2.0-inches

LITHOS ENGINEERING

Boring Location: 39.853406, -104.939981
Boring Elevation: 5,094' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**ASPHALT PAVEMENT- 7" thick**												
			13 8	10			0.6 ft. **FILL** Clayey SAND with gravel (SC), mostly fine to medium sand, little fine gravel, little clay, medium dense, dark brown, moist, PID=5 ppm.												
			6 6	10			1.3' - LEAN CLAY with sand (CL), little fine to medium sand, trace fine to coarse gravel, stiff, dark brown to black, moist, black organic debris.												
	5090		3 3	10			2.5' - As above except few fine gravel, stiff, dark brown, moist, PID=6 ppm.							39.3	32	11			
5							4' - Clayey SAND (SC), mostly fine to coarse sand, some clay, few fine gravel, loose, dark gray to black, asphalt fragment, PID= 7 ppm.												
	5085		3 5	10			As above except dark gray, maximum particle size 1.0-inch, PID=28 ppm.												
10							Cobbles and gravel inferred based on drilling action from 12-13'.												
	5080		8 13	12			Clayey SAND with gravel (SC), mostly fine to coarse sand, some clay, little fine gravel, medium dense, dark gray, moist, clear plastic debris present, PID=8 ppm.												
15																			
	5075		8 9	12			Silty SAND (SM), mostly fine to coarse sand, little silt, trace fine gravel, medium dense, dark gray, moist, PID=7 ppm.	(20.8 ft.)						20.2	29	6			
20																			
	5070		6 14	12			24.0 ft. **COARSE ALLUVIUM** Poorly graded SAND (SP), mostly fine to coarse sand, trace fine to coarse gravel, medium dense, pale olive, wet, maximum particle size 2.0-inches, PID= 5 ppm.												
25																			
	5065		8 13	12			29' - Lean clay interlayer 6" thick, PID=11 ppm.												
30																			

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/24/22	0-days	20.8-feet

BORING: CHM-2

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/24/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Modified California
Sampler Diameter(s): 2.0-inches

LITHOS ENGINEERING

Boring Location: 39.853406, -104.939981
Boring Elevation: 5,094' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results: In-Situ States: Moisture Content (%)	In-Situ States: Dry Unit Weight (pcf)	In-Situ States: Water Soluble Sulfates (%)	INDEX DATA: Gravel Content (%)	INDEX DATA: Sand Content (%)	INDEX DATA: Fines Content (%)	INDEX DATA: Liquid Limit (%)	INDEX DATA: Plasticity Index (%)	Strength & Compressibility: UCS (psf)	Strength & Compressibility: Swell Pressure (psf)	Strength & Compressibility: Swell Percent (%)
30							Silty SAND (SM), mostly fine sand, little silt, yellowish brown, wet.												
							Cobbles and gravel 33'												
	5060		13 27	12			Well-graded SAND with silt and gravel (SW-SM), mostly fine to coarse sand, little fine to coarse gravel, few silt, dense, pale olive, wet, maximum particle size 1.5-inches, PID=4 ppm.					25.7	67.8	6.5					
35																			
	5055		18 26	12			As above except PID=12 ppm.												
40							40.0 ft.												
							END OF EXPLORATION												
45	5050																		
50	5045																		
55	5040																		
60	5035																		

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/24/22	0-days	20.8-feet

BORING: CHM-3

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Elite Drilling Services
Lithos Representative: J. Halverson
Date(s) of Drilling: 11/16/22

Drilling and Sampling Methods

Drill Make and Model: Mobile 48X
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Mod. Cal., SPT
Sampler Diameter(s): 2.0-inches, 1.4-inches

LITHOS ENGINEERING

Boring Location: 39.853414, -104.940086
Boring Elevation: 5,095' +/-
Notes: Elevation estimated based on provided site topo

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration
0	5095						**PAVEMENT SECTION- AC= 1.5", ABC= 3"**	
							0.4 ft.	
			5 7	11			**FILL** 0.4' - Poorly graded SAND with silt and gravel (SP-SM), mostly fine to coarse sand, little fine gravel, few silt, loose, yellowish brown, moist. 1.3' - Sandy FAT CLAY (CH), some fine to medium sand, trace fine gravel, stiff, dark blueish gray, moist. 4.5'- As above except some fine to coarse sand, medium stiff, mottled greenish gray to blueish gray.	
5	5090		3 3	6				
10	5085		6 7	7			Sandy LEAN CLAY with gravel (CL), some fine to coarse sand, little fine to coarse gravel, stiff, greenish gray, moist, medium plasticity, maximum particle size 1.5-inches.	
15	5080		7 8	9			As above except mottled dark blueish gray to greenish gray to black, organics, wood chunks.	
20	5075		4 11	11			As above, organics, wood chunks, trash present. 20'- Clayey SAND with gravel (SC), mostly fine to coarse sand, some clay, little fine gravel, medium dense, greenish gray, moist.	(23-0.0
25	5070							
							27.0 ft.	
							COARSE ALLUVIUM Drilling smoothed out indicative of material transition.	
30	5065		12 15	18			Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, little fine gravel, few clay, medium dense, pale olive, wet.	

Laboratory Testing Results

Depth (ft)	In-Situ States: Moisture Content (%)	In-Situ States: Dry Unit Weight (pcf)	In-Situ States: Water Soluble Sulfates (%)	INDEX DATA: Gravel Content (%)	INDEX DATA: Sand Content (%)	INDEX DATA: Fines Content (%)	INDEX DATA: Liquid Limit (%)	INDEX DATA: Plasticity Index (%)	Strength & Compressibility: UCS (psi)	Strength & Compressibility: Swell Pressure (psf)	Strength & Compressibility: Swell Percent (%)
5						66.2	56	36			

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
11/16/22	0-days	23-feet

BORING: CHM-3

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Elite Drilling Services
Lithos Representative: J. Halverson
Date(s) of Drilling: 11/16/22

Drilling and Sampling Methods

Drill Make and Model: Mobile 48X
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Mod. Cal., SPT
Sampler Diameter(s): 2.0-inches, 1.4-inches

LITHOS ENGINEERING

Boring Location: 39.853414, -104.940086
Boring Elevation: 5,095' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
							31' - Auger grinding; cobbles.												
35	5060		19 27 36	7			Clayey SAND with gravel (SC), mostly fine to coarse sand, some fine to coarse gravel, little clay, very dense, pale olive, wet, maximum particle size 1.5-inches.												
40	5055		3 5 9	4			Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, little fine to coarse gravel, few clay, medium dense, pale olive, wet, maximum particle size 1.25-inches.												
							42.0 ft.												
							DENVER FORMATION Drilling difficulty increase indicative of material transition.												
45	5050		50/6"	7			Sandstone, very soft, fresh, blueish gray, mostly fine sand, some silt, mica grains, moist.							32.8					
50	5045		50/6"	7			As above except dark blueish gray to gray, claystone present at tip of sample.							40.3	NV	NP			
55	5040		50/6"	2			As above except greenish gray, some clay.		17.8		0.0								
60	5035		50/4"	6			Claystone, very soft, fresh, dark blueish gray to gray, few fine sand.							93.9	45	22			

Sampling Data

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Laboratory Testing Results

In-Situ States | INDEX DATA | Strength & Compressibility

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
11/16/22	0-days	23-feet

BORING: CHM-3

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Elite Drilling Services
Lithos Representative: J. Halverson
Date(s) of Drilling: 11/16/22

Drilling and Sampling Methods

Drill Make and Model: Mobile 48X
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Mod. Cal., SPT
Sampler Diameter(s): 2.0-inches, 1.4-inches

LITHOS ENGINEERING

Boring Location: 39.853414, -104.940086
Boring Elevation: 5,095' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		In-Situ States			INDEX DATA						Strength & Compressibility		
65	5030		50/4"	4			As above except trace fine sand.		14.1	112.8				96.9	46	23		4,000	2.1
70	5025		50/6"	6			As above except trace fine sand.												
75	5020		50/6"	7			Siltstone, very soft, fresh, dark blueish gray to gray, trace fine sand. 75.0 ft. **END OF EXPLORATION**		14.4	118.4				96.9	45	18		17,560	5.2
80	5015																		
85	5010																		
90	5005																		

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
11/16/22	0-days	23-feet

BORING: VLT-1

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/25/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Modified California
Sampler Diameter(s): 2.0-inches

LITHOS ENGINEERING

Boring Location: 39.854547, -104.939167
Boring Elevation: 5,082' +/-
Notes: Elevation estimated based on provided site topo

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0	5080		13 16	10			**FILL** Sandy LEAN CLAY (CL), some fine to medium sand, very stiff, olive brown, dry to moist, roots, glass, PID=78 ppm.													
5	5075		4 4	5			As above except medium stiff, moist, PID=11 ppm. 4.8 ft. **COARSE ALLUVIUM** Poorly graded SAND with silt (SP-SM), mostly fine to coarse sand, few fine gravel, few silt, loose, pale olive, moist.													
10	5070		2 2	12			As above except very loose, PID=33 ppm. 9.5 ft. **FINE ALLUVIUM** Sandy SILT (ML), little fine sand, very loose, olive brown, wet.	10.6 ft. 13.8 ft.			0.017									
15	5065		5 7	10			14.0 ft. **COARSE ALLUVIUM** Poorly graded SAND with gravel (SP), mostly fine to coarse sand, little fine to coarse gravel, trace silt, loose, pale olive, wet, maximum particle size 2.0-inches, PID=70 ppm.													
20	5060		6 9	8			Silty SAND (SM), mostly fine to coarse sand, few to little silt, trace gravel, medium dense, pale olive to olive, wet, PID=45 ppm.					0.2	86.3	13.5	NV	NP				
25	5055		16 28	8			As above except few fine gravel, PID=7 ppm.													
30			35 50/3"	4			Driller notes increase in drilling difficulty at 28'. 28.0 ft. **DENVER FORMATION** Claystone, soft, fresh, dark greenish gray, PID=4 ppm.													

Sampling Data | Laboratory Testing Results | In-Situ States | INDEX DATA | Strength & Compressibility

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/25/22	0-days	13.8-feet
2/14/22	3 weeks	10.6-feet

BORING: VLT-1

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/25/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Modified California
Sampler Diameter(s): 2.0-inches

LITHOS ENGINEERING

Boring Location: 39.854547, -104.939167
Boring Elevation: 5,082' +/-
Notes: Elevation estimated based on provided site topo

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration
30	5050							
35	5045		50/3"	3			As above, PID=6 ppm.	
40	5040		50/5"	4			As above, PID=3 ppm.	
							39.4 ft.	
							END OF EXPLORATION	
45	5035							
50	5030							
55	5025							
60								

Laboratory Testing Results

In-Situ States			INDEX DATA					Strength & Compressibility		
Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/25/22	0-days	13.8-feet
2/14/22	3 weeks	10.6-feet

BORING: VLT-2

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/25/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Mod. Cal., SPT
Sampler Diameter(s): 2.0-inches, 1.4-inches

LITHOS ENGINEERING

Boring Location: 39.854247, -104.939283
Boring Elevation: 5,082' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0	5080		7 18	12			**FILL** Sandy LEAN CLAY with gravel (CL), some fine to medium sand, little fine gravel, very stiff, olive brown, moist, roots, PID<2 ppm.												
							3.0 ft.												
5	5075		5 7	10			**COARSE ALLUVIUM** Well-graded SAND with silt and gravel (SW-SM), mostly fine to coarse sand, little fine gravel, few silt, loose, pale olive, moist, maximum particle size 0.75-inches, PID=88 ppm.												
10	5070		5 6 6	12			As above except wet, maximum particle size 1.25-inches, PID<2 ppm.					44.9	48.7	6.4					
								(13.9 ft.)											
15	5065		8 11	8			Poorly graded SAND with silt (SP-SM), mostly fine to medium sand, few silt, trace fine gravel, medium dense, olive, wet, PID=3 ppm.							5.5					
20	5060		3 4 3	18			As above except loose, PID<2 ppm.												
25	5055		6 8 12	14			Poorly graded SAND (SP), mostly fine to coarse sand, trace silt, trace fine gravel, medium dense, pale olive, wet, PID=33 ppm.												
							28.0 ft.												
30			20 50	10			**DENVER FORMATION** Sandstone, soft, fresh, dark greenish gray, mostly fine sand,												

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/25/22	0-days	13.9-feet

BORING: VLT-2

Project Name: TWP Booster and Hammer PS
Project Number: 21207
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Vine Laboratories
Lithos Representative: J. Halverson
Date(s) of Drilling: 01/25/22

Drilling and Sampling Methods

Drill Make and Model: CME-55
Drilling Method: Hollow Stem Auger (HSA)
Bit Type: Cutting Head
Casing Description: HSA
Hammer Weight (lbs)/Fall (in): 140/30
Sampler Type(s): Mod. Cal., SPT
Sampler Diameter(s): 2.0-inches, 1.4-inches

LITHOS ENGINEERING

Boring Location: 39.854247, -104.939283
Boring Elevation: 5,082' +/-
Notes: Elevation estimated based on provided site topo

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
							Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions. Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		In-Situ States			INDEX DATA					Strength & Compressibility		
30	5050						some lean clay, PID=2 ppm.												
35	5045		50/5"	5			As above.		16.3	110.8				31.0	42	18		6,370	3.7
40	5040		50/5"	4			As above, PID=3 ppm. 39.4 ft. **END OF EXPLORATION**												
45	5035																		
50	5030																		
55	5025																		
60																			

General Notes:
1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
01/25/22	0-days	13.9-feet

LITHOS ENGINEERING

APPENDIX – B

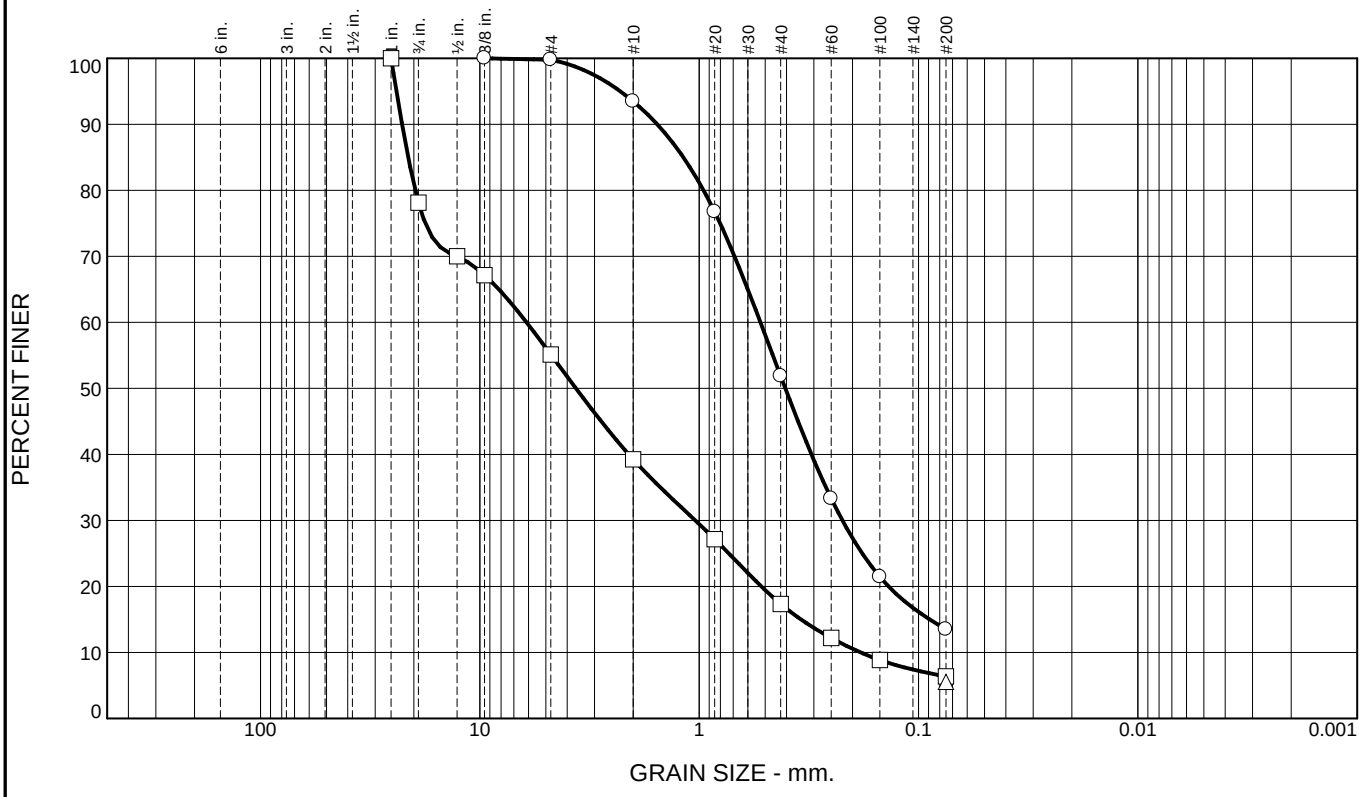
Geotechnical Laboratory Testing Results

Geotechnical Laboratory Testing Results													
Sample Identification		In-Place States		Sulfates	Material Classification and Index Testing					Stress Strain Behavior		USCS Classification [1,2]	Description
					Particle Size Distribution			Atterberg Limits (%)		One-Dimensional Swell/Consolidation			
Boring	Sample Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Water Soluble Sulfates (%)	Gravel (%)	Sand (%)	Fines (%)	Liquid Limit	Plasticity Index	Swell (%)	Swell Pressure (psf)		
VLT-1	19.0 - 20.0				0.2	86.3	13.5	NV	NP			SM	Silty SAND
VLT-2	9.0 - 10.0				44.9	48.7	6.4					SP-SM	Poorly Graded SAND with Silt and Gravel
VLT-2	14.0 - 15.0						5.5					SP-SM	Poorly Graded SAND with Silt
VLT-2	34.0 - 34.4	16.3	110.8				31.0	42	18	3.7	6,370	BR	Clayey Sandstone
CHM-1	4.0 - 5.0						35.5	28	7			SC-SM	Silty, Clayey SAND
CHM-1	9.0 - 10.0						68.6	39	15			CL	Sandy LEAN CLAY
CHM-1	19.0 - 20.0				39.5	55.8	4.7					SW	Well-Graded SAND with Gravel
CHM-2	4.0 - 5.0						39.3	32	11			SC	Clayey SAND
CHM-2	19.0 - 20.0						20.2	29	6			SM	Silty SAND
CHM-2	34.0 - 35.0				25.7	67.8	6.5					SW-SM	Well-Graded SAND with Silt and Gravel
CHM-3	4.5-5.5						66.2	56	36			CH	Sandy FAT CLAY
CHM-3	44.5-45.0						32.8					BR	Sandstone
CHM-3	49.5-50.0						40.3	NV	NP			BR	Sandstone
CHM-3	54.5-55.5	17.8		0.0								BR	Sandstone
CHM-3	59.5-59.8						93.9	45	22			BR	Claystone
CHM-3	64.5-64.8	14.1	112.8				96.9	46	23	2.1	4,000	BR	Claystone
CHM-3	74.5-75.0	14.4	118.4				96.9	45	18	5.2	17,560	BR	Siltstone

[1] Where Atterberg Limits and fines content testing were not performed, USCS classifications were visually determined in the field during the subsurface investigation

[2] "BR" is used in place of USCS classifications for bedrock

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	0.2	86.3	13.5		SM	NV	NP	NP
□	0.0	44.9	48.7	6.4					
△									

SIEVE inches size	○	□	△
1"		100.0	
3/4"		78.1	
1/2"		70.0	
3/8"	100.0	67.1	
GRAIN SIZE			
D_{60}	0.5257	6.1238	
D_{30}	0.2224	1.0421	
D_{10}		0.1835	
COEFFICIENTS			
C_c		0.97	
C_u		33.37	

SIEVE number size	○	□	△
#4	99.8	55.1	
#10	93.5	39.3	
#20	76.7	27.2	
#40	51.9	17.3	
#60	33.3	12.2	
#100	21.5	8.8	
#200	13.5	6.4	5.5

Material Description
○ USCS: silty sand

□

△

REMARKS:
○

□

△

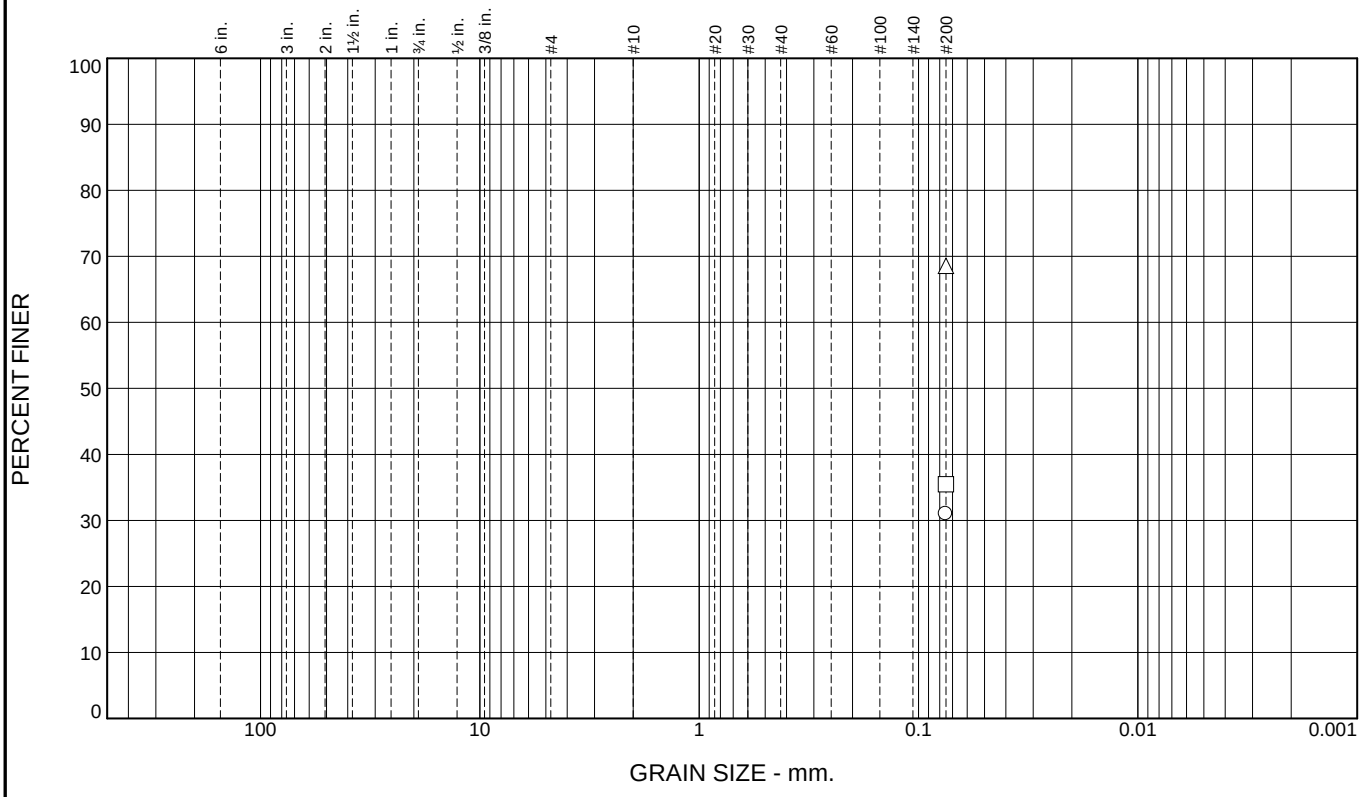
○ Location: VLT-1 Depth: 19-20' Sample Number: 10638
□ Location: VLT-2 Depth: 9-10' Sample Number: 10639
△ Location: VLT-2 Depth: 14-15' Sample Number: 10640

Martinez Associates

Client: Lithos Engineering
Project: Thornton Water Project Chem Building & Vaults
LE Project # 21207
Project No.: 21-0198

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							42	24	18
□							28	21	7
△							39	24	15

SIEVE inches size	PERCENT FINER ○	□	△
	GRAIN SIZE		
D_{60}			
D_{30}			
D_{10}			
	COEFFICIENTS		
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#200	31.0	35.5	68.6

Material Description
○
□
△

REMARKS:
○
□
△

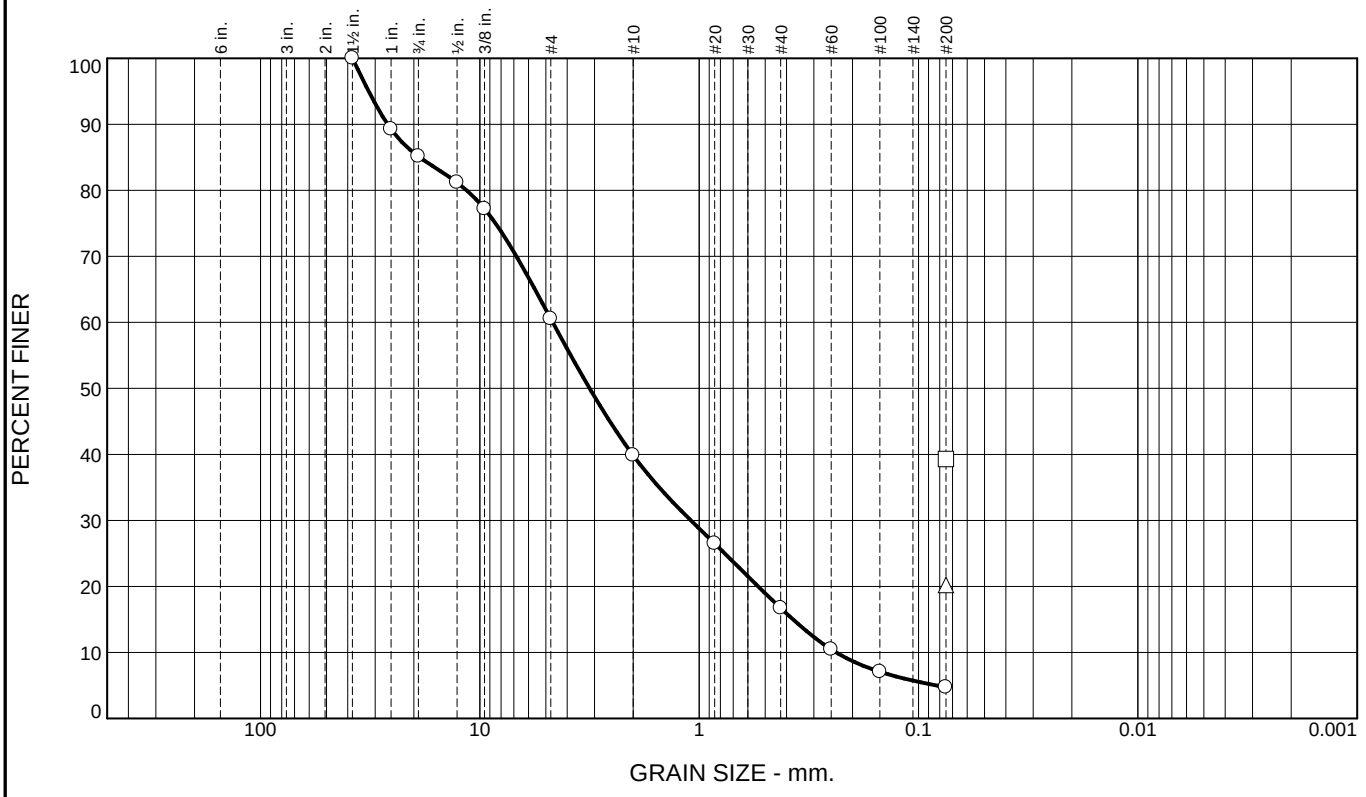
○ Location: VLT-2 Depth: 34-34.4' Sample Number: 10641
□ Location: CHM-1 Depth: 4-5' Sample Number: 10642
△ Location: CHM-1 Depth: 9-10' Sample Number: 10643

Martinez Associates

Client: Lithos Engineering
Project: Thornton Water Project Chem Building & Vaults
LE Project # 21207
Project No.: 21-0198

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	39.5	55.8	4.7		SW			
□							32	21	11
△							29	23	6

SIEVE inches size	PERCENT FINER ○	□	△
1.5"	100.0		
1"	89.3		
3/4"	85.1		
1/2"	81.2		
3/8"	77.2		
	GRAIN SIZE		
D_{60}	4.6545		
D_{30}	1.0909		
D_{10}	0.2373		
	COEFFICIENTS		
C_c	1.08		
C_u	19.61		

SIEVE number size	PERCENT FINER ○	□	△
#4	60.5		
#10	39.9		
#20	26.5		
#40	16.7		
#60	10.5		
#100	7.1		
#200	4.7	39.3	20.2

Material Description

○ USCS: well-graded sand with gravel

□

△

REMARKS:

○

□

△

○ Location: CHM-1 Depth: 19-20' Sample Number: 10644

□ Location: CHM-2 Depth: 4-5' Sample Number: 10645

△ Location: CHM-2 Depth: 19-20' Sample Number: 10646

Martinez Associates

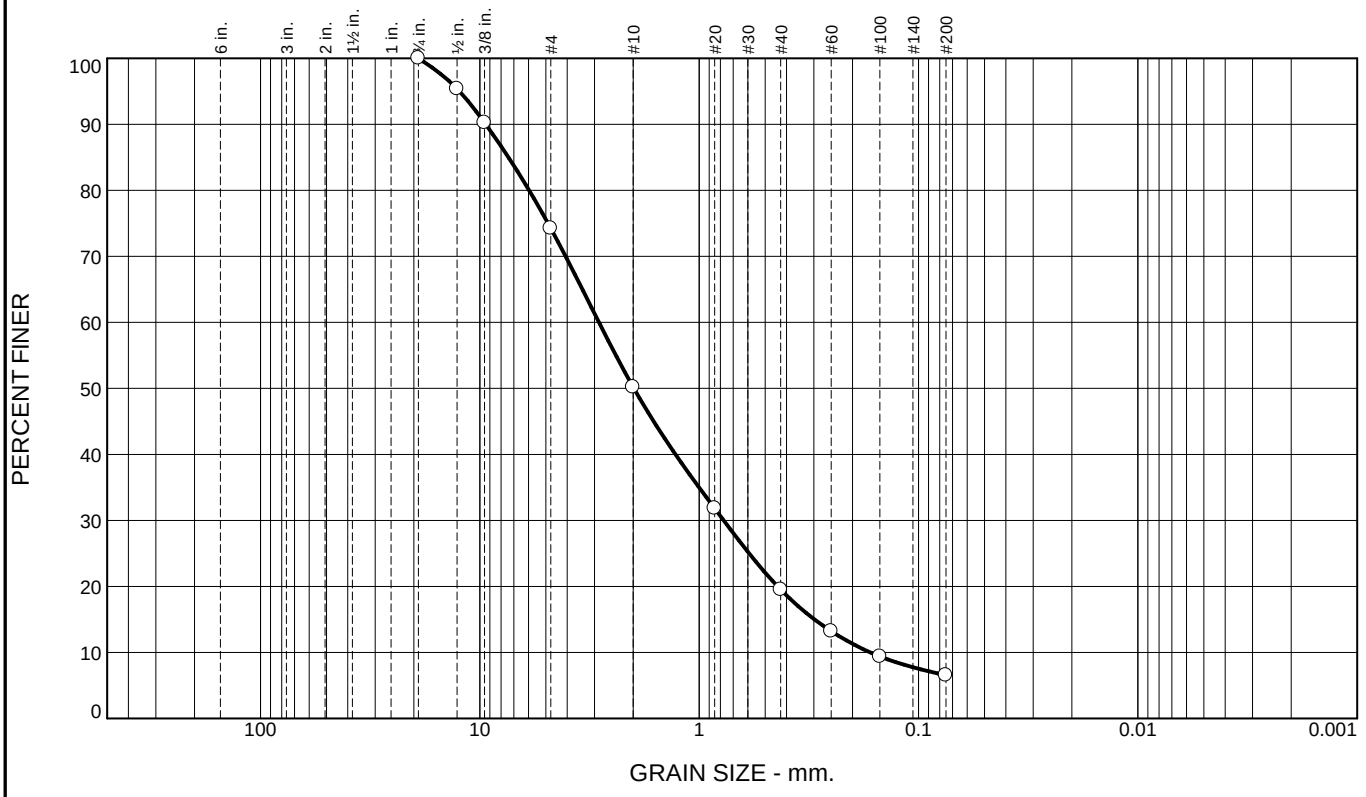
Client: Lithos Engineering

Project: Thornton Water Project Chem Building & Vaults
LE Project # 21207

Project No.: 21-0198

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	25.7	67.8	6.5					

SIEVE inches size	PERCENT FINER ○		
3/4"	100.0		
1/2"	95.4		
3/8"	90.3		
	GRAIN SIZE		
D_{60}	2.8635		
D_{30}	0.7735		
D_{10}	0.1660		
	COEFFICIENTS		
C_c	1.26		
C_u	17.25		

SIEVE number size	PERCENT FINER ○		
#4	74.3		
#10	50.2		
#20	31.8		
#40	19.5		
#60	13.2		
#100	9.4		
#200	6.5		

Material Description
○

REMARKS:
○

○ Location: CHM-2 Depth: 34-35' Sample Number: 10647

Martinez Associates

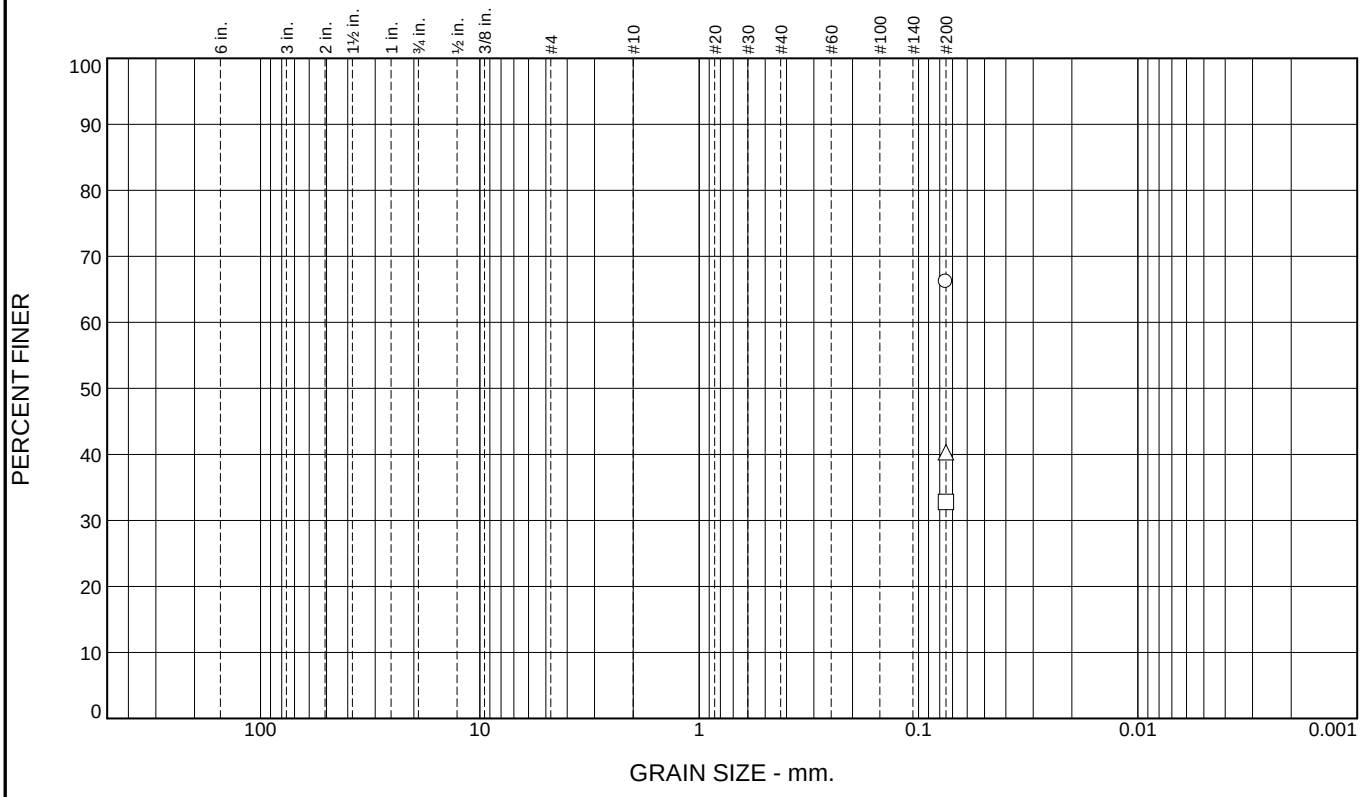
Client: Lithos Engineering

Project: Thornton Water Project Chem Building & Vaults
LE Project # 21207

Project No.: 21-0198

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							56	20	36
□									
△							NV	NP	NP

SIEVE inches size	PERCENT FINER ○	□	△
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#200	66.2	32.8	40.3

Material Description
○
□
△

REMARKS:
○
□
△

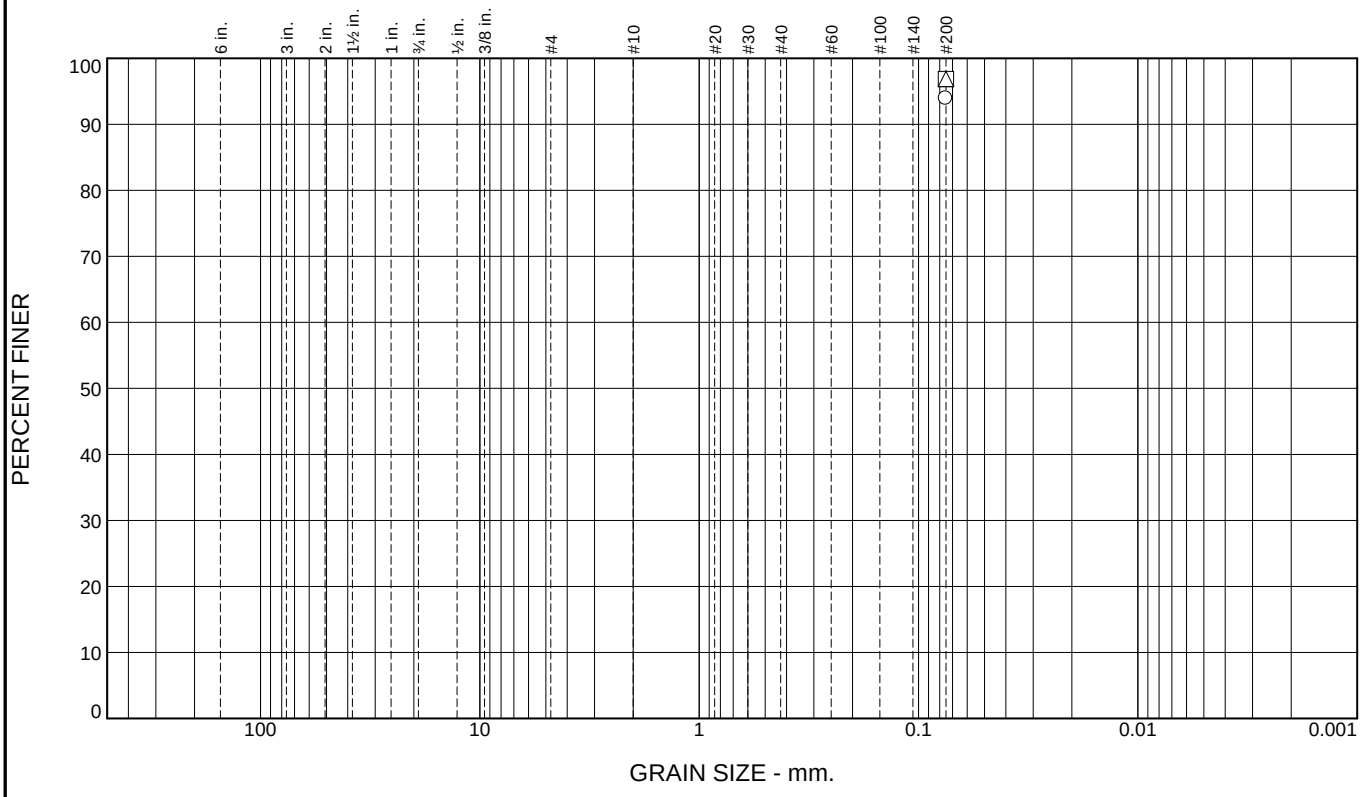
○ Location: CHM-3 Depth: 4.5-5.5' Sample Number: 11436
□ Location: CHM-3 Depth: 44.5-45' Sample Number: 11437
△ Location: CHM-3 Depth: 49.5-50' Sample Number: 11438

Martinez Associates

Client: Lithos Engineering
Project: Thornton Water Project Chem Building & Vaults
LE Project # 21207
Project No.: 21-0198

Figure

Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							45	23	22
□							46	23	23
△							45	27	18

SIEVE inches size	PERCENT FINER ○	□	△
GRAIN SIZE			
D_{60}			
D_{30}			
D_{10}			
COEFFICIENTS			
C_c			
C_u			

SIEVE number size	PERCENT FINER ○	□	△
#200	93.9	96.9	96.9

Material Description
○
□
△

REMARKS:
○
□
△

○ Location: CHM-3 Depth: 59.5-60' Sample Number: 11440
□ Location: CHM-3 Depth: 64.5-65' Sample Number: 11440.5
△ Location: CHM-3 Depth: 74.5-75' Sample Number: 11441.5

Martinez Associates

Client: Lithos Engineering
Project: Thornton Water Project Chem Building & Vaults
LE Project # 21207
Project No.: 21-0198

Figure

Martinez Associates
14828 West 6th Avenue, Unit 9-B
Golden, Colorado 80401
Phone: (303) 459-2216
Fax: (303) 482-2230

Martinez Associates

One Dimensional Swell/Consolidation (ASTM D 4546)

(Denver Area Swell/Consolidation Test)

Client Project No.:	21207	Proj. Name:	Thornton Water Project Chem Bldg & Vaults	Sampled By:	LE
Martinez Job No.:	21-0198	Lab Tech:	T. Reid	Test Date: 2/1/22	Sample Date: NP
Sample ID:	10641				Reviewed By: K. Runner
Sample Location:	VLT-2 at 34-34.4'				
Soil Description:					
USCS:					

Sample Data:

Ring No:	E	Dish No:	54
Ring Mass (g):	237.8	Dish Mass (g):	8.2
Sample Height (in):	0.75	Swell Machine #:	5

Pre-test Sample		Post-test Sample	
Ring + Sample (g):	312.5	Ring + Sample (g):	313.6
Dish wt:	8.2	Dish wt:	8.6
Wet wt (g):	356.9	Wet wt (g):	84.5
Dry wt (g):	308.0	Dry wt (g):	71.1

Results:

Pre-test Sample		Post-test Sample	
Moisture Content:	16.3%	Moisture Content:	21.4%
Wet Density (pcf):	128.9	Wet Density (pcf):	132.4
Dry Density (pcf):	110.8	Dry Density (pcf):	109.1

Swell/Consolidation

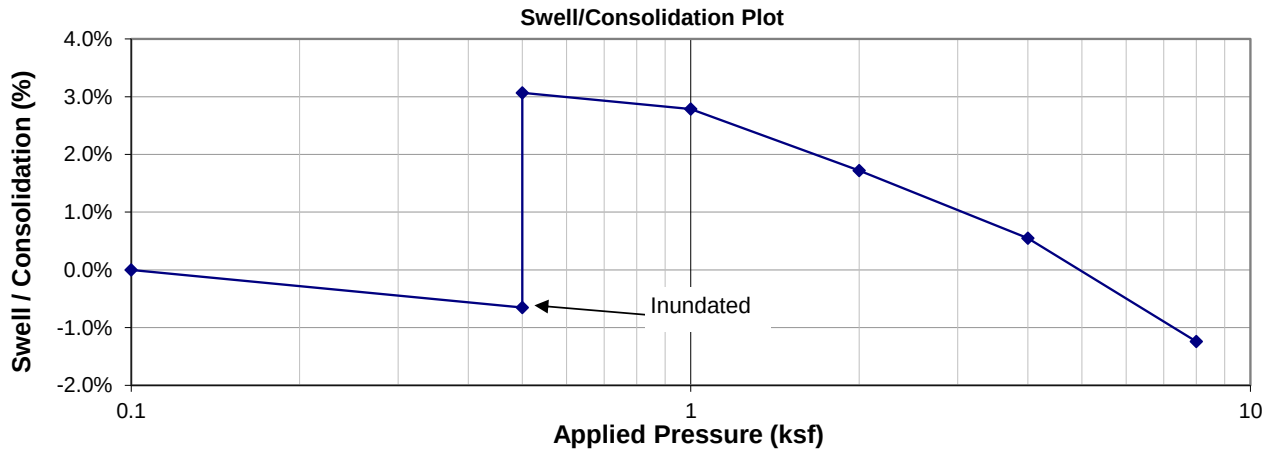
Load (ksf):	0.1	0.5	Add Water	0.5	1	2	4	8	
Correction (x 10-4):	0	14		14	32	65	94	119	
Dial Reading (x 10-4):	2922	2859		3138	3099	2986	2869	2710	
Swell/Consolidation %:	**0.0%**	**-0.7%**		**3.1%**	**2.8%**	**1.7%**	**0.5%**	**-1.2%**	

Results:

Swell Upon Wetting @ 500 psf: **3.7%**

Swell Pressure (psf): **6,370**

Tested By: T. Reid
Checked By K. Runner



Martinez Associates
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Phone: (303) 459-2216
Fax: (303) 482-2230

Martinez Associates

One Dimensional Swell/Consolidation (ASTM D 4546)

(Denver Area Swell/Consolidation Test)

Client Project No.:	21207	Proj. Name:	Thornton Water Project Chem Building & Vaults	Sampled By:	LE
Martinez Job No.:	21-0198	Lab Tech:	WSG	Test Date:	11/22/22	Sample Date:	NP
Sample ID:	11440.5					Reviewed By:	K. Runner
Sample Location:	CHM-3 64.5-65'						
Soil Description:							
USCS:							

Sample Data:

Ring No:	G	Dish No:	16
Ring Mass (g):	237.30	Dish Mass (g):	8.00
Sample Height (in):	0.75	Swell Machine #:	7

Pre-test Sample		Post-test Sample	
Ring + Sample (g):	311.90	Ring + Sample (g):	314.10
Dish wt:	8.00	Dish wt:	8.08
Wet wt (g):	337.30	Wet wt (g):	84.38
Dry wt (g):	296.50	Dry wt (g):	72.83

Results:

Pre-test Sample		Post-test Sample	
Moisture Content:	14.1%	Moisture Content:	17.8%
Wet Density (pcf):	128.7	Wet Density (pcf):	135.2
Dry Density (pcf):	112.8	Dry Density (pcf):	114.7

Swell/Consolidation

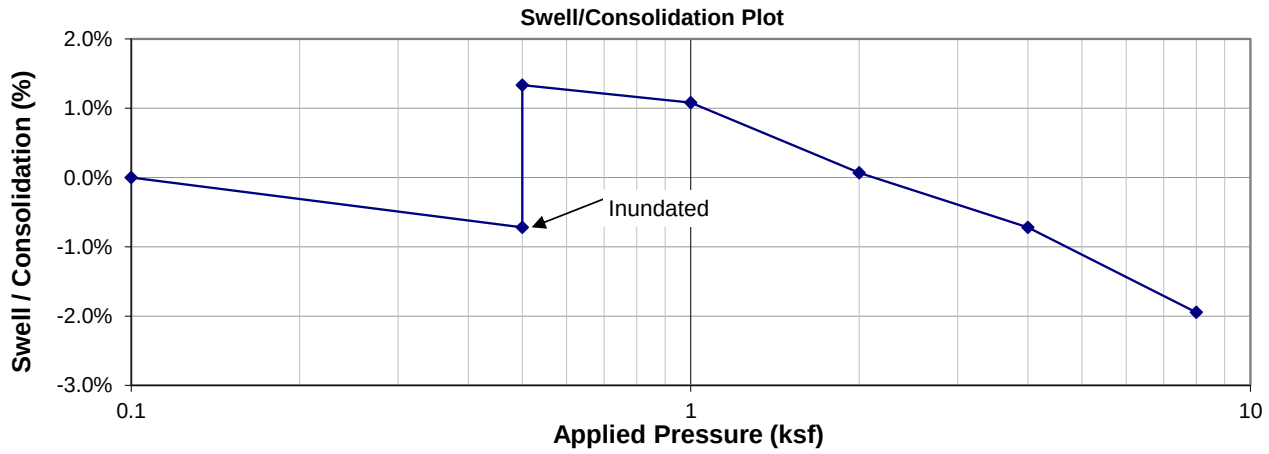
Load (ksf):	0.1	0.5	Add Water	0.5	1	2	4	8
Correction (x 10-4):	0	20		20	36	59	76	95
Dial Reading (x 10-4):	2382	2308		2462	2427	2328	2252	2141
Swell/Consolidation %:	**0.0%**	**-0.7%**		**1.3%**	**1.1%**	**0.1%**	**-0.7%**	**-1.9%**

Results:

Swell Upon Wetting @ 500 psf: **2.1%**

Swell Pressure (psf): **4,000**

Tested By: WS Greer
Checked By K. Runner



Martinez Associates
14828 West 6th Avenue, Unit 9-B
Golden, Colorado 80401
Phone: (303) 459-2216
Fax: (303) 482-2230

Martinez Associates

One Dimensional Swell/Consolidation (ASTM D 4546)

(Denver Area Swell/Consolidation Test)

Client Project No.: 21207 Proj. Name: Thornton Water Project Chem Building & Vaults Sampled By: LE
Martinez Job No.: 21-0198 Lab Tech: WSG Test Date: 11/22/22 Sample Date:
Sample ID: 11441.5 Reviewed By: K. Runner
Sample Location: CHM-3 74.5-75'
Soil Description:
USCS:

Sample Data:

Ring No:	H	Dish No:	48
Ring Mass (g):	236.80	Dish Mass (g):	8.00
Sample Height (in):	0.75	Swell Machine #:	8

Pre-test Sample		Post-test Sample	
Ring + Sample (g):	315.30	Ring + Sample (g):	317.20
Dish wt:	8.00	Dish wt:	8.09
Wet wt (g):	359.20	Wet wt (g):	87.90
Dry wt (g):	315.00	Dry wt (g):	76.03

Results:

Pre-test Sample		Post-test Sample	
Moisture Content:	14.4%	Moisture Content:	17.5%
Wet Density (pcf):	135.5	Wet Density (pcf):	141.7
Dry Density (pcf):	118.4	Dry Density (pcf):	120.6

Swell/Consolidation

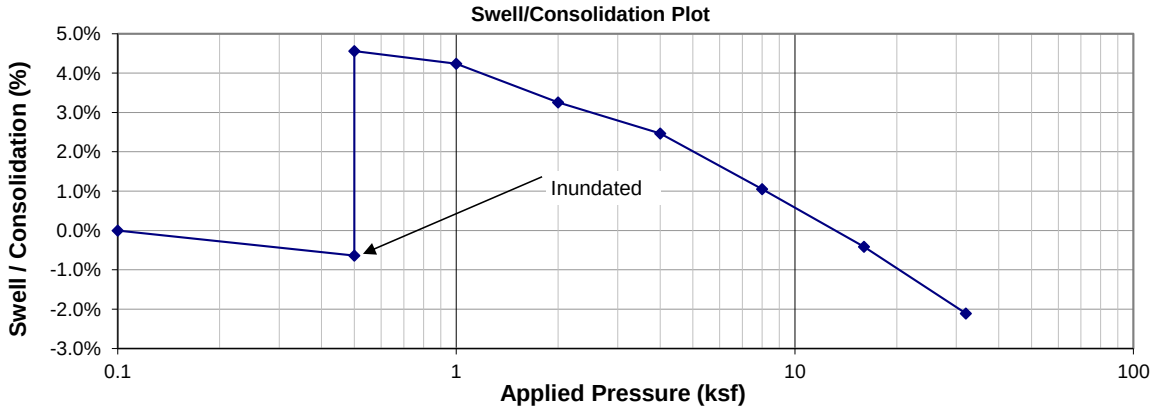
Load (ksf):	0.1	0.5	Add Water	0.5	1	2	4	8	16	32
Correction (x 10-4):	0	12		12	27	46	68	87	114	144
Dial Reading (x 10-4):	2821	2761		3151	3112	3019	2938	2813	2676	2519
Swell/Consolidation %:	**0.0%**	**-0.6%**		**4.6%**	**4.2%**	**3.3%**	**2.5%**	**1.1%**	**-0.4%**	**-2.1%**

Results:

Swell Upon Wetting @ 500 psf: **5.2%**

Swell Pressure (psf): **17,560**

Tested By: WS Greer
Checked By K. Runner



Martinez Associates

Water Soluble Sulfates/Colorado Procedure- Laboratory 2103 (Method B)

Project:	Thornton Water Project Chem Building & Vaults	**Date:**	12/1/2022
Sample Location:	CHM-3 at 54.5-55'	**Client Job No.:**	21207
Lab ID Number:	11439	**Martinez Job No.:**	21-0198
Soil Description:		**Lab Technician:**	R. Kay
		Reviewed by:	K. Runner

Sample Flask ID:	B
Date Test Set Up:	11/21/2022
Date in Solution:	11/21/2022
Date of Test:	11/22/2022

A	Number of Dilutions	2	
B	Final Dilution	100	:1
C	Reading	0	mg/L
C.1	Corrected Reading	0	mg/L
D	Sulfate Concentration ; D=(BxC.1)	0	ppm
E	Percent Sulfate Concentration E=D/10,000	0	%

Moisture Content

Dish ID:	25
Dish Mass (g):	8.3
Mass of Wet Soil+Dish (g):	217.7
Mass of DrySoil+Dish (g):	186.1
Moisture Content:	17.8%

LITHOS ENGINEERING

APPENDIX – C

Laboratory Corrosion Results

Results Only Soil Testing for Thornton Water Project Chemical Building & Vaults

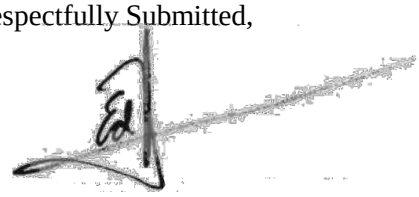
February 7, 2022

Prepared for:

Derek Magnuson
Lithos Engineering
2750 S. Wadsworth Blvd, Suite D-200
Denver, CO 80227
derek@lithoseng.com

Project X Job#: S220203E
Client Job or PO#: 21207, Task 1.3.7

Respectfully Submitted,



Eduardo Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com

Soil Analysis Lab Results

Client: Lithos Engineering
Job Name: Thornton Water Project Chemical Building & Vaults
Client Job Number: 21207, Task 1.3.7
Project X Job Number: S220203E
February 7, 2022

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM G51	ASTM G200	SM 4500-D	ASTM D4327	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D6919	ASTM D4327	ASTM D4327
Bore# / Description	**Depth**	**Sulfates** SO_4^{2-}		**Chlorides** Cl^-		**Resistivity** As Rec'd | Minimum		**pH**	**Redox**	**Sulfide** S^{2-}	**Nitrate** NO_3^-	**Ammonium** NH_4^+	**Lithium** Li^+	**Sodium** Na^+	**Potassium** K^+	**Magnesium** Mg^{2+}	**Calcium** Ca^{2+}	**Fluoride** F_2^{--}	**Phosphate** PO_4^{3-}
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)		(mV)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
VLT-1 Soil	9-10	165.5	0.0166	75.3	0.0075	2,077	2,077	7.9	110	0.27	0.3	3.2	0.02	158.9	4.1	15.0	6.5	7.1	1.0
CHM-1 Soil	2.5-3.5	295.9	0.0296	404.0	0.0404	804	670	8.0	121	0.03	1.0	6.4	0.07	275.0	3.2	23.4	2.2	7.2	0.5

Cations and Anions, except Sulfide and Bicarbonate, tested with Ion Chromatography
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
ND = 0 = Not Detected | NT = Not Tested | Unk = Unknown
Chemical Analysis performed on 1:3 Soil-To-Water extract
PPM = mg/kg (soil) = mg/L (Liquid)

Project X
Corrosion Engineering
Corrosion Control - Soil, Water, and Metallurgy Lab

Lab Request Sheet Chain of Custody
Phone: (213) 928-7213 · Fax (951) 226-1720 · www.projectxcorrosion.com

Ship Samples To: 29990 Technology Dr, Suite 13, Murrieta, CA 92563

Project X Job Number S220203E Lithos 21207 Thornton W 2 Full

IMPORTANT: Please complete Project and Sample Identification Data as you would like it to appear in report & include this form with samples.

Company Name:	Lithos Engineering	**Contact Name:**	Derek Magnuson
Phone No:	510.543.5852		
Mailing Address:	2750 S. Wadsworth Blvd, Suite D-200, Denver, CO 80227	**Contact Email:**	derek@lithoseng.com
Accounting Contact:	Sissy Morphew	**Invoice Email:**	sissy@lithoseng.com
Client Project No:	21207, Task 1.3.7	**Project Name:**	Thornton Water Project Chemical Building & Vaults

P.O. #:

3-5 Day Standard	3 Day Guarantee 50% mark-up	24 Hr RUSH 100% mark-up
(Business Days) Turn Around Time: ✔		

Results By: ☐ Phone ☐ Fax ☐ Email

Date & Received by :

Default Method

Special Instructions:

ANALYSIS REQUESTED (Please circle)

Default Method	Soil Resistivity	pH	Sulfate	Chloride	Redox Potential	Sulfide	Ammonia	Nitrate	Flouride	Phosphate	Lithium	Sodium	Potassium	Magnesium	Calcium	BiCarbonate	Full Corrosion Series	Soil Corrosivity Evaluation Report	Water Corrosivity Mini Report	Moisture Content	Total Alkalinity	Thermal Resistivity	Metallurgical Analysis	Langelier Index	Puckorius Index	XRF Elemental Analysis	Water Hardness
	Caltrans CTM643	Caltrans CTM643	Caltrans CTM417	Caltrans CTM422																							
	AASHTO T288	AASHTO T 289	AASHTO T 290	AASHTO T 291	SM 2580B		SM 4500-NH3	SM 4500-NO3																			
	ASTM G187	ASTM G 51	ASTM D4327	ASTM D4327	ASTM G200	SM 4500-S2	ASTM D4327	ASTM D4327	SM 2320B	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	SM 2320B				ASTM D2216	SM 2320B						
	Full Corrosion Series																	Reports									
	Geo Quad																										

	SAMPLE ID - BORE #	DESCRIPTION	DEPTH (ft)	DATE COLLECTED
1	VLT-1	soil	9-10'	1/25/22
2	CHM-1	soil	2.5-3.5'	1/24/22
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

*Req: Min. 3 Samples, site map, and groundwater info

59
60