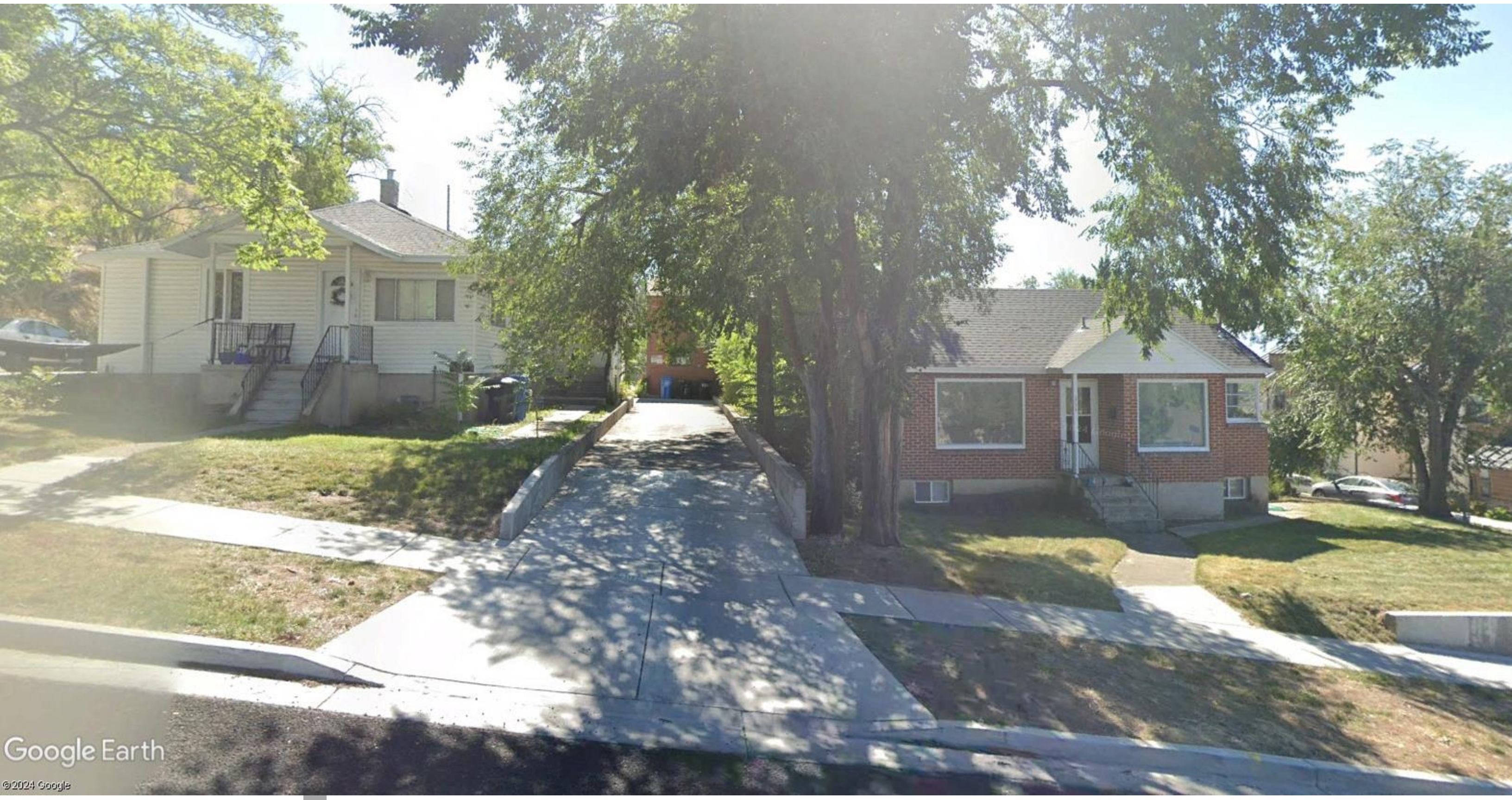
CMT TECHNICAL SERVICES



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

GEOTECHNICAL ENGINEERING STUDY

K & B Apartments

About 698 East 700 North
Logan, Utah

CMT PROJECT NO. 21794

FOR:
Cartwright Architects & Engineers
2120 North Main Street
Logan, Utah 84341

April 5, 2024

April 5, 2024

Mr. Justin Campbell
Cartwright Architects and Engineers
2120 North Main Street
Logan, Utah 84341

Subject: Geotechnical Engineering Study
K & B Apartments
About 698 East 700 North
Logan, Utah
CMT Project No. 21794

Mr. Campbell:

Submitted herewith is the report of our geotechnical engineering study of 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 27 and March 8, 2024, CMT Technical Services (CMT) staff professionals were on-site and observed the drilling of 2 bore holes extending to depths of about 16.5 to 46.5 feet, and the excavation of 2 test pits extending to depths of about 9.0 to 9.5 feet below the existing ground surface. Samples of the subsurface soils were collected from the explorations during the field operations and subsequently transported to our laboratory for further observation and testing of select samples.

Conventional spread and/or continuous footings may be utilized to support the proposed structure, provided the recommendations in this report are followed. This report presents detailed discussions of geotechnical design and construction criteria for this site.

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, Idaho, Arizona, Colorado and Texas, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at 801-590-0394.

Sincerely,
CMT Technical Services

LICENSED PROFESSIONAL ENGINEER # 374995 JEFFREY J. EGBERT 4/5/24 STATE OF UTAH

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

Reviewed by:

William G. Turner, P.E., M. ASCE
Senior Geotechnical Engineer

TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 General

CMT Technical Services (CMT) was retained to conduct a geotechnical subsurface study for the development of the site for the construction of a 4-level apartment building. The parcel is situated on the south side of 700 Norh Street at about 698 West in Logan, Utah, as shown in the **Vicinity Map** below.

VICINITY MAP

1.2 Objectives and Scope

The objectives and scope of our study were planned in discussions between Mr. Justic Campbell of Cartwright Architects and Engineers, and Mr. Andrew Harris of CMT. In general, the objectives of this study were to define and evaluate the subsurface soil and groundwater conditions at the site, and provide foundation, earthwork, pavement and seismic recommendations to be utilized in the design and construction of the proposed development.

In accomplishing these objectives, our scope of work included performing field exploration, which consisted of the drilling/logging/sampling of 2 bore holes, the excavating/logging/sampling of 2 test pits, performing laboratory testing on representative samples of the subsurface soils collected in the explorations, and conducting an office program, which consisted of correlating available data, performing engineering analyses, and preparing this summary report. In addition, a double ring infiltration test was performed at the site. Authorization to proceed with the work outlined in our proposal dated November 3, 2023 was given via email dated February 19, 2024 from Mr. Justin Campbell.

1.3 Description of Proposed Construction

We anticipate that the structure will likely be 4 levels above grade including 3 levels constructed using conventional wood/light metal framing over a concrete podium for parking (partially below grade on the uphill side), founded on spread and strip footings with slab on grade floor established at or near existing site grades. Maximum continuous wall and column loads are anticipated to be 7,000 pounds per lineal foot and 200,000 pounds, respectively. Floor slab loads are expected to not exceed a uniform loading of 100 pounds per square foot.

Exterior pavements at the site are planned as an asphalt paved light-duty parking area on the upslope side of the building with internal drive lane and a concrete paved entrance driveway and dumpster pad. Traffic is projected to consist predominately of cars and pickup trucks, a weekly garbage truck, and an occasional fire truck.

Site development will require removal of existing structures, and earthwork in the form of cutting and filling. There is approximately 15 feet of elevation gain across the property (west to east). We understand that the structure will be established at the lower elevation of the site (west side), with a proposed parking lot at the second level on the east side. We project that maximum cuts and fills may be on the order of 10 to 15 feet. If deeper cuts or fills are planned, CMT should be notified to provide additional recommendations, if needed.

1.4 Executive Summary

The proposed structure can be supported upon conventional spread and continuous wall foundations. The most significant geotechnical aspects regarding site development include the following:

1. Two existing residences, exterior concrete flatwork, and mature trees to be removed from the site.
2. Approximately 5 feet of gravelly fill soil, considered undocumented/untested, encountered on the surface at the location of B-1. Footings and floor slabs should not be placed on undocumented fill, unless ground improvement is conducted.
3. Subsurface soils consisted of near surface GRAVEL (GM, GP) and SAND (SM) underlain by SILT (ML) extending to the maximum depth explored of 46.5 feet below existing grade.
4. Groundwater was encountered at about 25 feet below the existing ground surface.
5. Subsurface saturated sand and low-plasticity silt soils are susceptible to liquefaction in a major earthquake. Ground improvement is recommended to reduce the potential for subsurface soils to liquefy.
6. Foundations and floor slabs may be placed on the ground improvement elements, or upon a structural fill pad placed over the ground improvement elements.

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 are provided, including subsurface descriptions, geologic/seismic setting, earthwork, foundations, lateral resistance, lateral pressure, floor slabs, and pavements.

2.0 FIELD EXPLORATION

To define and evaluate the subsurface soil and groundwater conditions, 2 bore hole was drilled at the site to depths of approximately 16.5 to 46.5 feet, and 2 test pits were excavated with a backhoe at the site to depths of approximately 9.0 to 9.5 feet, below the existing ground surface under the observation of experienced members of our geotechnical staff. Locations of the explorations are shown on ***Figure 1, Site Plan***, included in the Appendix.

Samples of the subsurface soils encountered in the bore holes were collected at varying depths through the hollow stem drill augers. Relatively undisturbed samples were obtained by driving a 2.5-inch outside diameter rings/liners into the undisturbed soils below the drill augers. Disturbed samples were collected utilizing a 2.0-inch outside diameter standard split spoon sampler that was driven 18 inches into the soils below the drill augers using a 140-pound hammer free-falling a distance of 30 inches. The number of hammer blows needed for each 6-inch interval was recorded. The sum of the hammer blows for the final 12 inches of penetration of the standard split -spoon sampler is known as a standard penetration test and this 'blow count' was recorded on the bore hole log. The blow count provides an approximation of the relative density of granular soils, but only a limited indication of the relative consistency of silt/clay soils because the consistency of these soils is significantly influenced by the moisture content.

In the test pits, representative subsurface soil samples were collected by obtaining disturbed "grab" samples which were then sealed in plastic bags prior to transport to the laboratory.

The subsurface soils encountered in the test pits, and the samples retrieved from the bore holes, were classified in the field based upon visual and textural examination, logged and described in general accordance with ASTM[1] D-2488. 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 exploration log, ***Figures 2 through 5***, included in the Appendix. A Key to Symbols defining the terms and symbols used on the logs, is provided as ***Figure 6*** in the Appendix.

Upon completion of logging and sampling, the bore holes were backfilled with the auger cuttings and the test pits were backfilled with the excavated soils. When backfilling, minimal to no effort was made to compact the backfill and no compaction testing was performed. Thus, the test pit backfill particularly is considered undocumented fill and settlement of the backfill in the test pits over time should be anticipated.

[1]American Society for Testing and Materials

3.0 LABORATORY TESTING

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

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Atterberg Limits, ASTM D-4318, Plasticity and workability
3. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
4. Hydrometer Analysis, ASTM D-7928, Grain Size Analysis

Laboratory test results are presented on the exploration logs (***Figures 2 through 5***) and in the following **Lab Summary Table**:

LAB SUMMARY TABLE

EXPLOR-ATION	DEPTH (feet)	SOIL CLASS	SAMPLE TYPE	MOISTURE CONTENT(%)	GRADATION			ATTERBERG LIMITS		
					GRAV.	SAND	FINES	LL	PL	PI
B-1	5	GM	SPT	6	44	39	17			
B-1	15	SM	SPT	10	3	57	40			
B-1	25	SM	SPT	20	2	53	45			
B-1	30	ML	SPT	29	0	47	53		NP	
B-1	35	ML	SPT	28	0	36	55 Silt 9 Clay			
B-1	40	ML	SPT	27	0	32	68		NP	
B-1	45	ML	SPT	28	0	25	65 Silt 10 Clay			
B-2	2.5	SM	SPT	4	38	47	15			
B-2	7.5	SM	SPT	7	3	66	31			
TP-1	2	SM	Grab	10	23	57	20			
TP-2	2	GP	Grab	3	89	7	4			

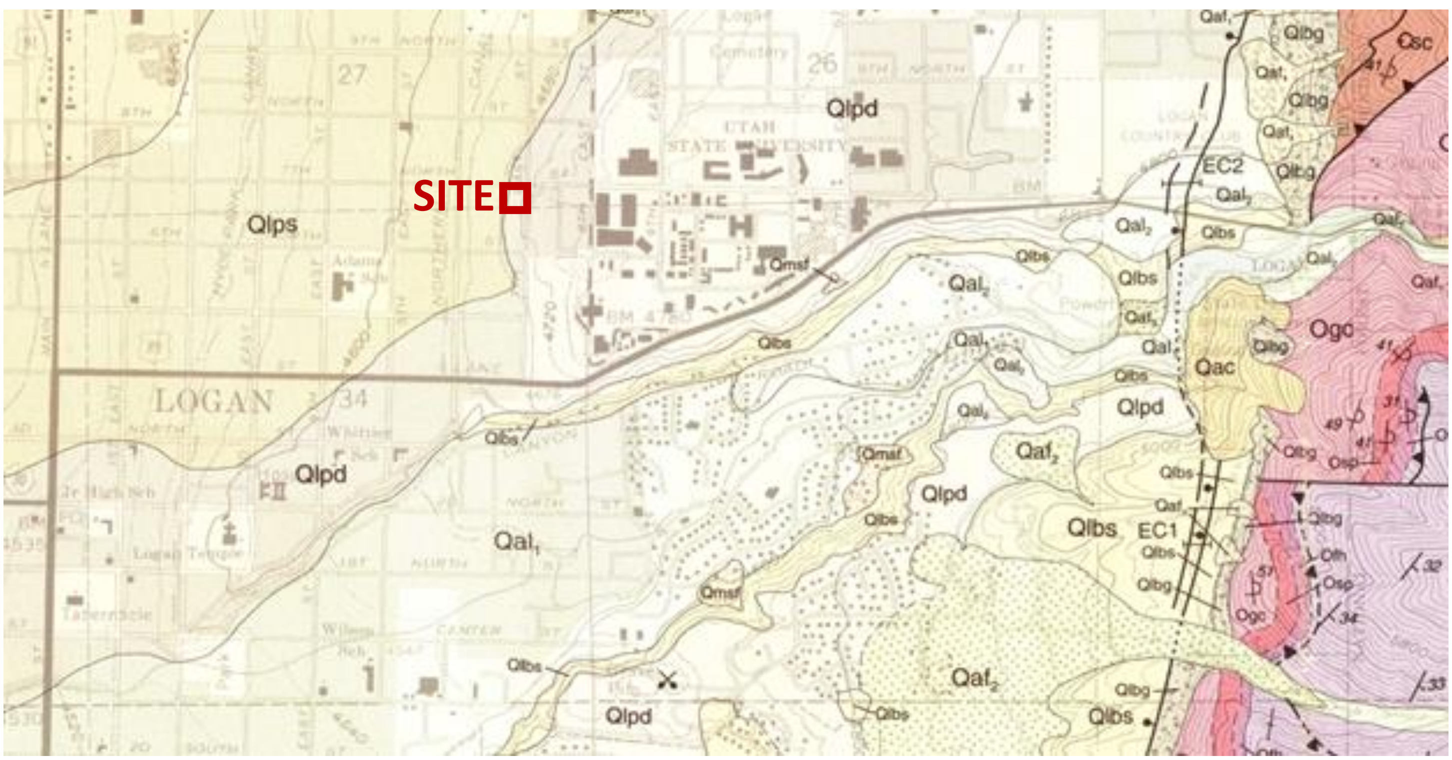
4.0 GEOLOGIC & SEISMIC CONDITIONS

4.1 Geologic Setting

The subject site is in the southeast portion of Cache Valley in northern Utah at an elevation of approximately 4,698 to 4,712 feet above sea level. The Cache Valley is a deep, sediment-filled basin that is part of the Middle Rocky Mountain Physiographic Province and is bordered by the Bear River Range on the east and the Wellsville Mountains on the west. 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 Cache Valley is a fault-block valley (Graben) structurally bounded on the east by the west-dipping East Cache Fault Zone and on the west by the east-dipping West Cache Fault Zone. Tectonic displacement along these faults has resulted in the relative down-drop of the valley in relation to the uplift of the bounding mountain ranges on the east and west.

Much of northwestern Utah, including the Cache Valley, was also previously covered by the Pleistocene age Lake Bonneville. The Great Salt Lake, located to the southwest of the valley, is a remnant of this ancient freshwater lake. Lake Bonneville reached a high-stand elevation of between approximately 5,160 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 Cache Valley was deposited as lacustrine sediments during both the transgressive (rise) and regressive (fall) phases of Lake Bonneville. These sediments were deposited over thick sequences of older Quaternary and Tertiary age, pre-Lake Bonneville deposits within the valley.

The geology of the USGS Logan, Utah 7.5 Minute Quadrangle, that includes the location of the subject site, has been mapped by Evans and others[2]. The surficial geology at the location of the subject site and adjacent properties is mapped as "Deltaic deposits related to the Provo and younger shorelines" (Map Unit Qlpd) dated upper Pleistocene. Unit Qlpd is described as "Clast-supported pebble and cobble gravel in a matrix of sand and minor silt, with thin sand beds; mostly deposited at the time of the Bonneville flood; exposed thickness less than 82 feet." No fill has been mapped at the location of the site on the geologic map. Refer to the **Geologic Map**, shown below.



GEOLOGIC MAP

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[2]Evans, J.P., McCalpin, J.P., and Holmes, D.C., 1996, Geologic Map of the Logan Quadrangle, Cache County, Utah; Utah Geological Survey Miscellaneous Publication 96-1, Scale 1:24,000.

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 is the central section of the East Cache Fault Zone approximately 1.3 miles to the east.

4.3 Seismicity

4.3.1 Site Class

Utah has adopted the International Building Code (IBC) 2021, which determines the seismic hazard for a site based upon 2014 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 2021 Section 1613.2.2 refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[3] 7-16, which stipulates that the average values of shear wave velocity, blow count and/or shear strength within the upper 100 feet (30 meters) be utilized to determine seismic site class. Based on the blow counts obtained in bore hole B-1 which extended to the maximum depth explored of 46.5 feet, it is our opinion the site best fits Site Class E – Soft Clay Soil. However, significant liquefaction and potential lateral spread will likely occur at this site (see **Section 4.3.3** below), which requires using Site Class F unless mitigation is performed such that liquefaction will not occur or will not cause significant structural damage. If mitigation is performed, it is our opinion the site will best fit Site Class E – Soft Clay Soil, which we recommend for seismic structural design. If mitigation is not performed, the site classifies as Site Class F, and a Site Response Analysis is required unless the fundamental building period of vibration does not exceed 0.5 seconds. If desired and/or needed, CMT can perform a Site Response Analysis to determine appropriate ground motions due to liquefaction occurring at the subject site.

4.3.2 Ground Motions

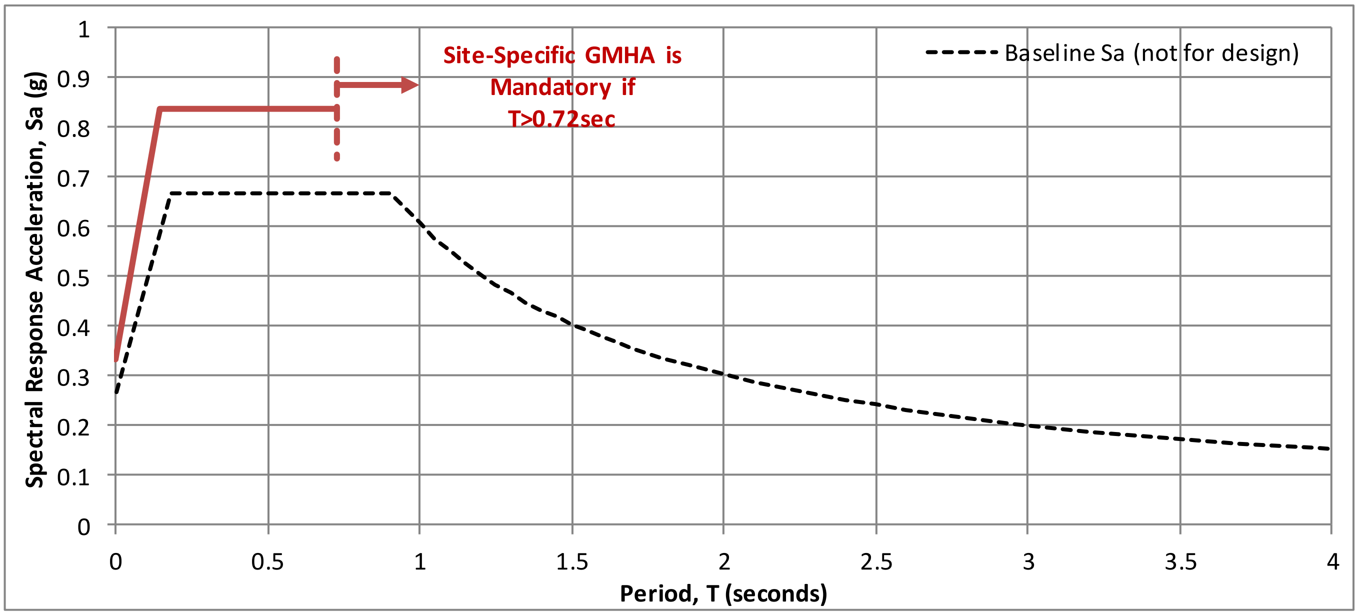
The 2014 USGS mapping utilized by the IBC provides values of peak ground, short period and long period spectral accelerations for the Site Class B/C boundary and the Risk-Targeted Maximum Considered Earthquake (MCE_R). This Site Class B/C boundary represents average bedrock values for the Western United States and must be corrected for local soil conditions. The table and response spectra on the following page summarize the peak ground, short period and long period accelerations for the MCE_R event, and incorporates appropriate soil correction factors for a Site Class E soil profile at site grid coordinates of 41.7441 degrees north latitude and -111.8171 degrees west longitude:

[3]American Society of Civil Engineers

SPECTRAL ACCELERATION PERIOD, T	SITE CLASS B/C BOUNDARY [mapped values] (g)	SITE COEFFICIENT	SITE CLASS E [adjusted for site class effects] (g)	MULTI-PLIER	DESIGN VALUES (g)
Peak Ground Acceleration	PGA = **0.451**	F_{pga} = 1.298	PGA_M = 0.585	1.000	PGA_M = 0.585
0.2 Seconds (Long Period Acceleration)	S_S = **1.045**	F_a = N/A	S_{MS} = N/A	0.667	S_{DS} = N/A
	(Exception 1:)	F_a = (1.200)	S_{MS} = (1.254)	0.667	S_{DS} = (0.836)
1.0 Second (Long Period Acceleration)	S_1 = **0.349**	F_v = N/A	S_{M1} = N/A	0.667	S_{D1} = N/A
	(Exception 3:)	F_v = (2.604)	S_{M1} = (0.909)	0.667	S_{D1} = (0.606)

NOTES: 1. TL (seconds): **6** *** Site Class E**

2. Site Class: **E** **4. ASCE 7-16 Requires Site-Specific Ground Motion Hazard Analysis (Since Ss≥1.0 & S1 ≥ 0.2 sec) - OR Can Use Exceptions 1 & 3 up to T=0.72sec (per §11.4.8)**



As shown in the response spectrum above, if the period of the proposed building is greater than 0.72 seconds, a site-specific ground motion hazard analysis (GMHA) is required. If this situation applies, please contact CMT for a proposal to perform the GMHA. Otherwise, the higher exception values may be used for design.

4.3.4 Liquefaction

The site is located within an area designated by the Utah Geologic Survey[4] as having "Low" liquefaction potential. This is defined as having between a 5% and 10% probability that within a 100-year period an earthquake strong enough to cause liquefaction will occur.

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.

[4]Utah Geological Survey, "Liquefaction-Potential Map for a Part of Utah County, Utah," Utah Geological Survey Public Information Series 28, August 1994. https://ugspub.nr.utah.gov/publications/public_information/pi-28.pdf

Groundwater was encountered at approximately 25 feet below the surface in bore hole B-1. Soils below this depth consisted of loose sand, and soft, non-plastic sandy silt. We evaluated the liquefaction potential of the site using the procedures described in Youd et al[5] and Idriss & Boulanger[6], applied to the saturated silty/sandy deposits. Our evaluation indicates the saturated silty/sandy soils could liquefy in a major seismic event. Maximum anticipated settlement resulting from the liquefaction is up to about 9 inches. In addition, we estimate up to 3.5 feet of lateral spreading could occur due to liquefaction. With the overlying 25 feet of unsaturated soils, considered non-liquefiable, a lesser amount of the estimated potential liquefaction related settlement would likely manifest at the surface, but could still be 4 to 5 inches or more. This amount of settlement, and the potential lateral spread, would likely result in collapse of the structure. To provide life-safety, we recommend ground improvement, such as rammed aggregate piers, to reduce the liquefaction susceptibility of the subsurface soils. We project that ground improvement would need to extend a minimum of 40 feet below the foundations and increase the blow counts in the upper 40 feet to a minimum of 20 blows per foot.

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[7], or rock fall hazard area.

5.0 SITE CONDITIONS

5.1 Surface Conditions

At the time of the field explorations the site was occupied by 2 residences. There was a concrete paved access driveway between the two residences. The landscape included several mature trees. Site grade sloped downward to the west with an overall relief of about 15 feet across the site from east to west. Based upon aerial photos dating back to 1993 that are readily available on the internet, the existing residences appear to have been in place since at least that time. The site is bordered on the north by 700 North Street, on the south and west by residences, and on the east by a vacant hillside and road (see **Vicinity Map** in **Section 1.1** above).

5.2 Subsurface Soils

At the locations of the test pits, and the location of B-1, we encountered approximately 4 to 8 inches of topsoil on the surface. Directly below the topsoil in B-1 we encountered what appeared to be fill soils, composed of

[5]Youd, T.L.; Idriss, I.M.; Andrus, R.D.; Arango, I.; Castro, G.; Christian, J.T.; Dobry, R.; Finn, W.D.L.; Harder, L.F. Jr.; Hynes, M.E.; Ishihara, K.; Koester, J.P.; Liao, S.C.; Marcuson, W.F. III; Martin, G.R.; Mitchell, J.K.; Moriwaki, Y.; Power, M.S.; Robertson, P.K.; Seed, R.B.; and Stokoe, K.H. II; October 2001, "Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshops on Evaluation of Liquefaction Resistance of Soils," ASCE Journal of Geotechnical and Geoenvironmental Engineering, p 817-833.

[6]Idriss, I.M. and Boulanger, R.W., December 2010, "SPT-Based Liquefaction Triggering Procedures," Department of Civil & Environmental Engineering, University of California at Davis, Report No. UCD/CGM 10/02, 259 p.

[7] https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd&extent=-111.36752238312305,40.474000783564726,-111.34675135651116,40.48216171946493

sandy gravel with organics, extending to about 5 feet below the surface. This fill is considered undocumented/untested.

Natural soils encountered in the explorations consisted of near surface layers of light brown to brown, slightly moist to moist, Silty GRAVEL (GM) and Poorly Graded GRAVEL (GP) with cobbles, with varying amounts of sand, and Silty SAND (SM) layers with varying amounts of gravel, extending to the bottom of the test pits at approximately 9.0 to 9.5 feet below the surface, to the bottom of B-2 at 16.5 feet below the surface, and to about 30 feet below the surface in B-1. Based upon the blow counts in the bore holes, the sand and gravel soils have loose to very dense relative density. Where saturated, the loose sand layers are susceptible to liquefaction in a strong earthquake.

Below the sand in B-1, at about 30 feet below the surface, we encountered wet, brown, sandy SILT (ML), extending to the bottom of B-1 at about 46.5 feet below the surface, of very soft to medium stiff consistency based upon the blow counts. Laboratory testing indicates the silt is non-plastic. This soil could also potentially liquefy in an earthquake.

For a more descriptive interpretation of subsurface conditions, please refer to the exploration logs, ***Figures 2 through 5***, 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

We encountered groundwater in bore hole B-1 at approximately 25 feet below the surface. We do not anticipate that groundwater would be encountered during construction.

Groundwater levels can fluctuate 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, and the magnitude of potential fluctuations, is beyond the scope of this study.

5.4 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. Undocumented fill soils were encountered on this site. The depth and lateral extent of undocumented fill soils should be expected to vary across the site.

Also, after completing the logging and sampling, the bore holes were backfilled with the auger cuttings, and the test pits were backfilled with the excavated soils, but minimal to no effort was made to compact these soils. Thus, the test pit backfill particularly, is considered undocumented fill and settlement of the backfill in the test pits over time should be anticipated.

6.0 SITE PREPARATION AND GRADING

6.1 General

The existing residences would need to be razed and removed to accommodate the proposed construction. Removals should include floor slabs, footings, and any existing underground utilities that will be abandoned. Resulting excavations should be backfilled with compacted structural fill.

All deleterious materials should be stripped from the site prior to commencement of construction activities. This includes vegetation, plus tree roots and root balls, topsoil, loose and disturbed soils, etc. Based upon the conditions observed at the time of our subsurface exploration, approximately 4 to 8 inches of topsoil is present on the surface where structures or flatwork are not present. All topsoil shall be removed from beneath the structure, exterior flatwork, and pavement areas. 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 2 to 6 inches.

At the location of B-1, immediately below the topsoil, approximately 4.5 feet of undocumented/untested fill of sandy gravelly composition and containing organics, is present. Ground improvement will likely allow the undocumented fill to remain below the proposed structure. Undocumented fills could remain beneath exterior flatwork and pavements, provided they are properly prepared, and the owner understands that additional maintenance of any surface constructed over undocumented fill may be required if the fill settles/consolidates over time. Outside of the building footprint, proper preparation of undocumented fill and disturbed soils shall consist of removing the upper 12 inches, scarifying the exposed surface to a minimum depth of 8 inches, moisture conditioning as needed, and recompacting the scarified soils in place. The removed 12 inches, if free or organics, debris, or other deleterious material, can then be replaced in compacted lifts. Prior to placement of pavement materials, we recommend that the exposed subgrade be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If soft or loose soils are encountered, they must be removed (up to a maximum depth of 2 feet) and replaced with structural fill.

Following clearing and grubbing, and other surface preparations, the subgrade should be observed 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, or that undocumented fill has been prepared as recommended above, prior to placing site grading fills, footings, and slabs.

Fill placed over large areas to raise overall site grades can induce settlements in the underlying natural soils. If more than 10 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

Excavations deeper than 8 to 10 feet are not anticipated at the site. We do not anticipate that groundwater will be encountered in excavations.

For sandy (cohesionless) soils, temporary construction excavations not exceeding 4 feet in depth should be no steeper than one-half horizontal to one vertical (0.5H:1V). For excavations up to 10 feet and above groundwater, side slopes should be no steeper than one- and one-half horizontal to one vertical (1.5H:1V). Excavations encountering saturated cohesionless soils will be very difficult to maintain and will require very flat side slopes and/or shoring, bracing and dewatering.

In clayey (cohesive) soils, temporary construction excavations not exceeding 4 feet in depth may be constructed with near-vertical side slopes. Temporary excavations up to 10 feet deep, above or below groundwater, may be constructed with side slopes no steeper than one horizontal to one vertical (1H:1V).

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

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, a maximum 50% passing No. 200 sieve, and a maximum Plasticity Index of 15.
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-inch to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i, or equivalent (see **Section 6.6**).

On-site gravel and some sand soils may be suitable for use as structural fill, if found to meet the specifications above, and may be used as site grading fill and non-structural fill. 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[8] T-180) in accordance with the following recommendations:

LOCATION	TOTAL FILL THICKNESS (FEET)	MINIMUM PERCENTAGE OF MAXIMUM DRY DENSITY
Beneath an area extending at least 4 feet beyond the perimeter of structures, and below flatwork and pavement (applies to structural fill and site grading fill) extending at least 2 feet beyond the perimeter	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 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 APWA[9] requirements.

All utility trench backfill material below structurally loaded facilities (foundations, floor slabs, flatwork, parking lots/drive areas, etc.) should 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).

[8] American Association of State Highway and Transportation Officials
[9] American Public Works Association

Where the utility does not underlie structurally loaded facilities and public rights of way, 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 likelihood of disturbance or rutting and/or pumping of the existing natural soils is a function of the soil moisture content, 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.

If rutting or pumping occurs, traffic should be stopped and the disturbed soils should be removed and replaced with stabilization material. Typically, a minimum of 18 inches of the disturbed soils must be removed to be effective. However, deeper removal is sometimes required.

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**. This coarse material may be placed and worked into the soft soils until firm and non-yielding or the soft soils removed an additional, minimum of 18 inches, and backfilled with the clean stabilizing fill. A test area should be implemented to achieve a proper stabilization strategy. 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 based on the previously described project characteristics, including the maximum structural loads discussed in **Section 1.3**, the subsurface conditions observed in the field and the laboratory test data, and standard geotechnical engineering practice.

7.1 Foundation Recommendations

Based on our geotechnical engineering analyses, the structure should be supported upon conventional spread and/or continuous wall foundations placed on ground improved with rammed aggregate piers or stone columns. Rammed aggregate soil reinforcement elements are constructed by drilling a 24- or 30-inch diameter hole and then building a bottom bulb of clean, open-graded stone using a beveled, high-energy tamper. The rammed aggregate shaft is constructed on top of the bottom bulb using well-graded highway base course stone placed in thin lifts (12 inches compacted thickness).

Stone columns are constructed by means of a crane-suspended down-hole vibrator and stone backfill, with the stone column compacted from the bottom to the top as the vibrator mandrel is removed and aggregate is vibrated/compacted in place.

For both methods, the result is a reinforced zone of soil directly under footings and floor slabs that allows for the construction of shallow spread footings proportioned for a relatively high bearing pressure. Rammed aggregate /stone column design would also limit or eliminate the need for removing existing non-engineered fills if/where present. Rammed aggregate/stone column elements are spaced singly under continuous footings or in close groups to support concentrated column loads. For mitigation of liquefaction, the rammed aggregate /stone columns elements would be installed in a grid pattern below the structure.

Rammed aggregate/stone column soil reinforcement are <u>design/build elements</u> and must be designed and constructed by a licensed installer. The installer should provide layout and detailed design calculations sealed by a professional engineer licensed in the State of Utah. The design calculations should demonstrate that Geopiers/stone column soil reinforcement is designed to control settlement to magnitudes within the criteria for this project.

Foundations should be established directly upon the undisturbed tops of the rammed aggregate/stone columns. Prior to installing rammed aggregate/stone columns, all site grading activities should be completed.

Typically, design net bearing pressures for spread footings installed over rammed aggregate/stone columns may be on the order of 4,000 to 6,000 psf. Final design will be provided by the selected rammed aggregate/stone columns contractor.

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.

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

Under no circumstances shall foundations be placed topsoil with organics, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. If these or other unsuitable soils are encountered, they must be completely removed and replaced with properly compacted structural fill.

Deep, large roots may be encountered where trees and larger bushes are located or were previously located at the site; such large roots should be removed. The base of footing excavations should be observed by a CMT geotechnical engineer to assess if suitable bearing conditions 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.

The minimum thickness of structural fill below footings should be equivalent to one-third the thickness of structural fill below any other portion of the foundations. For example, if the footings will cross over an area where an old basement was backfilled, and the maximum depth of structural fill used for the backfill is 6 feet, all footings for the new structure should be underlain by a minimum 2 feet of structural fill.

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. Additional settlement could occur as a result of liquefaction in a major earthquake.

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 0.40 for natural sand/gravel soils or structural fill may be utilized for design. Passive resistance provided by properly placed and existing sand/gravel soils above the water table may be considered equivalent to a fluid with a density of 450 pcf. A combination of passive earth resistance and friction may be utilized if the passive resistance component of the total is divided by 1.5.

8.0 LATERAL EARTH PRESSURES

We project that a partial subgrade wall up to 10 feet high will be constructed on the upslope side of the structure. The lateral earth pressure values given below anticipate that existing sand/gravel soils or structural fill will be used as backfill material, 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 depend upon the relative rigidity and movement of the backfilled structure. Following are the recommended lateral pressure values, which also assume that the soil surface behind the wall is horizontal and that the backfill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

CONDITION	STATIC (psf/ft)*	SEISMIC (psf/ft)**
Active Pressure (wall is allowed to yield, i.e. move away from the soil, with a minimum 0.001H movement/rotation at the top of the wall, where "H" is the total height of the wall)	37	30
At-Rest Pressure (wall is not allowed to yield)	57	N/A
Passive Pressure (wall moves into the soil)	450	210

*Equivalent Fluid Pressure (applied at 1/3 Height of Wall)
**Equivalent Fluid Pressure (added to static and applied at 1/3 Height of Wall)

Lateral pressures on subgrade walls could be reduced using lightweight backfill, or expanded polystyrene foam blocks, such as Geofoam.

9.0 FLOOR SLABS

Floor slabs may be established directly on the ground improvement elements, or on a structural fill pad constructed over the ground improvement elements (same as for foundations). Under no circumstances shall floor slabs be established directly on any topsoil, undocumented fills outside of ground improvement elements, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

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 to 1-inch minus, clean, gap-graded gravel.

To help control normal shrinkage and stress cracking, the floor slabs should have the following features:

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

10.0 DRAINAGE RECOMMENDATIONS

10.1 Surface Drainage

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

1. All areas around the structure 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. Overwatering should be avoided.

5. Other precautions that may become evident during construction.

10.2 Foundation Subdrains

Groundwater was encountered relatively deep (25 feet) at this site, and we anticipate that the lowest floor slab will be no more than 15 feet below existing grade. Thus, it is our opinion that perimeter foundation subdrains are not needed for this site.

11.0 PAVEMENTS

All pavement areas must be prepared as discussed above in **Section 6.1**. Under no circumstances shall pavements be established over topsoil, undocumented fills (if encountered), loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In the proposed parking area, subsequent to stripping 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.

We anticipate the natural sand/gravel soils that predominated in the near surface will exhibit good pavement support characteristics when saturated or nearly saturated. Based on our laboratory testing experience with similar soils, our pavement design is based upon a California Bearing Ratio (CBR) of 10 for the natural sand/gravel soils. Given the projected traffic as discussed above in **Section 1.3** (which does not include construction traffic), the following pavement sections are recommended:

MATERIAL	PAVEMENT SECTION THICKNESS (inches)					
	PARKING AREAS (1 ESAL per day)			DRIVE AREAS (3 ESAL'S per day)		
Asphalt	3	3	---	3.5	3.5	---
Concrete	---	--	5	---	---	6
Road-Base (UTBC)	8	4	4	10	6	5
Subbase	0	6	0	0	6	0
Total Thickness	11	13	9	13.5	13.5	11

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 with a minimum CBR of 40% can be used for subbase. 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-gyration Superpave mix containing no more than 15% of recycled asphalt (RAP) and a PG58-28 binder.

The rigid pavement sections recommended above are for non-reinforced Portland cement concrete. Concrete should be designed in accordance with the American Concrete Institute (ACI) and joint details should conform to the Portland Cement Association (PCA) guidelines. The concrete should have a minimum 28-day unconfined compressive strength of 4,000 pounds per square inch and contain 6% ±1% air-entrainment.

For dumpster pads, we recommend a pavement section consisting of 6.5 inches of Portland cement concrete and 6 inches of aggregate base over properly prepared suitable natural subgrade or site grading structural fills extending to suitable natural soils. Constructing dumpster pads overlying undocumented fills must be avoided, or the pads heavily reinforced.

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 vary from those described in this report. Without such a program CMT cannot be responsible for the 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.

13.0 LIMITATIONS

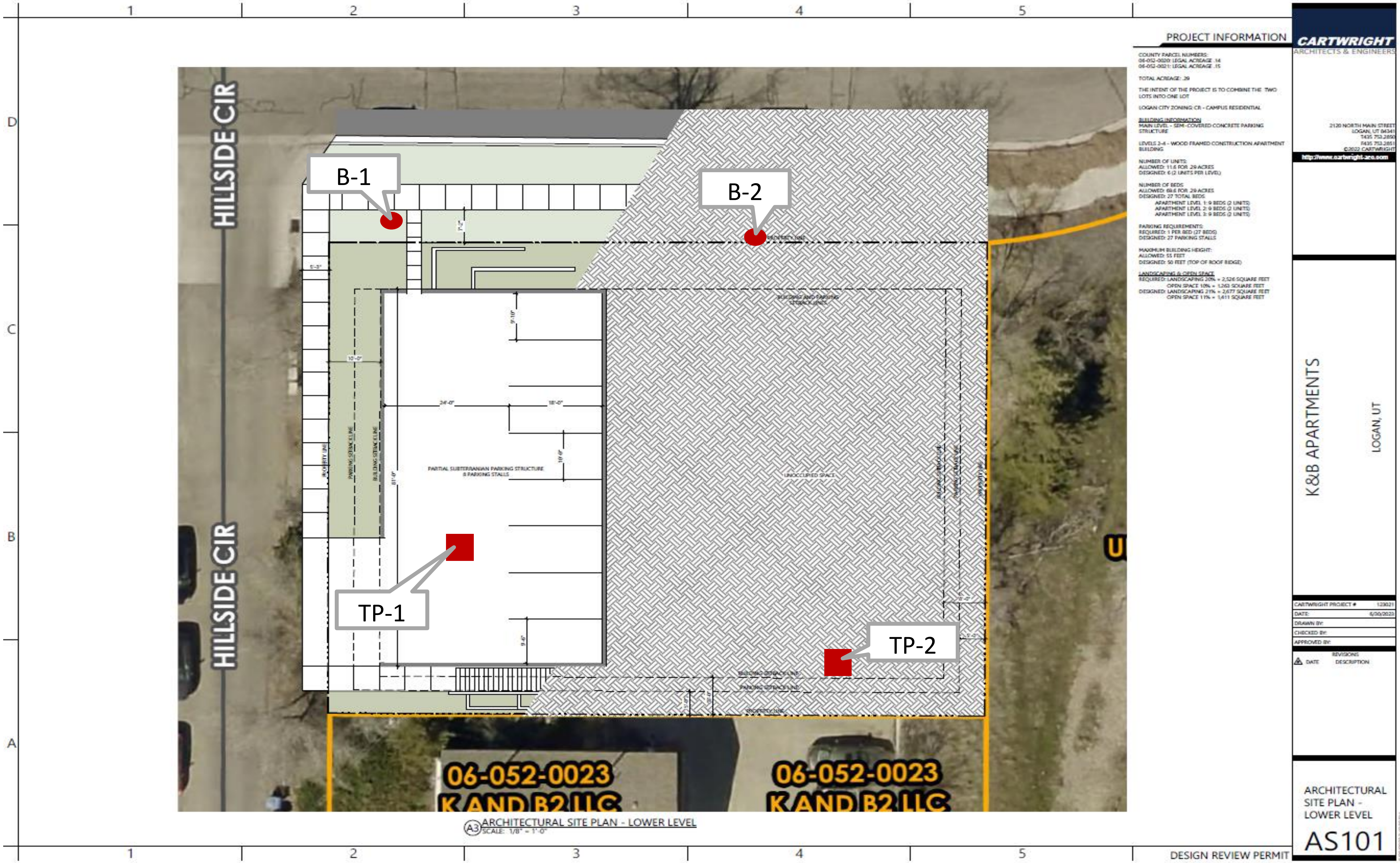
The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. The exploration logs reflect the subsurface conditions only at the specific location at the particular time designated on the logs. Soil and ground 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 801-590-0394. To schedule materials testing, please call 801-381-5141.

APPENDIX

SUPPORTING DOCUMENTATION



CMT TECHNICAL SERVICES	K&B Apartments About 698 East 700 North, Logan, Utah	SITE PLAN	Date:	6-Mar-2024	Figure: 1
			CMT No.:	21793	

K&B Apartments

About 698 East 700 North, Logan, UT

Bore Hole Log — B-1

Total Depth: 46.5'
Water Depth: 25'
Date: 2/27/24
Job #: 21794

Depth (ft)	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	Topsoil												
	Fill: Brown sandy gravel with organics												
			1	2 1 2	3								
4													
	Light Brown Silty GRAVEL (GM) with sand and cobbles, slightly moist — very dense		2	19 50/5"		6		44	39	17			
8	dense		3	15 23 25	48								
	Brown Silty SAND (SM), trace gravel, trace oxidation, moist — loose to medium dense		4	7 5 5	10								
12													
16	grades gray brown — loose		5	4 4 4	8	10		3	57	40			
20			6	3 3 4	7								
24													
	wet		7	3 1 2	3	20		2	53	45			
28													

Remarks: Groundwater encountered during drilling at depth of 25 feet.

Coordinates: 41.7443754°, -111.8172363°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push
Logged By: Steve L.

CMT TECHNICAL SERVICES

Figure: 2

K&B Apartments

About 698 East 700 North, Logan, UT

Bore Hole Log B-1

Total Depth: 46.5'
Water Depth: 25'

Date: 2/27/24
Job #: 21794

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
28		Gray Brown Silty SAND (SM), trace gravel, trace oxidation, moist												
		Brown Sandy SILT (ML), wet — very soft		8	1 0 0	0	29		0	47	53		NP	NP
32														
36				9	1 1 0	1	28		0	36	64			
40		soft to medium stiff		10	0 2 2	4	27		0	32	68		NP	NP
44		soft		11	3 2 1	3	25		0	25	75			
		END AT 46.5'												
48														
52														
56														

Remarks: Groundwater encountered during drilling at depth of 25 feet.

Coordinates: 41.7443754°, -111.8172363°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push
Logged By: Steve L.

CMT TECHNICAL SERVICES

Figure: 2

K&B Apartments

About 698 East 700 North, Logan, UT

Bore Hole Log B-2

Total Depth: 16.5'
Water Depth: (see Remarks)
Date: 2/27/24
Job #: 21794

Depth (ft)	Soil Description		Sample Type	Sample #	Blows (N)	Total	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	Brown Gravelly Silty SAND (SM), slightly moist													
		very dense		12	15 50/5"		4		38	47	15			
4														
		dense		13	17 23 24	47								
	Brown Silty SAND (SM), trace gravel, slightly moist													
8		medium dense		14	15 14 12	26	7		3	66	31			
	grades some gravel			15	7 8 18	26								
12														
	grades moist	loose		16	3 3 5	8								
16	END AT 16.5'													
20														
24														
28														

Remarks: Groundwater not encountered during drilling.

Coordinates: 41.7443757°, -111.8169658°
Surface Elev. (approx): Not Given

Equipment: Hollow-Stem Auger
Automatic Hammer, Wt=140 lbs, Drop=30"
Excavated By: Direct Push
Logged By: Steve L.

CMT TECHNICAL SERVICES

Figure: 3

K&B Apartments

About 698 East 700 North, Logan, UT

Test Pit Log — TP-1

Total Depth: 9.5'
Water Depth: (see Remarks)
Date: 3/8/24
Job #: 21794

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	Topsoil: Dark brown silty sand with roots, about 8 inches										
~0.7–9.5	Brown Silty SAND (SM) with gravel, slightly moist; dense (estimated)										
2		◣	1	10		23	57	20			
5		◣	2								
8		◣	3								
9.5	END AT 9.5'										

Remarks: Groundwater not encountered during excavation.

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

Equipment: Mini Excavator
Excavated By: CMT Technical Services
Logged By: Christine Underdown

CMT TECHNICAL SERVICES

Figure: 4

K&B Apartments

About 698 East 700 North, Logan, UT

Test Pit Log — TP-2

Total Depth: 9'
Water Depth: (see Remarks)

Date: 3/8/24
Job #: 21794

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gravel %	Sand %	Fines %	LL	PL	PI
0	Topsoil: Silty sand with roots, about 4 inches										
	Brown Poorly Graded GRAVEL (GP) with cobbles, some sand, slightly moist — dense (estimated)										
2			4	3		89	7	4			
5			5								
8			6	3		83	14	3			
9	END AT 9'										

Remarks: Groundwater not encountered during excavation.

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

Equipment: Mini Excavator
Excavated By: CMT Technical Services
Logged By: Christine Underdown

CMT TECHNICAL SERVICES

Figure: 5

K&B Apartments

Key to Symbols

About 698 East 700 North, Logan, UT

Date: 3/8/24
Job #: 21794

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

COLUMN DESCRIPTIONS

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

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

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

④ **Sample Type:** Type of soil sample collected; 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).

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

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

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

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

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

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

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

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

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

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

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

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

SAMPLER SYMBOLS

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

WATER SYMBOL

- Encountered Water Level
- Measured Water Level

(see Remarks on Logs)

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

CMT TECHNICAL SERVICES

Figure: 6