CMT ENGINEERING LABORATORIES

Geotechnical Engineering and Geological Reconnaissance Study Selected Lots within Eagle Ridge Subdivision Lots 49 to 52, 54, 56, 58 to 62, and 69 to 73 Eden, Weber County, Utah

PREPARED FOR:

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PREPARED BY:

CMT Engineering Laboratories

CMT Project No. 13119

September 18, 2019

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Mr. Ryan Udell
A.R.C. Builders
1234 East 2500 North
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Subject: Geotechnical Engineering and Geological Reconnaissance Study
Selected Lots within Eagle Ridge Subdivision
Lots 49 to 52, 54, 56, 58 to 62, and 69 to 73
Eden, Weber County, Utah
CMT Project Number 13119

Mr. Udell:

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

CMT Engineering Laboratories (CMT) personnel supervised the excavation of ten test pits extending to depths of approximately 9.0 to 16.0 feet below the existing ground surface. Soil samples were obtained during the field operations and subsequently transported to our laboratory for further testing. Based on the findings of the subsurface explorations, conventional spread and continuous footings may be utilized to support the proposed residence, provided the recommendations in this report are followed. A detailed discussion of design and construction criteria is presented in this report. A Professional Geologist also visited the site, and conducted a review of the site geological and hazard conditions.

We appreciate the opportunity to work with you on this project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With four offices throughout Northern Utah, and in Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 870-6730. To schedule materials testing please call (801) 908-5859.

Sincerely,

CMT Engineering Laboratories

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APPENDIX

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1.0 INTRODUCTION

1.1 General

CMT Engineering Laboratories (CMT) was authorized by Mr. Ryan Udell to conduct design level geotechnical engineering, and reconnaissance level geological study for selected homesite lots within Eagle Ridge Subdivision, including Lots 49 to 52, 54, 56, 58 to 62, and 69 to 73 which are located in Eden, Weber County, Utah. The site is located on the northeast side of Ogden Valley as shown on Figure 1, Vicinity Map, and more detailed aerial coverage of the subdivision site and selected lots are shown on Figure 2, Site Plan. Geological mapping of the subdivision site is included on Figure 3, Geological Mapping, and slope-terrain information for the same area is provided on Figure 4, LiDAR Analysis. The locations of our test pits excavated for our subsurface evaluation are shown on Figure 5, Site Evaluation.

The selected lots are presently undeveloped properties, that are part of the Eagle Ridge Subdivision Phase 5 and Phase 6, which are a cluster subdivision type project that includes 15 or more homesite lots, each a three-quarters acre or more in area, and with open space common areas included for the two subdivision phases. The subject parcel and surrounding properties are zoned by Weber County as AV-3 (Agricultural Valley Zone - 3) and RE-20 (Residential Estate Zone - 20), with ssingle-family residences included as a permitted use for both zones.

1.2 Objectives and Scope

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

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

To achieve these objectives our scope of work included:

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1. To provide geological reconnaissance studies as specified by Weber County Code, Section 108-22 Natural Hazard Areas guidelines and standards (Weber County, 2019). The reconnaissance level geological study was performed to assess whether all or parts of the site are exposed to the hazards that are included in the Weber County Code, Section 108-22 Natural Hazard Areas. These hazards include, but are not limited to: Surface-Fault Ruptures, Landslide, Tectonic Subsidence, Rock Fall, Debris Flows, Liquefaction Areas, Flood, or other Hazardous Areas.
2. To define and evaluate the subsurface soil and groundwater conditions across the site.
3. To provide appropriate foundation and earthwork recommendations as well as geoseismic information to be utilized in the design and construction of the proposed homesite including; a field program consisting of the excavating, logging, and sampling of ten geotechnical test pits, and a laboratory soils testing program.
4. An office program consisting of the correlation of available data, engineering and geological analyses, and the preparation of this summary report.

1.3 Authorization

Authorization was provided by Mr. Udell by returning a signed copy of our Proposal dated July 10, 2019.

2.0 EXECUTIVE SUMMARY

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

The results of our analyses indicate that the proposed residential structures may be supported upon conventional spread and/or continuous wall foundations established entirely upon a minimum 18 to 24 inches of suitable, undisturbed natural gravel soils, or granular structural replacement fill extending to suitable natural soils.

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

1. The site is located upon mapped Pleistocene to Holocene age lacustrine deposits **Qdab** and **Qadb**, and **Qc** mass movement and colluvial deposits. The deposits exposed appear to be coarse alluvium that was modified by Pleistocene lacustrine processes, and are relatively coarse and contain significant percentage of over-size clast and may be difficult to excavate.

2. The natural clay soils encountered are moderately high plastic soils with test results indicating some low to moderate swell potential when wetted. The swell potential becomes more significant for lightly loaded slabs-on-grade and less for loaded foundations. To help minimize the effect of potential swell of in-situ natural clay soils on the structure, we recommend that there be a minimum of 18 inches of natural low plastic granular soil or granular structural replacement fill placed directly below footings and a minimum of 24 inches of natural low plastic granular soil or granular structural replacement fill be placed below structural slabs-on-grade if clay soils are exposed at the base of excavations. Further, the exposed natural clay soils must be protected from drying following excavation and placement of structural fill and subsequent construction.

Site-specific slope stability studies were not part of the scope of work for this project. Where the homesite construction is proposed to occur, the site slopes are gently sloping and less than 25 percent. However, unbraced slopes at the site must not be steepened to more than four horizontal to one vertical (4H:1V). All retaining walls at the site must be properly engineered. Rockery walls less than 4 feet in height with adjacent tiers separated by at least 2 times the height of the tallest wall, may be considered as landscaping walls.

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

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

3.0 DESCRIPTION OF PROPOSED CONSTRUCTION

The selected homesite lots have been developed for single-family dwelling construction. The intended/proposed structures for the lots are likely to be constructed with concrete basement levels supported on conventional spread and strip footings. Above grade levels will consist of wood framed construction, one to three levels in height. Projected maximum column and wall loads will be on the order of about 10 to 50 kips and 1 to 4 kips per lineal foot, respectively.

Site development will require a moderate amount of earthwork in the form of site grading. We estimate in general that maximum cuts and fills to achieve design grades will be on the order of about 3.0 to 5.0 feet. Larger cuts and fills may be required in isolated areas. In general, the projected site grading activities are anticipated to consist primarily of cutting

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into the existing ground to construct the residence, with very little fill projected for the site. Final cuts and fills must be designed to maintain stability of the slopes at the site and not steepen the slope greater than four horizontal to one vertical (4H:1V), and all planned retaining walls will need to be properly engineered.

4.0 FIELD EXPLORATION AND SITE CONDITIONS

The site subsurface soil conditions were explored by excavating ten test pits on July 16 and 17, 2019 on the selected lots at the locations shown on Figure 5. The test pits were excavated using an 18-ton track-mounted excavator and extended to depths of approximately 9.0 to 16.0 feet below the existing ground surface, at which point excavation was either stopped or refused. During the course of the excavating operations, a continuous log of the subsurface conditions encountered was maintained. Within the test pits undisturbed tube, block and disturbed bulk samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. The representative soil samples were placed in sealed plastic bags and containers prior to transport to the laboratory.

The collected samples were logged and described in general accordance with ASTM standard 2488, packaged, and transported to our laboratory. The soils were classified in the field based upon visual and textural examination. These classifications have been supplemented by subsequent inspection and testing in our laboratory. The subsurface conditions encountered in the field exploration are discussed below in Section 5.4. Subsurface Soil Conditions, and are illustrated on Figures 6 through 15, Log of Test Pits. Sampling information and other pertinent data and observations are also included on the logs. In addition, a Key to Symbols defining the terms and symbols used on the logs is provided as Figure 16 in this report.

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

5.0 ENGINEERING GEOLOGY

5.1 General Geology

The site is located in Ogden Valley which is a northwest trending fault bounded graben structure, with the Wasatch Range comprising the western flank of the valley and the Bear River Range the eastern flank (Avery, 1994). Topographically the site is located on the valley margin near the lower reaches of Wolf Creek near where the creek joins the North Fork Ogden River. The elevation of the site is roughly 5160 feet, with elevations in the site vicinity ranging between approximately 5060 feet on the southwest in the vicinity of the North Fork of Ogden River and 5290 feet on valley-margin slopes to the northeast of the subdivision as shown on Figure 4. The Eagle Ridge Subdivision is located on the transition of low gradient piedmont surfaces formed along Wolf Creek, and the gentle valley margin slopes at the base of a 7000-foot-high ridgelines that buttress James Peak which rises to 9424 feet approximately 5 miles northeast of the site.

The site is located on the northeastern margin of Ogden Valley, on the east side of the Wasatch Range, which western side the Wasatch Front is marked by the Wasatch fault. The Wasatch fault is approximately 4.8 miles west of the site, and provides the basis of division between the Middle Rocky Mountain Physiographic Province on the east and the Basin and Range Physiographic Province on the west. The Basin and Range Physiographic Province is characterized by approximately north-south trending valleys and mountain ranges that have been formed by extensional tectonics and displacement along normal faults and extends from the Wasatch Range on the east to the Sierra Nevada Range on the west (Hunt, 1967).

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

The site is located within a setting of complex geological conditions wherein Pre-Cambrian and Paleozoic rocks were locally rafted over the same during a series of eastward thrust extensions the last of which is named the Willard Thrust sheet, which is believed to have moved onto the vicinity during the Cretaceous Sevier orogeny, and occurred approximately 140 million years ago (ma). The exposure of the present surficial geology of the site vicinity is the result of the uplift and exposure of older pre-Cambrian rocks which forms the crests of Lewis Peak (8,031 feet) west of the valley and James Peak on the east. This exposure was the result of movement along locally high-angle faults (i.e. The Wasatch fault) during late Tertiary and Quaternary age (Bryant, 1988). The Norwood Formation is mapped as outcropping in the site vicinity, and overlies parts of the older rocks, but is largely covered by the more recent Quaternary sediments in the area. The Norwood Formation is described as "light-gray to light brown, altered tuff (claystone), tuffaceous siltstone, sandstone, and conglomerate" derived from volcanic ash deposition that occurred during the lower Oligocene and upper Eocene (King and others, 2008). Finally, Quaternary stream deposition and planation by Wolf Creek has deposited range-margin coarse alluvium that has been modified by late-Pleistocene lacustrine processes, forming the surface of the Eagle Ridge site vicinity. The current geological mapping drawn from Coogan and King (2016) of the site is shown on Figure 3.

5.2 Site Surface Conditions

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

The topography of the site vicinity consists of gentle to moderately steep valley-margin foothill slopes. Vegetation at the site is open with a cover of grass, weeds and sage brush with few trees. The site slopes developed from our LiDAR analysis were found to range from level to over 100-percent as shown on Figure 4.

5.3 Surficial Geology

The surficial geology of the site is presented on Figure 3, of this report and has been taken from mapping prepared by Coogan and King (2016). A summary of the mapping units identified on the site vicinity and described by Coogan and King (2016) are paraphrased below in relative age sequence (youngest-top to oldest bottom):

> **Qal –** Alluvial deposits mostly Holocene. Moderately sorted, unconsolidated sand, silt, clay, and gravel; locally includes muddy, organic overbank and oxbow lake deposits...
>
> **Qac –** Alluvial and colluvial deposits, Holocene and Pleistocene. Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; typically mapped along smaller drainages that lack flat bottoms; includes stream and fan alluvium...
>
> **Qadb - Qadb? –** Mixed lacustrine (Lake Bonneville) deposits, upper Pleistocene. Poorly to well sorted cobbly gravel, sand, silt, and clay; rounded to subangular clasts in a matrix of sand and silt with interbeds of sand and silt; typically better sorted delta and lake deposits over poorly sorted alluvial-fan deposits...
>
> **Qdlb –** Mixed lacustrine (Lake Bonneville) deposits, upper Pleistocene. Mostly sand, silty sand, and gravelly sand; locally contains more cobbles and overall more gravel...
>
> **Qc –** Mass movement and colluvial deposits, Holocene and Pleistocene. Unsorted clay- to boulder-sized material...

Qcg – Mixed deposits, colluvial, Holocene and Pleistocene. Gravelly materials with prominent stone stripes that trend downhill; stripes are concentrations of gravel up to boulder size...

Qafb ? – Lake Bonneville-age alluvial-fan deposits upper Pleistocene. Mostly sand, silt, gravel, cobbles and boulders...

Qafo - Qafoe – Alluvial fan deposits (older), middle and lower Pleistocene. Mostly poorly bedded and poorly sorted sand, silt, and gravel; fan remnants higher than Lake Bonneville deposits...

Qmso – Older landslide deposits Pleistocene. Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods; generally characterized by hummocky topography...

Tn – Norwood Formation (lower Oligocene and upper Eocene) – Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate...

The selected lot sites are located upon **Qdab** and **Qadb** lacustrine deposits, and **Qc** mass movement and colluvial deposits. These deposits and formative geological processes are considered presently inactive under the existing site and slope conditions.

5.4 Subsurface Soil Conditions

Subsurface conditions encountered in the test pits excavated for the selected lots, including Test Pits TP-1 to TP-10, ranged from Silty Clays CL to Silty Gravels GM, with cobbles and boulders observed in most of the excavations. Surficial topsoil, Soil A-B horizons, two to eight inches thick were observed on the surfaces of the native soils in the test pits, and fill soils were noted in some tests pits up to 9.0 feet below the surface.

Test Pit TP-1, which log is shown on Figure 6 was excavated on Lot 54 exposed Silty Clay CL with some fine sand, and cobbles and boulders to the 16.0-foot depth excavated. These soils were observed to be brown in color, moist, and estimated to be stiff in consistency.

Test Pit TP-2, which log is shown on Figure 7 was excavated on Lot 56 and exposed a fill soil comprised of cobbles and boulders with some sand and gravel to 6.0-feet in depth. Beneath the fill, and extending to the 11.0 feet depth excavated, Clay CL with some fine sand, and cobbles and boulders was exposed. The clay was observed to be brown in color, moist, and estimated to be medium stiff to stiff in consistency.

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Test Pit TP-3, which log is shown on Figure 8 was excavated in the vicinity of Lots -58, and -59 and exposed fill soil comprised of cobbles and boulders with some clay, sand and gravel to a depth of 5.0-feet. Beneath the fill, and extending to 12.0 feet depth excavated, Clay CL with some fine sand, and occasional cobbles was exposed. The clay was observed to be brown in color, moist, and estimated to be medium stiff in consistency.

Test Pit TP-4, which log is shown on Figure 9 was excavated in the vicinity of Lots -59, and -60, exposed fill soil comprised of cobbles and boulders with some clay, sand and gravel to 8.5-feet in depth. Beneath the fill, and extending to 13.0 feet depth excavated, Clayey Gravel GC with some fine sand, and occasional cobbles and boulders were exposed. These soils were observed to be brown in color, slightly moist, and estimated to be in a very dense state.

Test Pit TP-5, which log is shown on Figure 10 was excavated in the vicinity of Lots -60, and -61, exposed fill soil comprised of cobbles and boulders with some clay, sand and gravel to the 9.0-foot refusal depth of the excavation.

Test Pit TP-6, which log is shown on Figure 11 was excavated in the vicinity of Lots -61, and -62, exposed Clayey Gravel GC with cobbles and boulders to the 12.0-foot depth excavated. These soils were observed to be brown in color, slightly moist, and to be in a dense to very dense state.

Test Pit TP-7, which log is shown on Figure 12 and excavated in the vicinity of Lots -69, and -70, exposed Gravelly Clay CL with some sand and cobbles to 3.0 feet in depth. The clay was brown in color, moist, and estimated to be stiff to very stiff in consistency. Below the clay to the 11.0-foot depth excavated, a Poorly Graded Gravel with clay GP-GC was encountered. The gravel was observed to be brown in color, moist, and estimated to be in a very dense state.

Test Pit TP-8, which log is shown on Figure 13 was excavated in the vicinity of Lots -70, and -71, exposed Gravelly Clay CL with some sand, gravel and cobbles to 4.5 feet in depth. The clay was brown in color, moist, and estimated to be stiff to very stiff in consistency. Below the clay to the 11.0-foot depth excavated a Clayey Gravel GC with some cobbles was encountered. The gravel was observed to be brown in color, slightly moist, and estimated to be in a very dense state.

Test Pit TP-9, which log is shown on Figure 14 was excavated in the vicinity of Lots -71, and -72, and exposed Clayey Gravel GM with sand, some cobbles to 7.0 feet in depth. The clayey gravel was brown in color, moist and estimated to be in a dense to very dense state. Below the clayey gravel a Poorly Graded Gravel with silt GP-GM with cobbles, some sand and clay was encountered to the 11.0-foot depth of the excavation. The poorly graded gravel was observed to be brown in color, moist, and estimated to be in a dense to very dense state.

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Test Pit TP-10, which log is shown on Figure 15 was excavated in the vicinity of Lots -72, and -73, and exposed Clayey Gravel GM with sand, some cobbles to 7.5 feet in depth. The clayey gravel was brown in color, moist and estimated to be in a dense to very dense state. Below the clayey gravel a Poorly Graded Gravel with silt GP-GM with cobbles, some sand and clay was encountered to the 11.0-foot depth of the excavation. The poorly graded gravel was observed to be brown in color, moist, and estimated to be in a dense to very dense state.

5.5 Groundwater

Static groundwater was not observed in the test pits. The local static groundwater elevation is projected to be below project depths by about 15 to 20 feet for the site.

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

5.6 Site Subsurface Variations

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

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

5.7 Seismic Setting

5.7.1 General

Utah has adopted the International Building Code (IBC) 2018, 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).

5.7.2 Active Earthquake Faults

Based upon our review of available maps and literature, no active faults are known to pass through or immediately adjacent to the site. The nearest active (Holocene) earthquake fault to the site is the Weber segment of the Wasatch fault zone (UT2351E) which is located 4.8 miles west of the site (Black and others, 2004). Accordingly, fault rupture hazards are not considered present on the site. The Ogden Valley North Fork fault (UT2376) is located much closer to the site, approximately 0.8 miles to the west, however the most recent movement along this fault is estimated to be pre-Holocene (<750,000 ybp), and is not considered an active risk to the site (Black and others, 1999).

5.7.3 Soil Class

For site class definitions, IBC 2018 Section 1613.2.2 refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[1] 7-16. Given the subsurface soils encountered at the site, which only extended to a depth of about 16.0 feet, it is our opinion the site best fits Site Class D – Stiff Soil Profile (without data, or default), which we recommend for seismic structural design.

5.7.4 Strong Ground Motion

Strong ground motion originating from the Wasatch fault or other near-by seismic sources is capable of impacting the site. The Wasatch fault zone is considered active and capable of generating earthquakes as large as magnitude 7.3 (Arabasz and others, 1992). Based on probabilistic estimates (Peterson and others, 2008) queried for the subdivision site (41.3300º N., 111.84201º E.), the expected peak horizontal ground acceleration (PGA) on rock from a large earthquake with a ten-percent probability of exceedance in 50 years is as high as 0.17*g*. For a two-percent probability of exceedance in 50 years, the PGA is as high as 0.38*g* for the site.

The a ten-percent probability of exceedance in 50 years event has a return period of 475 years, and the 0.17*g* acceleration for this event corresponds to "strong" perceived shaking with "light" potential damage based on instrument intensity correlations. The two-percent probability of exceedance in 50 years event has a return period of 2475 years, and the 0.38*g* acceleration for this event corresponds to "severe" perceived shaking with "moderate to heavy" potential damage based on instrument intensity correlations (Wald and others, 1999).

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

[1]American Society of Civil Engineers

probability of occurrence.

5.7.5 Liquefaction

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

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

5.7.6 Tectonic Subsidence

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

5.8 Landslide and Slump Deposits

The nearest landslide units are mapped as **Qmso** deposits by Coogan and King (2016), and are closest located to the selected lots approximately 825 feet to the north of the Lot 49 site as shown on Figure 3. These deposits are considered currently inactive and should not potentially impact the proposed improvements.

5.10 Sloping Surfaces

The surface slopes of the site vicinity developed from our LiDAR analysis and shown on Figure 4 range from near-level to over 100-percent. For the selected lots the slope gradients ranged from 2.6-percent on Lot 71, to 15.6-percent on Lot 73. The limiting steep

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slope gradients for development considerations according to the Weber County Code is 25-percent (Weber County Code, 2019).

5.11 Alluvial Fan - Debris Flow Processes

Active alluvial fan deposits indicative of processes including flash flooding and debris flow hazard do not appear to occur on the subdivision site. The nearest active alluvial fan deposits are mapped as **Qafy** by Coogan and King (2016), and are closest located to the selected lots approximately 1200 feet to the west of the Lot 59 site as shown on Figure 3. These deposits and processes do not appear to be a potential impact to the selected lot locations.

5.12 Flooding Hazards

Mapping by Federal Emergency Management Agency (FEMA, 2015) indicates the selected lot locations are outside the FEMA designated 100-year flood zone areas, as shown on Figure 3.

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

5.13 Rockfall and Avalanche Hazards

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

6.0 LABORATORY TESTING

6.1 Laboratory Examination

In order to provide data necessary for our engineering analyses, a laboratory testing program was completed. The program included performing moisture, partial gradation, Atterberg limits, and consolidation tests on representative subsurface soil samples. The following paragraphs and tables describe the tests and summarize the test data.

6.1.1 Partial Gradation Test

To aid in classifying the granular soils, gradation tests were performed. Results of the tests are tabulated below.

Test Pit No.	Depth (feet)	Percent Gravel	Percent Sand	Percent Passing No. 200 Sieve	Moisture Content Percent	Soil Classification
TP-2	3.0	66	6	28	3.4	GC
TP-2	7.0	48	6	46	7.4	GC
TP-3	11.5	--	--	89	41.1	CL
TP-4	11.0	67	22	11	4.3	GP-GM
TP-7	6.5	82	12	6	3.6	GP-GC
TP-10	10.0	79	13	8	3.1	GP-GM

6.1.2 Atterberg Limits Test

To further aid in classifying the soils, Atterberg limit tests were performed. Results of the tests are tabulated below:

Test Pit No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Soil Classification
TP-2	7.0	42	15	27	GC
TP-3	11.5	46	19	27	CL
TP-7	6.5	40	18	22	GP-GC

6.1.3 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed on each of two representative samples of the fine-grained clay soils encountered at the site. The results indicate that the tested clay soils are slightly to moderately expansive at their current moisture content with swells on the order of about 1.5 to 2.5 percent when wetted and will exhibit moderate strength when loaded below the pre-consolidation pressure.

7.0 SITE PREPARATION AND GRADING

7.1 Site Preparation

Initial site preparation will consist of the removal of surface vegetation, topsoil, and other deleterious materials and non-engineered fills from beneath an area extending out at least 3 feet from the perimeter of each proposed residence, and 2 feet beyond pavements, and exterior flatwork areas. Topsoil, although unsuitable for utilization as structural fill, may be stockpiled for subsequent landscaping purposes.

Due to the moderately high plastic soils encountered which exhibit some swell potential in their present condition, native undisturbed gravel soils with low plasticity or granular structural replacement fill is recommended below foundations and floor slabs on the order of 18 inches and 24 inches respectively. Further it is recommended that the fines content (silts and clays) of the granular structural fill be in the range of 15 to 30 percent to reduce soil permeability. The fines content shall also have low plasticity (Liquid limit less than 35 percent and Plastic Index less than 10 percent). Care must be taken such that the natural clay soils below structures shall not be allowed to dry out prior to placement of structural fills, foundations, and slabs. A foundation subdrain must also be installed around any sublevel of the home and gravity daylight well beyond and down gradient of the home.

Based on the soil conditions encountered and the geologic history it is recommended that site cuts be limited across the site such that un-braced site grading slopes remain similar to existing slope (roughly 4H:1V or less).

The natural clay soils may become easily disturbed, and stabilization may be required prior to placement of footings, floor slabs, pavements, or structural fills. This will especially be true during periods of precipitation and areas of construction traffic.

Subsequent to stripping and prior to the placement of structural site grading fill, pavements, driveway, and garage slabs on grade, the prepared subgrade must be proof rolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If excessively soft or loose soils are encountered, they must be removed to a maximum depth of 2 feet and replaced with structural fill. Beneath footings, all soft, loose, and disturbed soils must be totally removed. If removal depth required is greater than 2 feet, CMT must be informed to provide further recommendations.

7.2 Temporary Excavations

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

For granular (cohesionless) soils, construction excavations above the water table, not exceeding 4 feet, should be no steeper than one-half horizontal to one vertical (0.5H:1V).

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

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

7.3 Structural Fill Material

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 minimum 15% passing and a maximum 30% 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-inch to 2.0-inch gravel placed on stabilization fabric, such as Mirafi RS280i, or equivalent (see **Section 7.6**).

Some on-site gravel soils appear suitable for use as structural fill, if processed to meet the requirements given above, and may also be used in site grading fill and non-structural fill situations.

The on-site clay soils should not be used as site grading fill or in structural areas but could be utilized in landscape areas.

7.4 Utility Trenches

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

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

In private utility areas, natural soils may be re-utilized as trench backfill over the bedding layer provided that they are properly moisture prepared and compacted to the minimum requirements stated in section 7.5 Fill Placement and Compaction below.

7.5 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 as determined by the ASTM[2] D-1557(AASHTO[3] T-180) compaction criteria in accordance with the table below:

[2] American Society for Testing and Materials
[3] American Association of State Highway and Transportation Officials

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Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 3 feet beyond the perimeter of the structure	0 to 5	95
Beneath an area extending at least 3 feet beyond the perimeter of the structure	5 to 8	98
Site grading fills outside area defined above	0 to 5	90
Site grading fills outside area defined above	5 to 8	95
Utility trenches within structural areas	--	96
Roadbase/Subbase	--	96

Structural fills greater than 8 feet thick are not anticipated at the site.

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade shall be prepared as discussed in Section 7.1, Site Preparation, of this report. In confined areas, subgrade preparation should include the removal of all loose or disturbed soils.

7.6 Stabilization

The natural clay soils could be susceptible to rutting and pumping particularly during wet periods of the year. To stabilize soft soil conditions, coarse angular gravel and cobble mixtures (stabilizing fill) may be utilize and shall be end-dumped, spread to a maximum loose lift thickness of 15 inches, and compacted by dropping a backhoe bucket onto the surface continuously at least twice. As an alternative, the stabilizing fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately compacted so that the "fines" are "worked into" the voids in the underlying coarser gravels and cobbles. Utilization of a filter fabric, such as Mirafi 280i or equivalent, over soft subgrade may also be advantageous.

Non-structural fill may be placed in lifts not exceeding 12 inches in loose thickness and compacted by passing construction, spreading, or hauling equipment over the surface at least twice.

Field density tests should be performed on each lift as necessary to verify that compaction is being achieved.

8.0 LATERAL EARTH PRESSURES

The lateral pressure parameters, as presented within this section, are for backfills which will consist of clean, drained on site or imported soil placed and compacted in accordance with the recommendations presented herein. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot in computing lateral pressures. For more rigid walls (moderately yielding), generally not exceeding 8 feet in height, backfill may be considered equivalent to a fluid with a density of 55 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is no steeper than 5 horizontal to 1 vertical and that the fill within 3 feet of the wall will be compacted with hand-operated compacting equipment.

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

Wall Height (feet)	Seismic Loading Active Case (psf)	Seismic Loading Moderately Yielding (psf)
4	15	30
6	17	45
8	25	60

9.0 FOUNDATION RECOMMENDATIONS

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

9.1 Foundation Recommendations

The proposed residences may be supported upon conventional spread and continuous wall foundations established entirely on suitable, undisturbed natural gravel soils, or entirely upon 18 inches of granular structural fill extending to suitable natural soil. For design, the following parameters are provided:

Minimum Recommended Depth of Embedment for Frost Protection	-	30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	-	15 inches
Recommended Minimum Width for Continuous Wall Footings	-	16 inches
Minimum Recommended Width for Isolated Spread Footings	-	24 inches
Recommended Net Bearing Pressure for Real Load Conditions Established on 18 inches of Undisturbed Natural Gravel soils or on 18 inches of Structural Fill Extending To Suitable Natural Clay Soil	-	2,000 pounds per square foot
Bearing Pressure Increase for Seismic Loading	-	30 percent

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

9.2 Installation

Footings shall not be installed upon soft or disturbed soils, non-engineered fill, construction debris, frozen soil, or within ponded water. Additionally, footings shall not be installed directly on natural clay soils. Where footing would otherwise be established on natural clay soils the footings must be over excavated and be underlain by a minimum 18 inches of granular structural fill meeting the requirements as stated in this report. If the granular structural fill upon which the footings are to be established becomes disturbed, it shall be recompacted to the requirements for structural fill or be removed and replaced with new structural fill.

The width of structural fill, where placed below footings, shall extend laterally at least 6 inches beyond the edges of the footings in all directions for each foot of fill thickness beneath the footings.

9.3 Estimated Settlement

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

9.4 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.40 should be utilized for structural fill. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 250 pounds per cubic foot.

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

10.0 FLOOR SLABS

Floor slabs may be established entirely upon natural gravel soils, or where natural clay soils are exposed, over a minimum of 24 inches of granular structural replacement fill extending to suitable natural soils. Under no circumstances shall floor slabs be established directly over native clay soils, non-engineered fills, loose or disturbed soils, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In order to facilitate curing of the concrete, it is recommended that floor slabs be directly underlain by at least 4 inches of "free-draining" fill, such as "pea" gravel or three-quarters to one-inch minus clean gap-graded gravel. This 4 inches may be incorporated as part of the 24 inches of granular structural fill requirement.

11.0 DRAINAGE RECOMMENDATIONS

11.1 General Drainage Recommendations

It is very important to the long-term performance of foundations and floor slabs that water not be allowed to collect near the foundation walls and infiltrate into the underlying soils, particularly the natural clay soils which can swell when wetted. 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 6 inches in the first 10 feet away from the structure.

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

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

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

Other precautions may become evident during construction.

11.2 Subdrains

11.2.1 General

Due to the potential for random perched groundwater conditions within the predominantly clay soils sequence it is recommended that a foundation drain be installed around subsurface levels.

11.2.2 Foundation Subdrains

Foundation subdrains should consist of a 4-inch diameter perforated or slotted plastic or PVC pipe enclosed in clean gravel comprised of three-quarter- to one-inch minus gap graded gravel and/or “pea” gravel. The invert of a subdrain should be at least 18 inches below the top of the lowest adjacent habitable 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 must be wrapped with a geotextile, such as Mirafi 140N or equivalent.

Above the foundation subdrain, a minimum 12-inch-wide zone of "free-draining" clean sand or gravel (chimney) should be placed adjacent to the foundation walls and extend to within 2 feet of final grade. The sand/gravel fill must be separated from adjacent native or backfill soils with a geotextile fabric (Mirafi 140N or equivalent). The upper 2 feet of soils should consist of a compacted clayey soil cap to reduce surface water infiltration into the drain. As an alternative to the zone of permeable sand or gravel, a prefabricated "drainage board," such as Miradrain or equivalent, may be placed against the exterior below-grade walls. Prior to the installation of the footing subdrain, the below-grade walls should be dampproofed. The slope of the subdrain should be at least 0.3 percent. The foundation subdrains shall be discharged to down-gradient location well away from the home.

12.0 QUALITY CONTROL

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

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 granular fill materials. The maximum density information should then be used for field density tests on each lift as necessary to ensure that the required compaction is being achieved.

12.3 Concrete and Asphalt Quality

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

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13.0 LIMITATIONS

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

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

We appreciate the opportunity to be of service to you on this project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With 4 offices throughout Northern Utah, and in Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 870-6730. To schedule materials testing please call (801) 908-5859.

14.0 REFERENCES

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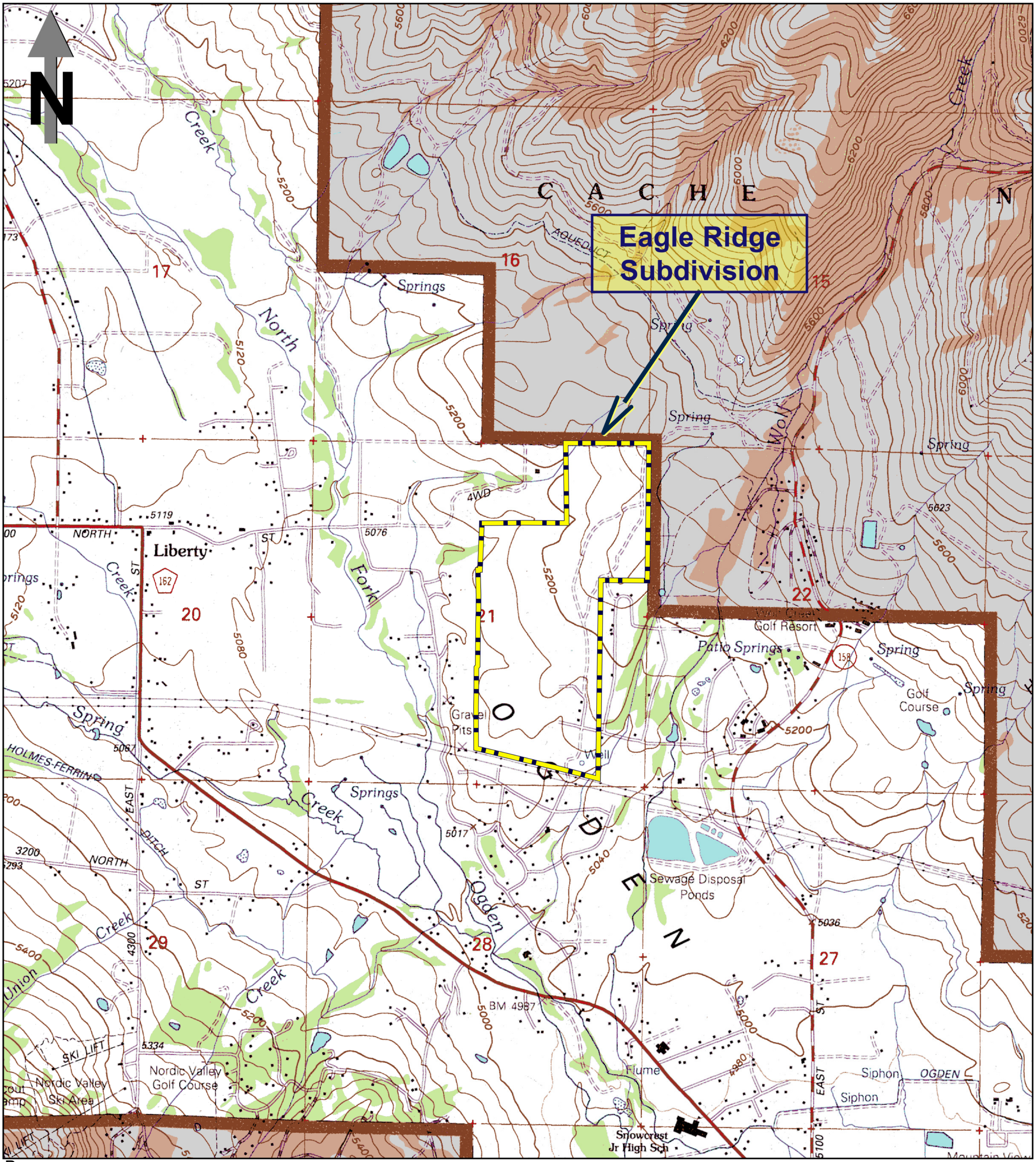
APPENDIX

SUPPORTING DOCUMENTATION

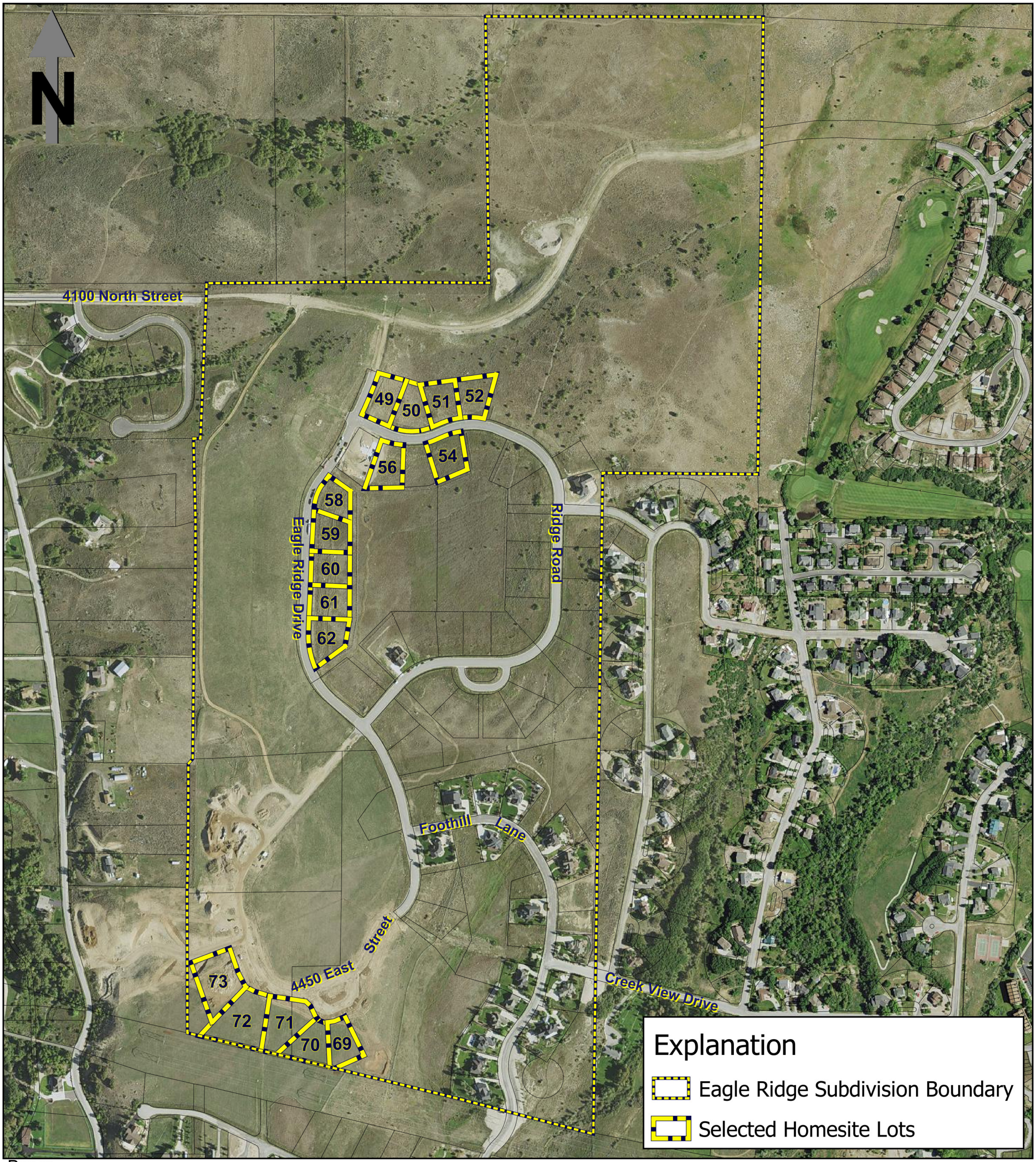


Base:
1998 USGS 7.5 Minute topographic map titled "Huntsville, Utah" from Utah AGRC; http://gis.utah.gov/

0 2000 4000 ft

1:24,000

Selected Lots Eagle Ridge Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES		Figure 1
	Vicinity Map	Date: 25 Aug.-19 Job # 13119	



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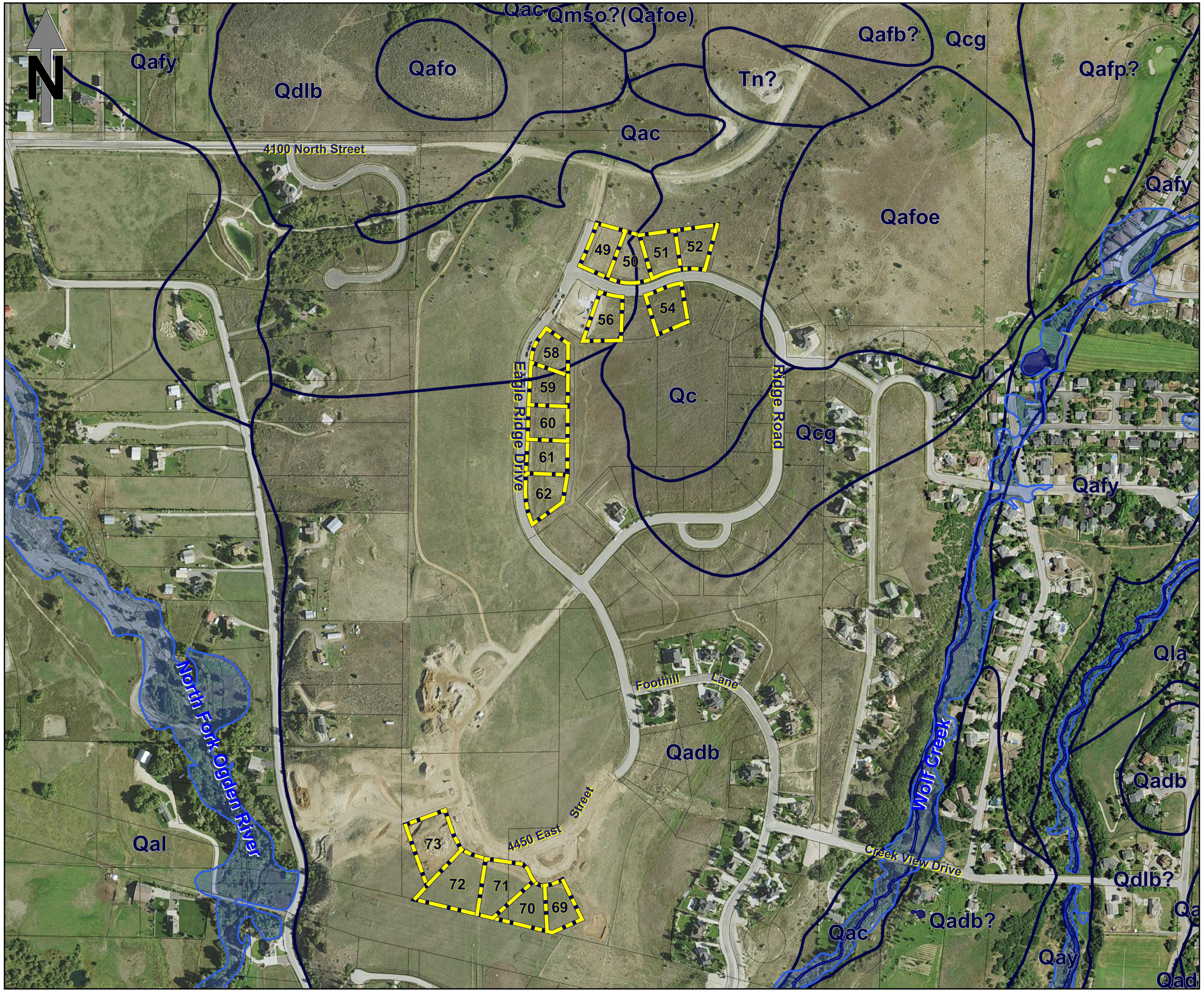
from Utah AGRC; http://gis.utah.gov/

0 600 1200 ft

1:7,200

Selected Lots Eagle Ridge Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES Site Plan	Date: 25 Aug.-19 Job # 13119	Figure 2



Base:
2014 1.0m Color NAIP Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 500 1000 ft

1:6,000

Geology (after Coogan and King, 2016)

Qafy – Alluvial-fan deposits (Holocene and Pleistocene) – Mostly sand, silt, and gravel that is poorly bedded and poorly...variably consolidated; includes debris flows, particularly in drainages and at drainage mouths (fan heads) ...

Qal – Alluvial deposits mostly Holocene. Moderately sorted, unconsolidated sand, silt, clay, and gravel; locally includes muddy, organic overbank and oxbow lake deposits...

Qac – Alluvial and colluvial deposits, Holocene and Pleistocene. Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; typically mapped along smaller drainages that lack flat bottoms; includes stream and fan alluvium...

Qadb - Qadb? – Mixed lacustrine (Lake Bonneville) deposits, upper Pleistocene. Poorly to well sorted cobbly gravel, sand, silt, and clay; rounded to subangular clasts in a matrix of sand and silt with interbeds of sand and silt; typically better sorted delta and lake deposits over poorly sorted alluvial-fan deposits...

Qdlb – Mixed lacustrine (Lake Bonneville) deposits, upper Pleistocene. Mostly sand, silty sand, and gravelly sand; locally contains more cobbles and overall more gravel...

Qc – Mass movement and colluvial deposits, Holocene and Pleistocene. Unsorted clay- to boulder-sized material...

Qcg – Mixed deposits, colluvial, Holocene and Pleistocene. Gravelly materials with prominent stone stripes that trend downhill; stripes are concentrations of gravel up to boulder size...

Qafb ? – Lake Bonneville-age alluvial-fan deposits upper Pleistocene. Mostly sand, silt, gravel, cobbles and boulders...

Qafo - Qafoe – Alluvial fan deposits (older), middle and lower Pleistocene. Mostly poorly bedded and poorly sorted sand, silt, and gravel; fan remnants higher than Lake Bonneville deposits...

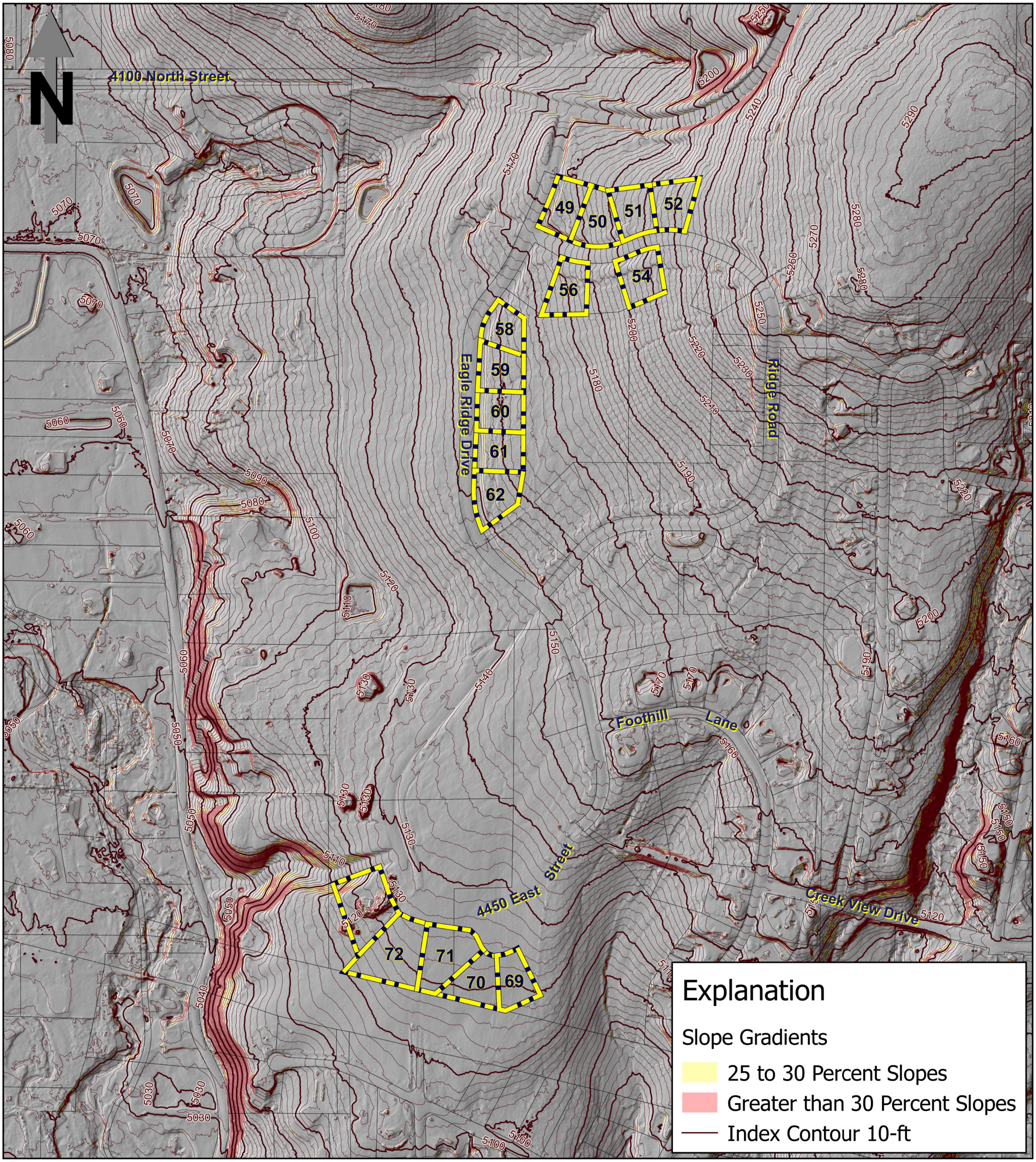
Qmso – Older landslide deposits Pleistocene. Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods; generally characterized by hummocky topography...

Tn – Norwood Formation (lower Oligocene and upper Eocene) – Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate...

FEMA - Flood Insurance Rating Zones (2015)

Areas subject to inundation by the 1-percent-annual-chance flood event generally determined using approximate methodologies...Mandatory flood insurance purchase requirements and floodplain management standards apply.

CMT ENGINEERING LABORATORIES	Selected Lots Eagle Ridge Subdivision Eden, Utah	GEOLOGIC MAPPING	Date:	25 Aug.-19	Figure 3
			Job #	13119	

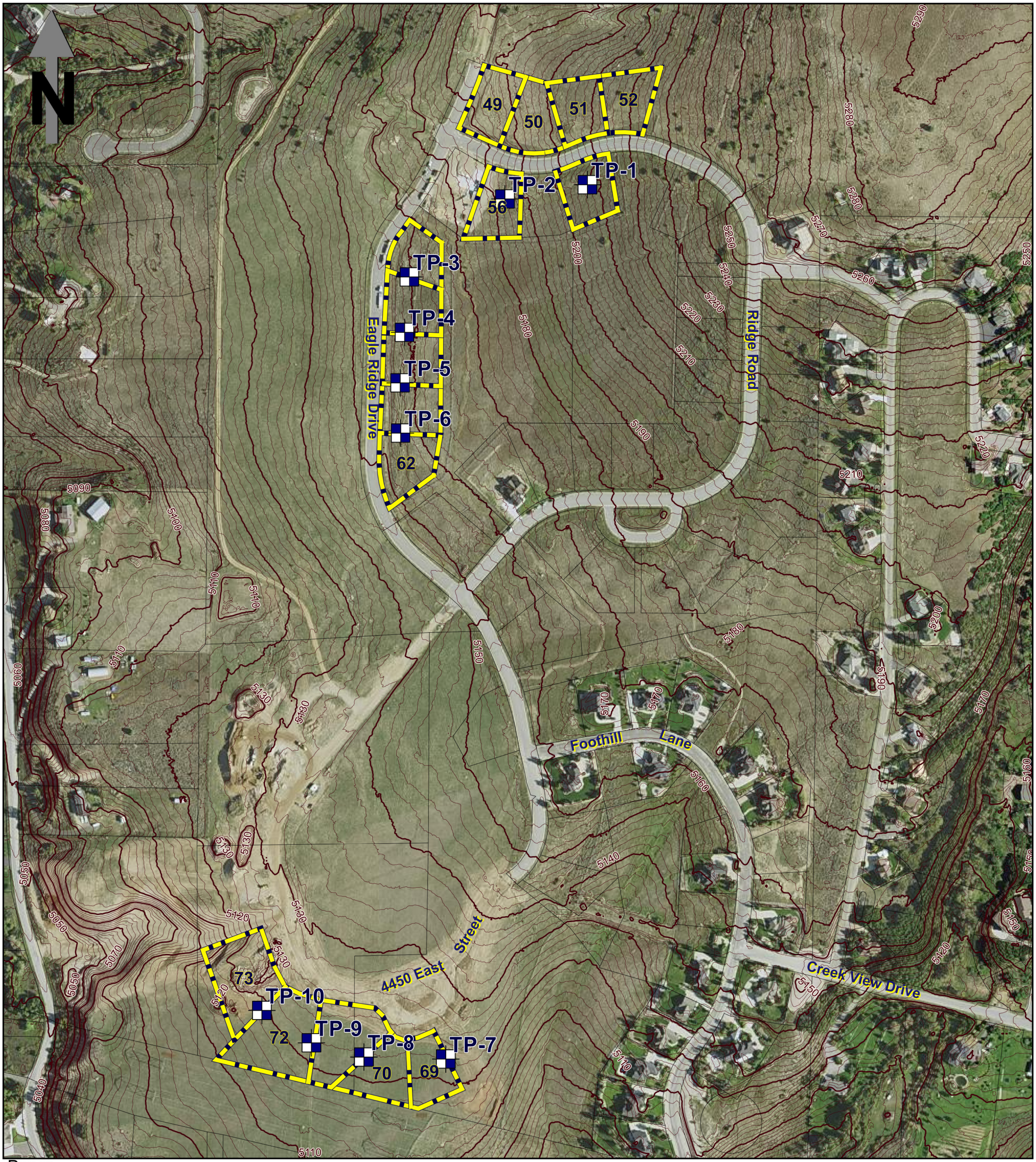


Base:
2011 1.0m LiDAR Imagery,
from Utah AGRC; http://gis.utah.gov/

0 500 1000 ft

1:6,000

Selected Lots Eagle Ridge Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES LiDAR Analysis	Date: 25 Aug.-19 Job # 13119	Figure 4



Base:
2014 1.0m NAIP Color Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 400 800 ft

1:4,800

Selected Lots Eagle Ridge Subdivision Eden, Utah	CMT ENGINEERING LABORATORIES		Figure 5
	Site Evaluation	Date: 25 Aug.-19 Job # 13119	

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-1

Lot 54

Equipment: Rubber Tire Backhoe	Total Depth: 16'	Date: 7/16/19	
Surface Elev. (approx):	Water Depth: (see Remarks)	Job #: 13119	

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0		TOPSOIL; Upper 2"-3", Loose to 8"										
0.67–16		Brown CLAY (CL), some fine sand, occasional cobbles, and boulders up to 3' in diameter moist, stiff (estimated)										
3				1	28.2	91.7						
6		grades with occasional thin volcanic ash										
8				2								
15				3								
16		END AT 16'										

Remarks: Groundwater not encountered during excavation.
Slotted PVC pipe installed to depth of 15 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright

Figure: 6

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-2

Lot 56

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

Total Depth: 11'
Water Depth: (see Remarks)

Date: 7/16/19
Job #: 13119

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0		TOPSOIL; Upper 2"-3", Loose to 8"										
2		FILL: Brown cobbles and boulders with some sand and gravel moist, medium stiff to stiff (estimated)										
				4	3.4		66	6	28			
4												
6		Brown CLAY (CL), some fine sand, occasional cobbles, and boulders moist, medium stiff to stiff (estimated)										
				5	7.4		48	6	46	42	15	27
8												
10												
		REFUSAL AT 11'		6								
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater not encountered during excavation.

Figure: 7

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-3

Lots 58/59

Equipment: Rubber Tire Backhoe	Total Depth: 12'	Date: 7/16/19	
Surface Elev. (approx):	Water Depth: (see Remarks)	Job #: 13119	

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0		TOPSOIL; Upper 2"-3", Loose to 8"										
2		FILL: Brown cobbles and boulders up to 3' in diameter with some clay, sand, and gravel slightly moist, dense to very dense (estimated) very hard (estimated)										
				7								
4												
6		Brown CLAY (CL), some sand, gravel, and occasional cobbles moist, medium stiff (estimated)										
				8								
8												
10		cobbles grade out										
				9	41.1				89	46	19	27
12		END AT 12'										
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater not encountered during excavation.

Figure: 8

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson

Logged By: Hogan Wright

Selected Lots within Eagle Ridge Subdivision

Lots 59/60

Test Pit Log

TP-4

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

Total Depth: 13'
Water Depth: (see Remarks)

Date: 7/16/19
Job #: 13119

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI
0		TOPSOIL; Upper 2"-3", Loose to 8"										
		FILL: Brown cobbles and boulders up to 3' in diameter with some clay, sand, and gravel; dry to slightly moist, very dense (estimated)										
3				10								
7				11								
9		Brown Clayey GRAVEL (GC) with sand, occasional cobbles and boulders; slightly moist, very dense (estimated)										
11				12	4.3		67	22	11			
13		END AT 13'										

Depth scale (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright

Figure: 9

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-5

Lots 60/61

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

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

Date: 7/16/19
Job #: 13119

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0		TOPSOIL; Upper 2"-3", Loose to 8"										
		FILL: Brown cobbles and boulders up to 3' in diameter with some clay, sand, and gravel dry to slightly moist, very dense (estimated)										
2												
				13								
4												
				14								
6												
8				15								
		REFUSAL AT 9'										
10												
12												
14												
16												
18												
20												
22												
24												
26												
28												

Remarks: Groundwater not encountered during excavation.

Figure: 10

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-6

Lots 61/62

Equipment: Rubber Tire Backhoe	Total Depth: 11'	Date: 7/16/19
Surface Elev. (approx):	Water Depth: (see Remarks)	Job #: 13119

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Gradation Sand %	Gradation Fines %	Atterberg LL	Atterberg PL	Atterberg PI
0		TOPSOIL; Upper 2"-3", Loose to 8"										
1–11		Brown Clayey GRAVEL (GC) with sand, cobbles, and boulders slightly moist, very dense (estimated)										
~3				16								
~7				17								
~10				18								
11		END AT 11.0 FEET										

Depth scale (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson

Logged By: Hogan Wright

Figure: 11

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-7

Lot 69

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

Total Depth: 11'
Water Depth: (see Remarks)

Date: 7/16/19
Job #: 13119

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0	TOPSOIL: Upper 2"-3", Loose to 8"										
	Brown Gravelly CLAY (CL), some sand and cobbles; moist, stiff to very stiff (estimated)										
			19								
	Brown Poorly Graded GRAVEL with clay (GP-GC), cobbles, some silt; slightly moist to moist, dense (estimated)										
	grades with increasing cobbles										
			20	3.6		82	12	6	40	18	22
			21								
11	END AT 11.0 FEET										

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

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

Figure: 12

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-8

Lots 70/71

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

Total Depth: 11'
Water Depth: (see Remarks)

Date: 7/16/19
Job #: 13119

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0	TOPSOIL: Upper 2"-3", Loose to 8"										
	Brown CLAY (CL), some sand and gravel; moist, stiff to very stiff (estimated)										
2	gravel grades out										
			22	22.1	102						
4	grades with gravel and cobbles										
	Brown Clayey GRAVEL (GC), some cobbles; slightly moist, dense to very dense (estimated)										
6			23								
	Brown Poorly Graded GRAVEL with silt (GP-GM), cobbles, some clay; slightly moist, dense to very dense (estimated)										
8											
10			24								
	END AT 11.0 FEET										
12											
14											
16											
18											
20											
22											
24											
26											
28											

Remarks: Groundwater not encountered during excavation.
Slotted PVC pipe installed to depth of 10 feet to facilitate water level measurements.

CMT ENGINEERING LABORATORIES

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

Figure: 13

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-9

Lots 71/72

Equipment: Rubber Tire Backhoe	Total Depth: 11'	Date: 7/16/19
Surface Elev. (approx):	Water Depth: (see Remarks)	Job #: 13119

Depth (ft)	GRAPHIC LOG	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation Gravel %	Sand %	Fines %	Atterberg LL	PL	PI
0		TOPSOIL: Upper 2"-3", Loose to 8"										
1–7		Brown Clayey GRAVEL (GC) with sand, some cobbles moist, dense to very dense (estimated)										
3			◣	25								
7–11		Brown Poorly Graded GRAVEL with silt (GP-GM), cobbles, some sand and clay moist, dense to very dense (estimated)	◣	26								
10			◣	27								
11		END AT 11.0 FEET										

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright

Figure: 14

Selected Lots within Eagle Ridge Subdivision

Test Pit Log

TP-10

Lots 72/73

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

Total Depth: 11'
Water Depth: (see Remarks)

Date: 7/16/19
Job #: 13119

Depth (ft)	Soil Description	Sample Type	Sample #	Moisture (%)	Dry Density(pcf)	Gradation: Gravel %	Gradation: Sand %	Gradation: Fines %	Atterberg: LL	Atterberg: PL	Atterberg: PI
0	TOPSOIL: Upper 2"-3", Loose to 8"										
~1	Brown Clayey GRAVEL (GC) with sand, some cobbles, moist, dense to very dense (estimated)										
~3		◣	28								
~6		◣	29								
~7.5	Brown Poorly Graded GRAVEL with silt (GP-GM), cobbles, some sand and clay										
~10		◣	30	3.1		79	13	8			
11	END AT 11.0 FEET										

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Todd Nelson
Logged By: Hogan Wright

Figure: 15

Selected Lots within Eagle Ridge Subdivision

Near the Intersection of Eagle Ridge Drive and Ridge Drive, North Salt Lake City, Utah

Key to Symbols

Date: Todd Nelson

Job #: 13119

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

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

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

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

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		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

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

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.).

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

CMT ENGINEERING LABORATORIES

Figure:

16