July 27, 2021

Mr. Dan Mabey
1715 Canyon Circle
Farmington, Utah 84025

Subject: Geotechnical Engineering Study Preliminary Letter
Mabey Subdivision
About 3685 East 3300 North
Liberty, Weber County, Utah
CMT Project No. 16942

Mr. Mabey:

INTRODUCTION

A geotechnical engineering study is currently underway for the above referenced subdivision. At this time the proposed field work, 7 test pits, have been excavated and soils samples obtained which are presently in our laboratory undergoing testing and further classification/review.

CMT has completed a similar study on the adjacent property directly to the east (Vue de Vahalla Subdivision) in May 2021 (attached). In this study the following, summary of findings, was discussed.

1. The site surface is covered in part with Holocene and upper Pleistocene age lacustrine and alluvial deposits (**Qla**) and part upper Pleistocene age alluvial fan deposits (**Qafb**), as mapped by Utah Geological Survey (UGS) geologist (McDonald, 2020).

2. Topsoil and varying vegetation blanket the surface of the site which must be removed below new structures and pavement.

3. The soils encountered near surface consisted of clayey gravel with some cobbles and occasional boulders.

4. Groundwater was not observed within the depths penetrated (about 10.5 feet) and is expected to be deeper than about 15 feet or more.

During the field work for this Mabey property, we encountered similar gravel with cobble soils containing varying amounts of fines (clay/silt) within the 7 test pits completed.

Pavements

Based on the proximity to the previous referenced study and the subsurface soil conditions observed during the field investigation for this proposed Mabey Subdivision, we anticipate very similar findings, engineering conclusions, and recommendations will be provided in our report as those provided for the study of the adjacent property.

Further, it is anticipated that similar roadway traffic will occur for each subdivision. We understand that an asphalt paved access roadway extension will be part of the development.

We anticipate the natural, surficial gravel soils will exhibit good pavement support characteristics when saturated or nearly saturated. Based on our laboratory testing experience with similar soils, we anticipate our pavement design will utilize a California Bearing Ratio (CBR) of about 15 percent for the natural clayey gravel soils.

Traffic is projected to consist of a light to moderate volume of light weight automobiles and light trucks with a light volume of deliver truck and an occasional heavy weight truck/garbage truck. Given the projected traffic the following pavement sections are recommended for approximately 4 to 5 ESAL's (18-kip equivalent single-axle loads) per day:

MATERIAL	PAVEMENT SECTION THICKNESS (inches)	
Asphalt	**3**	**3**
Road-Base	**8**	**4**
Subbase	**0**	**5**
Total Thickness	**11**	**12**

CLOSURE

We appreciate the opportunity to provide geotechnical services on your project. Please call with any questions at 801-870-6730.

Sincerely,
CMT Engineering Laboratories

Bryan N. Roberts, P.E.
Senior Geotechnical Engineer
Addressee (email)

Reviewed by:

Andrew M. Harris, P.E.
Geotechnical Division Manager

CMT ENGINEERING LABORATORIES

ENGINEERING • GEOTECHNICAL • ENVIRONMENTAL (ESA I & II) • MATERIALS TESTING • SPECIAL INSPECTIONS • ORGANIC CHEMISTRY • PAVEMENT DESIGN • GEOLOGY

GEOTECHNICAL ENGINEERING AND GEOLOGICAL RECONNAISSANCE STUDY

Vue de Vahalla Subdivision

About 3825 East 3300 North
Liberty, Weber County, Utah

CMT PROJECT NO. 16171

FOR:
Marcus Zabokrtsky
3835 East 3300 North
Liberty, Utah 84310

May 17, 2021

May 17, 2021

Marcus Zabokrtsky
3835 East 3300 North
Liberty, Utah 84310

Subject: Geotechnical Engineering and Geological Reconnaissance Evaluation
Vue de Vahalla Subdivision
About 3825 East 3300 North
Liberty, Weber County, Utah
CMT Project No. 16171

Mr. Zabokrtsky;

Submitted herewith is the report of our geotechnical engineering and geological reconnaissance study for the subject subdivision site. This report contains the results of our findings and an interpretation of the results with respect to the available project characteristics. It also contains recommendations to aid in the design and construction of the earth related phases of this project.

CMT Engineering Laboratories (CMT) personnel supervised the excavation of two test pits extending to depths of 10.0- and 10.5-feet below the existing ground surface on the site. Soil samples were obtained during the field operations and were transported to our laboratory for further testing. Based upon the findings of this investigation conventional strip and spread footings may be utilized to support the proposed residence provided the recommendations within this report are followed. A detailed discussion of design and construction criteria is presented in this report. A Professional Geologist also visited the site, and conducted a review of the site geological and related geological hazard conditions.

We appreciate the opportunity to work with you on this project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With offices throughout Utah, Idaho, and in Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 590-0394. To schedule materials testing please call (801) 908-5859.

Sincerely,
CMT Engineering Laboratories

LICENSED PROFESSIONAL GEOLOGIST
GREGORY C. SCHLENKER
5224720-2250
STATE OF UTAH

LICENSED PROFESSIONAL ENGINEER
276476
BRYAN N. ROBERTS
5-17-2021
STATE OF UTAH

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Senior Geotechnical Engineer

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APPENDIX

1.0 INTRODUCTION

1.1 General

CMT Engineering Laboratories (CMT) was retained by Mr. Marcus Zabokrtsky to conduct a design level geotechnical engineering, and a reconnaissance level geological study for a two-lot subdivision, and a paved roadway extension to access the proposed subdivision. The plans also include the construction of a single-family residence on one of the proposed subdivision lots. The proposed subdivision and improvements are located at approximately at 3825 East 3300 North Street in the unincorporated community Liberty, Weber County, Utah as shown on attached **Figure 1**, **Site Vicinity Map**. **Figure 2, Site Plan** provides aerial coverage of the site and detail of the current (2018) layout of the site vicinity, and the locations of the proposed improvements. Geological mapping of the site is included on **Figure 3, Geological Mapping**, and slope-terrain information is provided on **Figure 4, LiDAR Analysis**. The locations of our test pits for our subsurface evaluation are shown on **Figure 5, Site Evaluation**.

The property is presently an undeveloped parcel 6.91 acres in size. The subject parcel and surrounding properties are zoned by Weber County as Forest Zone FV-3 (Forest Valley Zone - 3) land-use zone. According to the Weber County Code of Ordinances *the purpose of the Forest Valley Zone, FV-3 is to provide area for residential development in a forest setting at a low density, as well as to protect as much as possible the naturalistic environment of the development. The prescribed minimum building lot area in the FV-3 Zone is 3 acres (excluding cluster type provision areas), with single-family residences included as a permitted use.*

1.2 Objectives and Scope

The objectives and scope of our study were planned in discussions between Mr. Zabokrtsky and Mr. Andrew Harris of CMT Engineering Laboratories (CMT). In general, the objectives of this study were to:

> To conduct a design level geotechnical study and reconnaissance level geologic study for the proposed design and construction.

To achieve these objectives our scope of work included:

1. To provide geological reconnaissance studies as specified by Weber County Code, Section 108-22 Natural Hazard Areas guidelines and standards (Weber County, 2021). The reconnaissance level geological study was performed to assess whether all or parts of the site are exposed to the hazards that are included in the code, including, but not limited to; alluvial fan processes including flash flooding and debris flow hazards, surface fault rupture hazards, liquefaction hazards, rockfall hazards, and avalanche hazards (snow avalanche). The geotechnical study was performed to define and evaluate the subsurface soil, and groundwater conditions on the site.
2. To provide the necessary personnel, equipment and materials to conduct a design level geotechnical investigation and reconnaissance level geological study for the proposed design and construction; a field program consisting of the excavating, logging, and sampling of two test pits, and a laboratory soils testing program.
3. An office program consisting of the correlation of available data, engineering and geological analyses, and the preparation of this summary report.

1.3 Authorization

Authorization was provided by Mr. Zabokrtsky by returning a signed copy of our Proposal dated March 3, 2021.

2.0 EXECUTIVE SUMMARY

The following is a brief summary of our findings and conclusions:

The results of our analyses indicate that the proposed residential structure may be supported upon conventional spread and/or continuous wall foundations established upon suitable natural soils or upon structural fill extending to suitable natural soils.

The most significant geotechnical/geological aspects of the site are:

1. The site surface is covered in part with Holocene and upper Pleistocene age lacustrine and alluvial deposits (**Qla**) and part upper Pleistocene age alluvial fan deposits (**Qafb**), as mapped by Utah Geological Survey (UGS) geologist (McDonald, 2020).

2. Topsoil and varying vegetation blanket the surface of the site which must be removed below new structures and pavement.

3. The soils encountered near surface consisted of clayey gravel with some cobbles and occasional boulders.

4. The current planed roadway will cross an existing drainage that will require a properly designed culver, (to be designed by the project “civil” engineer).

5. Groundwater was not observed within the depths penetrated (about 10.5 feet) and is expected to be deeper than about 15 feet or more.

A geotechnical engineer from CMT will need to verify that all topsoil/disturbed soils an possible non-engineered fill material have been completely removed and suitable natural soils encountered prior to the placement of structural fills, floor slabs, footings, or foundations.

In the following sections, detailed discussions pertaining to the proposed construction, field exploration, the geologic setting and mapped hazards, geoseismic setting of the site, earthwork, foundations, lateral pressure and resistance, floor slabs, and subdrains are provided.

3.0 DESCRIPTION OF PROPOSED CONSTRUCTION

The proposed project is to be the development of a two-lot subdivision, including the construction of a paved roadway extension to access the proposed subdivision, and the construction of a single-family residence with a detached garage on Lot #1, located on the southwest corner of the proposed subdivision, as shown on **Figure 2** and **Figure 5**.

The new roadway will likely be paved with asphalt concrete. Long term traffic is projected to consist of a light volume of automobiles and pickup trucks, with occasional medium-weight delivery trucks and a weekly garbage truck.

The proposed residence will likely be of conventional wood-framed construction and founded on spread footings with a basement (if conditions allow), and will be located on the property as shown on **Figure 2** and **Figure 5**. Maximum continuous wall and column loads are anticipated to be 1,000 to 3,000 pounds per lineal foot and 10,000 to 40,000 pounds, respectively.

Site development will require a moderate amount of earthwork in the form of site grading. We anticipate maximum cuts and fills to be less than about 3 feet. Isolated areas may require larger cuts and fills. The proposed roadway crosses an existing drainage that will require an adequately designed culvert.

4.0 FIELD EXPLORATION

The subsurface soil conditions were explored by excavating two test pits on the site at the locations shown on **Figure 5**. The test pits were excavated on March 23, 2021 using a 5-ton rubber-tired excavator and extended to depths of 10.0- and 10.5-feet below the existing ground surface. During the course of the excavating operations, a continuous log of the subsurface conditions encountered was maintained. Within the test pits undisturbed block and disturbed bulk samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The representative soil samples were placed sealed in plastic bags prior to transport to the laboratory.

The soils exposed in the test pits were logged and described in the field based upon visual and textural examination in general accordance with ASTM standard 2488, packaged, and transported to our laboratory. These classifications have been supplemented by subsequent inspection and testing in our laboratory. The subsurface conditions encountered in the field exploration are discussed below in **Section 5.4, Subsurface Soil Conditions**, and are illustrated on **Figures 6 through 8**, **Log of Test Pits**. Sampling information and other pertinent data and observations are also included on the logs. In addition, a **Key to Symbols** defining the terms and symbols used on the logs is provided as **Figure 9** in this report.

Following completion of excavating and logging, each test pit was backfilled. However, the backfill was not placed in uniform lifts and compacted to a specific density and therefore must be considered as non-engineered backfill. Settlement of the backfill with time is likely to occur.

5.0 ENGINEERING GEOLOGY

5.1 General Geology

The site is located in Ogden Valley, which is a northwest trending fault bounded graben structure, with the Wasatch Range comprising the western flank of the valley and the Bear River Range the eastern flank (Avery, 1994). Topographically the site is located on older valley-margin slopes that flank floodplains of the North Fork of the Ogden River, which is located a half-mile to the east of the site. The elevation of the site surface ranges between approximately 5130 feet on the north side of the site, and 5196 feet on the southwest side of the site as shown on Figure 4. The surface of the site is formed upon lacustrine and alluvial sediments that were deposited during or since the transgression and regression of Lake Bonneville between 19,000 to 10,000 years ago (Currey and Oviatt, 1985).

The site is located on the western margin of Ogden Valley, on the east side of the Wasatch Range, which western side the Wasatch Front is marked by the Wasatch fault. The Wasatch fault is approximately 3.8 miles west of the site, and provides the basis of division between the Middle Rocky Mountain Physiographic Province on the east and the Basin and Range Physiographic Province on the west. The Basin and Range Physiographic Province is characterized by approximately north-south trending valleys and mountain ranges that have been formed by extensional tectonics and displacement along normal faults and extends from the Wasatch Range on the east to the Sierra Nevada Range on the west (Hunt, 1967).

The Middle Rocky Mountain province covers parts of Utah, Colorado, Wyoming, Idaho, and Montana. The geology of the province is an assemblage of sedimentary, igneous, and metamorphic rocks that have been folded, faulted, and uplifted. Mountain building (tectonic) activity commenced about 30 million years ago (Cretaceous time) and continues to the present. The province is characterized by mountainous terrain with deep canyons and broad intervening basins, with temperate semi-arid to mesic climatic conditions (Hunt, 1967).

The site is located within a setting of complex geological site formation conditions wherein Pre-Cambrian and Paleozoic rocks were rafted over the same during a series of eastward thrust extensions the last of which is named the Willard Thrust sheet, which is believed to have moved onto the vicinity during the Cretaceous Sevier orogeny, and occurred approximately 140 million years ago (Ma). The older Precambrian rocks have since been exposed on adjacent mountain slopes by uplift along the valley bounding faults that has been occurring over the past 10 million years (Bryant, 1988). Finally, Quaternary stream deposition and incision has modified valley margin slopes, forming the surface of the proposed subdivision site vicinity. The current geological mapping drawn from McDonald (2020) of the site is shown on **Figure 3**.

5.2 Site Surface Conditions

The site conditions and site geology were interpreted through an integrated compilation of data, including a review of literature and mapping from previous studies conducted in the area (Sorensen and Crittenden, 1979; Bryant, 1988; King and others, 2008; King and McDonald, 2014; Coogan and King, 2016; and McDonald, 2020); photogeologic analyses of 2012 and 2018 orthorectified imagery shown on **Figure 2** and **Figure 5**; historical stereoscopic imagery flown in 1947 and 1963; GIS analyses of elevation and geoprocessed LiDAR terrain data as shown on **Figure 4**; field reconnaissance of the general site area; and the interpretation of the test pits made on the site as part of our field program. Seismic hazards information was developed from United States Geologic Survey (USGS) databases (Petersen and others, 2014).

As shown on **Figure 2**, the site consists of an area 6.19 acres in size that is presently vacant and undeveloped. The topography of the site vicinity consists of gentle to moderately sloping valley-margin foothill slopes. A north to south perennial drainageway, Pine Creek, passes on the northwest side of the site. Vegetative cover at the site is open with a cover of grass, weeds and sage brush, with cottonwood and box elder trees lining the drainageway. The site slopes developed from our LiDAR analysis were found to range from level to over 100-percent as shown on **Figure 4**.

5.3 Surficial Geology

The surficial geology of the site is presented on **Figure 3**, of this report and has been taken from mapping prepared by McDonald (2020). A summary of the mapping units identified on the site vicinity and described by McDonald (2020) are paraphrased below in relative age sequence (youngest top to oldest bottom):

Qaly – Stream alluvium and floodplain deposits (Holocene to upper Pleistocene) – Poorly to moderately sorted, pebble to cobble gravel with a matrix of sand, silt, and clay…

Qafy – Younger alluvial-fan deposits (Holocene to upper Pleistocene) – Poorly to moderately sorted pebble to cobble gravel with silt, sand and minor clay matrix; angular to subangular grains; poorly to moderately bedded…includes debris flows, debris floods, and channel deposits…

Qal2 – Stream alluvium and floodplain deposits (middle Holocene to upper Pleistocene) – Poorly to moderately sorted, pebble to cobble gravel with a matrix of sand, silt, and clay in channels and floodplains and low terraces…

Qafb – Younger alluvial-fan deposits (upper Pleistocene) – Poorly sorted pebble to cobble gravel with silt, sand and minor clay matrix; angular to subangular grains; poorly to moderately bedded…includes debris flows, debris
floods, and channel deposits…

Qmsy – Landslide deposits, younger (Holocene to upper Pleistocene?) – Poorly sorted clay- to boulder-sized material in slides, slumps, flows, and landslide complexes; generally characterized by hummocky topography, head, lateral, and/or internal scarps, and chaotic
bedding in displaced blocks…likely post-Lake Bonneville movement...

Qla – Lacustrine and alluvial deposits, undivided (Holocene to upper Pleistocene) – Poorly to moderately sorted silt, sand, clay, and gravel; subangular to rounded clasts; moderately to well-bedded; includes Lake Bonneville-age transgressional deposits below and near the highstand shoreline and post-Bonneville stream alluvium...

Qls – Lake Bonneville sand and gravel deposits (upper Pleistocene) – Moderately to poorly sorted, moderately to well-bedded sand and gravel with silt and clay; subangular to rounded clasts; deposited in transgressive Lake Bonneville nearshore environments; includes thin clay and silt interbeds deposited off shore…

Qao/BR – Older alluvial deposits over bedrock (upper to middle Pleistocene? over Neogene to Precambrian) – Poorly to moderately sorted pebble to boulder gravel with a matrix of silt, sand and clay over Neogene to Precambrian bedrock; angular to subangular grains; poorly bedded; matrix may be somewhat lithified, and characterized by a reddish, clayrich matrix…

Qls/BR – Lake Bonneville sand and gravel deposits over bedrock (upper Pleistocene over Neogene to Precambrian) – Moderately to poorly sorted, moderately to well-bedded sand and gravel with minor silt and clay over Neogene to Precambrian bedrock; subangular to rounded clasts; deposited in transgressive Lake Bonneville nearshore environments...

BR - Rock (Tertiary to Precambrian)...

The site is mapped as located upon; in part with Holocene and upper Pleistocene age lacustrine and alluvial deposits (**Qla**), and in part upper Pleistocene age alluvial fan deposits (**Qafb**), as mapped by Utah Geological Survey (UGS) geologist (McDonald, 2020). The **Qla** and **Qafb** deposits are considered relatively ancient, and are believed to be no longer subject to active geologic processes.

5.4 Subsurface Soil Conditions

Subsurface conditions encountered in the two test pits were relatively consistent across the site. A surficial topsoil, three to six inches thick were observed on the surface of the test pits, with brown Clayey Gravel GC with Cobble and Boulder sized particles extending 6.0 to 7.5 feet below the surface. Below the brown Clayey Gravel GC, a 2.0 to 3.0 thick layer of brown Sandy or Silty Clay CL was observed, with brown Clayey Gravel GC with Cobble and Boulder sized particles comprising the materials in the base of the test pits.

For a detailed graphical description of the subsurface soils encountered, please refer to **Figures 6** through **8** of this report.

5.5 Groundwater

Groundwater was not observed in the test pits. The local static groundwater elevation is projected to be below project depths by about 15 or more feet for the site.

Future seasonal and longer-term groundwater fluctuations should be anticipated for the site, with the highest seasonal levels generally occurring during the late spring and summer months. Numerous other factors such as heavy precipitation, rapid snow-melt, and other unforeseen factors, may also influence ground water elevations at the site.

5.6 Site Subsurface Variations

Based on the results of the subsurface explorations and our experience, variations in the continuity and nature of subsurface conditions should be anticipated. Due to the heterogeneous characteristics of natural and fill soils, caution should be taken in interpolating or extrapolating subsurface conditions beyond the exploratory locations. Seasonal fluctuations in ground water conditions may also occur.

In addition, once the subsurface explorations were completed the test pits were backfilled with the excavated soils but little effort was made to compact these soils. Test pit backfill soils must be considered non-engineered. Settlement of the backfill in the test pits over time should be anticipated and caution should be exercised when constructing over these locations.

5.7 Seismic Setting

5.7.1 General

Utah has adopted the International Building Code (IBC) 2018. IBC 2018 determines the seismic hazard for a site based upon 2014 mapping of bedrock accelerations prepared by the USGS and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2018 (Section 1613.3.2) refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[1] 7.

5.7.2 Active Earthquake Faults

Based upon our review of available maps and literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active (Holocene) earthquake fault to the site is the Weber segment of the Wasatch fault zone (UT2351E) which is located 3.8 miles west of the site (Black and others, 2004). Accordingly, fault rupture hazards are not considered present on the site. The Ogden Valley - North Fork fault (UT2376) is located much closer to the site, approximately 2000 feet to the northeast, however the most recent movement along this fault is estimated to be pre-Holocene (<1.6 Ma ybp), and is not considered an active risk to the site (Black and Hecker, 1999).

5.7.3 Soil Class

Given the subsurface soils encountered at the site in our explorations, which only extended to a depth of about 15.0 feet, it is our opinion the site best fits Site Class D – Stiff Soil Profile (without data, or default), which we recommend for seismic structural design.

5.7.4 Strong Ground Motion

Strong ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.3 (Arabasz and others, 1992). Based on probabilistic estimates (Petersen and others,

[1]American Society of Civil Engineers

2014) queried for the site (41.3137º N., 111.8566º E.) the expected peak horizontal ground acceleration (PGA) on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.19*g.* For a two-percent probability of exceedance in 50 years, the PGA is as high as 0.46*g* for the site.

The ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.19*g* acceleration for this event corresponds to "strong" perceived shaking with "light" potential damage based on instrument intensity correlations. The two-percent probability of exceedance in 50 years event has a return period of 2475 years, and the 0.46*g* acceleration for this event corresponds to "severe" perceived shaking with "moderate to heavy" potential damage based on instrument intensity correlations (Wald and others, 1999).

Future ground accelerations greater than these are possible at the site but will have a lower probability of occurrence.

5.7.5 Seismic Design Category

The Seismic Design Categories in the International Residential Code (IRC 2018 Table R301.2.2.1.1) are based upon the Site Class as addressed in section **5.7.3**, **Soil Class**. For Site Class D (default) at site grid coordinates of 41.3299 degrees north latitude and 111.8135 degrees west longitude, $\mathbf{S_{DS}}$ is 0.833 and the **Seismic Design Category** is D2.

5.7.6 Liquefaction

In conjunction with the ground shaking potential of large magnitude seismic events as discussed previously, certain soil units may also possess a potential for liquefaction during a large magnitude event. Liquefaction is a phenomenon whereby loose, saturated, granular soil units lose a significant portion of their shear strength due to excess pore water pressure buildup resulting from dynamic loading, such as that caused by an earthquake. Among other effects, liquefaction can result in densification of such deposits causing settlements of overlying layers after an earthquake as excess pore water pressures are dissipated. Horizontally continuous liquefied layers may also have a potential to spread laterally where sufficient slope or free-face conditions exist. The primary factors affecting liquefaction potential of a soil deposit are: (1) magnitude and duration of seismic ground motions; (2) soil type and consistency; and (3) occurrence and depth to groundwater.

Liquefaction potential hazards have not been studied or mapped for the Ogden Valley area, as has occurred in other parts of northern Utah (Anderson and others 1994). Liquefaction commonly occurs in saturated non-cohesive soils such as sandy alluvium, which conditions are not found on the site, consequently the conditions susceptible to liquefaction do not appear to be present at the site within the depths penetrated.

5.7.7 Tectonic Subsidence

Tectonic subsidence is surface tilting subsidence that occurs along the boundaries of normal faults in response to surface-faulting earthquakes (Keaton, 1986). Because the site is not located in near proximity to active earthquake faults, tectonic subsidence hazards are not considered a risk to the site.

5.8 Landslide and Slump Deposits

The nearest potentially active Holocene landslide units are mapped as **Qmsy** deposits by McDonald (2020), and are located approximately 2000 feet to the south of the site, as shown on **Figure 3**. The **Qmsy** deposits are distant and should not potentially impact the site or proposed improvements.

5.9 Sloping Surfaces

The surface slopes of the site vicinity developed from our LiDAR analysis and shown on **Figure 4** range from near-level to over 100-percent (isolated locations). For the two-lot subdivision parcel the average slope gradients were calculated to be 9.4 percent. The limiting steep slope gradients for development considerations according to the Weber County Code is 25-percent (Weber County Code, 2021).

5.10 Alluvial Fan - Debris Flow Processes

The nearest potentially active alluvial fan deposits are mapped as **Qafy** by McDonald (2020), and occur approximately 120 feet north of the property. These deposits and processes occupy lower ground north of the site, and as located do not appear to be a potential impact to the proposed residence location.

5.11 Flooding Hazards

Mapping by Federal Emergency Management Agency (FEMA, 2015) is shown on Figure 3. The Zone A shown on Figure 3, along Pine Creek includes the 100-year flood hazard zone as delimited by recent FEMA studies conducted in the Ogden Valley area. On the basis of the FEMA determination *...mandatory flood insurance purchase requirements and floodplain management standards apply...*for improvements made in the Zone A area shown on Figure 3.

Local sheet flow, slope wash, and seasonally perched soil water typical of sloping areas should also be anticipated for the site, and site improvements.

5.12 Rockfall and Avalanche Hazards

The site is not located down-slope from steep slope areas where such hazards may originate.

6.0 LABORATORY TESTING

6.1 General

Selected samples of the subsurface soils were subjected to various laboratory tests to assess pertinent engineering properties, as follows:

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Atterberg Limits, ASTM D-4318, Plasticity and workability

3. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
4. One Dimension Consolidation, ASTM D-2435, Consolidation properties

6.2 Lab Summary

Laboratory test results are presented in the following Lab Summary table:

Lab Summary Table

Test Pit	Depth (feet)	Sample Type	Soil Class	Moisture Content (%)	Dry Density (pcf)	Gradation			Atterberg Limits		
						Grav.	Sand	Fines	LL	PL	PI
TP-1	2.5	Bag	GC	9.9		64	16	20			
	6	Bag	GC	11.3		59	22	19			
TP-2	3.5	Bag	GC	5.2		78	16	6.2	23	16	7
	8	Block	CL						32	17	15

6.3 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed on a representative sample of the subsurface fine-grained (clay) soil encountered in the exploration test pits.

The results of the tests indicate these soils are moderately over consolidated and exhibit moderate strength and compressibility characteristics. Detailed results of the consolidation tests are maintained within our files and can be transmitted to you upon request.

7.0 SITE PREPARATION AND GRADING

7.1 Site Preparation

Initial site preparation will consist of the removal of surface vegetation, topsoil, and other deleterious materials from beneath an area extending out at least 3 feet from the perimeter of the proposed residence, and 2 feet beyond exterior flatwork areas. Surface vegetation and other deleterious materials should generally be removed from the site. Topsoil, although unsuitable for utilization as structural fill or site grading fill below foundations, floor slabs, or exterior concrete flatwork, may be stockpiled for subsequent landscaping purposes.

All non-engineered fill, If encountered, must be removed below footing and floor slab areas, but may remain below exterior flatwork areas if: free of debris and deleterious materials, not more than 3 feet thick, are properly prepared, and subsequent structural site grading fills placed over the prepared existing fill are not more than 3 feet thick. Proper preparation of existing fills below pavements/flatwork will consist of scarification of the exposed surface to a minimum depth of 10 inches, moisture conditioning to within ±2% of optimum moisture, and re-compacting the scarified soils to the requirements for structural fill given in **Section 7.4**, below. Even with proper preparation, flat work over some remaining thickness of non-engineered fill may experience some settlement over time. If this is not acceptable then the entire sequence of non-engineered fill must be removed.

Subsequent to stripping and prior to the placement of structural site grading fill, driveways, and garage slabs on grade, the prepared subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered below footings they must be completely removed. If required removal depth below footings is greater than 2 feet CMT must be notified to provide further recommendations. Below driveways and slabs on grade, they must be removed to a maximum depth of 2 feet and replaced with structural fill. Existing fills must be handled as described above.

The site should be examined by a CMT geotechnical engineer to assess that suitable natural soils have been exposed/properly prepared and any deleterious materials, loose and/or disturbed soils have been removed, prior to placing site grading fills, footings, and slabs/flatwork/pavements.

7.2 Temporary Excavations

Temporary excavations within granular (cohesionless) soils above the water table, not exceeding 4 feet, should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 8 feet, in granular soils and above the water table, the slopes should be no steeper than one horizontal to one vertical (1H:1V). Excavations encountering saturated cohesionless soils will be very difficult and will require very flat side slopes and/or shoring, bracing, and dewatering. Excavations deeper than about 8 feet are not anticipated at the site.

Temporary excavations up to 8 feet deep in fine-grained cohesive soils, above the water table, may be constructed with side slopes no steeper than one-half horizontal to one vertical (0.5H:1V).

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated. All excavations should be made following OSHA safety guidelines.

7.3 Structural Fill Material

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and possibly as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

The following table contains our recommendations for the various fill types we anticipate will be used at this site:

Fill Material Type	Description/Recommended Specification
Select Structural Fill	Placed below structures, flatwork and pavement. Imported structural fill should consist of well-graded sand/gravel mixture, with maximum particle size of 4 inches, a minimum 70% passing 3/4-inch sieve, a maximum 20% passing the No. 200 sieve, and a maximum Plasticity Index of 10.
Site Grading Fill	Placed over larger areas to raise the site grade. Sandy to gravelly soil, with a maximum particle size of 6 inches, a minimum 70% passing 3/4-inch sieve, and a maximum 50% passing No. 200 sieve.
Non-Structural Fill	Placed below non-structural areas, such as landscaping. On-site soils or imported soils, with a maximum particle size of 8 inches, including silt/clay soils not containing excessive amounts of degradable/organic material.
Stabilization Fill	Placed to stabilize soft areas prior to placing structural fill and/or site grading fill. Coarse angular gravels and cobbles 1 inch to 8 inches in size. May also use 1.5- to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i, or equivalent (see **Section 7.6**).

Natural soils (except topsoil) may be used as structural site grading fill and as non-structural fill if free of deleterious material and processed to meet the criteria provided herein. Please note that fine grained soils are inherently difficult to properly moisture prepare and compact as structural fill. This may be extremely difficult to near impossible during cold and wet periods of the year.

All fill material should be approved by a CMT geotechnical engineer prior to placement.

7.4 Fill Placement and Compaction

The various types of compaction equipment available have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about 4 inches and most "trench compactors" have a maximum, consistent compaction depth of about 6 inches. Large rollers, depending on soil and moisture conditions, can achieve compaction at 8 to 12 inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density as determined by ASTM D-1557 (or AASHTO[2] T-180) in accordance with the following recommendations:

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of structures, and 2 feet beyond flatwork and pavement (applies to structural fill and site grading fill)	0 to 5 5 to 10	95 98
Site grading fill outside area defined above	0 to 5 5 to 10	92 95
Utility trenches within structural areas	--	96
Roadbase and subbase	-	96
Non-structural fill	0 to 5 5 to 10	90 92

[2] American Association of State Highway and Transportation Officials

Structural fills greater than 8 feet thick are not anticipated at the site. For best compaction results, we recommend that the moisture content for structural fill/backfill be within 2% of optimum. Field density tests should be performed on each lift as necessary to verify that proper compaction is being achieved.

7.5 Utility Trenches

For the bedding zone around the utility, we recommend utilizing sand bedding fill material that meets current APWA[3] requirements.

Most utility companies and local governments are requiring Type A-1a or A-1b (AASHTO Designation) soils (sand/gravel soils with limited fines) be used as backfill over utilities within public rights of way, and the backfill be compacted over the full depth above the bedding zone to at least 96% of the maximum dry density as determined by AASHTO T-180 (ASTM D-1557).

Where the utility does not underlie structurally loaded facilities and public rights of way, on-site fill and natural soils may be utilized as trench backfill above the bedding layer, provided they are properly moisture conditioned and compacted to the minimum requirements stated above in **Section 7.4**.

7.6 Stabilization

To stabilize soft subgrade conditions (if encountered), a mixture of coarse, clean, angular gravels and cobbles and/or 1.5- to 2.0-inch clean gravel should be utilized. Often the amount of gravelly material can be reduced with the use of a geotextile fabric such as Mirafi RS280i, or equivalent. Its use will also help avoid mixing of the subgrade soils with the gravelly material. After excavating the soft/disturbed soils, the fabric should be spread across the bottom of the excavation and up the sides a minimum of 18 inches. Otherwise, it should be placed in accordance with the manufacturer's recommendation, including proper overlaps. The gravel material can then be placed over the fabric in compacted lifts as described above.

8.0 LATERAL EARTH PRESSURES

The lateral pressure parameters, as presented within this section, are for backfills which will consist of clean, drained on site or imported granular soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid walls (moderately yielding), generally not exceeding 8 feet in height, backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is no steeper than 10 horizontal to 1 vertical and that the fill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

[3] American Public Works Association

For seismic loading, a uniform pressure should be added. The uniform pressures based on different wall heights are provided in the following table:

Wall Height (feet)	Seismic Loading Active Case (psf)	Seismic Loading Moderately Yielding (psf)
4	31	69
6	47	103
8	62	138

9.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics, including the maximum loads discussed in **Section 3.0 Description of Proposed Construction**, the subsurface conditions observed in the field and the laboratory test data, and standard geotechnical engineering practice.

9.1 Foundation Design

Based on our geotechnical engineering analyses, the proposed residential structure may be supported upon conventional spread and/or continuous wall foundations constructed on suitable natural soils or structural fill extending to suitable natural soils. Footings may be designed using a net bearing pressure of 2,000 psf.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade, thus the weight of the footing and backfill to lowest adjacent final grade need not be considered. The allowable bearing pressure may be increased by 1/2 for temporary loads such as wind and seismic forces.

We also recommend the following:

1. Continuous footing widths should be maintained at a minimum of 18 inches.
2. Spot footings should be a minimum of 24 inches wide.

9.2 Installation

Under no circumstances shall the footings be established upon non-engineered fills, loose or disturbed soils, topsoil, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill.

The width of structural replacement fill below footings should be equal to the width of the footing plus one foot for each foot of fill thickness. For instance, if the footing width is 2 feet and the structural fill depth beneath the footing is 2 feet, the fill replacement width should be 4 feet, centered beneath the footing.

We also recommend the following:

1. Exterior footings subject to frost should be placed at least 36 inches below final grade.
2. Interior footings not subject to frost should be placed at least 18 inches below grade.

9.3 Estimated Settlement

Foundations designed and constructed in accordance with our recommendations could experience some settlement, but we anticipate that total settlements of footings founded as recommended above will not exceed 1 inch. We expect approximately 50% of the total settlement to initially take place during construction.

9.4 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.4 for natural granular soils or imported granular structural fill may be utilized. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 250 pounds per cubic foot.

A combination of passive earth resistance and friction may be utilized provided that the passive component of the total is divided by 1.5.

10.0 FLOOR SLABS

It is recommended that floor slabs be established upon suitable natural soils or structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established directly over non-engineered fills, topsoil, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In order to facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by at least 4 inches of “free-draining” fill, such as “pea” gravel or three-quarters to one-inch minus clean gap-graded gravel. To help control normal shrinkage and stress cracking, the floor slabs may include the following features:

1. Adequate reinforcement for the anticipated floor loads with the reinforcement continuous through interior floor joints;
2. Frequent crack control joints; and
3. Non-rigid attachment of the slabs to foundation walls and bearing slabs.

11.0 DRAINAGE RECOMMENDATIONS

It is very important to the long-term performance of foundations and floor slabs that water not be allowed to collect near the foundation walls and infiltrate into the underlying soils. We recommend the following:

1. All areas around the proposed residence should be sloped to provide drainage away from the foundations. We recommend a minimum slope of 6 inches in the first 10 feet away from the structure.

2. All roof drainage should be collected in rain gutters with downspouts designed to discharge at least 10 feet from the foundation walls or well beyond the backfill limits, whichever is greater.

3. Adequate compaction of the foundation backfill should be provided. We suggest a minimum of 90% of the maximum laboratory density as determined by ASTM D-1557. Water consolidation methods should not be used under any circumstances.

4. Sprinklers should be aimed away and kept at least 4 feet from the foundation walls. The sprinkling systems should be designed with proper drainage and be well-maintained. Over watering should be avoided.

5. Other precautions may become evident during construction.

12.0 PAVEMENTS

We understand that an asphalt paved access roadway extension will be part of the development. All pavement areas must be prepared as discussed above in **Section 6.1**. Under no circumstances shall pavements be established over topsoil, unprepared/unsuitable non-engineered fills (if encountered), loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

We anticipate the natural, surficial clayey gravel soils will exhibit good pavement support characteristics when saturated or nearly saturated. A bulk sample of the clayey gravel soils was taken at the location of test pit TP-1 to conduct a Proctor and California Bearing Ratio (CBR) test. However, due to the amount of oversized material (greater than ¾ inches) the typical laboratory proctor methods could not be completed. Based on our laboratory testing experience with similar soils, our pavement design utilized a California Bearing Ratio (CBR) of 15 for the natural clayey gravel soils.

Given the projected traffic as discussed above in **Section 1.3**, the following pavement sections are recommended for approximately 4 ESAL's (18-kip equivalent single-axle loads) per day:

MATERIAL	PAVEMENT SECTION THICKNESS (inches)	
Asphalt	**3**	**3**
Road-Base	**8**	**4**
Subbase	**0**	**5**
Total Thickness	**11**	**12**

13.0 QUALITY CONTROL

We recommend that CMT be retained to as part of a comprehensive quality control testing and observation program to help facilitate implementation of our recommendations and to address any subsurface conditions encountered which vary from those described in this report saving both time and expense. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This may include but not necessarily be limited to the following:

13.1 Field Observations

Observations should be completed during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement.

13.2 Fill Compaction

Compaction testing by CMT is required for all structural supporting fill materials. Maximum Dry Density (Modified Proctor/ASTM D-1557) tests should be requested by the contractor immediately after delivery of any granular fill materials. The maximum density information should then be used for field density tests on each lift as necessary to ensure that the required compaction is being achieved.

13.3 Concrete and Asphalt Quality

We recommend that freshly mixed concrete and asphalt be tested by CMT in accordance with all applicable standards.

14.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the test pits and site exploration. The exploration data reflects the subsurface conditions only at the specific locations at the particular time designated on the test pit logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With four offices throughout Northern Utah, and in Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 590-0394. To schedule materials testing please call (801) 908-5859.

15.0 REFERENCES

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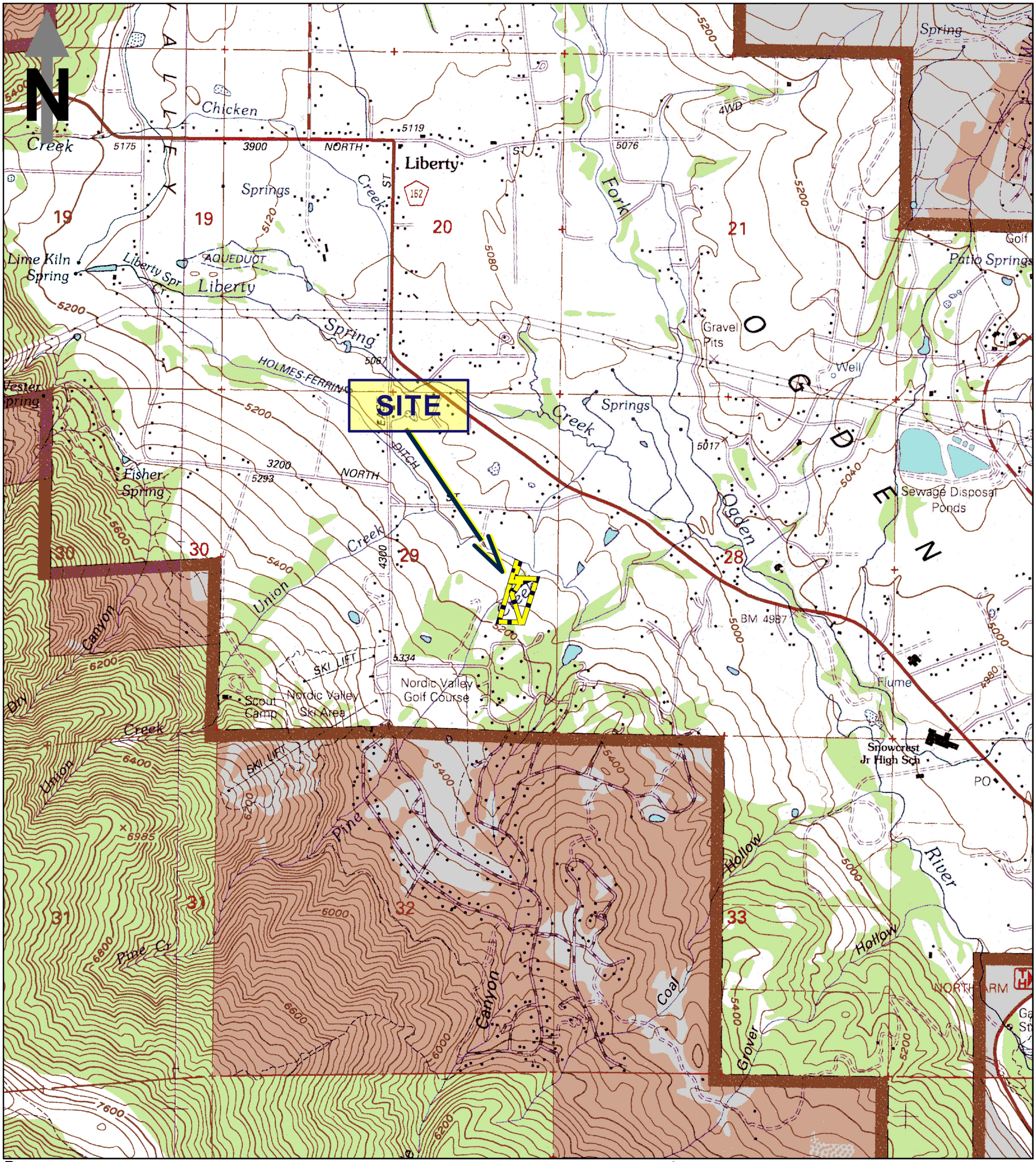
APPENDIX

SUPPORTING

DOCUMENTATION



Base:
1998 USGS 7.5 Minute topographic maps titled "Huntsville, Utah" and North Ogden, Utah, from Utah AGRC; http://gis.utah.gov/

0 2000 4000 ft

1:24,000

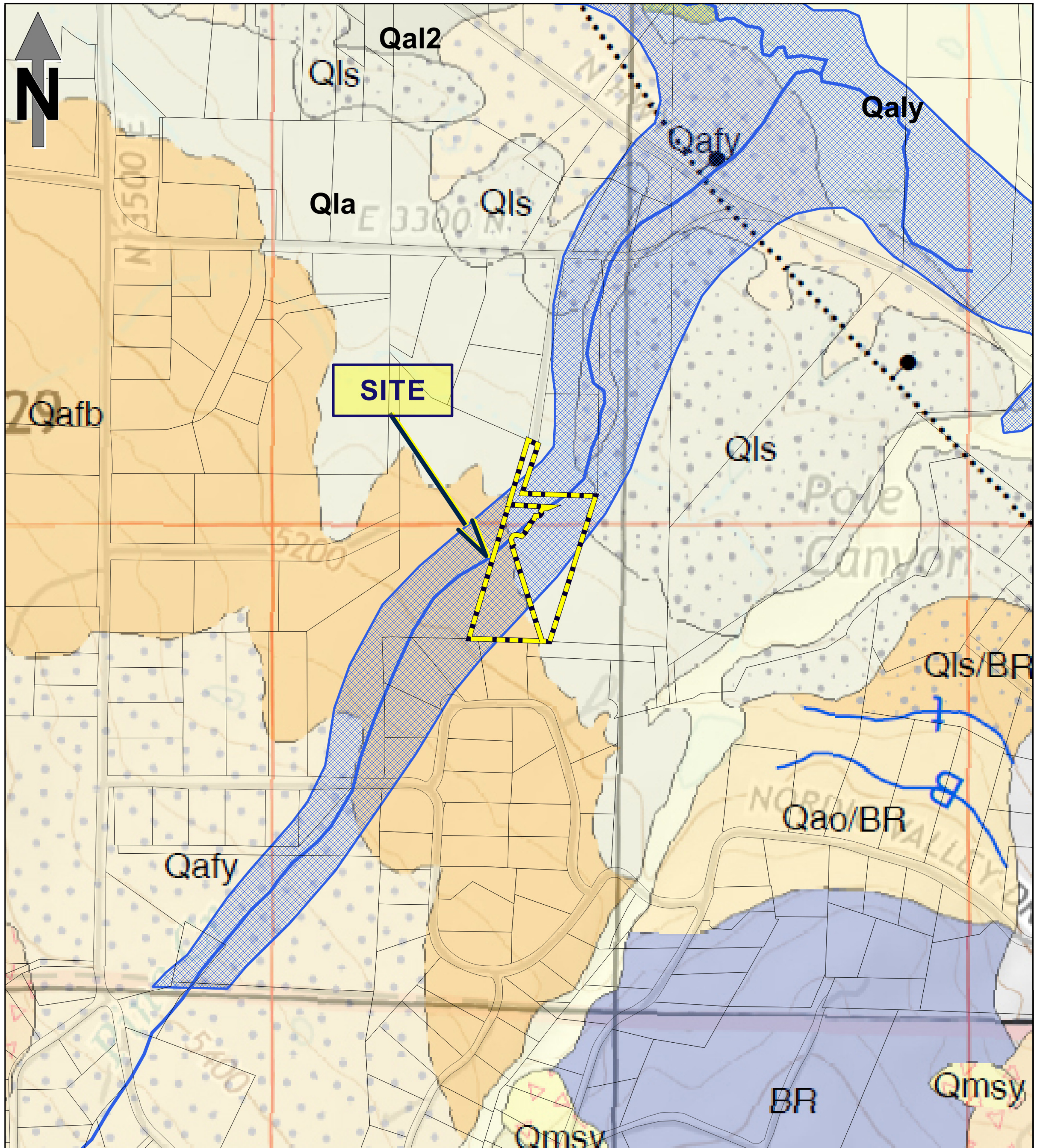
Vue de Vahalla Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES		Figure 1
	VICINITY MAP	Date: 10-May-21 Job # 16171	

Base:
2018 0.6m NAIP Color Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 500 1000 ft

1:6,000

Vue de Vahalla Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES		Figure 2
	SITE PLAN	Date: 10-May-21	
		Job # 16171	



Base:
McDonald and others, 2020

0 600 1200 ft

1:7,200

GEOLOGCIAL CLASSIFICATION (after McDonald, 2020)

Qaly – Stream alluvium and floodplain deposits (Holocene to upper Pleistocene) – Poorly to moderately sorted, pebble to cobble gravel with a matrix of sand, silt, and clay…

Qafy – Younger alluvial-fan deposits (Holocene to upper Pleistocene) – Poorly to moderately sorted pebble to cobble gravel with silt, sand and minor clay matrix; angular to subangular grains; poorly to moderately bedded…includes debris flows, debris floods, and channel deposits…

Qal2 – Stream alluvium and floodplain deposits (middle Holocene to upper Pleistocene) – Poorly to moderately sorted, pebble to cobble gravel with a matrix of sand, silt, and clay in channels and floodplains and low terraces…

Qafb – Younger alluvial-fan deposits (upper Pleistocene) – Poorly sorted pebble to cobble gravel with silt, sand and minor clay matrix; angular to subangular grains; poorly to moderately bedded…includes debris flows, debris floods, and channel deposits…

Qmsy – Landslide deposits, younger (Holocene to upper Pleistocene?) – Poorly sorted clay- to boulder-sized material in slides, slumps, flows, and landslide complexes; generally characterized by hummocky topography, head, lateral, and/or internal scarps, and chaotic bedding in displaced blocks…likely post-Lake Bonneville movement...

Qla – Lacustrine and alluvial deposits, undivided (Holocene to upper Pleistocene) – Poorly to moderately sorted silt, sand, clay, and gravel; subangular to rounded clasts; moderately to well-bedded; includes Lake Bonneville-age transgressional deposits below and near the highstand shoreline and post-Bonneville stream alluvium...

Qls – Lake Bonneville sand and gravel deposits (upper Pleistocene) – Moderately to poorly sorted, moderately to well-bedded sand and gravel with silt and clay; subangular to rounded clasts; deposited in transgressive Lake Bonneville nearshore environments; includes thin clay and silt interbeds deposited off shore…

Qao/BR – Older alluvial deposits over bedrock(upper to middle Pleistocene? over Neogene to Precambrian) – Poorly to moderately sorted pebble to boulder gravel with a matrix of silt, sand and clay over Neogene to Precambrian bedrock; angular to subangular grains; poorly bedded; matrix may be somewhat lithified, and characterized by a reddish, clayrich matrix…

Qls/BR– Lake Bonneville sand and gravel deposits over bedrock (upper Pleistocene over Neogene to Precambrian) – Moderately to poorly sorted, moderately to well-bedded sand and gravel with minor silt and clay over Neogene to Precambrian bedrock; subangular to rounded clasts; deposited in transgressive Lake Bonneville nearshore environments...

BR - Rock (Tertiary to Precambrian)...

Normal Fault - Bar and ball on downthrown block, dashed where approximate, dotted where concealed.

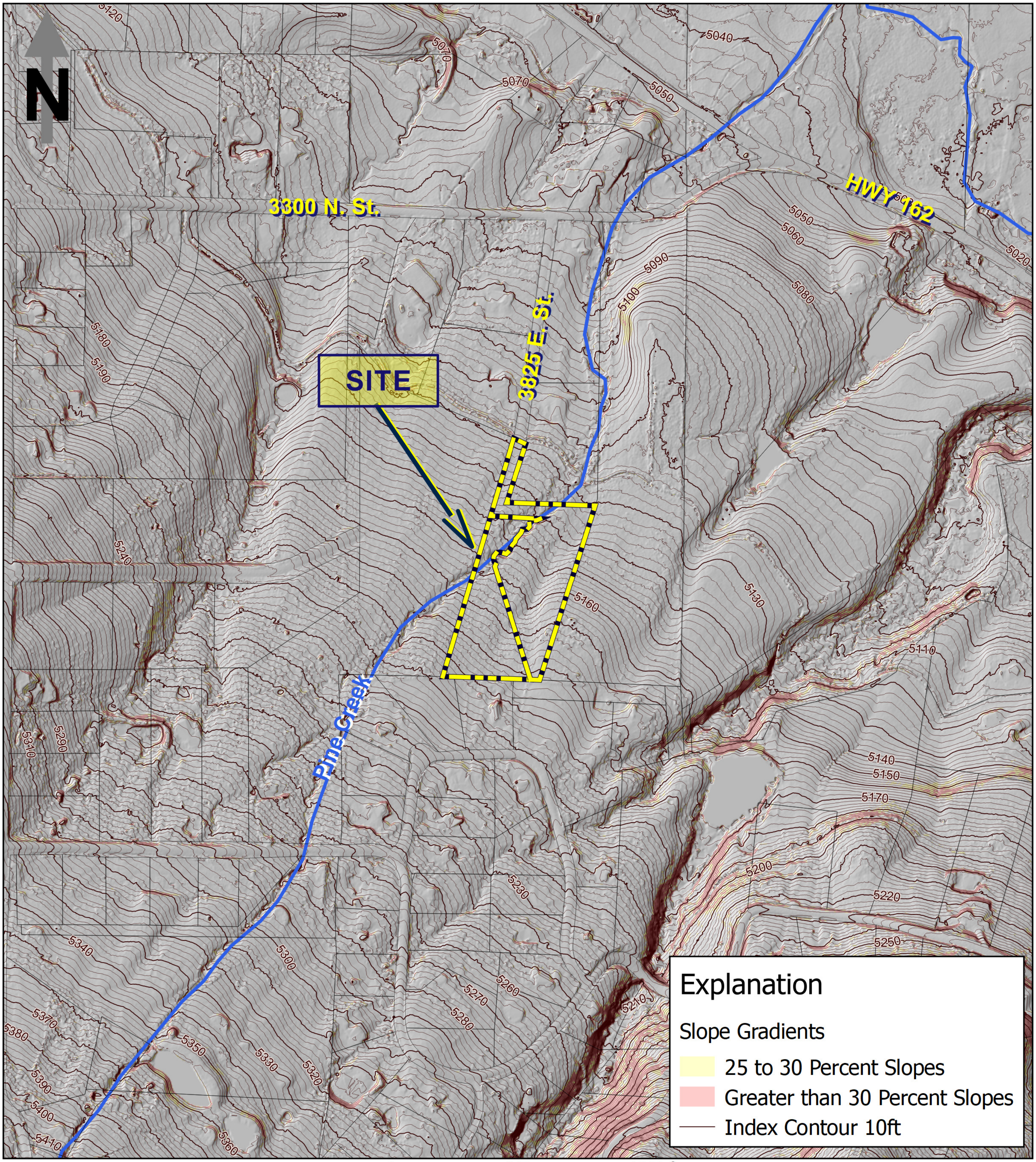
Lake Bonneville Shorelines

B — Bonneville Level Shoreline

t — Transgressive Level Shoreline

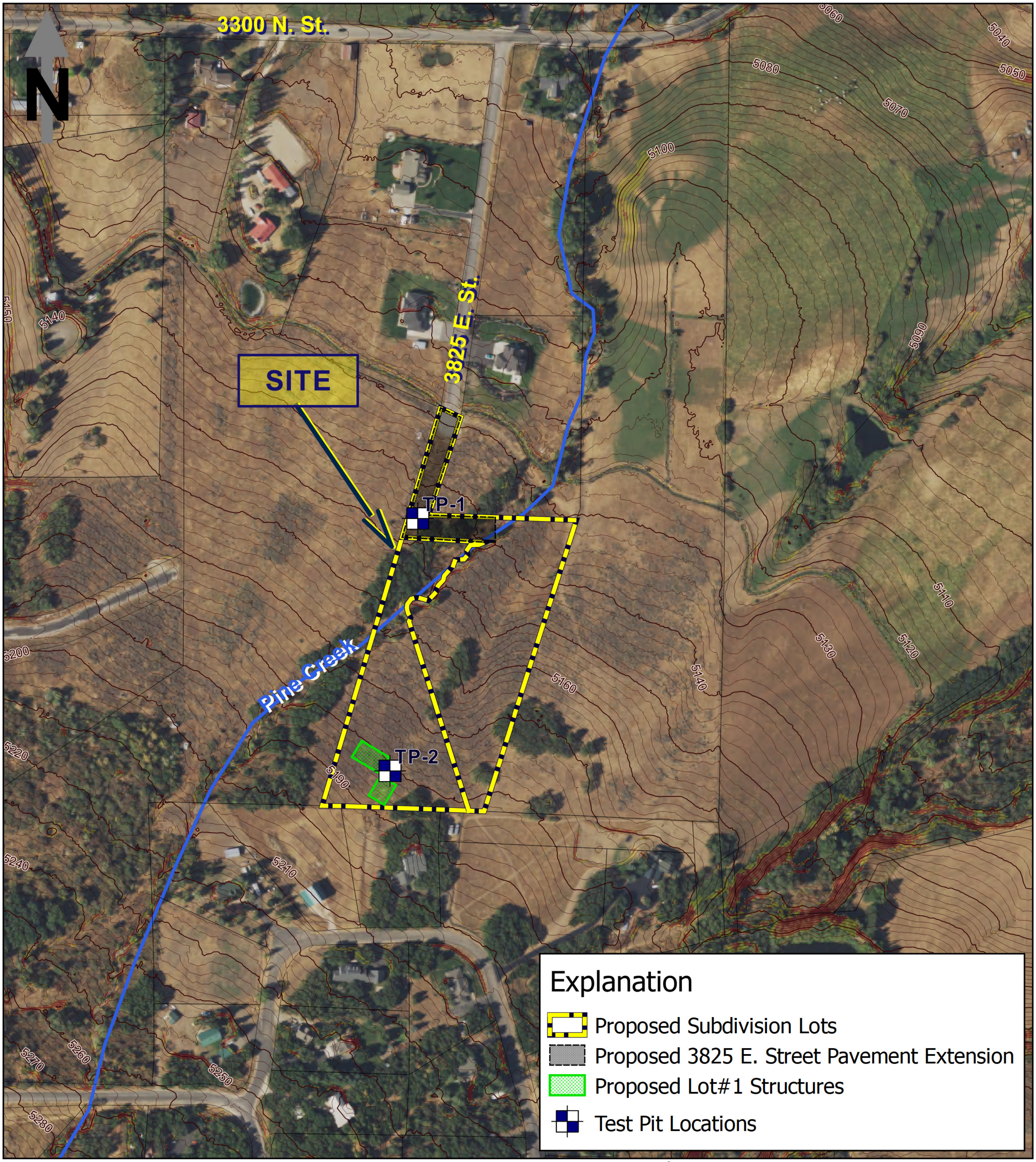
FEMA - Flood Insurance Rating Zones (2015)- Zone A - Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies. Because detailed hydraulic analyses have not been performed, no Base Flood Elevations (BFEs) or flood depths are shown. Mandatory flood insurance purchase requirements and floodplain management standards apply.

CMT ENGINEERING LABORATORIES	Vue de Vahalla Subdivision Eden, Utah	GEOLOGIC MAPPING	Date:	10 May-21	Figure 3
			Job #	16171	



Base:
2011 1.0m LiDAR Imagery,
from Utah AGRC; http://gis.utah.gov/

Vue de Vahalla Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES LiDAR ANALYSIS	Date: 10-May-21 Job # 16171	Figure 4



Base:
2018 0.6m NAIP Color Orthoimagery, from Utah AGRC; http://gis.utah.gov/

Vue de Vahalla Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES SITE EVALUATION	Date: 10-May-21 Job # 16171	Figure 5

Carol Street, Vue de Vahalla Subdivision — Test Pit Log — TP-1

About 3825 East 3300 North, Liberty, Utah

Total Depth: 10'
Water Depth: (see Remarks)

Date: 3/23/21
Job #: 16171

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	6" Topsoil; sandy clay with gravel										
0.5	Dark Brown Clayey GRAVEL (GC) with cobble, occasional boulder, roots/organics to 3' — moist, medium dense										
2.5			1	10		64	16	20			
3	grades brown										
4			2								
5	grades with more boulders										
6			3	11		59	22	19			
7	Brown Sandy CLAY (CL) with gravel — very moist, medium dense										
9	Brown Clayey GRAVEL (GC) with cobbles and boulders — moist, medium dense										
10	END AT 10'										

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Rubber Tire Backhoe
Excavated By: Rockwell
Logged By: Olivia Roberts

CMT ENGINEERING LABORATORIES

Figure: 6

Carol Street, Vue de Vahalla Subdivision

Test Pit Log — TP-2

About 3825 East 3300 North, Liberty, Utah

Total Depth: 10.5'
Water Depth: (see Remarks)

Date: 3/23/21
Job #: 16171

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gravation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0	Topsoil; dark brown clayey sand with gravel, organics to 3'; moist, medium dense										
1	Brown Clayey Fine and Coarse GRAVEL (GC) with cobbles; moist, medium dense										
2–3	grades with occasional boulder										
4	very moist		4	5		78	16	6	23	16	7
7.5	Brown Silty CLAY (CL) with sand; moist, medium stiff										
8			5						32	17	15
9.5	Brown Clayey GRAVEL (GC) with cobbles and boulders										
10.5	END AT 10.5'										

Depth scale: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14

Remarks: Groundwater not encountered during excavation.

Coordinates: °, °
Surface Elev. (approx): Not Given

Equipment: Rubber Tire Backhoe
Excavated By: Rockwell
Logged By: Olivia Roberts

CMT ENGINEERING LABORATORIES

Figure: 7

Carol Street, Vue de Vahalla Subdivision

Key to Symbols

About 3825 East 3300 North, Liberty, Utah

Date: 3/23/21
Job #: 16171

① Depth (ft)	② GRAPHIC LOG	③ Soil Description	④ Sample Type	⑤ Sample #	⑥ Moisture (%)	⑦ Dry Density(pcf)	Gradation ⑧ Gravel %	Sand %	Fines %	Atterberg ⑨ LL	PL	PI

COLUMN DESCRIPTIONS

① **Depth (ft.):** Depth (feet) below the ground surface (including groundwater depth - see water symbol below).

② **Graphic Log:** Graphic depicting type of soil encountered (see ② below).

③ **Soil Description:** Description of soils encountered, including Unified Soil Classification Symbol (see below).

④ **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below-right.

⑤ **Sample #:** Consecutive numbering of soil samples collected during field exploration.

⑥ **Moisture (%):** Water content of soil sample measured in laboratory (percentage of dry weight of sample).

⑦ **Dry Density (pcf):** The dry density of a soil measured in laboratory (pounds per cubic foot).

⑧ **Gradation:** Percentages of Gravel, Sand and Fines (Silt/Clay), obtained from lab test results of soil passing the No. 4 and No. 200 sieves.

⑨ **Atterberg:** Individual descriptions of Atterberg Tests are as follows:

LL = Liquid Limit (%): Water content at which a soil changes from plastic to liquid behavior.

PL = Plastic Limit (%): Water content at which a soil changes from liquid to plastic behavior.

PI = Plasticity Index (%): Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

STRATIFICATION	
Description	**Thickness**
Seam	Up to ½ inch
Lense	Up to 12 inches
Layer	Greater than 12 in.
Occasional	1 or less per foot
Frequent	More than 1 per foot

MODIFIERS
Trace
<5%
Some
5-12%
With
> 12%

MOISTURE CONTENT
Dry: Absence of moisture, dusty, dry to the touch.
Moist: Damp / moist to the touch, but no visible water.
Wet: Visible water, usually soil below groundwater.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	②	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	**GRAVELS** The coarse fraction retained on No. 4 sieve.	**CLEAN GRAVELS** (< 5% fines)	GW		Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GP		Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
		GRAVELS WITH FINES (≥ 12% fines)	GM		Silty Gravels, Gravel-Sand-Silt Mixtures
			GC		Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS The coarse fraction passing through No. 4 sieve.	**CLEAN SANDS** (< 5% fines)	SW		Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP		Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (≥ 12% fines)	SM		Silty Sands, Sand-Silt Mixtures
			SC		Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size.	**SILTS AND CLAYS** Liquid Limit less than 50%		ML		Inorganic Silts and Sandy Silts with No Plasticity or Clayey Silts with Slight Plasticity
			CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
			OL		Organic Silts and Organic Silty Clays of Low Plasticity
	SILTS AND CLAYS Liquid Limit greater than 50%		MH		Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils
			CH		Inorganic Clays of High Plasticity, Fat Clays
			OH		Organic Silts and Organic Clays of Medium to High Plasticity
HIGHLY ORGANIC SOILS			PT		Peat, Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

SAMPLER SYMBOLS

- Block Sample
- Bulk/Bag Sample
- Modified California Sampler
- 3.5" OD, 2.42" ID D&M Sampler
- Rock Core
- Standard Penetration Split Spoon Sampler
- Thin Wall (Shelby Tube)

WATER SYMBOL

- Encountered Water Level
- Measured Water Level

(see Remarks on Logs)

1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

CMT ENGINEERING LABORATORIES

Figure:
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