

GEOTECHNICAL ENGINEERING STUDY

Bertoldi Property

1800 South about 3900 West
West Weber, Utah

Prepared For:

Mr. Ray L. Bertoldi
1530 N. Church Street
Layton, UT 84041

CMT Project No. 10878
March 7, 2018

Engineering

Geology

Environmental (ESA I & II)

Organic Chemistry

Materials Testing

Special Inspections

CMT ENGINEERING LABORATORIES

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Subject: Geotechnical Engineering Study
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CMT Project Number: 10878

Mr. Bertoldi:


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.

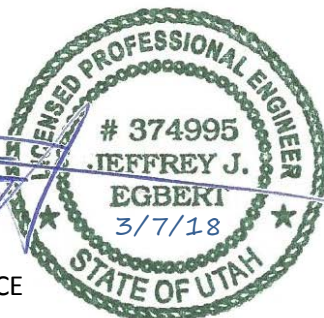
On February 7, 2018, a CMT Engineering Laboratories (CMT) engineer was on-site and supervised the excavation of 12 test pits extending to depths of about 9.0 to 12.0 feet below the existing ground surface. Soil samples were obtained during the field operations and subsequently transported to our laboratory for further testing and observation. Groundwater was encountered at very shallow depths.

Conventional spread and/or continuous footings may be utilized to support the proposed residences, 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 offices throughout Utah and 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) 870-6730.

Sincerely,
CMT Engineering Laboratories


Jeffrey J. Egbert, P.E., LEED A.P., M. ASCE
Senior Geotechnical Engineer



Reviewed by:


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

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1.0 INTRODUCTION

1.1 General

CMT Engineering Laboratories (CMT) was retained to conduct a geotechnical subsurface study for the proposed development of approximately 40 acres as a residential subdivision. The parcel is situated on the north side of 1800 South Street at about 3900 West in West Weber, Utah, as shown in the **Vicinity Map** below.



Vicinity Map

1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Mr. Bill Frandsen, 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/sampling of 12 test pits, performing laboratory testing on representative samples, and conducting an office program, which consisted of correlating available data, performing engineering analyses, and preparing this summary report.

1.3 Description of Proposed Construction

We understand that the proposed structures will be single family residences which we project will have one to two levels of wood frame construction above grade, with a possible single level of reinforced concrete below or partially below grade (basement) if conditions allow. 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. Floor slab loads are anticipated to be relatively light, with an average uniform loading not exceeding 100 pounds per square foot. 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.

We anticipate that asphalt-paved residential streets will be constructed as part of the development. Traffic is projected to consist of a light volume of automobiles and pickup trucks, a few weekly medium-weight delivery trucks, a weekly garbage truck, daily school buses, and an occasional fire truck.

Site development will require some earthwork in the form of minor cutting and filling. 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 are projected to be on the order of 2 to 3 feet. Larger cuts and fills may be required in isolated areas. If deeper cuts or fills are planned, CMT should be notified to provide additional recommendations, if needed.

1.4 Executive Summary

Our evaluation indicates that proposed residences can be supported upon conventional spread and continuous wall foundations established upon suitable, undisturbed, natural soils and/or upon structural fill extending to suitable natural soils. Further, some periodic stabilization of exposed bearing subgrade must be anticipated due to shallow groundwater.

The most significant geotechnical aspects regarding site development include the following:

1. Up to 4 inches of clayey sandy topsoil blankets the site, which will require removal beneath structures;
2. Relatively shallow groundwater which will limit the practical depth of subgrade floor slabs (basements);
and
3. Clay and sand layers easily disturbed by construction activities which may require stabilization.

Static groundwater was measured on February 27, 2018 within installed pipes at the test pits completed across the site between about 2.8 and 6.5 feet below the existing ground surface. The shallow groundwater encountered at the site may 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 natural clay soils encountered within the test pits are not recommended for re-utilization as structural fill due to their high moisture content and difficulty to properly rework. Further saturated natural sand soils will require drying to near optimum moisture content in order to recompact. This will be difficult during wet and cold periods of the year. The natural soil may be re-utilized in non- structural and landscape areas.

CMT must assess that topsoil, undocumented fills, debris, disturbed or unsuitable soils have been removed and that suitable soils have been encountered prior to placing site grading fills, footings, slabs, and pavements.

In the following sections, detailed discussions pertaining to the site and subsurface descriptions, geologic/seismic setting, earthwork, foundations, lateral resistance, lateral pressure, floor slabs, and pavements are provided.

2.0 FIELD EXPLORATION

In order to define and evaluate the subsurface soil and groundwater conditions, twelve test pits were excavated with a backhoe throughout the site to depths of approximately 9.0 to 12.0 feet below the existing ground surface. Locations of the test pits are presented on **Figure 1, Site Plan**, included in the Appendix. The field exploration was performed under the supervision of an experienced member of our geotechnical staff.

Representative soil samples were collected by obtaining disturbed "grab" samples and utilizing a 2.42-inch inside diameter thin-wall drive sampler. The samples were placed in sealed plastic bags and containers prior to transport to the laboratory.

The subsurface soils encountered in the test pits were logged and described in general accordance with ASTM¹ D-2488. Soil samples were collected as described above, and were classified in the field based upon visual and textural examination. These field classifications were supplemented by subsequent examination and testing of select samples in our laboratory. Graphical representations of the subsurface conditions encountered are presented on each individual Test Pit Log, **Figures 2 through 13**, included in the Appendix. A Key to Symbols defining the terms and symbols used on the logs, is provided as **Figure 14** in the Appendix.

Following completion of exploration operations, 1.25-inch diameter slotted PVC pipe was installed in test pits TP-1 through TP-7, and TP-9 through TP-12 to allow subsequent water level measurements.

When backfilling the test pits, only minimal effort was made to compact the backfill and no compaction testing was performed. Thus, settlement of the backfill in the test pits over time should be anticipated and the backfilled materials must be considered non-engineered.

3.0 LABORATORY TESTING

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

¹American Society for Testing and Materials

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

Laboratory test results are presented on the test pit logs (**Figures 2 through 13**) and in the following Lab Summary table:

Lab Summary Table

Test Pit	Depth (feet)	Soil Class	Sample Type	Moisture Content (%)	Dry Density (pcf)	Gradation			Atterberg Limits			Collapse (-) or Expansion (+)
						Grav	Sand	Fines	LL	PL	PI	
TP-1	2.5	CL	Thin Wall	27.6	96.0							<+0.5%
TP-2	3	CL	Thin Wall	26.1	96.3			75				
TP-4	2.5	CL	Thin Wall	15.3	117.6							<+0.5%
TP-5	7.5	SM	Bag	21.8				25				
TP-6	3	SM	Bag	10.5				25				
TP-7	3	SM	Bag	10.4				24				
TP-8	2.5	SC	Bag	19.4				49	24	16	8	
TP-9	2.5	CL	Thin Wall	17.0	109.0							<+0.5%
TP-10	3	CL	Thin Wall	24.9	99.4			41				
TP-12	3	CL	Bag	19.2				50	24	16	8	

Consolidation test results indicate the natural soils at this site are moderately over-consolidated and moderately compressible under additional loading, and have a minor potential to swell when wetted. 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 between approximately 4,230 and 4,240 feet above sea level. The site is located in 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 between approximately 5,100 and 5,200 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 by almost 300 feet relatively fast 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.

The geology of the USGS Roy, Utah 7.5 Minute Quadrangle, that includes the location of the subject site, has been mapped by Sack². The surficial geology over the majority of the subject site and adjacent properties is mapped as “Early Holocene fine-grained deltaic deposits” (Map Unit Qd₂) dated to be early Holocene. On areas of the central portions of the site Unit Qd₂ is overlain by “Marsh Deposits” (Map Unit Qsm) dated to be Holocene to uppermost Pleistocene. No fill has been mapped at the location of the site on the geologic map. The referenced geologic map describes Unit Qd₂ as “Muddy to sandy fines deposited between about 9.7 and 9.4 ka. Estimated thickness 10 to 20 feet (3-6 m).” Unit Qsm is described in the referenced mapping as “Wet, fine-grained, organic-rich sediments in association with springs, ponds, and seeps. Deposited from about 12.1 ka to present. Thickness probably less than 5 feet (1.5 m).” Refer to the **Geologic Map**, shown below.



Geologic Map

²Sack, D., 2005, Geologic Map of the Roy 7.5' Quadrangle, Weber and Davis Counties, Utah; Utah Geological Survey Miscellaneous Publication, Map MP-05-03, Scale 1:24,000.

4.2 Faulting

No surface fault traces are shown on the referenced geologic map crossing or projecting toward the subject site. The nearest mapped active fault trace is the Weber segment of the Wasatch fault located about 6.75 miles northeast of the site.

The Wasatch Fault is considered a “normal” fault because movement along the fault is typically vertical. The east side of the fault, or the mountain block, typically moves upward relative to the valley block on the west side of the fault. The fault generally dips to the west below the valleys. In an earthquake, the point where the fault initially ruptures is called the “focus” and generally occurs about 10 miles below the surface. The point on the surface directly above the focus, the epicenter, typically out in the valley, is usually where the strongest ground shaking occurs. The Wasatch Fault is one of the longest and most active normal faults in the world.

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 ASCE³ 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.

4.3.2 Seismic Design Category

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 Seismic Design Categories in the International Residential Code (IRC 2015) are based upon the Site Class as addressed in the previous section. For Site Class D at site grid coordinates of 41.2364 degrees north latitude and 112.0710 degrees west longitude, S_{DS} is 0.835 and the **Seismic Design Category** is D₂.

4.3.3 Liquefaction

The site is located within an area designated by the Utah Geologic Survey⁴ 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.

³ American Society of Civil Engineers

⁴ Liquefaction Special Study Areas, Wasatch Front and Nearby Areas, Utah Geological Survey, 2008

A special liquefaction study was not performed for this site. We encountered some saturated sand layers, estimated to be in a medium dense state, which could be potentially liquefiable. Additional exploration, testing, and engineering analysis would be required to further quantify the liquefaction potential at the site.

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 known or mapped potential debris flow, stream flooding, or rock fall hazard area. The Walker Slough crosses the northwest corner of the site and is a location of surface water collection.

5.0 SITE CONDITIONS

5.1 Surface Conditions

At the time the test pits were excavated the site predominately consisted of undeveloped pasture land vegetated with grasses and weeds, with a few trees in the extreme northwest corner. The site grade was relatively flat. Based upon aerial photos readily available online dating back to 1993, the site has been pasture since that time. Open ditches were observed along the south boundary, and cutting across the northwest corner of the site. The site is bounded on the north by fields, on the south by 1800 South Street, on the east by fields and a single residence, and on the west by residential development (See **Vicinity Map** in **Section 1.1** above).

5.2 Subsurface Soils

At the locations of the test pits we encountered approximately 4 inches of clayey sandy topsoil and disturbed soils on the surface of the site. Natural soils were observed beneath the topsoil including brown CLAY (CL) with varying sand contents, and brown to gray Silty and Clayey SAND (SM, SC) layers, extending to the bottom of the test pits. The clay soils were moist to wet, and estimated to have medium stiff consistency. The sand soils were moist to wet and estimated to be in a medium dense state.

For a more descriptive interpretation of subsurface conditions, please refer to the test pit logs, **Figures 2 through 13**, 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

Groundwater was encountered in the test pits at depths of about 4 to 10 feet below existing grade at the time of our field exploration. On February 27, 2018, CMT personnel returned to the site and measured stabilized/static groundwater levels within slotted PVC pipes installed in most of the test pits. The stabilized/static water levels are tabulated on the following page:

Test Pit No.	Static Groundwater Level Below Existing Grade (feet)
	February 27, 2018
TP-1	2.8
TP-2	5.5
TP-3	6.5
TP-4	4.8
TP-5	6.4
TP-6	5.5
TP-7	5.5
TP-8	No pipe installed
TP-9	5.2
TP-10	4.2
TP-11	3.5
TP-12	3.5

These depths to groundwater will affect the installation of utilities at the site and the practical depth of basements.

Groundwater levels can fluctuate as much as 1.0 to 2.0 feet seasonally. 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 5.3, 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. Test pit backfill materials must be considered non-engineered fill.

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. Similarly remove surface vegetation, topsoil, any other deleterious materials, non-engineered fills from beneath an area extending out at least 2 feet beyond pavements and exterior flatwork areas. Disturbed soils may remain below flexible pavements and flatwork if properly prepared. Proper preparation consists of scarifying the upper 9 inches of disturbed soils, moisture conditioning, and compacting the soils to the requirements of structural fill.

Based upon the conditions observed in the test pits there is topsoil on the surface of the site which we estimated to be about 4 inches in thickness. When stripping and grubbing, topsoil should be distinguished by the apparent organic content and not solely by color; thus we estimate that topsoil stripping will need to include the upper about 4 inches.

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.

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

Fill placed over large areas to raise overall site grades can induce settlements in the underlying natural soils. If more than 3 feet of site grading fill is anticipated over the natural ground surface, we should be notified to assess potential settlements and provide additional recommendations as needed. These recommendations may include placement of the site grading fill far in advance to allow potential settlements to occur prior to construction.

6.2 Temporary Excavations

Relatively shallow groundwater was encountered during our field investigation for the site and later measured at depths of 2.8 to 6.5 feet below the existing ground surface. We anticipate that excavations extending below a depth of about 2.5 to 6 feet will likely encounter groundwater, and dewatering of such excavations will likely be required. Groundwater levels could be shallower in the spring and early summer.

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 cohesionless (sandy/gravelly) soils, temporary construction excavations not exceeding 4 feet in depth and above the groundwater should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 8 feet and above groundwater, side 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, if encountered, may flow into the excavation. Under such cases, 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

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 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 (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 equivalent (see Section 6.6).

On-site clay soils, are not recommended for re-utilization as structural site grading fill but may be utilized in landscape areas. On-site sand soils may be used as site grading fill and non-structural fill, however, if these soils are saturated they will required drying prior to recompacting which will be very difficult, if not impossible, during wet and cold periods of the year. We also recommend that the grading fill thickness using on-site soils be no more than 3 feet below structures, to minimize potential settlements.

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 AASHTO⁵ T-180) in accordance with the following recommendations:

⁵ 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	95
	5 to 8	98
Site grading fill outside area defined above	0 to 5	92
	5 to 8	95
Utility trenches within structural areas	--	96
Roadbase and subbase	-	96
Non-structural fill	0 to 5	90
	5 to 8	92

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.

6.5 Utility Trenches

For the bedding zone around the utility, we recommend utilizing sand bedding fill material that meets current APWA⁶ requirements.

All utility trench backfill material below structurally loaded facilities (foundations, floor slabs, flatwork, parking lots/drive areas, etc.) shall be placed at the same density requirements established for structural fill in the previous section.

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 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 6.4**.

6.6 Stabilization

The natural 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

⁶ American Public Works Association

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 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, as indicated above in **Section 6.3**. 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.

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

Based on our geotechnical engineering analyses, the proposed residential structures may be supported upon conventional spread and/or continuous wall foundations placed on suitable, undisturbed natural soils or on structural fill extending to suitable natural soils. Footings may be designed using a net bearing pressure of 1,500 psf if placed entirely on suitable, undisturbed, natural soils or 2,000 psf if placed entirely on a minimum 18 inches of granular structural fill. 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 1/3 for temporary loads such as wind and seismic forces.

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

We also recommend the following:

1. Exterior footings subject to frost should be placed at least 30 inches below final grade.
2. Interior footings not subject to frost should be placed at least 16 inches below grade.
3. Continuous footing widths should be maintained at a minimum of 18 inches.
4. Spot footings should be a minimum of 24 inches wide.

7.2 Installation

Foundations shall not be placed on topsoil with organics or undocumented fill, nor should they be placed on 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 properly compacted structural fill.

Excavation bottoms should be examined by a CMT geotechnical engineer to confirm that suitable bearing materials soils have been exposed.

All structural fill should meet the requirements for such, and should be placed and compacted in accordance with **Section 6** above. The width of structural replacement fill below footings should be equal to the width of the footing plus 1 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.

7.3 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, with differential settlements on the order of 0.5 inches over a distance of 25 feet. We expect approximately 50% of the total settlement to initially take place during construction.

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 soils or 0.40 for 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

Due to shallow ground water, sublevels may or may not be constructed and will vary in depth if constructed. The lateral earth pressure values given below are for a backfill material that will consist of drained sand/gravel soils (less than 10% passing No. 200 sieve) placed and compacted in accordance with the recommendations presented herein. If other soil types will be used as backfill, we should be notified so that appropriate modifications to these values can be provided, as needed.

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 45 pounds per cubic foot in computing lateral pressures. For more rigid walls (moderately yielding), 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 of 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, 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	33	63	93
6	50	95	140
8	67	127	187

9.0 FLOOR SLABS

Floor slabs may be established upon suitable, undisturbed, natural soils or on structural fill extending to suitable natural soils (same as for foundations). Under no circumstances shall floor slabs be established directly on topsoil, 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, we recommend that floor slabs be directly underlain by at least 4 inches of “free-draining” fill, such as “pea” gravel or 3/4-inch quarters to 1-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.

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 Surface Drainage

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 each residence should be sloped to provide drainage away from the foundations. We recommend a minimum slope of 4 inches in the first 10 feet away from the structure. This slope should be maintained throughout the lifetime of 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. Landscape sprinklers should be aimed away 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 that may become evident during construction.

10.2 Foundation 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 variation 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 Subdrain Design

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 2 feet of final grade and similarly separated from adjacent soils with a geotextile such as Mirafi 140N or equivalent. The upper 1 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 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 shall be discharged into the area subdrains 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.

11.0 PAVEMENTS

We anticipate the natural 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.

In roadway areas, the subgrade must be prepared as recommended in **Section 6.1**. Subsequent to stripping of topsoil and preparation of disturbed soils, and prior to the placement of pavement materials, the exposed subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or otherwise unsuitable soils are encountered, we recommend they be removed to a minimum of 18 inches below the subgrade level and replaced with structural fill.

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

Material	Pavement Section Thickness (inches)	
	Residential Street (6 ESAL's per day)	
Asphalt	3	3
Road-Base	12	6
Subbase	0	8
Total Thickness	15	17

Untreated base course (UTBC) should conform to city specifications, or to 1-inch-minus UDOT specifications for A-1-a/NP, and have a minimum CBR value of 70%. Material meeting our specification for structural fill can be used for subbase, as long as the fines content (percent passing No. 200 sieve) does not exceed 15%. Roadbase and subbase material should be compacted as recommended above in **Section 6.4**. Asphalt material generally should conform to APWA requirements, having a ½-inch maximum aggregate size, a 75-gyraton Superpave mix containing no more than 15% of recycled asphalt (RAP) and a PG58-28 binder.

12.0 QUALITY CONTROL

We recommend that CMT be retained as part of a comprehensive quality control testing and observation program. With CMT on-site we can help facilitate implementation of our recommendations and address, in a timely manner, any subsurface conditions encountered which may 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 their 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



Bertoldi Property

About 3908 W 1800 S, West Weber, UT

CMT ENGINEERING
LABORATORIES

Site Plan

Date:	13-Feb-18
Job #	10878

Figure:

1

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 11'
Water Depth: 5.5', 2.8'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown											
0-1	Brown CLAY (CL), some fine sand	moist, medium stiff (estimated)										
1-3				1	27.6	96						
3-4	Gray Silty SAND (SM), fine grained	moist, medium dense (estimated)		2								
4-7		wet										
7-9	Brown CLAY (CL), some fine sand	wet, medium stiff (estimated)										
9-11	Brown Silty SAND (SM), fine grained			3								
11-14		END AT 11'										

Remarks: Groundwater encountered during excavating at depth of 5.5 feet and measured on 2/27/18 at depth of 2.8 feet.
Slotted PVC pipe installed to depth of 11.0 feet to facilitate water level measurements.

Figure:

2

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 11'
Water Depth: 7.5', 5.5'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg			
							Gravel %	Sand %	Fines %	LL	PL	PI	
0		TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown Brown CLAY (CL), some fine sand moist, medium stiff (estimated)											
1													
2													
3				4	27.1	96.3			75				
4													
5		Brown Silty SAND (SM), fine grained moist, medium dense (estimated)											
6				5									
7													
8		Brown CLAY (CL), some fine sand wet, medium stiff (estimated)											
9													
10					6								
11		END AT 11'											
12													
13													
14													

Remarks: Groundwater encountered during excavating at depth of 7.5 feet and measured on 2/27/18 at depth of 5.5 feet.
Slotted PVC pipe installed to depth of 11.0 feet to facilitate water level measurements.

Figure:

3

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 9'
Water Depth: 4.75', 6.5'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown										
1		Brown CLAY (CL), some fine sand moist, medium stiff (estimated)										
2												
3												
4												
5												
5												
5		Brown Silty SAND (SM), fine to medium grained		7								
6		wet, medium dense (estimated)										
7												
8				8								
9		END AT 9'										
10												
11												
12												
13												
14												

Remarks: Groundwater encountered during excavating at depth of 4.75 feet and measured on 2/27/18 at depth of 6.5 feet.
Slotted PVC pipe installed to depth of 9.0 feet to facilitate water level measurements.

Figure:

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 10'
Water Depth: 6.5', 4.8'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown											
0-1	Brown CLAY (CL), some fine sand	moist, stiff (estimated)										
1-3				9	15.3	118						
3-7												
7												
7-8	Brown Silty SAND (SM), fine to medium grained	wet, medium dense (estimated)		10								
8-10												
10		END AT 10'										
11												
12												
13												
14												

Remarks: Groundwater encountered during excavating at depth of 6.5 feet and measured on 2/27/18 at depth of 4.8 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

Figure:


5

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 11'
Water Depth: 6.5', 6.4'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown											
0	Brown CLAY (CL), some fine sand	moist, stiff (estimated)										
1												
2												
3												
3			▲	11								
4												
5												
6												
6.5		wet										
7	Brown Silty SAND (SM), fine grained	wet, medium dense (estimated)	▲	12	21.8				25			
8												
9												
10	grades with some clay layers up to 4" thick											
10			▲	13								
11		END AT 11'										
12												
13												
14												

Remarks: Groundwater encountered during excavating at depth of 6.5 feet and measured on 2/27/18 at depth of 6.4 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

Figure:

6

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 10'
Water Depth: 5', 5.5'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown										
1		Brown Silty SAND (SM), fine grained, some clay medium dense (estimated)										
2												
3				14	10.5				25			
4		Brown CLAY (CL), some fine sand very moist, stiff (estimated) wet										
6		Brown Silty SAND (SM), fine grained, some clay wet, medium dense (estimated)										
7		Brown CLAY (CL), some fine sand wet, medium stiff (estimated)										
9				15								
10		END AT 10'										
11												
12												
13												
14												

Remarks: Groundwater encountered during excavating at depth of 5 feet and measured on 2/27/18 at depth of 5.5 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

Figure:

7

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 10'
Water Depth: 6.5', 5.5'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown										
0		Brown Silty SAND (SM), fine grained, some clay moist, medium dense (estimated)										
1												
2												
3				16	10.4				24			
4												
5												
6												
7		Brown CLAY (CL), some fine sand wet, medium stiff (estimated)										
8												
9				17								
10		END AT 10'										
11												
12												
13												
14												

Remarks: Groundwater encountered during excavating at depth of 6.5 feet and measured on 2/27/18 at depth of 5.5 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

Figure:

About 3908 W. 1800 S., West Weber, UT

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

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

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown											
0	Brown Clayey SAND (SC)	moist, medium dense (estimated)										
1												
2												
3				18	19.4				49	24	16	8
4												
5												
6	Brown Silty SAND (SM), fine grained	wet, medium dense (estimated)		19								
7												
8												
9												
10		END AT 10'										
11												
12												
13												
14												

Remarks: Groundwater not encountered during excavating.

Figure:

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 12'
Water Depth: 10', 5.2'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0	TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown											
0	Brown CLAY (CL), some fine sand	moist, medium stiff (estimated)										
1												
2												
3				20	16.8	109						
4												
5												
6												
7												
8												
9												
10			wet	21								
11												
12		END AT 12'										
13												
14												

Remarks: Groundwater encountered during excavating at depth of 10 feet and measured on 2/27/18 at depth of 5.2 feet.
Slotted PVC pipe installed to depth of 12 feet to facilitate water level measurements.

Figure:

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 10'
Water Depth: 4.2'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI
0		TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown										
0		Brown Silty SAND (SM), fine grained, some clay										
1		moist, medium dense (estimated)										
2												
3				22	24.9	99.4			41			
4		Brown Silty SAND (SM), fine grained										
5		moist, medium dense (estimated)										
6				23								
7												
8												
9				24								
10		END AT 10'										
11												
12												
13												
14												

Remarks: Groundwater encountered during excavating at depth of 4.2 feet and measured on 2/27/18 at depth of 4.2 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

Figure:

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 11'
Water Depth: 10', 3.5'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg			
							Gravel %	Sand %	Fines %	LL	PL	PI	
0	TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown												
0	Brown CLAY (CL), some fine sand	moist, medium stiff (estimated)											
1													
2													
3													
4				25									
5													
6													
7													
8													
9													
10			wet	26									
11		END AT 11'											
12													
13													
14													

Remarks: Groundwater encountered during excavating at depth of 10 feet and measured on 2/27/18 at depth of 3.5 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

Figure:

About 3908 W. 1800 S., West Weber, UT

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

Total Depth: 11'
Water Depth: 9', 3.5'

Date: 2/7/18
Job #: 10878

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density (pcf)	Gradation			Atterberg			
							Gravel %	Sand %	Fines %	LL	PL	PI	
0	*****	TOPSOIL: 4" Clay, sand, roots, organics, moist, dark brown											
0		Brown CLAY (CL) with fine sand moist, medium stiff (estimated)											
1													
2													
3													
3				27	19.2				50	24	16	8	
4													
5													
6													
7													
8													
9													
10													
10				28									
11		END AT 11'											
12													
13													
14													

Remarks: Groundwater encountered during excavating at depth of 9 feet and measured on 2/27/18 at depth of 3.5 feet.
Slotted PVC pipe installed to depth of 10.0 feet to facilitate water level measurements.

Figure:

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation			Atterberg		
							Gravel %	Sand %	Fines %	LL	PL	PI

COLUMN DESCRIPTIONS

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

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

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

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

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

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

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

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

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		MODIFIERS	MOISTURE CONTENT
Description	Thickness	Trace	Dry: Absence of moisture, dusty, dry to the touch.
Seam	Up to ½ inch	<5%	Moist: Damp / moist to the touch, but no visible water.
Lense	Up to 12 inches	Some	
Layer	Greater than 12 in.	5-12%	Saturated: Visible water, usually soil below groundwater.
Occasional	1 or less per foot	With	
Frequent	More than 1 per foot	> 12%	

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)	MAJOR DIVISIONS		USCS SYMBOLS	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
GRAVELS WITH FINES (≥ 12% fines)			GP	Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines
			GM	Silty Gravels, Gravel-Sand-Silt Mixtures
SANDS The coarse fraction passing through No. 4 sieve.			CLEAN SANDS (< 5% fines)	SW
		SANDS WITH FINES (≥ 12% fines)	SP	Poorly-Graded Sands, Gravelly Sands, Little or No 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
	SILTS AND CLAYS Liquid Limit greater than 50%		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
			MH	Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils
	SILTS AND CLAYS Liquid Limit greater than 50%		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	

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)

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

- The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
- 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.
- The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

Figure: