GORDON GEOTECHNICAL ENGINEERING, INC.

REPORT
GEOTECHNICAL STUDY
PROPOSED
EARLY CHILDHOOD CENTER ADDITION
325 WEST 400 SOUTH
LOGAN, UTAH

April 20, 2022

Job No. 745-003-22

Prepared for:
Design West Architects
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April 20, 2022
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Design West Architects
255 South 300 West
Logan, Utah 84321

Attention: Mr. Stephen Williams

Ladies and Gentlemen:

Re: Report
Geotechnical Study
Proposed Early Childhood Center Addition
325 West 400 South
Logan, Utah

1. INTRODUCTION

1.1 GENERAL

This report presents the results of our geotechnical study performed at the site of a proposed Early Childhood Center Addition, which is located at 325 West 400 South in Logan, Utah. The general location of the site with respect to major topographic features and existing facilities, as of 1998, is presented on Figure 1, Vicinity Map. A detailed location of the site showing existing roadways and surrounding facilities, on an air photograph base, is presented on Figure 2, Area Map. The locations and alignments of photographs taken of the site during the field portion are also presented on Figure 2. The proposed development and the boring locations drilled in conjunction with this study are also presented on Figure 3.

1.2 OBJECTIVES AND SCOPE

The objectives and scope of our study were planned in discussions between Mr. Stephen Williams of Design West Architects and Mr. Patrick Emery of Gordon Geotechnical Engineering, Inc. (G^2).

In general, the objectives of this study were to:

1. Accurately define and evaluate the subsurface soil and groundwater conditions across the site.

2. Provide appropriate foundation, earthwork, pavement, and geoseismic recommendations to be utilized in the design and construction of the proposed addition.

In accomplishing these objectives, our scope has included the following:

1. A field program consisting of the drilling, logging, and sampling of two borings.

2. A laboratory testing program.

3. An office program consisting of the correlation of available data, engineering analyses, and the preparation of this summary report.

1.3 AUTHORIZATION

Authorization was provided by authorizing our Professional Services Agreement No. 22-0114 dated January 17, 2022 and executed on March 8, 2022 (via Design West Architects Consultant Agreement).

1.4 PROFESSIONAL STATEMENTS

Supporting data upon which our recommendations are based are presented in subsequent sections of this report. Recommendations presented herein are governed by the physical properties of the soils encountered in the exploration borings, measured and projected groundwater conditions, and the layout and design data discussed in Section 2., Proposed Construction, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, G^2 must be informed so that our recommendations can be reviewed and amended, if necessary.

Our professional services have been performed, our findings developed, and our recommendations prepared in accordance with generally accepted engineering principles and practices in this area at this time.

2. PROPOSED CONSTRUCTION

An addition is planned for the west side of the existing structure. The addition will be one-extended level in height and of wood-frame construction established slab-on-grade. The existing structure is one-level in height and of wood-frame/masonry construction established slab-on-grade.

It is anticipated that the maximum anticipated column and wall loads will be in the range of 90 to 120 kips and 3 to 5 kips per lineal foot, respectively.

The final alignment for the new footings placed next to existing footings for the addition will need to be submitted to G^2 for our review. Footing placement next to existing footings could induce additional settlements in the existing structure and must be analyzed.

We estimate that maximum cuts and fills to achieve design grades will be on the order of three to five feet. Currently the site is used as a small detention pond with approximately five feet of elevation change observed.

Paved entryways and at-grade parking on the north and south sides of the existing building will also be a part of the overall development. Traffic over the entryway pavement surface will consist of a moderate volume of automobiles and light trucks, and a light volume of medium- and heavy-weight trucks. Traffic in the parking areas will be lighter.

3. INVESTIGATIONS

3.1 FIELD PROGRAM

In order to evaluate the subsurface soil and groundwater conditions across the site, 2 borings were drilled to depths ranging from 19.0 to 46.5 feet below surrounding grades in the area of the proposed addition. The borings were drilled using a rubber tire truck-mounted drill rig equipped with hollow-stem augers. Locations of the borings are presented on Figure 3.

The field portion of our study was under the direct control and continual supervision of an experienced member of our geotechnical staff. During the course of the drilling operations, a continuous log of the subsurface conditions encountered was maintained. In addition, relatively undisturbed and small disturbed samples of the typical soils encountered were obtained for subsequent laboratory testing and examination. 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. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 4A and 4B, Log of Borings. Soils were classified in accordance with the nomenclature described on Figure 5, Unified Soil Classification System.

A 3.25-inch outside diameter, 2.42-inch inside diameter drive sampler (Dames & Moore) was utilized in the majority of the subsurface sampling at the site. Additionally, a 2.0-inch outside diameter, 1.38-inch inside diameter drive sampler (SPT) was utilized at select locations and depths. The blow counts recorded on the boring logs were those required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

Following completion of drilling operations, one and one-quarter-inch diameter slotted PVC pipe was installed in Borings B-1 and B-2 in order to provide a means of monitoring the groundwater fluctuations.

3.2 LABORATORY TESTING

3.2.1 General

In order to provide data necessary for our engineering analyses, a laboratory testing program was performed. The program included moisture and density, Atterberg limits, partial gradation, and consolidation tests. The following paragraphs describe the tests and summarize the test data.

3.2.2 Moisture and Density Tests

To aid in classifying the soils and to help correlate other test data, moisture and density tests were performed on selected undisturbed samples. The results of these tests are presented on the boring logs, Figures 4A and 4B.

3.2.3 Atterberg Limits Test

To further aid in classifying the site soils, an Atterberg limits test was performed on a selected sample. Results of the tests are tabulated below:

Boring No.	Depth (feet)	Liquid Limit (percent)	Plastic Limit (percent)	Plasticity Index (percent)	Soil Classification
B-1	2.5	45	26	19	CL

3.2.4 Partial Gradation Tests

To aid in classifying the soils and to provide general index parameters, a partial gradation test was performed upon five representative samples of the soils encountered in the exploration borings. The results of the tests are tabulated on the following page.

Boring No.	Depth (feet)	Percent Passing No. 4 Sieve	Percent Passing No. 200 Sieve	Soil Classification
B-1	7.5	86.7	41.0	SM/ML
B-1	10.0	54.3	22.0	SM/GM
B-2	5.0	68.1	36.1	SM/GM – FILL
B-2	10.0	49.4	20.0	SM/GM
B-2	30.0	-	86.4	CL

3.2.5 Consolidation Tests

To provide data necessary for our settlement analyses, a consolidation test was performed on a representative sample of the fine-grained soils encountered in the exploration borings. The data available indicates that the soils are moderately over-consolidated and when loaded below the preconsolidated pressure the soils will exhibit moderate compressibility characteristics. Detailed results of the tests are maintained within our files and can be transmitted to you, at your request.

4. SITE CONDITIONS

4.1 SURFACE

The site consists of a roughly rectangular-shaped parcel containing the existing Early Childhood Center. An addition is planned for the west side of the existing structure. The site of the addition consists of a grass covered depression which appears to function as a detention basin. The bottom of the depression is approximately two to three feet below surrounding grades.

The site of the proposed addition is covered by landscaping grasses with occasional trees up to 30 feet in height.

The site of the proposed addition is bordered by Little Logan River to the west, existing asphalt concrete parking lots to the north and south, and the existing Early Childhood Center to the east.

The overall topography of the site is relatively flat with an overall relief on the order of four to five feet across the site. The site grade is approximately the same elevation as the adjacent streets.

Representative photographs of the site area are shown on Figure 6, Photographs.

4.2 SUBSURFACE SOIL

Subsurface conditions encountered at the boring locations were relatively consistent. In order to evaluate the subsurface soil and groundwater conditions across the site, 2 borings were drilled to depths ranging from 19.0 to 46.5 feet below surrounding grades within the footprint of the proposed addition. Subsurface conditions encountered at the boring locations were relatively consistent.

The upper three inches of the surficial soils contain topsoil and are loose. Underlying the topsoil and extending to a depth of four to seven feet below the surrounding grade, non-engineered fill was encountered. In general, the fills consisted of silty or clayey sands and gravels. The fills were likely placed in a somewhat controlled manner during construction of the area; however, unless compaction testing reports can be provided, they must be considered a non-engineered fill. Non-engineered fill will exhibit variable and, in most cases, poor engineering characteristics.

Underlying the fill, natural silty sands and gravels were encountered to 12.0 to 15.5 feet below the surrounding grade. The natural sands and gravel are loose to medium dense, slightly moist to very moist, olive-gray in color, and will exhibit high strength and low compressibility characteristics under the anticipated loading range.

Underlying the natural sands and gravels, to the maximum depth explored of 19.0 to 46.5 feet, natural silty clay with occasion silty sand layers was encountered. The clay is saturated, soft to medium stiff, olive-gray in color, and will exhibit moderate strength and compressibility characteristic under the anticipated loading range.

The lines designating the interface between soil types on the boring logs generally represent approximate boundaries. In-situ, the transition between soil types may be gradual.

4.3 GROUNDWATER

Immediately following drilling operations, the groundwater was measured in each boring. On April 4, 2022, the groundwater was measured within the piezometers placed in the borings. Groundwater measurements are tabulated below:

	Groundwater Depth (feet)	
Boring No.	**March 29, 2022**	**April 4, 2022**
B-1	12.0*	11.9
B-2	12.0*	PVC destroyed

* During drilling; not stabilized

Seasonal and longer-term groundwater fluctuations on the order of one to two feet are projected, with the highest seasonal levels generally occurring during the late spring and early summer months.

5. DISCUSSIONS AND RECOMMENDATIONS

5.1 SUMMARY OF FINDINGS

The proposed addition can be supported upon conventional spread and continuous wall foundations established on suitable natural soils and/or granular structural fill extending to suitable natural soils.

The most significant geotechnical aspects of the site are:

1. The non-engineered fills encountered to depths of four to seven feet at Borings B-1 and B-2, respectively.

2. Stabilized groundwater was measured to be at a depth of 11.9 feet in Boring B-1. For design groundwater recommendations see Section 5.9, Design Water Table.

Due to the variable nature of the non-engineered fills encountered, a qualified geotechnical engineer from our staff must aid in verifying the non-engineered fills have been completely removed and that suitable natural soils have been encountered prior to the placement of structural site grading fills, or foundations.

When developing site grading plans, the 100-year flood level of the Little Logan River must be considered. Standard practice is to establish the top of the lowest slabs in habitable areas at least one foot above the 100-year flood level.

Detailed discussions pertaining to earthwork, foundations, floor slabs, lateral resistance, pavement, and the geoseismic setting of the site are discussed in the following sections.

5.2 EARTHWORK

5.2.1 Site Preparation

Initial preparation of the site must consist of the removal of any existing structures, debris, and pavements, and any associated non-engineered fills.

Further preparation of the site must consist of the removal of all non-engineered fills, loose surficial soils, topsoil, debris, and other deleterious materials from beneath an area extending at least three feet beyond the perimeter of the proposed building, rigid pavement, and exterior flatwork areas. In proposed flexible pavement areas, the existing asphalt concrete and fills may remain provided that they do not interfere with the final grade. The asphalt concrete should be perforated to facilitate drainage and proofrolled.

The non-engineered fills may remain in flexible pavement areas as long as they are properly prepared. Proper preparation will consist of scarifying and moisture conditioning the upper eight inches and recompacting to the requirements of structural fill. However, it should be noted that compaction of fine-grained soils (clays and silts, if utilized) as structural site grading fill will be very difficult, if not impossible, during wet and cold periods of the year. As an option for proper preparation and recompaction, the upper eight inches of the non-engineered fills may be removed and replaced with granular subbase over proofrolled subgrade. Even with proper preparation, flexible pavements established on non-engineered fills may experience some long-term movements. If the possibility of these movements is not acceptable, these non-engineered fills must be completely removed.

Subsequent to the above operations and prior to the placement of footings, structural site grading fill, or floor slabs, the exposed natural subgrade must be proofrolled by passing moderate-weight rubber tire-mounted construction equipment over the surface at least twice. If any loose, soft, or disturbed zones are encountered, they must be completely removed in footing and floor slab areas and replaced with granular structural fill. If removal depth required is greater than two feet, G^2 must be notified to provide further recommendations. In pavement areas, unsuitable soils encountered during recompaction and proofrolling must be removed to a maximum depth of two feet and replaced with compacted granular structural fill.

5.2.2 Excavations

Temporary construction excavations not exceeding four feet in depth may be constructed with near-vertical sideslopes. Excavations up to eight feet in the finer-grained soils can be constructed with sideslopes no steeper than one-half horizontal to one vertical (0.5H:1.0V). Excavations up to eight feet in the granular soils can be constructed with sideslopes no steeper than one horizontal to one vertical (1.0H:1.0V). If saturated granular soils are encountered, flatter sideslopes, shoring and bracing, and/or dewatering will be required.

Utility trench excavations must conform within Occupational Safety and Health (OSHA) guidelines for trench safety.

To minimize disturbance to the underlying soils, it is our recommendation that footings be excavated with a backhoe equipped with a smooth-lip bucket.

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.

5.2.3 Structural Fill

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by footings, floor slabs, pavements, etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and in some areas, as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials. Structural site grading fill is defined as fill placed over fairly large open areas to raise the overall site grade. For structural site grading fill, the maximum particle size should generally not exceed four inches; although, occasional larger particles, not exceeding six inches in diameter may be incorporated if placed randomly in a manner such that “honeycombing” does not occur and the desired degree of compaction can be achieved. The maximum particle size within structural fill placed within confined areas should generally be restricted to two inches.

The on-site non-engineered fills and underlying natural soils may be utilized as structural site grading fill. It should be noted that unless moisture control is maintained, utilization of natural on-site clayey soils as structural site grading fill will be very difficult, if not impossible, during wet and cold periods of the year. Only granular soils are recommended as structural fill in confined areas, such as around foundations and within utility trenches.

To stabilize soft subgrade conditions or where structural fill is required to be placed below a level one foot above the water table at the time of construction, a mixture of coarse gravels and cobbles and/or one and one-half- to two-inch gravel (stabilizing fill) should be utilized.

Non-structural site grading fill is defined as all fill material not designated as structural fill and may consist of any cohesive or granular soils not containing excessive amounts of degradable material.

5.2.4 Fill Placement and Compaction

Coarse gravel and cobble mixtures (stabilizing fill), if utilized, 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 fill may be compacted by passing moderately heavy construction equipment or large self-propelled compaction equipment onto the surface continuously at least twice. Subsequent fill material placed over the coarse gravels and cobbles shall be adequately placed so that the “fines” are “worked into” the voids in the underlying coarser gravels and cobbles.

All other structural fill shall be placed in lifts not exceeding eight inches in loose thickness. Structural fills shall be compacted in accordance with the percent of the maximum dry density as determined by the AASHTO[1] T-180 (ASTM[2] D-1557) compaction criteria in accordance with the table below:

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 8	95
Outside area defined above	0 to 6	90
Outside area defined above	6 to 8	92
Road base	-	96

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

Subsequent to stripping and prior to the placement of structural site grading fill, the subgrade must be prepared as discussed in Section 5.2.1, Site Preparation, of this report. In confined areas, subgrade preparation should consist of the removal of all loose or disturbed soils.

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.

5.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) should 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 should be proofrolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proofrolling may 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 should be removed to a maximum depth of two feet below design finish grade and replaced with structural fill.

Most utility companies and City-County governments are now requiring that Type A-1 or A-1-a (AASHTO Designation – basically granular soils with limited fines) soils be used as backfill over

1 American Association of State Highway and Transportation Officials
2 American Society for Testing and Materials

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. We recommend that as the major utilities continue onto the site that these compaction specifications are followed.

The natural fine-grained cohesive soils are not recommended for use as trench backfill. Some of the natural sand soils (and surficial granular fills) may be suitable for use as trench backfill provided it meets the requirements of Type A-1 or A-1-a material.

5.2.6 Areal Settlements

Areal settlements resulting from site grading fills as much as two to three feet should be less than one-half of an inch. These settlements are in addition to settlements induced by foundation and floor slab loads. To reduce the total settlement that the addition will realize, site grading fill must be placed as far in advance of other construction as possible. The majority of this settlement will occur during placement.

5.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

5.3.1 Design Data

The proposed addition may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Under no circumstances shall footings be placed overlying non-engineered fills.

For design, the following parameters are provided with respect to the projected loading discussed in Section 2., Proposed Construction, of this report:

Minimum Recommended Depth of Embedment for Frost Protection	- 30 inches
Minimum Recommended Depth of Embedment for Non-frost Conditions	- 15 inches
Recommended Minimum Width for Continuous Wall Footings	- 18 inches
Minimum Recommended Width for Isolated Spread Footings	- 24 inches
Recommended Net Bearing Pressure for Real Load Conditions	
For footings on suitable natural soils and/or structural fill extending to suitable natural soils	- 2,500 pounds per square foot
Bearing Pressure Increase for Seismic Loading	- 50 percent*

* Not applicable for edge bearing pressure when the footings are established upon granular soil. Use 25 percent for overturning or other inclined loading.

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 the 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.

5.3.2 Installation

<u>The final alignment for the new footings placed next to existing footings for the addition will need to be submitted to G^2 for our review. Footing placement next to existing footings could induce additional settlements in the existing structure and must be analyzed.</u>

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

The width of structural replacement fill below footings should be equal to the width of the footing plus one foot for each foot of fill thickness.

5.3.3 Settlements

Settlements of foundations designed and installed in accordance with above recommendations and supporting maximum projected structural loads are anticipated to be less than one inch. Settlements are expected to occur rapidly with approximately 60 to 70 percent of the settlements occurring during construction.

As previously mentioned, settlements of existing footings due to new loads from the addition will need to be reviewed by G^2 as soon as they are available.

5.4 LATERAL PRESSURES

The lateral pressure parameters, as presented within this section, assume that the backfill extending at least five feet from the back of the wall be properly placed and compacted granular soil. The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), granular backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid basement walls, granular backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. For very rigid non-yielding walls, granular backfill should be considered equivalent to a fluid with a density with at least 55 pounds per cubic foot. The above values assume that the surface of the soils slope behind the wall is horizontal, that the granular fill has been placed and lightly compacted, not as structural fill. If the fill is placed as a structural fill the values should be increased to 45 pounds per cubic foot, 60 pounds per cubic foot, and 120 pounds per cubic foot, respectively.

Recommended average lateral uniform pressure for various height walls are tabulated below and assume a granular wall backfill with a horizontal grade above the wall. It should be noted that the lateral pressures as quoted assume that the backfill materials will not become saturated. If the backfill becomes saturated, the above values may be decreased by one-half; however, full hydrostatic water pressures will have to be included.

Wall Height (feet)	Uniform Seismic Lateral Pressure* (psf)
4	58

* Maximum short-term pressures, they are not sustained loads.

Note that the pressures presented in this section do not include surcharge loadings, such as floor slabs, adjacent footings, etc.

5.5 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 on fine-grained soils, a coefficient of 0.40 should be utilized. In determining frictional resistance on granular soils, a coefficient of 0.45 should be utilized. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot. Below the water table, this granular soil should be considered equivalent to a fluid with a density of 150 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.

5.6 FLOOR SLABS

Floor slabs may be established upon suitable undisturbed natural soils, and/or upon structural fill extending to suitable natural soils or properly prepared existing surface soils. Non-engineered fills, and topsoil are not considered suitable. To provide a capillary break, it is recommended that floor slabs be directly underlain by at least four inches of “free-draining” fill, such as “pea” gravel or three-quarters- to one-inch minus clean gap-graded gravel. Settlements of lightly to moderately loaded floor slabs are anticipated to be minor.

Design water table recommendations are presented in Section 5.9, Design Water Table.

5.7 PAVEMENTS

The properly prepared non-engineered fills will exhibit poor engineering characteristics when saturated or nearly saturated. Non-engineered fills may remain in flexible pavement areas if properly prepared, as stated previously in this report. Rigid pavements shall not be placed overlying non-engineered fills, even if properly prepared. Considering the existing non-engineered fills as the subgrade soils and the projected traffic, the pavement sections on the following pages are recommended.

<u>Parking Areas</u>

(Light Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
and No Heavy-Weight Trucks)
[1 equivalent 18-kip axle load per day]

<u>Flexible:</u>

2.5 inches	Asphalt concrete
7.0 inches	Aggregate base
Over	Properly prepared natural soils, properly prepared existing non-engineered fill, and/or structural site grading fill extending to suitable stabilized natural soils.

<u>Rigid:</u>

5.0 inches	Portland cement concrete (non-reinforced)
4.0 inches	Aggregate base
Over	Properly prepared natural soils, and/or structural site grading fill extending to suitable stabilized natural soils.*

* Rigid pavements shall not be placed over non-engineered fills, even if properly prepared.

Primary Roadway Areas

(Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and Occasional Heavy-Weight Trucks)
[5 equivalent 18-kip axle loads per day]

Flexible:

3.0 inches	Asphalt concrete
9.0 inches	Aggregate base
Over	Properly prepared natural soils, properly prepared existing non-engineered fill, and/or structural site grading fill extending to suitable stabilized natural soils.

Rigid:

5.5 inches	Portland cement concrete (non-reinforced)
5.0 inches	Aggregate base
Over	Properly prepared natural soils, and/or structural site grading fill extending to suitable stabilized natural soils.*

* Rigid pavements shall not be placed over non-engineered fills, even if properly prepared.

For dumpster pads, we recommend a pavement section consisting of six and one-half inches of Portland cement concrete, four inches of aggregate base, over properly prepared natural stabilized subgrade or site grading structural fills.

These above rigid pavement sections 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 percent $\pm$1 percent air-entrainment.

5.8 GEOSEISMIC SETTING

5.8.1 General

In July 2019, the State of Utah adopted the International Building Code (IBC) 2018. The IBC 2018 code 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).

The addition must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2018 edition.

5.8.2 Faulting

Based on our review of available literature, no active faults pass through or are immediately adjacent to the site.

5.8.3 Soil Class

Based on the soils encountered to a depth of 46.5 feet and our knowledge of the underlying geology, we recommend that Site Class D - Stiff Soil Profile as defined in Table 20.3-1, Site Classification, of ASCE 7-16 be utilized for dynamic structural analysis.

5.8.4 Ground Motions

The IBC 2018 code is based on 2014 USGS mapping, which provides values of short and long period accelerations for the Site Class B boundary for the Maximum Considered Earthquake (MCE). This Site Class B boundary represents a hypothetical sandstone bedrock surface and must be corrected for local soil conditions. The following table summarizes the peak ground and short and long period accelerations for a MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the second column. Based on the site latitude and longitude (41.7246 degrees north and -111.8440 degrees west, respectively), the values for this site are tabulated on the following page.

Spectral Acceleration Value, T Seconds	Site Class B-C Boundary [mapped values] (% g)	Site Class D [adjusted for site class effects] (% g)
Peak Ground Acceleration (Geo-Mean)	46.8	53.0
0.2 Seconds (Short Period Acceleration)	S_S = 108.0	S_{MS} = 115.4
1.0 Seconds (Long Period Acceleration)	S_1 = 36.0	S_{M1} = *

* See Section 11.4.8 for requirements on site-specific ground motion studies. Please contact us for a proposal, if needed.

5.8.5 Liquefaction

The site is located in an area that has been identified by the Utah Geological Survey as having “high” liquefaction potential. Liquefaction is defined as the condition when saturated, loose, finer-grained sand-type soils lose their support capabilities because of excessive pore water pressure which develops during a seismic event.

As stated previously, potentially liquefiable soils encountered at depths of 8 to 10 feet in Boings B-1 and B-2. Our analysis indicates that this layer could liquefy during the design seismic event with liquefaction-induced settlement on the order of 1.0 to 1.2 inches or less. However, due to the depth, limited thickness, and discontinuous nature of the potentially liquefiable layer the potential for ground rupture and lateral spread is considered low. Based on our experience, the proposed addition can likely tolerate the projected liquefaction-induced settlement and protect life safety; however, this should be confirmed by the project structural engineer.

Calculations were performed using the procedures described in the 2008 Soil Liquefaction During Earthquakes Monograph by Idriss and Boulanger[3].

5.9 DESIGN WATER TABLE

As stated previously, the water table was measured at a depth of 11.9 feet below existing grade at the location of Boring B-1. Considering seasonal and long-term groundwater fluctuations, a recommend that the design groundwater table of 9.9 feet below existing grade be utilized in the design. We recommend that all habitable floor slabs be established a minimum of two feet above the design water table.

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3 Idriss, I. M., and Boulanger, R. W. (2008), Soil liquefaction during earthquakes: Monograph MNO-12, Earthquake Engineering Research Institute, Oakland, CA, 261 pp.

5.10 SITE OBSERVATIONS

As stated previously, due to the variable nature of the non-engineered fills encountered, a qualified geotechnical engineer from our staff must aid in verifying that all non-engineered fills have been completely removed prior to the placement of structural site grading fills, footings, or foundations.

We appreciate the opportunity of providing this service for you. If you have any questions or require additional information, please do not hesitate to contact us.

Respectfully submitted,

Gordon Geotechnical Engineering, Inc.

Joshua M. Whitney, State of Utah No. 6252902
Senior Engineer

Reviewed by:

Patrick R. Emery, State of Utah No. 7941710
Senior Engineer

JMW/PRE:sn

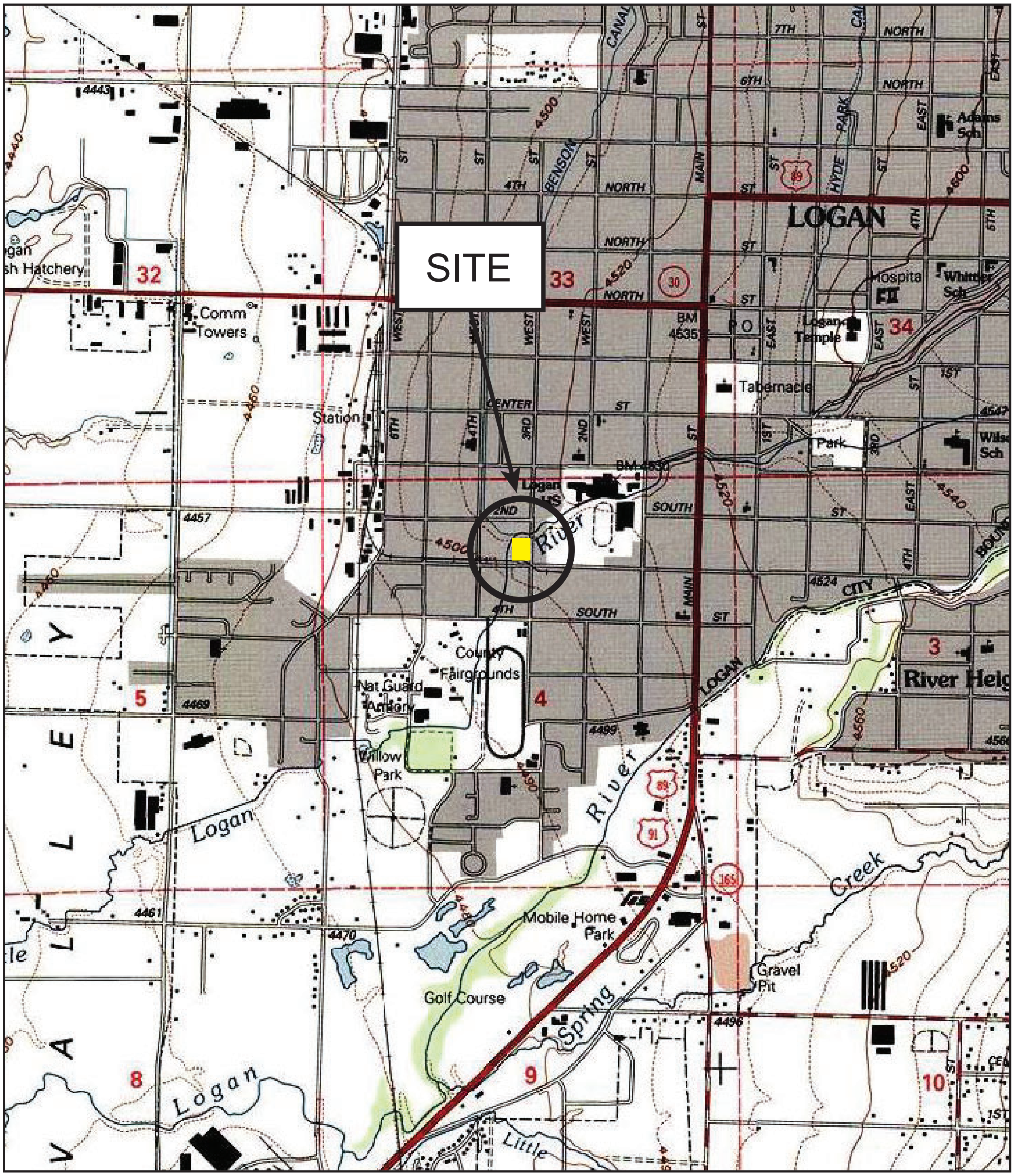
Encl. Figure 1, Vicinity Map
Figure 2, Area Map
Figure 3, Site Plan
Figures 4A and 4B, Log of Borings
Figure 5, Unified Soil Classification System
Figure 6, Photographs

Addressee (3 + email)

LICENSED PROFESSIONAL ENGINEER
No. 7941710
PATRICK R. EMERY
4-20-22
STATE OF UTAH

DESIGN WEST ARCHITECTS
JOB NO. 745-003-22

GORDON GEOTECHNICAL ENGINEERING, INC.



SCALE IN FEET
1000 0 1000 2000

REFERENCE:
USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE MAP
TITLED "LOGAN, UTAH", DATED 1998

FIGURE 1
VICINITY MAP

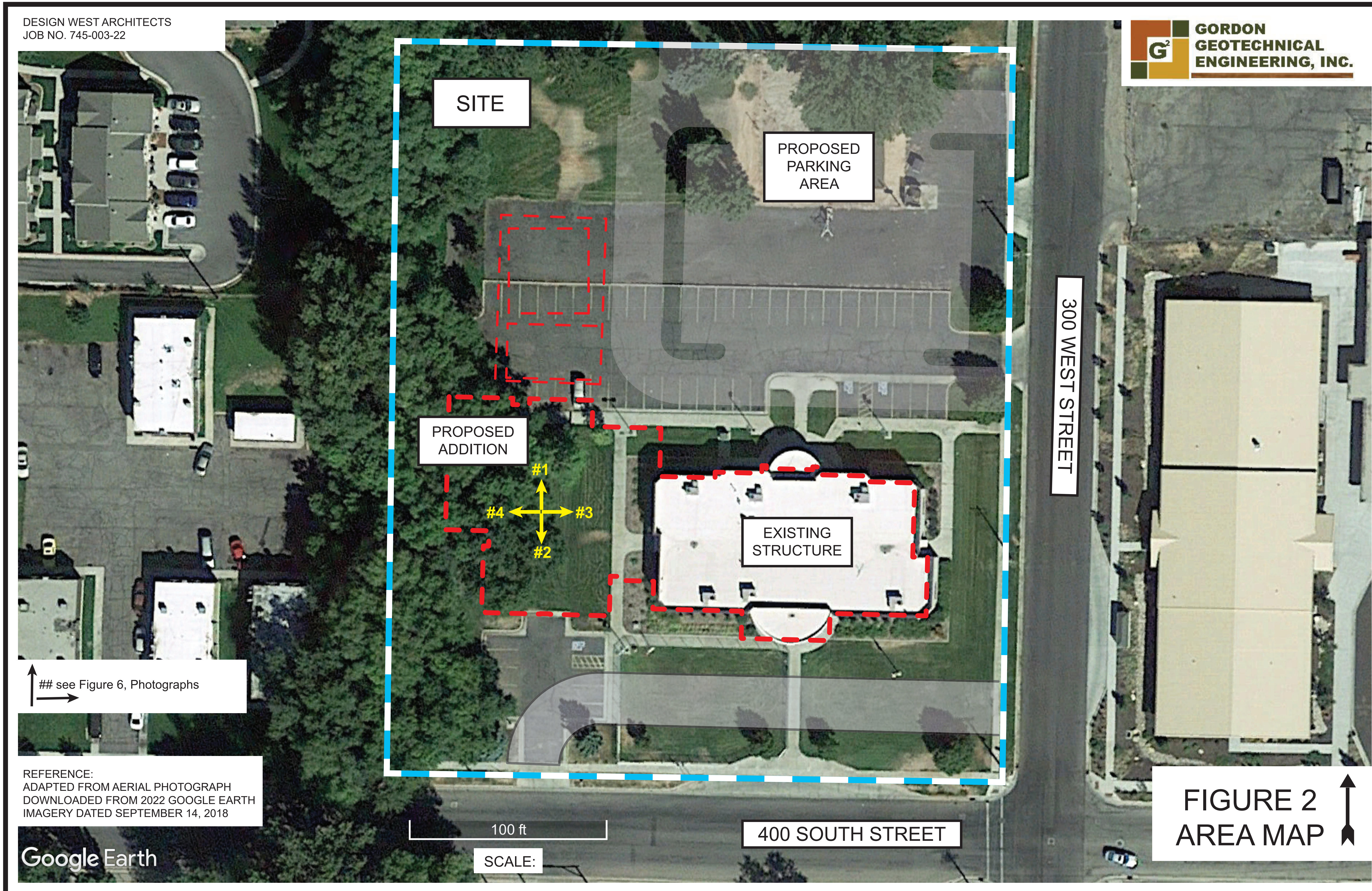


FIGURE 2
AREA MAP

DESIGN WEST ARCHITECTS
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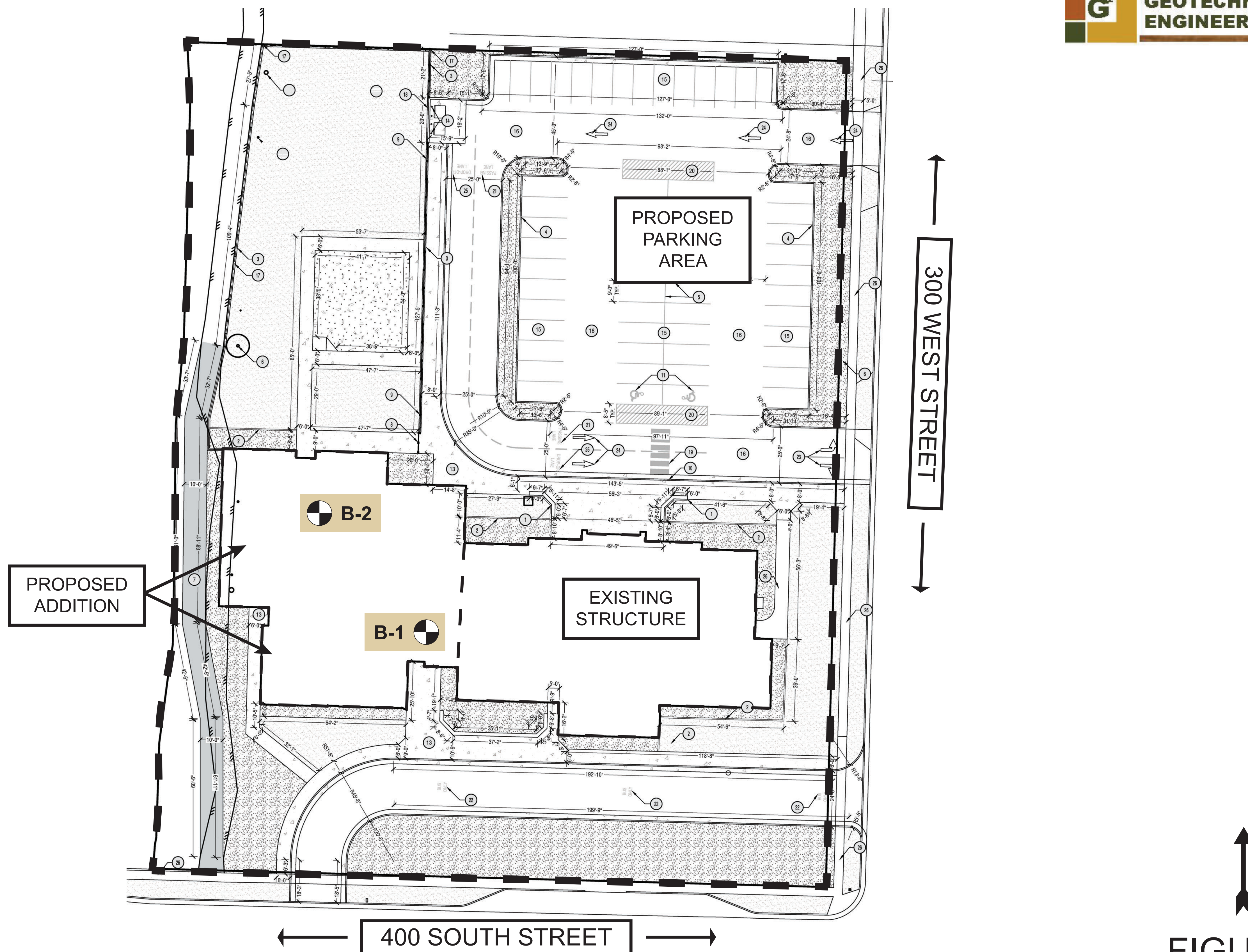

REFERENCE:
ADAPTED FROM DRAWING ENTITLED
"EARLY CHILDHOOD CENTER - LAYOUT PLAN",
SHEET NO. C-10
BY DESIGN WEST ARCHITECTS, NOT DATED

NOT TO SCALE

FIGURE 3
SITE PLAN

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

BOREHOLE B-1

Project Name: Proposed Early Childhood Center Addition
Project No.: 745-003-22
Location: 325 West 400 South, Logan, Utah
Client: Design West Architects
Drilling Method: 3.75" ID Hollow-Stem Auger
Date Drilled: 03-29-22
Elevation: ---
Water Level: 12.0' (03-29-22), 11.9' (04-04-22)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
SILTY CLAY, FILL with trace fine sand; major roots (topsoil) to 3"; dark brown (CL-FILL)												
SILTY CLAY with trace fine sand; dark brown (CL)					D	13				45	26	moist stiff
SILTY FINE SAND with fine sandy clay layers to 1" thick; olive-gray (SM)			5		D	12						moist loose
					SPT	5	18.9		41.0			very moist
grades with trace gravel			10		D	28	8.7		22.0			
		▼										moist medium dense saturated
			15		D	12						
SILTY CLAY with trace fine sand; olive-gray (CL)												saturated soft
					SPT	P						
Stopped drilling at 15.5'. Stopped sampling at 19.0'. Installed slotted PVC pipe to 15.0'.			20									
			25									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4A

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

BOREHOLE B-2

Project Name: Proposed Early Childhood Center Addition
Project No.: 745-003-22
Location: 325 West 400 South, Logan, Utah
Client: Design West Architects
Drilling Method: 3.75" ID Hollow-Stem Auger
Date Drilled: 03-29-22
Elevation: ---
Water Level: 12.0' (03-29-22)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
CLAYEY GRAVEL, FILL with sand; major roots (topsoil) to 3"; gray to dark gray (CL-FILL)												moist loose
					D	33						
			5		D	12	13.6		36.1			
SILTY GRAVEL with sand; olive-gray (GM)												moist loose
			10		D	10	8.3		20.0			
SILTY CLAY with trace fine sand; olive-gray (CL)		▼										saturated soft
			15		D	4						
			20		SPT	8						medium stiff
			25									

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BOREHOLE B-2

Project Name: Proposed Early Childhood Center Addition
Project No.: 745-003-22
Location: 325 West 400 South, Logan, Utah
Client: Design West Architects
Drilling Method: 3.75" ID Hollow-Stem Auger
Date Drilled: 03-29-22
Elevation: ---
Water Level: 12.0' (03-29-22)
Remarks:

DESCRIPTION	GRAPHIC LOG	WATER LEVEL	DEPTH (FT.)	SAMPLE SYMBOL	SAMPLE TYPE	BLOWS/FT.	MOISTURE (%)	DRY DENSITY (PCF)	% PASSING 200	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	REMARKS
					SPT	2						soft
grades with frequent silty fine sand layers to 2" thick			30		SPT	11	32.1		86.4			stiff
			35		SPT	14						
			40		SPT	10						medium stiff
			45		SPT	7						
Stopped drilling at 45.0'. Stopped sampling at 46.5'. Installed slotted PVC pipe to 10.0'.			50									

The discussion in the text under the section titled, SUBSURFACE CONDITIONS, is necessary for a proper understanding of the nature of the subsurface material.

FIGURE 4B
(con't)

GORDON GEOTECHNICAL ENGINEERING, INC.

UNIFIED SOIL CLASSIFICATION SYSTEM

FIELD IDENTIFICATION PROCEDURES						LETTER SYMBOL [1]	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More than half of material is larger than No. 200 sieve size. [2]	GRAVELS More than half of coarse fraction is larger than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.			GW	Well graded gravels, gravel-sand mixtures, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines.
		GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).			GC	Clayey gravels, poorly graded gravel-sand-clay mixtures.
(The No. 200 sieve size is about the smallest particle visible to the naked eye)	SANDS More than half of coarse fraction is smaller than No. 4 sieve size. (For visual classifications, the 1/4" size may be used as equivalent to the No. 4 sieve size.)	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate particle sizes.			SW	Well graded sands, gravelly sands, little or no fines.
			Predominantly one size or a range of sizes with some intermediate sizes missing.			SP	Poorly graded sands, gravelly sands, little or no fines.
		SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).			SM	Silty sands, poorly graded sand-silt mixtures.
			Plastic fines (for identification procedures see CL below).			SC	Clayey sands, poorly graded sand-clay mixtures.
	IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SIEVE SIZE		DRY STRENGTH (CRUSHING CHARACTERISTICS)	DILATANCY (REACTION TO SHAKING)	TOUGHNESS (CONSISTENCY NEAR PLASTIC LIMIT)		
FINE GRAINED SOILS More than half of material is smaller than No. 200 sieve size.	SILTS AND CLAYS Liquid limit less than 50		None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sand with slight plasticity.
			Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
			Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity.
(The No. 200 sieve size is about the smallest particle visible to the naked eye)	SILTS AND CLAYS Liquid limit greater than 50		Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
			High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays.
			Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity.
HIGHLY ORGANIC SOILS			Readily identified by color, odor, spongy feel and frequently by fibrous texture.			Pt	Peat and other highly organic soils.

[1] Boundary classifications: —Soils possessing characteristics of two groups are designated by combinations of group symbols. For example GW—GC, well graded gravel—sand mixture with clay binder.
[2] All sieve sizes on this chart are U.S. standard.

GENERAL NOTES

1. In general, Unified Soil Classification Designations presented on the logs were evaluated by visual methods only. There rore, actual designations (based on laboratory testing) may differ.

2. Lines seperating strata on the logs represent approximate boundaries only Actual transitions may be gradual.

3. Logs represent general soil conditions observed at teh point of exploration onthe date indicated.

4. No warranty is provided as to the continuity of soil conditions between individual sample locations.

FINE - GRAINED SOIL

CONSISTENCY	SPT (blows/ft)	TORVANE UNDRAINED SHEAR STRENGTH (tsf)	POCKET PENETROMETER UNCONFINED COMPRESSIVE STRENGTH (tsf)	FIELD TEST
Very Soft	<2	<0.125	<0.25	Easily penetrated several inches by Thumb. Squeezes through fingers.
Soft	2 - 4	0.125 - 0.25	0.25 - 0.5	Easily penetrated 1 " by Thumb . Molded by light finger pressure.
Medium Stiff	4 - 8	0.25 - 0.5	0.5 - 1.0	Penetrated over 1/2 " by Thumb with moerate effort. Molded by strong finger pressure.
Stiff	8 - 15	0.5 - 1.0	1.0 - 2.0	Indented about 1/2 " by Thumb but penetrated only with great effort
Very Stiff	15 - 30	1.0 - 2.0	2.0 - 4.0	Readily indented by Thumbnail
Hard	>30	>2.0	>4.0	Indented with difficulty by Thumbnail

LOG KEY SYMBOLS

Bulk / Bag Sample	Thin Wall
Standard Penetration Split Spoon Sampler	No Recovery
Rock Core	3-3/4" ID D&M Sampler
	3" ID D&M Sampler
Water Level	California Sampler

COARSE -GRAINDE SOIL

APPERENT DENSITY	SPT (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
Very Loose	<4	0 - 15	Easily penetrated with 1/2 " reinforcing rod pushed by hand
Loose	4 - 10	15 - 35	Difficult to penetrated with 1/2 " reinforcing rod pushed by hand
Medium Dense	10 - 30	35 - 65	Easily penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Dense	30 - 50	65 - 85	Difficult to penetrated a foot with 1/2 " reinforcing rod driven with 5-lb hammer
Very Dense	>50	85 - 100	Penetrated only a few inches with 1/2 " reinforcing rod driven with 5-lb hammer

STRATIFICATION

DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2 "
LAYER	1/2 - 12 "

DESCRIPTION	THICKNESS
Occasional	One or less per foot of thickness
Frequent	More than on per foot of thichness

CEMENTATION

DESCRIPTION	DESCRIPTION
Weakely	Crumbles or breaks with handling of slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumbles or breaks with finger pressure

MODIFIERS

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

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil below Water Table

FIGURE 5

DESIGN WEST ARCHITECTS
JOB NO. 745-03-22

GORDON GEOTECHNICAL ENGINEERING, INC.

#1 Looking north.

#2 Looking south.

#3 Looking east.

#4 Looking west.

FIGURE 6
PHOTOGRAPHS

Locations and direction, see Figure 2, Area Map