Geotechnical Evaluation Report

Proposed Herriman Senior Seminary
Approximately 14150 South 4400 West
Herriman, Utah
LDS Property Number: 501-3419

Prepared for:
The Church of Jesus Christ of Latter-day Saints

1765 South 4250 West
Salt Lake City, Utah 84104

GSH

Prepared by
GSH Geotechnical
March 16, 2018

LICENSED PROFESSIONAL ENGINEER
No. 318650
MICHAEL S. HUBER
STATE OF UTAH

473 West 4800 South, Murray, UT, Phone (801)-685-9190, Fax (801)-685-2990, Email Address mike@gshgeotech.com

March 16, 2018
Job No. 0153-345-17

Mr. Bryan Stephenson
The Church of Jesus Christ of Latter-day Saints
1765 South 4250 West
Salt Lake City, Utah 84104

Mr. Stephenson:

Re: Geotechnical Evaluation Report
Proposed Herriman Senior Seminary
Approximately 14150 South 4400 West
Herriman, Utah
LDS Property Number: 501-3419

1. EXECUTIVE SUMMARY

This report presents the results of the geotechnical study performed at the site of the proposed Herriman Senior Seminary to be located at approximately 14150 South 4400 West in Herriman, Utah.

The soils across the site were fairly similar at the boring locations. Borings B-1 and B-2 encountered natural soils consisting of clay with varying sand content overlying layers of sand and gravel with varying silt content. Borings B-3 through B-5 encountered natural clay with varying silt and sand content extending to the maximum depths explored. Approximately 6 to 9 inches of topsoil and plow disturbed soils were encountered at the surface of each boring.

The results of the study indicate that the proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils or granular structural fill extending to suitable natural soils. Under no circumstance shall the footings or floor slabs be placed over the surficial loose/disturbed soils or non-engineered fill (if encountered).

2. INTRODUCTION

This report presents the results of the geotechnical study performed at the site of the proposed Herriman Senior Seminary to be located in Herriman, Utah. The general location of the site with respect to existing roadways, as of 2018, is presented on Figure 1, Vicinity Map. A more

GSH Geotechnical, Inc.
473 West 4800 South
Salt Lake City, Utah 84123
Tel: 801.685.9190 Fax: 801.685.2990
www.gshgeo.com

detailed site plan showing the proposed construction is presented on Figure 2, Site Plan. The approximate locations of the borings completed in conjunction with this study are also presented on Figure 2.

3. AUTHORIZATION

Authorization was provided by the client returning a signed "Agreement Between Client and Geotechnical Consultant" in accordance with our Professional Services Agreement No. 17-0603.

4. PROJECT DESCRIPTION, PURPOSE OF EVALUATION, & SCOPE OF WORK

The objectives and scope of our study were planned in discussions among Mr. Bryan Stephenson of The Church of Jesus Christ of Latter-day Saints, Mr. Chad Spencer of Evans + Associates Architecture, and Mr. Mike Huber of GSH Geotechnical, Inc. (GSH).

In general, the objectives of this study were to:

1. Define and evaluate the subsurface soil and groundwater conditions at the proposed site.

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

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

1. A field program consisting of the drilling/excavating, logging, and sampling of 5 borings.

2. A laboratory testing program.

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

5. 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, projected groundwater conditions, and the layout and design data discussed in Section 6, Design Criteria, of this report. If subsurface conditions other than those described in this report are encountered and/or if design and layout changes are implemented, GSH 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.

6. DESIGN CRITERIA

The seminary will be constructed on an approximately 1.037-acre parcel and have a footprint of approximately 8,400 square feet. The building is to be 1 to 1-extended level in height and of wood-frame construction established slab on grade supported over conventional spread and continuous wall footings.

Maximum real column and wall loads are anticipated to be 10 to 60 kips and 2 to 4 kips per lineal foot, respectively. Real loads are defined as the total of all dead plus frequently applied (reduced) live loads.

A small at-grade paved parking area will be part of the overall site development. Projected traffic in the parking areas is anticipated to consist of a light volume of automobiles and light trucks, with occasional medium-weight, and no heavyweight trucks.

Maximum site grading cuts and fills are anticipated to be on the order of 1 to 3 feet.

7. SITE CONDITIONS

The site consists of a nearly rectangular-shaped, 1.037-acre vacant/undeveloped agricultural parcel, located in Herriman, Utah. During drilling at the site, the surface of the site had been recently plowed. The site is mostly flat and slopes downward to the northeast with a total relief of approximately 5 to 8 feet.

The site is bordered to the north, east, and west by similar vacant/undeveloped agricultural land and to the south by the high school structure that is presently under construction.

8. FIELD STUDY

In order to define and evaluate the subsurface soil and groundwater conditions across the site, 5 borings were drilled to depths ranging from 5 to 21.5 feet below existing grade using a truck-mounted rotary drill rig equipped with hollow-stem augers and hand-auger equipment. Auger refusal occurred at a depth of 10.5 feet within very dense gravels at Boring B-1. The approximate locations of the borings are presented on Figure 2.

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, samples of the typical soils penetrated were obtained for subsequent laboratory testing and examination. The soils were classified in the field based upon visual and textural properties. These

classifications were later supplemented by subsequent inspection and testing in our laboratory. Detailed graphical representation of the subsurface conditions encountered is presented on Figures 3A through 3E, Log of Borings. Soils were classified in accordance with the nomenclature described on Figure 4, Key to Boring Log (USCS).

A 3.0-inch outside diameter, 2.42-inch inside diameter drive sampler (Dames & Moore) was utilized in the subsurface sampling of the borings at the site. The blow counts recorded on the boring logs were the number required to drive the sampler 12 inches with a 140-pound hammer dropping 30 inches.

Following completion of drilling operations, 1.25-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. The borings were backfilled with auger cuttings.

9. SUBSURFACE CONDITIONS AND GROUNDWATER

The soils across the site were generally similar at the boring locations. All of the borings encountered approximately 6 to 9 inches of topsoil and plow disturbed soils. The soils encountered in Boring B-1 consisted of sandy clay overlying silty sand that transitioned to gravel at a depth of 10 feet. Auger refusal occurred within the gravel soils at a depth of 10.5 feet. The soils in Boring B-2 consisted of silty clay overlying sand with varying silt content. The sand transitioned to clay at a depth of 19 feet that extended to the maximum depth explored of 21.5 feet. Borings B-3 through B-5 encountered clay with varying silt and sand content that extended to the maximum depths explored of 5 feet.

The natural clay soils at the site were loose to very stiff, slightly moist to moist, and gray and brown in color. The natural clay soils are anticipated to exhibit moderate strength and compressibility characteristics under the anticipated load range.

The natural granular soils were medium dense to very dense, slightly moist to moist, and gray, light brown, and brown in color. The natural sand soils are anticipated to exhibit moderately high strength and moderately low compressibility characteristics under the anticipated load range.

For additional details pertaining to the subsurface conditions encountered, please refer to Figures 3A through 3E, Boring Logs. 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.

Groundwater was not encountered within the borings at the time of the field work nor again on March 14, 2018 (8 days following drilling) and is anticipated to be at significant depth at the site.

Seasonal and longer-term groundwater fluctuations on the order of 1 to 2 feet are projected, with the highest seasonal levels generally occurring during the late spring and early summer months.

Additional groundwater fluctuations could occur due to snowmelt and/or irrigation on this and surrounding fields.

10. LABORATORY TESTING

10.1 General

In order to provide data necessary for our engineering analysis, a laboratory testing program was completed. The program included moisture and density, partial gradation, consolidation, chemical, and topsoil tests. The following paragraphs describe the tests and summarize the test data.

10.2 Moisture and Density Tests

To provide index parameters and to correlate other test data, moisture and density tests were performed on selected samples. The results of these tests are presented on the boring logs, Figures 3A through 3E.

10.2.1 Partial Gradation Tests

To aid in classifying the granular soils, partial gradation tests were performed. Results of the tests are tabulated below and are presented on the boring logs, Figures 3A through 3E.

Boring No.	Depth (feet)	Percent Passing No. 200 Sieve	Moisture Content Percent	Soil Classification
B-2	7.5	16.9	9.4	SM
B-2	15.0	11.0	10.0	SP/SM

10.3 Consolidation Tests

To provide data necessary for our settlement analysis, consolidation tests was performed on a representative sample of the clay soils encountered at the site. The results of the tests indicated that the tested soils are moderately over-consolidated and, when loaded below the over-consolidation pressure, will exhibit moderate strength and compressibility characteristics. Detailed results of the tests are maintained within our files and can be transmitted to you, upon your request.

10.4 Chemical Tests

To determine if the site soils will react detrimentally with concrete, chemical tests were performed on a representative sample of the near-surface soils encountered at the site. The results of the chemical tests are tabulated on the table on the following page.

Boring No.	Depth (feet)	Soil Classification	pH	Total Water Soluble Sulfate (mg/kg-dry)
B-1	2.5	CL	8.48	170

10.5 Topsoil Tests

A series of topsoil tests were performed on a representative surface sample. The results of these tests are attached to this study as Appendix A, Topsoil Testing Report.

11. RECOMMENDATIONS AND CONCLUSIONS

11.1 SUMMARY OF FINDINGS

The results of the study indicate that the proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils or granular structural fill extending to suitable natural soils. Under no circumstance shall the footings, floor slabs, or pavements be placed upon topsoil, loose/disturbed soils, or non-engineered fill (if encountered).

Prior to proceeding with construction, removal of all topsoil, loose/disturbed soils, non-engineered fills (if encountered), surface vegetation, root systems, and any deleterious materials from beneath an area extending out at least 5 feet from the perimeter of the proposed building foundations and 3 feet beyond pavements and exterior flatwork areas will be required. All footing excavations must extend to suitable natural soils.

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

11.2 EARTHWORK

11.2.1 Site Preparation

Initial site preparation will consist of the removal of all topsoil, loose/disturbed soils, surface vegetation, root systems, non-engineered fill (if encountered), debris, and any deleterious materials from beneath an area extending out at least 5 feet from the perimeter of the proposed building foundations and 3 feet beyond pavements and exterior flatwork areas.

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 proof rolled 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 2 feet

below footings, GSH must be notified to provide further recommendations. In pavement, floor slab, and outside flatwork areas, unsuitable soils encountered during compaction and proof rolling must be removed to a maximum depth of 2 feet and replaced with compacted granular structural fill.

Subgrade preparation as described must be completed prior to placing overlying structural site grading fills.

GSH must be notified prior to the placement of structural site grading fills, floor slabs, footings, and pavements to verify that all topsoil, loose/disturbed soils, and non-engineered fills (if encountered) have been completely removed.

11.2.2 Temporary Excavations

Temporary construction excavations in clay soils, not exceeding 4 feet in depth, may be constructed with near-vertical sideslopes. Temporary excavations up to 8 feet deep in clay soils shall be constructed with sideslopes no steeper than one-half horizontal to one vertical (0.5H:1V). Temporary excavations up to 8 feet deep in sand and gravel soils shall be constructed with sideslopes no steeper than one horizontal to one vertical (1H:1V). Excavations deeper than 8 feet are not anticipated at the site.

If excessive sloughing occurs or where extensive layers of clean granular soils or groundwater (not anticipated at the site) are encountered, the sideslopes should be appropriately flattened and/or shoring/bracing utilized.

All excavations must be inspected periodically by qualified personnel. If any signs of instability are noted, immediate remedial action must be initiated.

11.2.3 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 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 structural fill placed over relatively large open areas to raise the overall grade. For structural site grading fill, the maximum particle size shall not exceed 4 inches; although, occasional larger particles, not exceeding 8 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 shall be restricted to 2 inches.

Only granular soils are recommended as structural fill in confined areas, such as around foundations, within utility trenches, and as replacement fill below foundations.

All imported granular structural fill shall consist of a fairly well graded mixture of sand and gravel containing less than 20 percent fines (percent by weight of material passing the U.S. No. 200 sieve) and no more than 30 percent retained on the three-quarter-inch sieve.

To stabilize soft subgrade conditions (if encountered) or where structural fill is required to be placed closer than 2.0 feet above the water table at the time of construction, a mixture of coarse angular gravels and cobbles and/or 1.5- to 2.0-inch gravel (stabilizing fill) should be utilized. It may also help to utilize a stabilization fabric, such as Mirafi 600X or equivalent, placed on the natural ground if 1.5- to 2.0-inch gravel is used as stabilizing fill.

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.

11.2.4 Fill Placement and Compaction

Coarse gravel and cobble mixtures (stabilizing fill), 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 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.

Structural fill shall be placed in lifts not exceeding 8 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] - D1557) compaction criteria in accordance with the following table:

Location	Total Fill Thickness (feet)	Minimum Percentage of Maximum Dry Density
Beneath an area extending at least 5 feet beyond the perimeter of the structure	0 to 8	95
Site Grading Fills Outside area defined above	0 to 5	90
Site Grading fills Outside area defined above	5 to 8	95
Utility Trenches	--	96
Aggregate base	--	96

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

Excavations deeper than 8 feet 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 11.2.1, Site Preparation, of this report.

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.

11.2.5 Utility Trenches

All utility trench backfill material below structurally loaded facilities (flatwork, floor slabs, roads, etc.) shall be placed at the same density requirements established for structural fill. If the surface of the backfill becomes disturbed during the course of construction, the backfill shall be proof rolled and/or properly compacted prior to the construction of any exterior flatwork over a backfilled trench. Proof rolling 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 proof rolling, 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 - D1557) method of compaction. GSH recommends that as the major utilities continue onto the site that these compaction specifications are followed.

Fine-grained soils, such as clays and silts, are not recommended for utility trench backfill.

11.3 SPREAD AND CONTINUOUS WALL FOUNDATIONS

11.3.1 Design Data

The proposed structure may be supported upon conventional spread and continuous wall foundations established upon suitable natural soils and/or structural fill extending to suitable natural soils. Loose/disturbed soils are not suitable for the support of footings and must be completely removed underneath footings. For design, the following parameters are provided with respect to the projected loading discussed in Section 6, Design Criteria 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 Capacity for Real Load Conditions	- 3,000 pounds per square foot
Bearing Capacity Increase for Seismic Loading	- 50 percent

The term "net bearing capacity" refers to the allowable 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.

11.3.2 Installation

Under no circumstances shall the footings be established over sod, rubbish, construction debris, frozen soil, non-engineered fills, or other deleterious materials.

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. If the granular structural fills become loose or disturbed prior to pouring the footings, they must be appropriately compacted.

11.3.3 Settlements

Settlements of foundations designed and installed in accordance with the above criteria and recommendations supporting the loads, as discussed in Section 6, Design Criteria, can be controlled to within one inch or less.

11.4 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 friction of 0.30 may be utilized for the footing interface with in situ natural clays soils and 0.40 for footing interface with natural granular soils or granular 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 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.

11.5 FLOOR SLABS

Floor slabs may be established upon suitable stabilized natural soils and/or upon structural fill extending to suitable stabilized natural soils. Under no circumstances shall floor slabs be established over topsoil, loose/disturbed soils, non-engineered fills, surface vegetation, root systems, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water.

In order to facilitate curing of the concrete and to provide a capillary moisture break, 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.

Settlement of lightly loaded floor slabs designed according to previous recommendations (average uniform pressure of 200 pounds per square foot or less) is anticipated to be less than one-quarter of an inch.

In accordance with the Geotechnical Evaluation Report Template, floor slabs are to be constructed without control or construction joints, are reinforced with No. 4 bars at 18 inches on center each way, and shall include a 15-mil vapor retarder placed directly under the concrete with at least 4 inches of "free-draining" fill, described previously, placed below the vapor retarder.

11.6 PAVEMENTS

The natural fine-grained soils encountered at the site will exhibit poor pavement support characteristics when saturated. All pavement areas must be prepared as previously discussed (see Section 11.2.1, Site Preparation). Under no circumstances shall pavements be established over topsoil, loose or disturbed soils, non-engineered fills, surface vegetation, root systems, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. With the subgrade soils and the projected traffic (40-year design life) as discussed in Section 6, Design Criteria, the pavement sections on the following pages are recommended.

Parking Areas

(Light Volume of Automobiles and Light Trucks,
Occasional Medium-Weight Trucks,
and No Heavyweight Trucks)
[3 equivalent 18-kip axle loads per week]

Flexible:

3.0 inches	Asphalt concrete
7.0 inches	Aggregate base
Over	Properly prepared natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

Rigid:

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

Parking Lot Drive Lanes and Access Driveways

(Moderate Volume of Automobiles and Light Trucks,
Light Volume of Medium-Weight Trucks,
and Occasional Heavyweight Trucks)
[10 equivalent 18-kip axle loads per week]

Flexible:

3.0 inches	Asphalt concrete
8.0 inches	Aggregate base

Over	Properly prepared natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

Rigid:

5.5 inches	Portland cement concrete (non-reinforced)
6.0 inches	Aggregate base
Over	Properly prepared natural subgrade soils and/or structural site grading fill extending to suitable natural subgrade soils

For trash enclosure approach slabs (one 40,000-pound axel load per week), we recommend a pavement section consisting of 6.5 inches of Portland cement concrete, 6.0 inches of aggregate base, over properly prepared and stabilized natural subgrade or site grading structural fills extending to suitable stabilized natural soils.

The 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 shall have a minimum 28-day unconfined compressive strength of 4,500 pounds per square inch, contain 6 percent ±1 percent air-entrainment, and meet the requirements given below in Section 11.7, Cement Types, of this report. In accordance with the Geotechnical Evaluation Report Template, 25 percent fly ash is required in all concrete exposed to freeze-thaw cycles and deicers.

The crushed stone should conform to applicable sections of the current Utah Department of Transportation (UDOT) Standard Specifications. All asphalt material and paving operations should meet applicable specifications of the Asphalt Institute and UDOT. A GSH technician shall observe placement and perform density testing of the base course material and asphalt.

Please note that the recommended pavement section is based on estimated post-construction traffic loading. If the pavement is to be constructed and utilized by construction traffic, the above pavement section may prove insufficient for heavy truck traffic, such as concrete trucks or tractor-trailers used for construction delivery. Unexpected distress, reduced pavement life, and/or premature failure of the pavement section could result if subjected to heavy construction traffic and the owner should be made aware of this risk. If the estimated traffic loading stated herein is not correct, GSH must review actual pavement loading conditions to determine if revisions to these recommendations are warranted.

11.7 CEMENT TYPES

The laboratory tests indicate that the natural soils tested contain a negligible amount of water soluble sulfates. Based on our test results, concrete in contact with the on-site soil will have a low potential for sulfate reaction (ACI 318, Table 4.3.1). Therefore, all concrete which will be in contact with the site soils may be prepared using Type I or IA cement.

11.8 DOWNSPOUTS

It is recommended that all surface water be directed away from the building with positive drainage measures, including downspouts.

11.9 GEOSEISMIC SETTING

11.9.1 General

Utah municipalities adopted the International Building Code (IBC) 2015. The IBC 2015 code determines the seismic hazard for a site based upon 2008 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points).

The structure must be designed in accordance with the procedure presented in Section 1613, Earthquake Loads, of the IBC 2015 edition.

11.9.2 Faulting

Based upon our review of available literature, no active faults are known to pass through or immediately adjacent to the site. The nearest mapped active fault is the Salt Lake City Section of the Wasatch Fault, approximately 8.3 miles east of the site.

11.9.3 Soil Class

For dynamic structural analysis, the Site Class D - Stiff Soil Profile as defined in Chapter 20 of ASCE 7 (per Section 1613.3.2, Site Class Definitions, of IBC 2015) can be utilized.

11.9.4 Ground Motions

The IBC 2015 code is based on 2008 USGS mapping, which provides values of short and long period accelerations for the Site Class B-C boundary for the Maximum Considered Earthquake (MCE). This Site Class B-C boundary represents a hypothetical bedrock surface and must be corrected for local soil conditions. The table on the following page summarizes the peak ground and short and long period accelerations for an MCE event and incorporates a soil amplification factor for a Site Class D soil profile in the fourth column. Based on the site latitude and

longitude (40.4969 degrees north and 111.9972 degrees west, respectively), the values for this site are tabulated below:

Spectral Acceleration Value, T	Site Class B Boundary [mapped values] (% g)	Site Coefficient	Site Class D [adjusted for site class effects] (% g)	Design Values (% g)
Peak Ground Acceleration	46.0	F_a = 1.040	47.8	31.9
0.2 Seconds (Short Period Acceleration)	S_S = 115.0	F_a = 1.040	S_{MS} = 119.6	S_{DS} = 79.7
1.0 Second (Long Period Acceleration)	S_1 = 38.3	F_v = 1.634	S_{M1} = 62.6	S_{D1} = 41.7

11.9.5 Liquefaction

The site is located in an area that has been identified by the U.S. Geological Survey (USGS) as being a "low" liquefaction potential zone. Liquefaction is defined as the condition when saturated, loose, granular soils lose their support capabilities because of excessive pore water pressure, which develops during a seismic event. Clayey soils, even if saturated, will generally not liquefy during a major seismic event.

Liquefaction of the site soils encountered during this exploration will not likely liquefy during the design seismic event due to the lack of groundwater and the dense nature of the granular soils encountered at the site.

11.10 SITE VISITS

Prior to placement of foundations and site grading fills, GSH must verify that suitable natural soils have been encountered below floor slabs, footings, structural fill, and pavements.

If you have any questions or would like to discuss these items further, please feel free to contact us at (801) 685-9190.

Respectfully submitted,

GSH Geotechnical, Inc.

Robert A. Gifford
Project Engineer

Reviewed by:

Michael S. Huber, P.E.
State of Utah No. 343650
Vice President/Senior Geotechnical Engineer

RAG/MSH:jlh

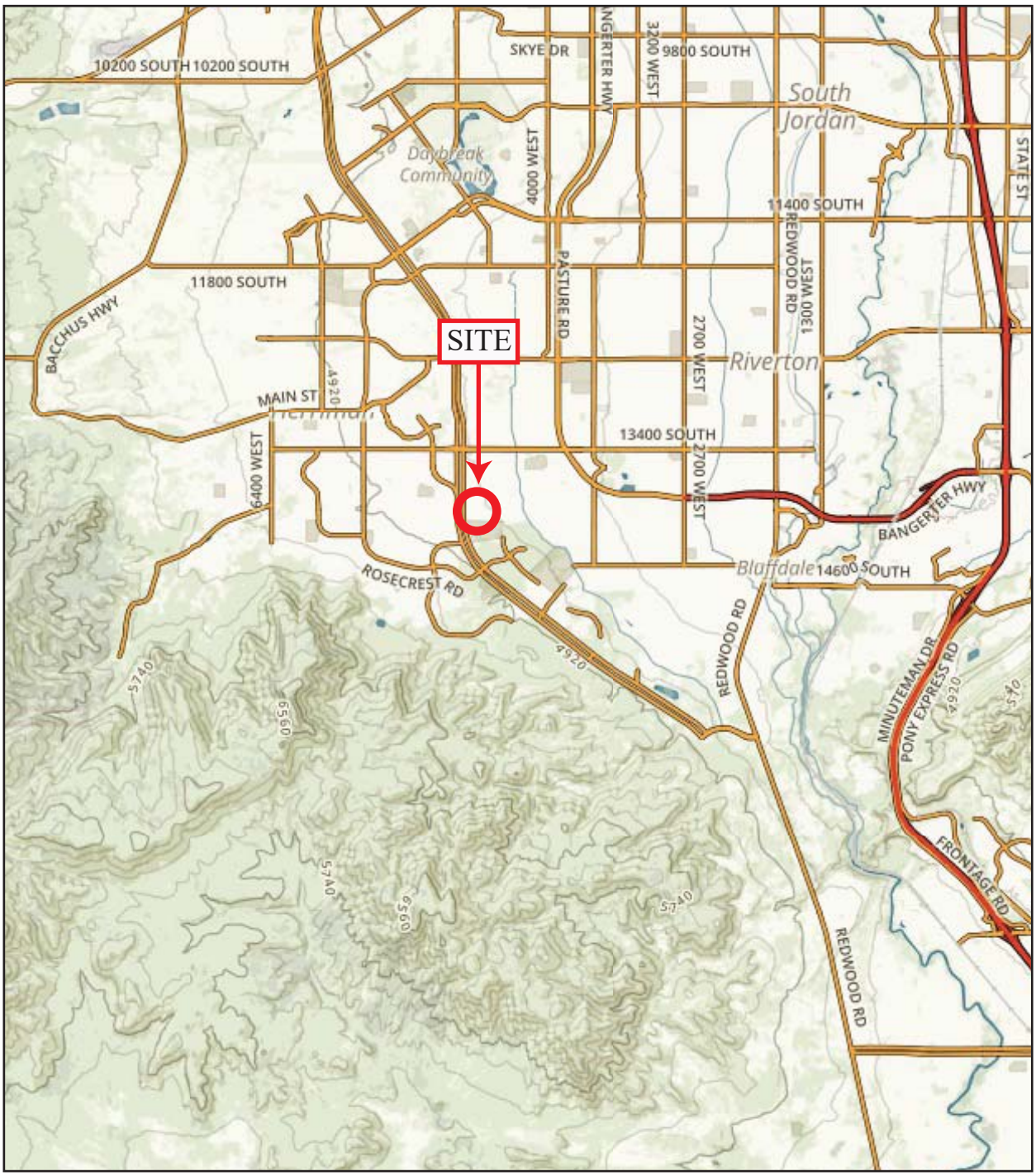
Addressee (email)

Encl. Figure 1, Vicinity Map
Figure 2, Site Plan
Figures 3A through 3E, Log of Borings
Figures 4, Key to Boring Log (USCS)
Appendix A, Topsoil Testing Report

Addressee (email)

cc: Mr. Chad Spencer (email)
Evans + Associates Architecture

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS
JOB NO. 0153-345-17



2 0 2 4 6 8 KM 10

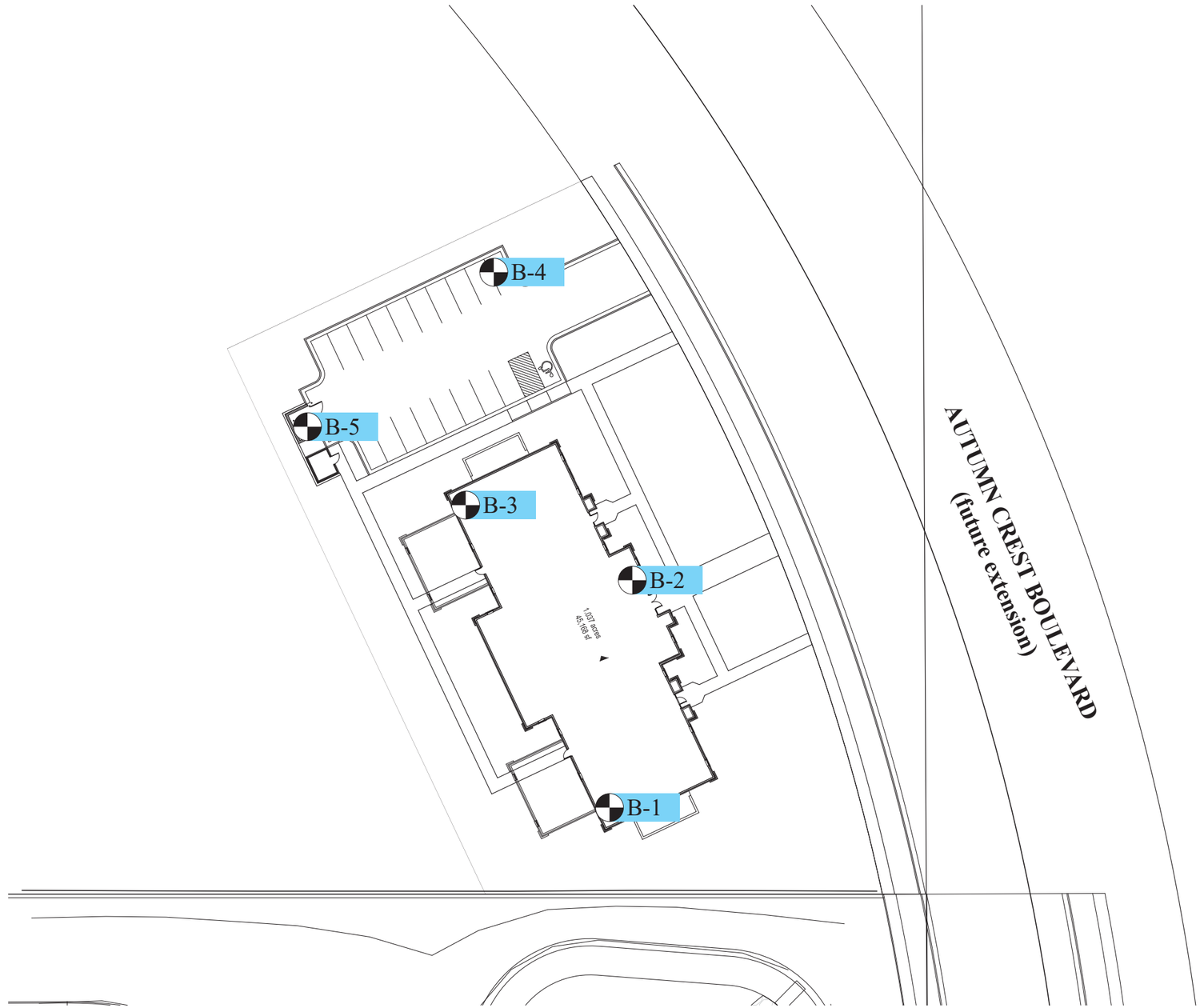
2 0 2 MI 4

FIGURE 1
VICINITY MAP

REFERENCE:
ALL TRAILS - NATIONAL GEOGRAPHIC TERRAIN
DATED 2018

GSH

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS
JOB NO. 0153-345-17



APPROXIMATE SCALE IN FEET
25 0 25 50

REFERENCE:
ADAPTED FROM DRAWING
PROVIDED BY CLIENT

FIGURE 2
SITE PLAN

GSH

BORING LOG

BORING: B-1

CLIENT: The Church of Jesus Christ of Latter-day Saints | PROJECT NUMBER: 0153-345-17

PROJECT: Proposed Herriman Senior Seminary | DATE STARTED: 3/6/18 | DATE FINISHED: 3/6/18

LOCATION: Approximately 14150 South 4400 West, Herriman, Utah | GSH FIELD REP.: BG

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/6/18 & 3/14/18) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	CL	FINE SANDY CLAY with major roots (topsoil) to 6"; gray with oxidation	0								loose to 9" slightly moist
				25	X	14.8	86				very stiff slightly moist
	SM	SILTY FINE SAND with occasional layers of silty clay up to 3" thick; gray									
			5	30	X	17.7	92				medium dense
	GP/GM	FINE TO COARSE SANDY FINE AND COARSE GRAVEL with silt; light brown	10	50/5"	X	12.8	83				slightly moist very dense
		Auger refusal at 10.5'. No groundwater encountered at time of drilling. Installed 1.25" diameter slotted PVC pipe to 10.5'.									
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3A

BORING LOG

BORING: B-2

CLIENT: The Church of Jesus Christ of Latter-day Saints | PROJECT NUMBER: 0153-345-17

PROJECT: Proposed Herriman Senior Seminary | DATE STARTED: 3/6/18 | DATE FINISHED: 3/6/18

LOCATION: Approximately 14150 South 4400 West, Herriman, Utah | GSH FIELD REP.: BG

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/6/18 & 3/14/18) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface	0								
	CL	SILTY CLAY with some fine sand; major roots (topsoil) to 6"; brown with oxidation									loose to 9" slightly moist
				23	X						very stiff
			5								
	SM	SILTY FINE TO MEDIUM SAND brown with oxidation									moist medium dense
				51	X	9.4	103	16.9			
			10								
	SP/SM	FINE TO COARSE SAND with some fine and coarse gravel and silt; brown									moist
			15	50/5"	X	10.0		11.0			very dense
	CL	FINE SANDY CLAY brown									moist
			20	27	X						very stiff
		End of Exploration at 21.5'. No groundwater encountered at time of drilling. Installed 1.25" diameter slotted PVC pipe to 21.5'.									
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3B

BORING LOG

BORING: B-3

CLIENT: The Church of Jesus Christ of Latter-day Saints | PROJECT NUMBER: 0153-345-17

PROJECT: Proposed Herriman Senior Seminary | DATE STARTED: 3/12/18 | DATE FINISHED: 3/12/18

LOCATION: Approximately 14150 South 4400 West, Herriman, Utah | GSH FIELD REP.: MSH

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/12/18) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	CL	SILTY CLAY with some fine sand; major roots (topsoil) to 6"; brown with oxidation	0								loose to 9" slightly moist
											stiff
		End of Exploration at 5.0'. No groundwater encountered at time of drilling.	5								
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3C

BORING LOG

BORING: B-4

CLIENT: The Church of Jesus Christ of Latter-day Saints | PROJECT NUMBER: 0153-345-17

PROJECT: Proposed Herriman Senior Seminary | DATE STARTED: 3/12/18 | DATE FINISHED: 3/12/18

LOCATION: Approximately 14150 South 4400 West, Herriman, Utah | GSH FIELD REP.: MSH

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/12/18) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	CL	SILTY CLAY with some fine sand; major roots (topsoil) to 6"; brown with oxidation	0								loose to 9" slightly moist
											stiff
		End of Exploration at 5.0'. No groundwater encountered at time of drilling.	5								
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3D

BORING LOG

BORING: B-5

CLIENT: The Church of Jesus Christ of Latter-day Saints | PROJECT NUMBER: 0153-345-17

PROJECT: Proposed Herriman Senior Seminary | DATE STARTED: 3/12/18 | DATE FINISHED: 3/12/18

LOCATION: Approximately 14150 South 4400 West, Herriman, Utah | GSH FIELD REP.: MSH

DRILLING METHOD/EQUIPMENT: 3-3/4" ID Hollow-Stem Auger | HAMMER: Automatic | WEIGHT: 140 lbs | DROP: 30"

GROUNDWATER DEPTH: Not Encountered (3/12/18) | ELEVATION: ---

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
		Ground Surface									
	CL	FINE SANDY CLAY with major roots (topsoil) to 6"; gray with oxidation	0								loose to 9" slightly moist
					◢						stiff
					◢						
		End of Exploration at 5.0'. No groundwater encountered at time of drilling.	5								
			10								
			15								
			20								
			25								

See Subsurface Conditions section in the report for additional information.

FIGURE 3E

CLIENT: The Church of Jesus Christ of Latter-day Saints
PROJECT: Proposed Herriman Senior Seminary
PROJECT NUMBER: 0153-345-17

KEY TO BORING LOG

WATER LEVEL	USCS	DESCRIPTION	DEPTH (FT.)	BLOW COUNT	SAMPLE SYMBOL	MOISTURE (%)	DRY DENSITY (PCF)	% PASSSING 200	LIQUID LIMIT (%)	PLASTICITY INDEX	REMARKS
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪	⑫

COLUMN DESCRIPTIONS

① **Water Level:** Depth to measured groundwater table. See symbol below.

② **USCS:** (Unified Soil Classification System) Description of soils encountered; typical symbols are explained below.

③ **Description:** Description of material encountered; may include color, moisture, grain size, density/consistency,

④ **Depth (ft.):** Depth in feet below the ground surface.

⑤ **Blow Count:** Number of blows to advance sampler 12" beyond first 6", using a 140-lb hammer with 30" drop.

⑥ **Sample Symbol:** Type of soil sample collected at depth interval shown; sampler symbols are explained below.

⑦ **Moisture (%):** Water content of soil sample measured in laboratory; expressed as percentage of dryweight of

⑧ **Dry Density (pcf):** The density of a soil measured in laboratory; expressed in pounds per cubic foot.

⑨ **% Passing 200:** Fines content of soils sample passing a No. 200 sieve; expressed as a percentage.

⑩ **Liquid Limit (%):** Water content at which a soil changes from plastic to liquid behavior.

⑪ **Plasticity Index (%):** Range of water content at which a soil exhibits plastic properties.

⑫ **Remarks:** Comments and observations regarding drilling or sampling made by driller or field personnel. May include other field and laboratory test results using the following abbreviations:

CEMENTATION:

Weakly: Crumbles or breaks with handling or slight finger pressure.

Moderately: Crumbles or breaks with considerable finger pressure.

Strongly: Will not crumble or break with finger pressure.

MODIFIERS:

Trace <5%

Some 5-12%

With > 12%

MOISTURE CONTENT (FIELD TEST):

Dry: Absence of moisture, dusty, dry to the touch.

Moist: Damp but no visible water.

Saturated: Visible water, usually soil below water table.

Descriptions and stratum lines are interpretive; field descriptions may have been modified to reflect lab test results. Descriptions on the logs apply only at the specific boring locations and at the time the borings were advanced; they are not warranted to be representative of subsurface conditions at other locations or times.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS			USCS SYMBOLS	TYPICAL DESCRIPTIONS
COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size.	GRAVELS More than 50% of coarse fraction retained on No. 4 sieve.	CLEAN GRAVELS (little or no 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 (appreciable amount of fines)	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SANDS More than 50% of coarse fraction passing through No. 4 sieve.	CLEAN SANDS (little or no fines)	SW	Well-Graded Sands, Gravelly Sands, Little or No Fines
			SP	Poorly-Graded Sands, Gravelly Sands, Little or No Fines
		SANDS WITH FINES (appreciable amount of 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 Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands 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 o f 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, Humus, Swamp Soils with High Organic Contents

Note: Dual Symbols are used to indicate borderline soil classifications.

STRATIFICATION:

DESCRIPTION	THICKNESS
Seam	up to 1/8"
Layer	1/8" to 12"

Occasional: One or less per 6" of thickness

Numerous; More than one per 6" of thickness

TYPICAL SAMPLER GRAPHIC SYMBOLS

- Bulk/Bag Sample
- Standard Penetration Split Spoon Sampler
- Rock Core
- No Recovery
- 3.25" OD, 2.42" ID D&M Sampler
- 3.0" OD, 2.42" ID D&M Sampler
- California Sampler
- Thin Wall

WATER SYMBOL

Water Level

FIGURE 4

GSH

APPENDIX A

Topsoil Testing Report

Topsoil Testing Report

Project	Name **Herriman Senior Seminary**		Property Number : **501-3419**
	Site Street Address, City, State/Province **Approximately 14150 South 4400 West, Herriman, UT**		
Person Submitting Test	Name **Mike Huber GSH mike@gshgeotech.com**	Date Requested **07 Mar 2018**	Phone **801 685 9190**
	Address, City, State/Province **473 W 4800 S, SLC, UT 84123**		Fax **2990**
Soil Testing Laboratory	Name **QA Consulting and Testing, LLC**	Date Submitted **10 Mar 2018**	Phone 801 423 1116
	Address, City, State/Province **645 South 240 East Salem, UT 84653 vonisaman@comcast.net**		Cel 801 372 7177

General

1. Owner will pay for pre-bid testing and one (1) final topsoil test.

Landscape Architect Instructions

1. Landscape Architect shall determine by investigation quality and quantity of topsoil on site before landscape design. Add physical and fertility recommendations from laboratory recommendations to relevant Church specifications.

Contractor Instructions

1. Test installed topsoil. Installed topsoil shall comply with Project Specifications.
2. If installed topsoil does not comply, Contractor will enhance and test at no cost to Owner until installed topsoil complies with Project Specifications.

Testing Instructions

1. Collect at least two (2) samples of on-site topsoil and each anticipated topsoil source. If site soil profile or borrow pit are not uniform, additional samples shall be taken. Uniform composite samples may also be used if properly acquired and documented.
2. Submit required soil samples to soil testing laboratory along with all required (for this report and laboratory) information.

Soil Testing Laboratory Instructions

1. This report must be completely filled out and provide soil interpretation and amendment, fertilizer, and soil conditioner recommendations for use by Landscape Architect. These recommendations should consider lawn areas, tree and shrub areas, and native plant areas.
2. Provide appropriate times for fertilizing.
3. Return completed Topsoil Testing Report to person submitting the test.

SOIL SAMPLE LOG

Soil Sample No.	Description of location where sample was taken	History of use of the soil
Herriman Sr. Seminary	0-1' Topsoil Surface	Not given

Existing Conditions Test Report

("Acceptable Levels" refers to the allowable soil specifications prior to being amended)

SOIL TEST DATA

Sample No.	pH(1)	EC(1) Mmhos/cm	SAR(1)	% Sand	% Silt	% Clay	Text(2) Class	%(3) OM	**NO3-N(4) ppm**	**P(5) ppm**	K(5) ppm	**Fe(5) ppm**
Herriman Sr. Seminary	7.7	1.3	0.5	42	35	23	Loam	1.9	**4**	**5**	400	**1**
Acceptable Level(s)	5.5 - 8.4	<3.0	<6.0	15-60	10-60	5-30	(2)	>1.0	**>20**	**>11**	>130	**>10**

(1) Saturated soil paste 1:1 soil:water method (please Indicate)

(2)Hydrometer method (Acceptable soil- sand:15-60 percent, silt:10-60 percent, clay-5-30 percent)

(3)Potassium dichromate method (Walkey-Black) or loss of ignition

(4)Chromotropic acid method

(5)AB-DTPA method

If other methods are used for NO3-N, P, K, and Fe, then note.

Continued next page.

ROCKS (Coarse Fragments)		
Sample No.	Percent > 1/4 inch (6.4 mm)	Rocks Present ≥ 1.5 inch (38 mm) Indicate as present or not present
Herriman Sr. Seminary	0.2	Not Present
Acceptable Level	≤ 5.0 percent	< 1.5 inch (38 mm)

Landscape Area Description

Lawn Areas: Receive 5 inch (125 mm) topsoil plus recommended amendments and fertilizers.

Shrub/Tree Areas: Unless otherwise indicated, plant pits are to be backfilled with three (3) parts native soil and one part compost or other recommended amendments. Additionally, contractor will add recommended fertilizer.

Native Grass/Shrub/Tree Areas: Planting to receive minimum recommended amendments and fertilizers for establishment.

INFILTRATION RATE	
Documented Infiltration rate of test sample(s) based on texture at 90 percent relative density (To nearest 1/10th of an inch)	
Sample No.	Rate
Herriman Sr. Seminary	1.2 Inches/Hour
	Inches/Hour

Interpretation Summary of Test Results:

Herriman Sr. Seminary does not meet Acceptable Levels for: NO3N, P and Fe.

Soil Amendments, Fertilizer and Soil Conditioner – Recommendations:

Lawn Areas: Amendments: Apply an organic material (compost, etc.) at 5.0 cu yds/1000 sq ft for every 5" of topsoil depth. Incorporate well. See the Compost Quality Guidelines for Landscaping, attached. Or, apply a similar product at label rate following manufacturer's recommendation for soil preparation and turf maintenance. Fertilizer: Apply a NP and Iron fertilizer at label rate. Incorporate well. Conditioner: None.

Shrub/Tree Areas: Amendments: See **Landscape Area Description** above. Fertilizer: Apply a NP and Iron fertilizer at label rate. Conditioner: None.

Native Grass/Shrub/Tree Areas: Amendments: None. Conditioners: None. Fertilizer: Incorporate a NP and Fe fertilizer at 1/2 label rate, or per nurseryman's recommendation.

Scarify the subsoil at least 6" before applying topsoil.

Long Term (5 Year) Fertilizer and Soil Conditioner – Recommendations:

Lawn Areas: Core aerate annually and top dress with an organic material 1/8" to ¼". Fertilizer: Continue with above recommendation. Conditioner: None.

Shrub/Tree Areas: Amendments: None. Conditioner: None. Fertilizer: As top dress, continue with above recommendation.

Native Grass/Shrub/Tree Areas: Amendments: None. Conditioner: None**:** Fertilizer: fertilize at 1/2 label rate, or per nurseryman's recommendation.

GshHerrimanSrSeminaryLdsRpt18.310

QA CONSULTING AND TESTING LLC

VON ISAMAN
PO BOX 627 SALEM, UT 84653
(801) 423-1116 FAX (801) 423-1813
www.qaconsultingandtesting.com
vonisaman@comcast.net

COMPOST QUALITY GUIDELINES FOR LANDSCAPING*

Category	pH**	Soluble Salts** dS/m or mmho/cm	Sodium Adsorption Ratio** (SAR)	Carbon:Nitrogen Ratio*** (C:N)	% Moisture****	≥98% Coarse Material Passing (dry wt basis)
Ideal	6 to 8	≤5	<10	≤20:1	25 to 35	3/8" (9.5 mm)
Acceptable	5-6, 8-9	≤10	≤20	21:1 to 30:1	<25, >35	3/4" (19 mm)
Suspect	<5, >9	>10	>20	<10:1, >30:1	<20, >50	<98% 3/4"

*Von Isaman MS, President of QA Consulting and Testing LLC, Dr. Rich Koenig, USU Cooperative Extension Soils Specialist, and Dr. Teresa Cerny, USU Cooperative Extension Horticulturalist, 3 March 2003.

for composts with biosolid feedstocks, biosolids must meet EPA 503 Class A standards

** 1:5 Compost:Water Slurry on Coarse Material passing 3/8" (9.5 mm)
*** on Coarse Material passing 3/8" (9.5 mm)
**** on total sample

Acceptable level Soluble Salts and/or SAR composts then do not exceed 3 cu yds/1000 sq ft for every 3 inches of soil depth.

CompostGuidelines09Msw.923