CMT ENGINEERING LABORATORIES

CMT Engineering Laboratories
ENGINEERING • ENVIRONMENTAL (ESA I & II) •MATERIALS TESTING
SPECIAL INSPECTIONS •ORGANIC CHEMISTRY

GEOTECHNICAL ENGINEERING STUDY

Terakee Village

About 4700 West 900 South
West Weber, Weber County, Utah

Prepared For:

Mr. Brad Blanch
Terakee Properties, L.P.
1060 East 3400 North
North Ogden, Utah 84414

CMT Project No. 10241
October 2, 2017

CMT ENGINEERING
LABORATORIES

October 2, 2017

Mr. Brad Blanch
Terakee Properties, L.P.
1060 East 3400 North
North Ogden, Utah 84414

Subject: Geotechnical Engineering Study
Terakee Village
About 4700 West 900 South Street
West Weber, Weber County, Utah
CMT Project Number: 10241

Mr. Blanch:

Submitted herewith is the report of our geotechnical engineering study for the subject site. This report contains the results of our findings and an engineering 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.

On September 1, 2017, a CMT Engineering Laboratories (CMT) engineer was on-site and supervised the excavating of 14 test pits extending to depths of about 8.5 to 13.0 feet below the existing ground surface. Soil samples were obtained during the field operations and subsequently transported to our laboratory for further testing and observation.

Conventional spread and/or continuous footings may be utilized to support the proposed structures, provided the recommendations in this report are followed. A detailed discussion of design and construction criteria is presented in this report.

We appreciate the opportunity to work with you at this stage of the project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With 7 offices throughout Northern Utah and an office 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) 492-4132.

Sincerely,
CMT Engineering Laboratories

Bryan N Roberts

LICENSED PROFESSIONAL ENGINEER
276476
BRYAN N.
ROBERTS
10/2/17
STATE OF UTAH

Bryan N. Roberts, P.E.
Senior Geotechnical Engineer

Reviewed by:

And M Harris

Andrew M. Harris, P.E.
Senior Geotechnical Engineer

ENGINEERING • ENVIRONMENTAL (ESA I & II) • MATERIALS TESTING • SPECIAL INSPECTIONS • ORGANIC CHEMISTRY

LOGAN OFFICE: 2005 NORTH 600 WEST, SUITE A, LOGAN, UTAH 84321 • TEL: (435) 753-6815 • FAX: (435) 787-4983
OGDEN OFFICE: 707 24th STREET, SUITE 1A, OGDEN, UTAH 84401 • TEL: (801) 870-6730
SALT LAKE CITY OFFICE: 2796 S. REDWOOD ROAD, SALT LAKE CITY, UTAH 84119 • TEL: (801) 908-5954 • FAX: (801) 972-9075
UTAH COUNTY OFFICE: 496 EAST 1750 NORTH, SUITE B, VINEYARD, UTAH 84057 • TEL: (801) 492-4132
ATL/ARIZONA OFFICE: 2921 NORTH 30th AVENUE, PHOENIX, ARIZONA 85017 • TEL: (602) 241-1097 • FAX: (602) 2771306
EMAIL = cmt@cmtlaboratories.com

TABLE OF CONTENTS

APPENDIX

1.0 INTRODUCTION

1.1 General

CMT Engineering Laboratories (CMT) was retained to conduct a geotechnical subsurface study for the Terakee Village property. The site is situated to the east side of 4700 West Street and north of 900 South Street in West Weber, Weber County, Utah, as shown in **Figure 1** below:

Figure 1, Vicinity Map

1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Mr. Brad Blanch of Terakee Properties, L.P. and Mr. Andrew Harris of CMT Engineering Laboratories (CMT). In general, the objectives of this study were to define and evaluate the subsurface soil and groundwater conditions at the site, and provide appropriate foundation, earthwork, and pavement recommendations and geoseismic information to be utilized in the design and construction of the proposed development.

In accomplishing these objectives, our scope of work has included performing field exploration, which consisted of the excavating, logging, and sampling of 14 test pits, followed by laboratory testing on representative samples, and conducting an office program, which consisted of correlating available data, performing engineering analyses, and preparing this summary report. This scope of work was authorized by returning a signed copy of our proposal dated August 17, 2017 and executed on August 18, 2017.

1.3 Description of Proposed Construction

We understand that the proposed construction will consist of subdividing a 58.6-acre parcel and constructing a 79-lot residential subdivision and future senior living center. The planned single-family residential structures are to be of one to two level wood-framed construction and founded on spread footings with floor slabs at or above existing grades. Maximum continuous wall and column loads for the single family residential structures are anticipated to be 1 to 3 kips per lineal foot and 10 to 25 kips, respectively. Specific details for the senior living location and construction has not yet been determined but is anticipated to be similarly constructed of wood framing with one to two levels above grade and supported on concrete spread footings. Pavements are to include residential street. If the loading conditions are different than we have projected, please notify us so that any appropriate modifications to our conclusions and recommendations contained herein can be made.

A site grading plan was not available at the time of this report. However, it is anticipated that site development will require a moderate amount of earthwork in the form of site grading. We recommend that site grading cuts be minimized to that required to remove vegetation, topsoil, disturbed soils and other unsuitable soils due to very shallow groundwater. Site grading fills to achieve design grades may be on the order of 2 to 3 feet. Larger cuts and fills may be required in isolated areas. Fills larger than about 3 feet must be identified and CMT informed to review settlements.

1.4 Executive Summary

Our analysis indicates that the proposed structures may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Further, some periodic stabilization of exposed bearing subgrade must be anticipated.

The most significant geotechnical aspects of the site are:

1 The very high groundwater levels;
2 Disturbed loose soil generally within the upper 6 inches and;
3 The existing shallow ditches/waterways traversing the site.

Static groundwater was measured across the site between about 1.8 to 6.6 feet below the existing ground surface. The shallow groundwater encountered at the site will affect the installation of utilities, foundations, and any sublevel construction. It is recommended that the top of the lowest habitable slab be kept a minimum of 3.0 feet above the measured groundwater level. If a land drain is constructed within the development, the top of slabs within the lowest habitable level are recommended to be at least 1.5 feet above the level controlled by individual foundation subdrains tied into land drains within the development. The existing ditches/waterways will likely need to be eliminated and/or fully piped to allow for new construction.

The upper 6 inches in general were loose/disturbed with the top 3 to 4 inches containing major roots/topsoil. CMT must verify that all topsoil, disturbed, or unsuitable soils have been removed and or properly prepared and that suitable soils have been encountered prior to placing site grading fills, footings, slabs, and pavements.

The on-site sand soils, may be re-utilized as structural site grading fills if they meet the requirements for such, and can be adequately re-compacted as stated herein. However, it must be noted that where the groundwater is very shallow, the natural soils near or within the groundwater depths will be saturated and must be dried out to near optimum moisture content in order to adequately recompact. From a handling and compaction standpoint, drying and recompacting of these soils will be very difficult, if not impossible, during wet and cold periods of the year.

In the following sections, detailed discussions pertaining to site description and geoseismic setting, earthwork, foundations, lateral resistance, lateral pressure, floor slabs, pavements and drainage are provided.

2.0 FIELD EXPLORATION

2.1 General

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 14 test pits were excavated with a backhoe throughout the site to depths of approximately 8.0.0 to 13.0 feet below the existing ground surface. Locations of the test pits are presented on **Figure 2**, shown below.

During the course of the excavating operations, a continuous log of the subsurface conditions encountered was maintained. In addition, samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. Representative soil samples were placed in sealed plastic bags and containers prior to transport to the laboratory. A 2.42-inch inside diameter thin-wall drive sampler was also utilized in the subsurface sampling at the site. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent inspection and testing in our laboratory.

Logs of the test pits, including a description of the soil strata encountered, is presented on each individual Test Pit Log, **Figures 4 through 17**, included in the Appendix. 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 18** in the Appendix.

Following completion of excavation operations, 1.25-inch diameter slotted PVC pipe was installed in each test pit to allow subsequent water level measurements. When backfilling the test pits, the backfill was not placed in uniform lifts and compacted to a specific density and therefore must be considered as non-engineered backfill. Thus, settlement of the backfill in the test pits over time should be anticipated.

Figure 2, Site Map

3.0 LABORATORY TESTING

3.1 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. Dry Density, ASTM D-2937, Dry unit weight representing field conditions
3. Atterberg Limits, ASTM D-4318, Plasticity and workability
4. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
5. One Dimension Consolidation, ASTM D-2435, Consolidation properties

3.2 Lab Summary

Laboratory test results are presented on the test pit logs (**Figures 4 through 17**) and in the following Lab Summary Table:

Lab Summary Table

Test Pit	Depth (feet)	Soil Class	Sample Type	Moisture Content (%)	Dry Denstiy (pcf)	Gradation			Atterberg Limits		
						Grav	Sand	Fines	LL	PL	PI
TP-1	3	CL	Thin Wall	26.05	96.7			82.9			
TP-3	2.5	CL	Thin Wall	28.86				71.7			
TP-4	2.5	CL	Thin Wall	23.08	101			82.4			
TP-5	2.5	CL	Thin Wall	26.5					27	18	9
TP-6	12.5	CL	Bag	29.49				80.2	27	19	8
TP-8	4.5		Thin Wall								
TP-9	2.5	CL	Thin Wall	32.07	90.4			90.8			
TP-10	4.5		Thin Wall								
TP-11	3		Thin Wall								
TP-11	8	GP/GM	Bag	31.01				10.3			
TP-12	3	CL	Thin Wall	28.64	97.1				25	19	6
TP-13	2.5		Thin Wall								
TP-14	2	CL	Thin Wall	21.21	98.4				27	17	10
TP-14	10	GP	Bag	20.66				2.9			

3.3 One-Dimensional Consolidation Tests

To provide data necessary for our settlement analysis, a consolidation test was performed on each of 6 representative samples of the fine grained natural clay soils encountered. The results of the tests indicate that the samples tested were slightly moderately to moderately over-consolidated and will exhibit low to moderate strength and moderately high compressibility characteristics under the anticipated loading range. Detailed results of the tests are maintained within our files and can be transmitted to you, upon your request.

4.0 GEOLOGIC & SEISMIC CONDITIONS

4.1 Geologic Setting

The subject site is located in the west-central portion of Weber County in north-central Utah. The site sits at an elevation of approximately 4,232 feet above sea level. The site is located in the north-central portion of a valley bound by the Wasatch Mountains on the east and Antelope Island (Great Salt Lake) and the Promontory Mountains to the west. The Valley is a deep, sediment-filled basin that is part of the Basin and Range Physiographic Province. The valley was formed by extensional tectonic processes during the Tertiary and Quaternary geologic time periods. The Valley is located within the Intermountain Seismic Belt, a zone of ongoing tectonism and seismic activity extending from southwestern Montana to southwestern Utah. The active (evidence of movement in the last 10,000 years) Wasatch Fault Zone is part of the Intermountain Seismic Belt and extends from southeastern Idaho to central Utah along the western base of the Wasatch Mountain Range.

Much of northwestern Utah, including the valley in which the subject site is located, was also previously covered by the Pleistocene age Lake Bonneville. The Great Salt Lake, located along the western margin of the valley and beyond, is a remnant of this ancient fresh water lake. Lake Bonneville reached a high-stand elevation of approximately 5,092 feet above sea level at between 18,500 and 17,400 years ago. Approximately 17,400 years ago, the lake breached its basin in southeastern Idaho and dropped relatively fast, by almost 300 feet, as water drained into the Snake River. Following this catastrophic release, the lake level continued to drop slowly over time, primarily driven by drier climatic conditions, until reaching the current level of the Great Salt Lake. Shoreline terraces formed at the high-stand elevation of the lake and several subsequent lower lake levels are visible in places on the mountain slopes surrounding the valley. Much of the sediment within the Valley was deposited as lacustrine sediments during both the transgressive (rise) and regressive (fall) phases of Lake Bonneville.

A geologic map that includes the location of the subject site has been completed by Harty and others[1]. A portion of the geologic map including the site, is provided below as **figure 3**. The surficial geology at the location of the subject site and adjacent properties is mapped as “Delta deposits” (Map Unit Qd_2) dated to be lower Holocene. No fill has been mapped at the location of the site on the geologic map. Unit Qd_2 is described on the referenced map as “Silt, fine sand, and clay deposited in a platform-like topographic form with an upper-surface elevation of about 1292 meters (4240 ft) (about 8 meters [25 feet] above modern Weber River flood plain); scattered pebble gravel covers the surface of the platform in some areas; deposited during transgression of the post-Gilbert Great Salt Lake shoreline between about 9.7 and 9.4 ka (Murchison, 1989; Sack, 2005); relates to the lower Holocene high water level; northwestern boundary of Qd_2 at Plain City is cut by a well-defined, sublinear upper Holocene shoreline at 1287 meters (4221 ft), and traceable for about 4.8 kilometers (3.0 mi) along the ground surface; formed between 2.5 and 2.0 ka, remnants of this shoreline are exposed elsewhere in the Lake Bonneville basin and are considered to mark Great Salt Lake’s upper Holocene high water level (Sack, 2005); Qd_2 is dissected by and thus predates Qal_2 deposits; total thickness about 3 to 6 meters (10–20 ft).”

---

[1] Harty, K.M., Lowe, M., and Kirby, S.M., 2012, Geologic Map of the Plain City Quadrangle, Weber and Box Elder Counties, Utah; Utah Geological Survey Map 253DM, Scale 1:24,000.

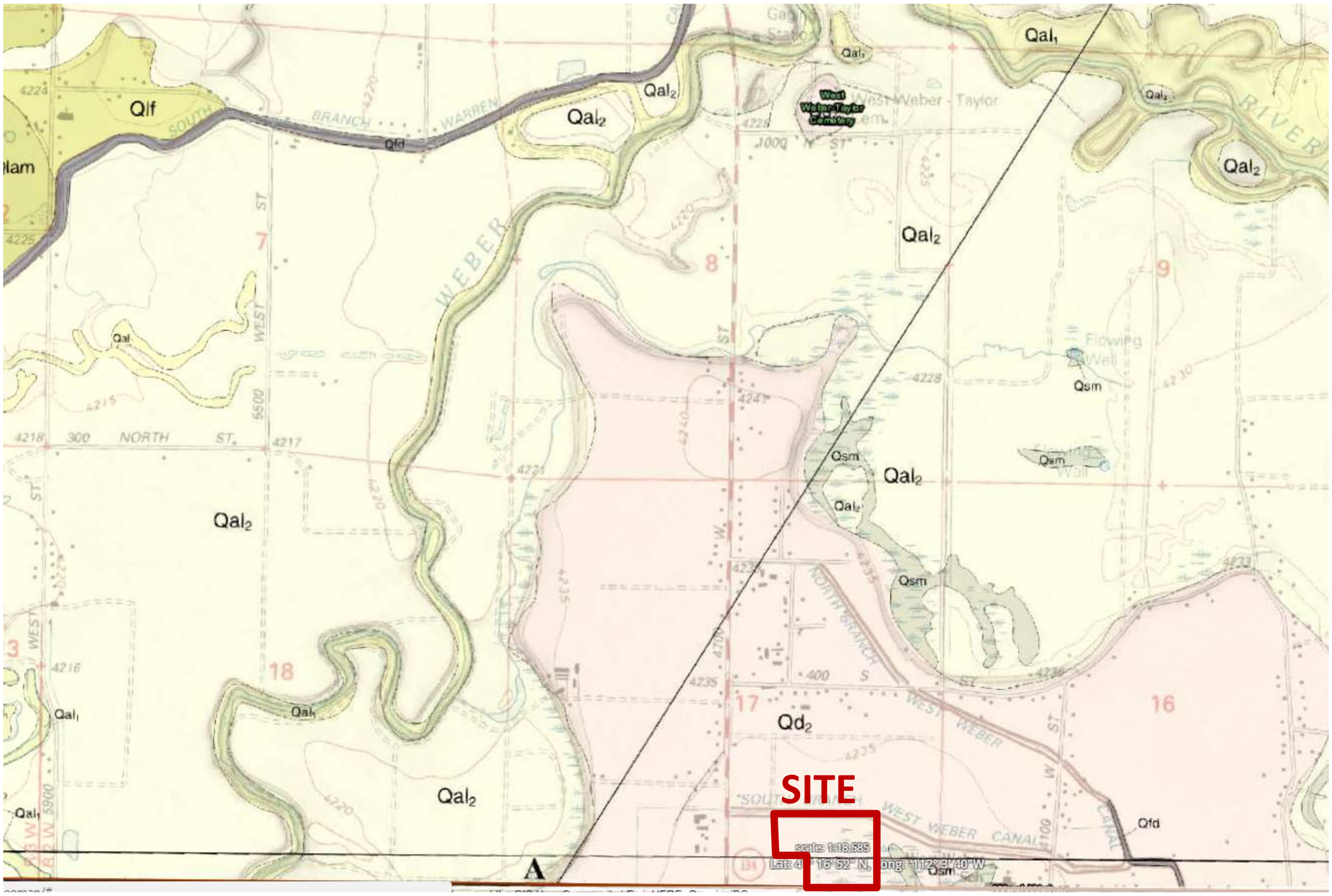


Figure 3, Geologic Map

4.2 Faulting

No surface fault traces are shown on the referenced geologic map crossing, adjacent to, or projecting toward the subject site. The nearest mapped active fault trace is the Weber segment of the Wasatch fault located about 7.4 miles east of the site.

4.3 Seismicity

4.3.1 Site Class

Utah has adopted the International Building Code (IBC) 2015. IBC 2015 determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (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 2015 (Section 1613.3.2) refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[2] 7. Given the subsurface soils at the site, including our projection of soils within the upper 100 feet of the soil profile, it is our opinion the site best fits Site Class D – Stiff Soil Profile, which we recommend for seismic structural design.

---

[2] American Society of Civil Engineers

4.3.2 Ground Motions

The 2008 USGS mapping utilized by the IBC provides values of peak ground, short period and long period accelerations for the Site Class B boundary and the Maximum Considered Earthquake (MCE). This Site Class B boundary represents average bedrock values for the Western United States and must be corrected for local soil conditions. The following table summarizes the peak ground, short period and long period accelerations for the MCE event, and incorporates the appropriate soil correction factor for a Site Class D soil profile at site grid coordinates of 41.250713 degrees north latitude and 112.088262 degrees west longitude:

Spectral Acceleration Value, T	Site Class B Boundary [mapped values] (g)	Site Coefficient	Site Class D [adjusted for site class effects] (g)	Design Values (g)
Peak Ground Acceleration	0.490	F_a = 1.010	0.495	0.330
Short Period Acceleration (0.2 Seconds)	S_S = 1.226	F_a = 1.010	S_{MS} = 123.800	S_{DS} = 82.533
Short Period Acceleration (1.0 Second)	S_1 = 0.409	F_v = 1.591	S_{M1} = 65.000	S_{D1} = 43.333

4.3.3 Liquefaction

The site is located in an area that has been identified by the Utah Earthquake Preparedness Information Center Utah Division of Comprehensive Emergency Management for Weber County as having “high” liquefaction potential. Liquefaction is defined as the condition when saturated, loose, sandy soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event. Clayey soils, even if saturated, will generally not liquefy during a major seismic event.

A liquefaction study was not completed as part of this study and would require drilling with Standard Penetration Test sampling (SPT) to a minimum depth of 30 feet below the ground surface and/or Cone Penetrometer Testing (CPT) in order to evaluate the saturated sand soils.

4.4 Other Geologic Hazards

No landslide deposits or features, including lateral spread deposits, are mapped on or adjacent to the site. The site is not located within a currently known or mapped potential debris flow, stream flooding, or rock fall hazard area.

5.0 SITE CONDITIONS

5.1 Surface Conditions

The site is currently vacant, undeveloped land. Based upon aerial photos dating back to 1993 that are readily available on the internet, the property has remained relatively unchanged. Between 2014 and 2015, a barn looking structure was constructed to the northwest. Overall, the site is relatively flat with a slight slope downward to the west, and locally- hummocky. The site is bordered northwest by a barn like structure; to the west by similar vacant property followed by 4700 West Street; to the south by 900 South Street followed by some residential construction; and to the north, east, by similar vacant, undeveloped land (see **Figure 1** in **Section 1.1** above).

5.2 Subsurface Soils

The subsurface soils encountered varied slightly across the site. At each test pit. the upper about 6 inches of soil was loose with the top about 3 to 4 inches containing major roots/topsoil. In general, a surface layer of silty clay was encountered at most of the test pits extending to depths ranging from about 3.0 to 11.0 feet below the ground surface underlain by sand with varying silt and clay content. The underlying sand layer was often broken up by additional clay layers up to several feet thick. At test pit TP-1, sandy silt was encountered at the surface to about 10 feet underlain by clayey sand extending down to the full depth penetrated, about 13.0 feet.

The natural silt and clay soils encountered were soft to medium stiff, moist to saturated, brown in color, slightly moderate to moderately over consolidated and will exhibit low to moderate strength and moderately high compressibility characteristics under planned loading.

The natural sand soils were generally loose to medium dense, saturated, brown in color, and will exhibit moderately high strength and low compressibility characteristics under planned static loading.

For a more descriptive interpretation of subsurface conditions, please refer to the test pit logs, **Figures 4 through 17**, which graphically represent the subsurface conditions encountered. The lines designating the interface between soil types on the logs generally represent approximate boundaries; in situ, the transition between soil types may be gradual.

5.3 Groundwater

During the excavation process groundwater was visibly noted within the test pits completed on September 1, 2017 at depths ranging between about 3.0 to 5.0 feet below the existing ground surface of the site. Stabilized/static groundwater was measured within installed PVC pipes at the test pit locations on September 15 & 25, 2017. The stabilized/static water levels are tabulated on the following page:

Test Pit No.	Static Groundwater Level Below Existing Grade (feet)
	September 15 & 25, 2017
TP-1	5.5
TP-2	3.9
TP-3	Pipe was installed but was damaged
TP-4	4.7
TP-5	3.8
TP-6	2.0
TP-7	2.8
TP-8	1.8
TP-9	2.8
TP-10	2.7
TP-11	1.9
TP-12	2.4
TP-13	2.8
TP-14	6.6

Seasonal and longer-term groundwater fluctuations of 1 to 2 feet should be anticipated. The highest seasonal levels will generally occur during the late spring and summer months. The contractor must be prepared to dewater excavations. Numerous other factors such as heavy precipitation, irrigation of neighboring land, and other unforeseen factors, may also influence ground water elevations at the site. The detailed evaluation of these and other factors, which may be responsible for ground water fluctuations, is beyond the scope of this study.

5.4 Design Groundwater

Very shallow static groundwater was measured following excavations for this project. As a result, further measures will be required to control groundwater levels within the development if sublevels are desired, such as the construction of a land drain system throughout the development. If a land drain is not constructed within the development, then the lowest habitable floor slab embedment should be kept a minimum of 3.0 feet above measured static groundwater levels indicated above in Section 4.5, Groundwater. Further if a land drain is not installed then the static groundwater level must be determined on each individual lot and minimum floor slab elevations determined based on the depth to groundwater.

5.5 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 soils, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory locations.

Also, when logging and sampling of the test pits was completed, the test pits were backfilled with the excavated soils but minimal to no effort was made to compact these soils. Thus, settlement of the backfill in the test pits over time should be anticipated.

6.0 SITE PREPARATION AND GRADING

6.1 General

Initial site preparation will consist of the removal of surface vegetation, topsoil, any other deleterious materials, non-engineered fills, if encountered, and loose/disturbed surface soils from beneath an area extending out at least 3 feet from the perimeter of the proposed homes buildings and 2 feet beyond pavements and exterior flatwork areas. Existing ditches/waterways/surface drainages will likely need to be piped and/or abandoned to allow for new construction.

Due to shallow groundwater conditions, we strongly recommend that land drains, if utilized, as well as major utilities be installed as far in advance as possible prior to roadway and residential construction. Further it is recommended that site grading cuts be kept to the minimum to remove vegetation, topsoil, disturbed soils and any other unsuitable soils. Ideally roadway structural sections would be designed at least two feet above the groundwater level to reduce potential subgrade stabilization needs. The earthwork contractor must be prepared to dewater and likely begin dewatering prior to major excavating. Further, some stabilization of very moist to saturated subgrade soils must be anticipated. Stabilization recommendations are provided later in this report.

Subsequent to stripping and prior to the placement of structural site grading fill, pavements, floor slabs, or footings, the exposed subgrade shall be proofrolled by running moderate-weight rubber tire-mounted construction equipment uniformly over the surface at least three times. An exception to this would be where the exposed subgrade is within 2 feet of groundwater. If excessively soft or otherwise unsuitable soils are encountered beneath footings, they must be totally removed and/or stabilized. If removal depth required is more than 2 feet or at groundwater level, CMT must be notified to provide additional recommendations. In pavement, outside flatwork areas, and in most cases below floor slab, unsuitable natural soils shall be removed to a maximum depth of 2 feet and replaced with compacted granular structural fill. Additional removal below floor slabs may be required depending on conditions encountered.

Surface vegetation and other deleterious materials should generally be removed from the site. Topsoil, although unsuitable for utilization as structural fill, may be stockpiled for subsequent landscaping purposes.

A representative of CMT must verify that suitable natural soils and/or proper preparation of existing soils have been encountered/met prior to placing site grading fills, footings, slabs, and pavements.

6.2 Temporary Excavations

Groundwater was measured at the test pit locations between 1.8 and 6.6 feet below the existing ground surface. We anticipate that utility and possible foundation excavations will encounter groundwater, and dewatering of such excavations will likely be required.

In cohesive (clayey) soils, temporary construction excavations not exceeding 4 feet in depth may be constructed with near-vertical side slopes. Temporary excavations up to 8 feet deep, above or below groundwater, may be constructed with side slopes no steeper than one-half horizontal to one vertical (0.5H:1V). Excavations deeper than 8 feet are not anticipated at the site.

For granular (cohesionless) soils, construction excavations 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 sideslopes and/or shoring, bracing and dewatering as these soils will tend to flow into the excavation. Where excavations are known to extend below groundwater it is recommended that dewatering begin as far in advance and reasonably possible to help facilitate the excavation process. Even with dewatering, adjacent saturated clean sand soils may flow into the excavation. Temporary shoring of excavations must be anticipated.

To reduce disturbance of the natural soils during excavation, we recommend that smooth edge buckets/blades be utilized.

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.

6.3 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.

Following are our recommendations for the various fill types we anticipate will be used at this site:

Fill Material Type	Description/Recommended Specification
Structural Fill	Placed below structures, flatwork and pavement. 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 40% 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 (see discussion below).
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 600X, or equivalent (see **Section 6.4**).

On-site sand soils, may be re-utilized as structural site grading fill if they meet the requirements of such. However, again as stated previously, with the shallow depth to groundwater, the natural sand soils are likely above optimum moisture content and would therefore require drying prior to recompacting to bring the percent moisture down to near optimum. Further, this may be extremely difficult especially during periods of precipitation or during colder periods of the year.

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

6.4 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[3] T-180) in accordance with the following recommendations:

---

[3] American Association of State Highway and Transportation Officials

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 below flatwork and pavement (applies to structural fill and site grading fill)	0 to 5 5 to 8	95 98
Site grading fill outside area defined above	0 to 5 5 to 8	92 95
Utility trenches within structural areas	--	96
Roadbase and subbase	-	96
Non-structural fill	0 to 5 5 to 8	90 92

Structural fills greater than 8 feet thick (thicker fill sequence up to 8 feet anticipated for trench backfill) are not anticipated at the site. If required site grading fills to raise the site are greater than 3 feet, CMT must be notified to review settlement calculations.

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.

6.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill shall be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling shall be performed by passing moderately loaded rubber tire-mounted construction equipment uniformly over the surface at least twice. If excessively loose or soft areas are encountered during proofrolling, they shall be removed to a maximum depth of 2 feet below design finish grade and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1a or A-1b (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over utilities within public right away. These organizations are also requiring that in public roadways the backfill over major utilities be compacted over the full depth of fill to at least 96 percent of the maximum dry density as determined by the AASHTO T-180 (ASTM D-1557) method of compaction.

In private areas, natural soils may be re-utilized as trench backfill over the bedding layer provided that they are properly moisture prepared and compacted to the minimum requirements stated in section 6.4 Fill Placement and Compaction above.

Where the groundwater is shallow the utility installation contractor must be prepared to dewater and consider possible other measures to maintain the required excavation.

6.6 Stabilization

The very moist to wet natural silt/clay/fine sand soils at this site will likely be susceptible to rutting and pumping. The likelihood of disturbance or rutting and/or pumping of the existing natural soils is a function of the load applied to the surface, as well as the frequency of the load. Consequently, rutting and pumping can be minimized by avoiding concentrated traffic, minimizing the load applied to the surface by using lighter equipment and/or partial loads, by working in drier times of the year, or by providing a working surface for the equipment. Rubber-tired equipment particularly, because of high pressures, promotes instability in moist/wet, soft soils.

To stabilize soft soil conditions, coarse angular gravel and cobble mixtures (stabilizing fill) may be utilize and spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the stabilizing fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately compacted so that the “fines” are “worked into” the voids in the underlying coarser gravels and cobbles.

As indicated previously a mixture of coarse, clean, angular gravels and cobbles and/or 1.5- to 2.0-inch clean gravel is recommended as stabilization fill. Often the amount of gravelly material can be reduced with the use of a geotextile fabric such as Mirafi RS280i or 600X, 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.

7.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics, the subsurface conditions observed in the field and the laboratory test data, as well as common geotechnical engineering practice.

7.1 Foundation Recommendations

The results of our analyses indicate that the proposed structures may be supported upon conventional spread and/or continuous wall foundations established upon suitable natural soils or granular structural fill extending to suitable natural soils. Due to shallow groundwater present at the site some stabilization of the exposed very moist to saturated natural soils below footings may be required and must be anticipated. For design, with respect to the proposed construction and anticipated loading given in Section 1.3, Description of Proposed Construction, the following parameters are recommended:

Minimum Recommended Depth of Embedment for Frost Protection - 30 inches

Minimum Recommended Depth of Embedment for Non-frost Conditions - 15 inches

Recommended Minimum Width for Continuous Wall Footings - 18 inches

Minimum Recommended Width for Isolated Spread Footings - 24 inches

Recommended Net Bearing Pressure for Real Load Conditions on Suitable Natural Soil - 1,500 pounds* per square foot

Bearing Pressure Increase for Seismic Loading - 30 percent

* Saturated subgrade soils below footings may require stabilization with coarse angular gravel/cobble fill as described in section **6.6 Stabilization** above.

The term "net bearing pressure" refers to the pressure imposed by the portion of the structure located above lowest adjacent final grade. Therefore, the weight of the footing and backfill to lowest adjacent final grade need not be considered. Real loads are defined as the total of all dead plus frequently applied live loads. Total load includes all dead and live loads, including seismic and wind.

7.2 Installation

Under no circumstances shall the footings be established upon non-engineered fills, loose or disturbed soils, topsoil, sod, rubbish, soft/poorly consolidated clay soils, 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.

Where shallow groundwater was encountered at the site, dewatering of the footing trenches may be necessary. To reduce stabilization needs, dewatering the site area a minimum of 2 feet below the bearing elevation should significantly help.

7.3 Estimated Settlement

Foundations designed and constructed in accordance with our recommendations could experience some settlement, but we anticipate that settlement of footings founded as recommended above will be 1 inch or less. We expect approximately 50 percent of initial settlement to take place during construction.

If site grading fills are required in greater thickness than 3 feet CMT must be notified to review settlements.

7.4 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 0.30 for natural clay soils or 0.40 for granular structural fill, may be utilized for design. Passive resistance provided by properly placed and compacted structural fill above the water table may be considered equivalent to a fluid with a density of 250 pcf. A combination of passive earth resistance and friction may be utilized if the friction component of the total is divided by 1.5.

8.0 LATERAL EARTH PRESSURES

The structures are anticipated to be constructed slab on grade. However, for shallow retaining walls or utility boxes up to 4 feet tall the following lateral pressure discussion is provided. Parameters, as presented within this section, are for backfills which will consist of drained on-site 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), granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot in computing lateral pressures. For more rigid sublevel walls that are not more than 10 inches thick, granular backfill may be considered equivalent to a fluid with a density of 55 pounds per cubic foot. For very rigid non-yielding walls, backfill should be considered equivalent to a fluid with a density with at least 65 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is horizontal and that the fill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

For seismic loading of retaining/below-grade walls up to 4 feet tall, the following uniform lateral pressures, in pounds per square foot (psf), should be added based on wall depth and wall case:

Uniform Lateral Pressures			
Wall Height (Feet)	**Active Pressure Case (psf)**	**Moderately Yielding Case (psf)**	**At Rest/Non-Yielding Case (psf)**
4	28	55	83

9.0 FLOOR SLABS

Floor slabs may be established upon suitable natural soils and/or upon structural fill extending to suitable natural soils. Under no circumstances shall floor slabs be established directly over non-engineered fills, 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.

The tops of all floor slabs in habitable areas must be established at least 3 feet above the measured static water level or a minimum 18 inches above levels controlled by subdrains.

10.0 DRAINAGE RECOMMENDATIONS

10.1 General Drainage Recommendations

It is 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 structures should be sloped to provide drainage away from the foundations. Where possible 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.

10.2 Subdrains

10.2.1 General

Groundwater at this site is shallow and variable across the site. If habitable floor slabs are to be placed less than 3.0 feet above measured groundwater then a foundation drain tied to a suitable down gradient land drain or another disposal system must be installed. Due to the variance in measured groundwater levels, it is recommended that the depth to groundwater be determined for each individual home if a land drain is not installed.

10.2.2 Foundation Subdrains

Foundation subdrains shall at a minimum consist of a 4-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel surrounding the home foundation. The invert of the subdrain should be at least 18 inches below the top of the lowest adjacent floor slab. The gravel portion of the drain should extend 2 inches laterally and below the perforated pipe and at least 1 foot above the top of the lowest adjacent floor slab. The gravel zone must be installed immediately adjacent to the perimeter footings and the foundation walls. To reduce the possibility of plugging, the gravel with drain pipe must be wrapped with a geotextile, such as Mirafi 140N or equivalent.

Above the subdrain, a minimum 12-inch-wide zone of “free-draining” sand/gravel should be placed adjacent to the foundation walls and extend to within 1.5 feet of final grade and similarly separated from adjacent soils with a geotextile such as Mirafi 140N or equivalent. The upper 1.5 foot of soils should consist of a compacted low permeable soil where possible to reduce surface water infiltration into the drain. As an alternative to the zone of permeable sand/gravel, a prefabricated “drainage board,” such as Miradrain or equivalent, may be placed adjacent to the exterior below-grade walls. Prior to the installation of the footing subdrain, the below-grade walls should be heavily dampproofed/waterproofed. The slope of the subdrain should be at least 0.3 percent. The gravel placed around the drain pipe should be clean 0.75-inch to 1.0-inch minus gap-graded gravel and/or “pea” gravel. The foundation subdrains can be discharged into the area subdrains, storm drains, or other suitable down-gradient location. Further it is recommended that a minimum 8 inches of gravel be placed below the floor slab which is hydraulically tied to the perimeter foundation drain through either drain pipes or a minimum 4-inch gravel layer extending out and below the foundation and connecting to the perimeter drain.

Proper grading shall be completed around the home with a minimum 5 percent drop within the first 10 feet away from the home.

11.0 PAVEMENTS

We anticipate the natural fine-grained surface soils will exhibit poor pavement support characteristics when saturated or nearly saturated. Based on our laboratory testing experience with similar soils, our pavement design utilized a California Bearing Ratio (CBR) of 3 for the natural clay soils and an average daily equivalent single axle load over a 20-year period (ESAL) of 6.0. The sections provided also assume that proper on-going maintenance be completed over the pavement lifetime.

.

Table 1: Pavement Design (New Residential Streets)

Material	Pavement Section Thickness (in)
Asphalt	**3.0**
Road-Base	**13**
Total Thickness	**16.0**
or	
Asphalt	**3.0**
Road-Base	**7**
Subbase	**8**
Total Thickness	**18.0**

*Subgrade should be proof-rolled

Prior to placing subbase, the subgrade must be properly prepared as outlined in **Section 6.1** of this report. Subbase shall consist of a granular soil meeting a minimum CBR or 30 percent. Roadbase/Untreated base course (UTBC) should conform to city or 1”-minus UDOT specifications and have a CBR value greater than 70 percent. Asphalt should conform to the standard city or UDOT specification.

The asphalt pavement should be compacted to 96% of the maximum density for the asphalt material. Roadbase and subbase material shall be compacted as outlined in **Section 6.4** Fill Placement and Compaction of this report.

12.0 QUALITY CONTROL

We recommend that CMT be retained to as part of a comprehensive quality control testing and observation program for which we can offer discounted rates. With CMT onsite we can help facilitate implementation of our recommendations and address, in a timely manner, any subsurface conditions encountered which vary from those described in this report. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This program may include, but not necessarily be limited to, the following:

12.1 Field Observations

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

12.2 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 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.

12.3 Excavations

All excavation procedures and processes should be observed by a geotechnical engineer from CMT or his representative. In addition, for the recommendations in this report to be valid, all backfill and structural fill placed in trenches and all pavements should be density tested by CMT. We recommend that freshly mixed concrete be tested by CMT in accordance with ASTM designations.

12.4 Vibration Monitoring

Construction activities, particularly site grading and fill placement, can induce vibrations in existing structures adjacent to the site. Such vibrations can cause damage to adjacent buildings, depending on the building composition and underlying soils. It can be prudent to monitor vibrations from construction activities to maintain records that vibrations did not exceed a pre-defined threshold known to potentially cause damage. CMT can provide this monitoring if desired.

13.0 LIMITATIONS

The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. The exploration logs reflect the subsurface conditions only at the specific location at the particular time designated on the 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. 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) 870-6730. To schedule materials testing, please call (801) 381-5141.

APPENDIX

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-1

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 5'
Water Depth: 5', 5.5'

Date: 9/1/17
Job #: 10241

Depth (ft)	Soil Description		Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI
0	TOPSOIL, 3"	loose to 6"										
	Brown Fine Sandy SILT (ML)	moist, soft to medium stiff										
2												
			ǁ	1	96.7	96.7			82.9			
4												
		wet										
6			◣	2								
8												
	grades with occasional thin clay layers											
10	Brown Fine SAND (SC)	saturated, medium dense										
	clay layers grade out											
12			◣	3								
	END AT 13'											
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 5 feet and measured on 9/15/17 at depth of 5.5 feet.
Slotted PVC pipe installed to depth of 12.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
4

Terakee Village

Test Pit Log

TP-2

About 4700 West 900 South, West Weber, Weber County, Utah

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 5'
Water Depth: 5', 3.9'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		TOPSOIL, 3" loose to 6"										
		Brown Silty Fine SAND (SM)										
2		Brown Silty CLAY (CL), with some fine sand moist, medium stiff										
			‖	4								
▼ 4 ▽												
			◢	5								
6		Brown Fine SAND (SC) with numerous silty clay layers up to 5" thick wet, medium dense										
8												
			◢	6								
10		END AT 10'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 5 feet and measured on 9/15/17 at depth of 3.9 feet.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
5

Terakee Village

About 4700 West 900 South, West Weber, Weber
County, Utah

Test Pit Log

TP-3

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 4'
Water Depth: 4'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	TOPSOIL, 3" loose to 6"										
	▨	Brown Silty CLAY (CL), with some fine sand very moist, soft										
2	▨		‖	7	28.9	94			71.7			
▽ 4	▨	wet										
	⁙	Brown Silty Fine SAND (SM) wet, medium dense										
6	⁙		◣	8								
8	⁙											
	⁙		◣	9								
10		END AT 10'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 4 feet. Pipe destroyed after drilling.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure: 6

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-4

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 4'
Water Depth: 4', 4.7'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI
0	⁘	TOPSOIL, 3" loose to 6"										
	▨	Brown Silty CLAY (CL), with some fine sand very moist, soft										
2	▨		‖	10	23.1	101			82.4			
4 ▽ ▼	▨	wet										
6	▨	Brown Fine Clayey SAND (SC) wet, loose to medium dense										
8	▨		◣	11								
10		END AT 10'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 4 feet and measured on 9/15/17 at depth of 4.7 feet.
Slotted PVC pipe installed to depth of 8.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
7

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-5

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 4.5'
Water Depth: 4.5', 3.8'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	TOPSOIL, 3" loose to 6"										
	▨	Brown Silty CLAY (CL), with some fine sand very moist, soft										
2	▨											
	▨		‖	12	22.3	98				27	18	9
4	▨	wet										
6	▨											
8	▩	Brown Fine Clayey SAND (SC) wet, loose to medium dense										
	▨	Brown Silty CLAY (CL), with some fine sand wet, medium stiff										
10	▨		◣	13								
		END AT 11'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 4.5 feet and measured on 9/15/17 at depth of 3.8 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
8

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-6

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):
Total Depth: 3'
Water Depth: 3', 2'
Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	TOPSOIL, 3" loose to 6"										
2 ▼ ▽	▨	Brown Silty CLAY (CL), with some fine sand very moist, medium stiff	ǁ	14								
4	⁘	Brown Silty Fine SAND (SM) wet wet, medium dense										
6 8 10 12	▨	Brown Silty CLAY (CL), with some fine sand wet, medium stiff grades with numerous thin fine sand layers	◢	15	29.5				80.2	27	19	8
14 16 18 20 22 24 26 28		END AT 13'										

Remarks: Groundwater encountered during drilling at depth of 3 feet and measured on 9/15/17 at depth of 2 feet.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
9

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-7

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 3'
Water Depth: 3', 2.8'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0	⁘	TOPSOIL, 3" loose to 6"										
2	▨	Brown Silty CLAY (CL), with some fine sand moist, medium stiff										
▼	▨	wet	◣	16								
4 6	▨											
	▨	Brown Fine Clayey SAND (SC) wet, medium dense										
8	▨	Brown Silty CLAY (CL), with some fine sand wet, medium stiff										
	▨	Brown Fine Clayey Sand (SC) wet, medium dense	◣	17								
10		END AT 10'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 3 feet and measured on 9/15/17 at depth of 2.8 feet.
Slotted PVC pipe installed to depth of 8.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
10

Terakee Village

About 4700 West 900 South, West Weber, Weber
County, Utah

Test Pit Log

TP-8

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 4'
Water Depth: 4', 1.8'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		TOPSOIL, 3" loose to 6"										
		Brown Silty CLAY (CL), with some fine sand very moist, medium stiff										
▼ 2												
▽ 4		wet, soft	‖	18	36	85						
6												
		Brown Fine Clayey SAND (SC) wet, loose to medium dense										
8			◣	19								
10		Brown Silty CLAY (CL), with some fine sand wet, medium stiff										
12		END AT 12'										
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 4 feet and measured on 9/25/17 at depth of 1.8 feet.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
11

Terakee Village

Test Pit Log

TP-9

About 4700 West 900 South, West Weber, Weber County, Utah

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 10'
Water Depth: 3', 2.8'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description		Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
								Gravel %	Sand %	Fines %	LL	PL	PI
0	⁘	TOPSOIL, 3"	loose to 6"										
	▨	Brown Silty CLAY (CL), with some fine sand	very moist soft										
2	▨												
▼	▨			‖	20	32.1	90			90.8			
	▨		wet										
4	▨												
	▨	Brown Fine Clayey SAND (SC) with occasional layers of silty clay up to 4" thick	wet, loose to medium dense										
6	▨			◢	21								
8	▨												
	▨			◢	22								
10		END AT 10'											
12													
14													
16													
18													
20													
22													
24													
26													
28													

Remarks: Groundwater encountered during drilling at depth of 3 feet and measured on 9/25/17 at depth of 2.8 feet.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
12

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-10

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 10'
Water Depth: 3', 2.7'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	 Sand %	 Fines %	Atterberg LL	 PL	 PI
0		TOPSOIL, 3" loose to 6"										
		Brown Silty CLAY (CL), with some fine sand very moist, soft										
2												
▼		wet										
4			‖	23	31.1	93						
6												
		Brown Fine Clayey SAND (SC), with interbedded clay layers up to 5" thick wet, medium dense										
8			◣	24								
		Brown Silty CLAY (CL), with some fine sand wet, medium stiff										
10		END AT 10'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 3 feet and measured on 9/25/17 at depth of 2.7 feet.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
13

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-11

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 8.5'
Water Depth: 3', 1.9'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	⁙	TOPSOIL, 3" loose to 6"										
2 ▼ ▽	▨	Brown Silty CLAY (CL), with some fine sand very moist, soft										
	▨	wet	▯	25	26.5	91						
4	▨											
	▨	Brown Fine Clayey SAND (SC), with interbedded clay layers wet, medium dense										
6	▨		◢	26								
	⁝	Brown Fine SAND (SM/SP), with some silt wet, medium dense										
8	⁝		◢	27	31				10.3			
		END AT 8.5'										
10												
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 3 feet and measured on 9/25/17 at depth of 1.9 feet.
Slotted PVC pipe installed to depth of 8.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
14

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Test Pit Log

TP-12

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 10'
Water Depth: 3', 2.4'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI
0	▨	Brown Silty CLAY/Clayey SILT (CL/ML), with some fine sand very moist, soft										
2	▨											
	▨	wet	‖	28	28.6	97.1				25	19	6
4	▨											
6	▨											
	▨	Brown Fine Clayey SAND (SC), with occasional clay layers wet, medium dense										
8	▨		◣	29								
	▨	Brown Silty CLAY (CL), with some fine sand wet, medium stiff										
10		END AT 10'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 3 feet and measured on 9/25/17 at depth of 2.4 feet.
Slotted PVC pipe installed to depth of 8.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright

Figure:
15

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

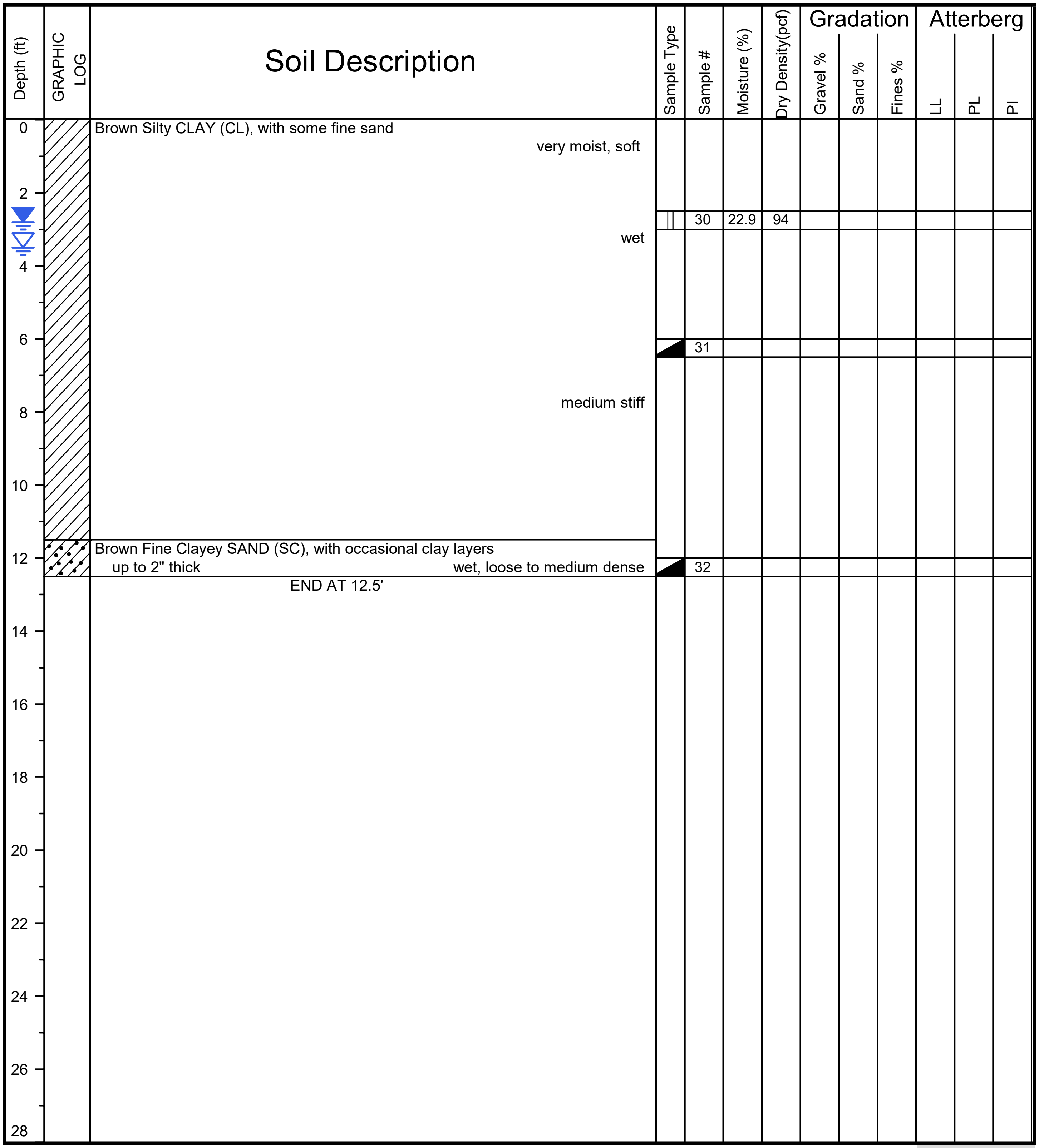
Test Pit Log

TP-13

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 12.5'
Water Depth: 3.5', 2.8'

Date: 9/1/17
Job #: 10241



Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	▨	Brown Silty CLAY (CL), with some fine sand very moist, soft										
2	▨		‖	30	22.9	94						
▼ ▽	▨	wet										
4	▨											
6	▨		◣	31								
8	▨	medium stiff										
10	▨											
12	▨	Brown Fine Clayey SAND (SC), with occasional clay layers up to 2" thick wet, loose to medium dense	◣	32								
		END AT 12.5'										
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 3.5 feet and measured on 9/25/17 at depth of 2.8 feet.
Slotted PVC pipe installed to depth of 11.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
16

Terakee Village

Test Pit Log

TP-14

About 4700 West 900 South, West Weber, Weber County, Utah

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 10.5'
Water Depth: 3', 6.6'

Date: 9/1/17
Job #: 10241

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	▨	Brown Silty CLAY (CL), with some fine sand very moist, stiff										
2	▨		‖	33	21.2	98.4				27	17	10
▽	▨	wet										
4	▨											
	▨		◤	34								
6 ▼	▨											
8	▨	Brown Fine Silty SAND (SM), with occasional clay layers up to 2" thick medium dense										
10	▨		◤	35	20.7				2.9			
		END AT 10.5'										
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater encountered during drilling at depth of 3 feet and measured on 9/25/17 at depth of 6.6 feet.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright
Page: 1 of 1

Figure:
17

Terakee Village

About 4700 West 900 South, West Weber, Weber County, Utah

Key to Symbols

Date: Todd Nelson
Job #: 10241

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

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.
Saturated: 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:
18