AGEC

Applied GeoTech

GEOTECHNICAL INVESTIGATION

~~REDWOOD GARDENS SUBDIVISION~~ HOLY TRINITY CHURCH

13269 SOUTH REDWOOD ROAD

RIVERTON, UTAH

PREPARED FOR:

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PROJECT NO. 1120308

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EXECUTIVE SUMMARY

1. The subsurface soils encountered in the test pits consist of approximately 6 to 10 inches of topsoil overlying clayey sand that extends to depths of approximately 2 to 4 feet below the ground surface. Poorly-graded sand was encountered below the clayey sand in Test Pits TP-1 and TP-2 and the sand extends the full depth investigated, approximately 11 to 14 feet below the ground surface. Poorly-graded sand with silt was encountered below the clayey sand in Test Pit TP-3 to a depth of approximately 6½ feet. Silty sand was encountered below this sand and extends the full depth investigated, approximately 11 feet below the ground surface in Test Pit TP-3.

2. Subsurface water was encountered at a depth of approximately 7½ feet below the ground surface in Test Pit TP-3 when measured 6 days after the field investigation. No subsurface water was encountered in the other two test pits.

3. The proposed residences may be supported on spread footings bearing on the undisturbed natural sand or on compacted structural fill extending down to the undisturbed natural sand. Spread footings bearing on the undisturbed natural sand or on compacted structural fill may be designed using an allowable net bearing pressure of 1,500 pounds per square foot (psf). Footings bearing on at least 2 feet of compacted structural fill may be designed using an allowable net bearing pressure of 2,500 psf.

4. The near surface soil consists of clayey sand. Construction equipment access difficulties may be encountered when the upper soil is very moist to wet such as during periods of precipitation or snowmelt. When the subgrade consists of very moist to wet clayey sand, placement of granular fill or removal of the upper clayey sand may be needed to provide equipment access and facilitate construction of the pavement.

5. Geotechnical information related to foundations, subgrade preparation, pavement design and materials is included in the report.

SCOPE

This report presents the results of a geotechnical investigation for the proposed Redwood Gardens subdivision to be located at 13269 South Redwood Road in Riverton, Utah. The report presents the subsurface conditions encountered, laboratory test results and recommendations for foundations and pavement. The study was conducted in general accordance with our proposal dated April 25, 2012.

Field exploration was conducted to obtain information on the subsurface conditions. Samples obtained from the field investigation were tested in the laboratory to determine physical and engineering characteristics of the on-site soil. Information obtained from the field and laboratory was used to define conditions at the site for our engineering analysis and to develop recommendations for the proposed foundations and pavement.

This report has been prepared to summarize the data obtained during the study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction are included in the report.

SITE CONDITIONS

There were two residential houses with basements, detached garages and several out buildings in the western portion of the site at the time of our field study. There were vacant fields and a pasture in the eastern portion of the property.

The site is relatively flat with a gentle slope down to the east, except in the southeast portion of the site where the ground surface slopes moderately down to the southeast.

Vegetation at the site consists of grass, weeds and several large trees in the western portion of the site and around the perimeter of the site in general.

There are several ditches extending along the northern edge of the site and also in the middle of the western portion of the site. There was no water in the ditches at the time of our field study. The surrounding area consists of residential development with one to two-story, wood-frame structures with basements. The site is bordered on the west by Redwood Road which is a wide two-lane asphalt-paved road with curb, gutter and sidewalks. The site is bordered on the north, south and east by residential development and vacant fields.

FIELD STUDY

The field study was conducted on February 27, 2013. Three test pits were excavated at the approximate locations indicated on Figure 1 using a rubber-tired backhoe. The test pits were logged and soil samples obtained by an engineer from AGEC. Logs of the subsurface conditions encountered in the test pits are graphically shown on Figure 2.

The test pits were backfilled without significant compaction. The backfill in the test pits should be properly compacted where it will support proposed buildings, slabs or pavement.

SUBSURFACE CONDITIONS

The subsurface soils encountered in the test pits consist of approximately 6 to 10 inches of topsoil overlying clayey sand that extends to depths of approximately 2 to 4 feet below the ground surface. Poorly-graded sand was encountered below the clayey sand in Test Pits TP-1 and TP-2 and the sand extends the full depth investigated, approximately 11 to 14 feet below the ground surface. Poorly-graded sand with silt was encountered below the clayey sand in Test Pit TP-3 to a depth of approximately 6½ feet. Silty sand was encountered below this sand and extends the full depth investigated, approximately 11 feet below the ground surface in Test Pit TP-3.

A description of the soils encountered in the test pits follows:

Topsoil - The topsoil consists of clayey sand to sandy lean clay. It is moist, dark brown and contains roots and organics.

Clayey Sand - The clayey sand is medium dense, moist, brown to light brown and contains small to moderate amounts of gravel.

Laboratory testing conducted on two samples of the sand indicates a natural moisture content of 12 percent and natural dry densities of 110 to 120 pounds per cubic foot. The results of two gradation tests conducted on samples of the sand indicate that it contains 26 and 34 percent fines.

Poorly-Graded Sand - The sand contains some gravel in Test Pit TP-2. The sand is medium dense, moist and light brown.

Silty Sand - The silty sand contains some clayey sand and clean sand layers. It is medium dense, wet and brown to light brown.

Results of the laboratory tests are summarized on Table I and are included on the logs of the test pits.

SUBSURFACE WATER

Subsurface water was encountered in the Test Pit TP-3 at a depth of 7½ feet below the surrounding ground surface when measured 6 days after the field investigation. No subsurface water was encountered in Test Pits TP-1 and TP-2 at the time of excavation to the maximum depth investigated, approximately 14 feet.

PROPOSED CONSTRUCTION

We understand that the site encompasses approximately 3½ acres that will be subdivided for residential development. We anticipate that the houses will consist of one to two-story, wood frame structures with basements. We have assumed building loads consisting of wall loads up to 3 kips per lineal foot and column loads up to 20 kips.

We understand that a road will be constructed through the proposed development. We have assumed traffic for the road consisting of passenger vehicles with two delivery trucks per day and two garbage trucks per week.

If the proposed construction, anticipated traffic or building loads are significantly different from those described above, we should be notified so that we can reevaluate the recommendations given.

RECOMMENDATIONS

Based on the subsurface conditions encountered, laboratory test results and the proposed construction, the following recommendations are given:

A. Site Grading

Final site grading plans were not available at the time of our investigation. We anticipate that there will be only a minor amount of cut and fill for the proposed development.

1. Subgrade Preparation

Prior to placing grading fill or base course, the topsoil, organic material, unsuitable fill and other deleterious materials should be removed. The subgrade should be proof-rolled to identify soft areas. Soft areas should be

removed and replaced with properly compacted granular fill consisting predominantly of gravel having no more than 15 percent passing the No. 200 sieve.

The upper natural soil consists of clayey sand. The upper clayey sand may result in construction equipment access difficulties during periods when the upper soil is very moist to wet, such as in the winter and spring or during periods of precipitation or snowmelt. In areas where the subgrade consists of very moist to wet clayey sand, the subgrade should be prepared by cutting to undisturbed natural soil below topsoil and fill and placing a sufficient thickness of granular fill consisting predominantly of gravel with less than 15 percent passing the No. 200 sieve or by removing the upper clayey sand to provide access for construction equipment.

2. Excavation

We anticipate that excavation at the site can be accomplished with typical excavation equipment.

3. Unretained Excavation Slopes

Difficulty maintaining the sides of temporary excavations should be expected. Temporary, unretained excavation slopes in the natural sand may be constructed at 1 ½ horizontal to 1 vertical or flatter. It is the responsibility of the contractor to provide appropriate slopes to assure safe working conditions and stability of adjacent areas. Additional evaluation of excavation slopes by a qualified engineer may be required during the construction process.

4. Materials

Listed below are materials recommended for imported structural fill.

Fill to Support	Recommendations
Footings	Non-expansive granular soil Passing No.200 Sieve < 35% Liquid Limit < 30% Maximum size 4 inches
Floor Slab (Upper 4 inches)	Sand and/or Gravel Passing No. 200 Sieve < 5% Maximum size 2 inches
Slab Support	Non-expansive granular soil Passing No. 200 Sieve < 50% Liquid Limit < 30% Maximum size 6 inches

Consideration may be given to using the on-site sand that meet the criteria for imported structural fill as structural fill, site grading fill and utility trench and wall backfill, if the topsoil, organics, unsuitable fill, debris and other deleterious materials are removed or it may be used in landscape areas.

The use of the on-site soil as fill may require moisture conditioning (wetting or drying) to facilitate compaction. Drying of the soil may not be practical during cold or wet periods of the year.

5. Compaction

Compaction of materials placed at the site should equal or exceed the minimum densities as indicated below when compared to the maximum dry density as determined by ASTM D 1557.

Fill To Support	Compaction
Foundations	≥ 95%
Concrete Flatwork and Pavement	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

To facilitate the compaction process, the fill should be compacted at a moisture content within 2 percent of the optimum moisture content.

Base course should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557.

Fill and pavement materials should be frequently tested for compaction.

6. Drainage

The ground surface surrounding the proposed buildings should be sloped away from the buildings in all directions. Roof downspouts and drains should discharge beyond the limits of backfill.

The collection and diversion of drainage away from the pavement surface is important to the satisfactory performance of the pavement section. Proper drainage should be provided.

B. Foundations

1. Bearing Materials

With the proposed construction and the subsurface conditions encountered, the proposed residences may be supported on spread footings bearing on the undisturbed natural sand or on compacted structural fill extending down to the undisturbed natural sand. Structural fill placed below footings should

extend out away from the edge of the footings at least a distance equal to the depth of fill beneath footings.

Topsoil, unsuitable fill and other deleterious materials should be removed from below proposed foundation areas.

2. Bearing Pressures

Spread footings bearing on the undisturbed natural sand or on compacted structural fill may be designed using an allowable net bearing pressure of 1,500 psf. Footings bearing on at least 2 feet of compacted structural fill may be designed for an allowable net bearing pressure of 2,500 psf. Footings should have a width of at least 18 inches and a depth of embedment of at least 10 inches.

3. Temporary Loading Conditions

The allowable bearing pressure may be increased by one-half for temporary loading conditions such as wind or seismic loads.

4. Settlement

We estimate that total and differential settlement will be less than 1 and ½ inch respectively, for footings designed as indicated above.

Care will be required to minimize disturbance of the natural soil to remain below proposed footings.

5. Frost Depth

Exterior footings and footings beneath unheated areas should be placed at least 30 inches below grade for frost protection.

6. Foundation Base

The base of footing excavations should be cleared of loose or deleterious material prior to structural fill or concrete placement.

7. Construction Observation

The base of footing excavations should be observed by a representative of the geotechnical engineer prior to structural fill or concrete placement.

C. Concrete Slab-on-Grade

1. Slab Support

Concrete slabs may be supported on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil.

Topsoil, existing fill, organics and other deleterious materials should be removed from below proposed floor slabs.

2. Underslab Sand and/or Gravel

A 4-inch layer of free draining sand and/or gravel (less than 5 percent passing the No. 200 sieve) should be placed below the concrete slabs to facilitate construction and allow even curing of the slab concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread footings placed on the natural gravel or on compacted structural fill is controlled by sliding resistance between the footing and the foundation soils. A friction value of 0.45 may be used in design for ultimate lateral resistance.

2. Subgrade Walls and Retaining Structures

The following equivalent fluid weights are given for design of subgrade walls and retaining structures. The active condition is where the wall moves away from the soil. The passive condition is where the wall moves into the soil and the at-rest condition is where the wall does not move. The values listed below assume a horizontal surface adjacent the wall.

Soil Type	Active	At-Rest	Passive
Sand & Gravel	40 pcf	55 pcf	300 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 28 and 13 pcf for active and at-rest conditions respectively, and decreased by 28 pcf for the passive condition. This assumes a peak horizontal ground acceleration of 0.52g for a 2 percent probability of exceedance in a 50-year period (IBC, 2009).

4. Safety Factors

The values recommended above assume mobilization of the soil to achieve ultimate soil strength. Conventional safety factors used for structural analysis for such items as overturning and sliding resistance should be used in design.

E. Seismicity, Faulting and Liquefaction

1. Listed below is a summary of the site parameters for the 2009 International Building Code:

		2009
a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.23g
c.	One Second Period Spectral Response Acceleration, S_1	0.51g

2. Faulting

There are no mapped active faults extending through the site. The closest mapped fault considered to be active is the Wasatch Fault located approximately 5 miles east of the site (Salt Lake County, 1995).

3. Liquefaction

The site is located in an area mapped as having a "very low" potential for liquefaction (Salt Lake County, 1995). Liquefaction may be a hazard at the site since there is sand below the water level to the depth investigated. The structural engineer should consider the potential for several inches of settlement to occur during a major seismic event. Deeper subsurface investigation using methods that allow for liquefaction evaluation would be needed to better understand the potential for and effects of liquefaction at this site. Such a study is beyond the scope of this report.

F. Water Soluble Sulfates

One sample of the natural soil was tested in the laboratory for water soluble sulfate content. Results of the test indicate there is less than 0.1 percent water soluble sulfate in the sample tested. Based on the results of the test and published literature, the natural soil possesses negligible sulfate attack potential on concrete. No special cement type is required for concrete placed in contact with the natural soil. Other conditions may dictate the type of cement to be used in concrete for the project.

G. Pavement

Based on the subsoil conditions encountered, laboratory test results and the assumed traffic, the following pavement support recommendations are given.

1. Subgrade Support

The near surface soil generally consists of clayey sand. A California Bearing Ratio (CBR) of 5 percent was used in the analysis which assumes a clayey sand subgrade.

2. Pavement Thickness

Based on the subsoil conditions, assumed traffic as described in the Proposed Construction section of the report, a design life of 20 years for flexible and 30 years for rigid pavements and methods presented by the Utah Department of Transportation, a flexible pavement section consisting of 3 inches of asphaltic concrete overlying 6 inches of high-quality base course is calculated. Alternatively, a rigid pavement section consisting of 5 inches of Portland cement concrete may be used.

Placement of granular fill or removal of the upper soil may be needed when the subgrade consists of very moist to wet clayey sand as discussed in the Subgrade Preparation section of the report.

3. Pavement Materials and Construction

a. Flexible Pavement (Asphaltic Concrete)

The pavement materials should meet the material specifications for the applicable jurisdiction. Other materials may be considered for use in the pavement section. The use of other materials may result in the need for different pavement material thicknesses.

b. Rigid Pavement (Portland Cement Concrete)

The pavement thickness assumes that the pavement will have aggregate interlock joints and that a concrete shoulder or curb will be provided.

The pavement materials should meet the material specifications for the applicable jurisdiction. The pavement thickness indicated above assumes that the concrete will have a 28-day compressive strength of 4,000 psi. Concrete should be air entrained with approximately 6 percent air. Maximum allowable slump will depend on the method of placement but should not exceed 4 inches.

4. Jointing

Joints for concrete pavement should be laid out in a square or rectangular pattern. Joint spacings should not exceed 30 times the thickness of the slab. The joint spacings indicated should accommodate the contraction of the concrete and under these conditions steel reinforcing will not be required. The depth of joints should be approximately one-fourth of the slab thickness.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in the area for the use of the client for design purposes. The conclusions and recommendations included within the report are based on the information obtained from the test pits excavated at the locations indicated on Figure 1 and the data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until additional excavation is conducted. If the subsurface conditions or groundwater level is significantly different from what is described above, we should be notified to reevaluate our recommendations.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

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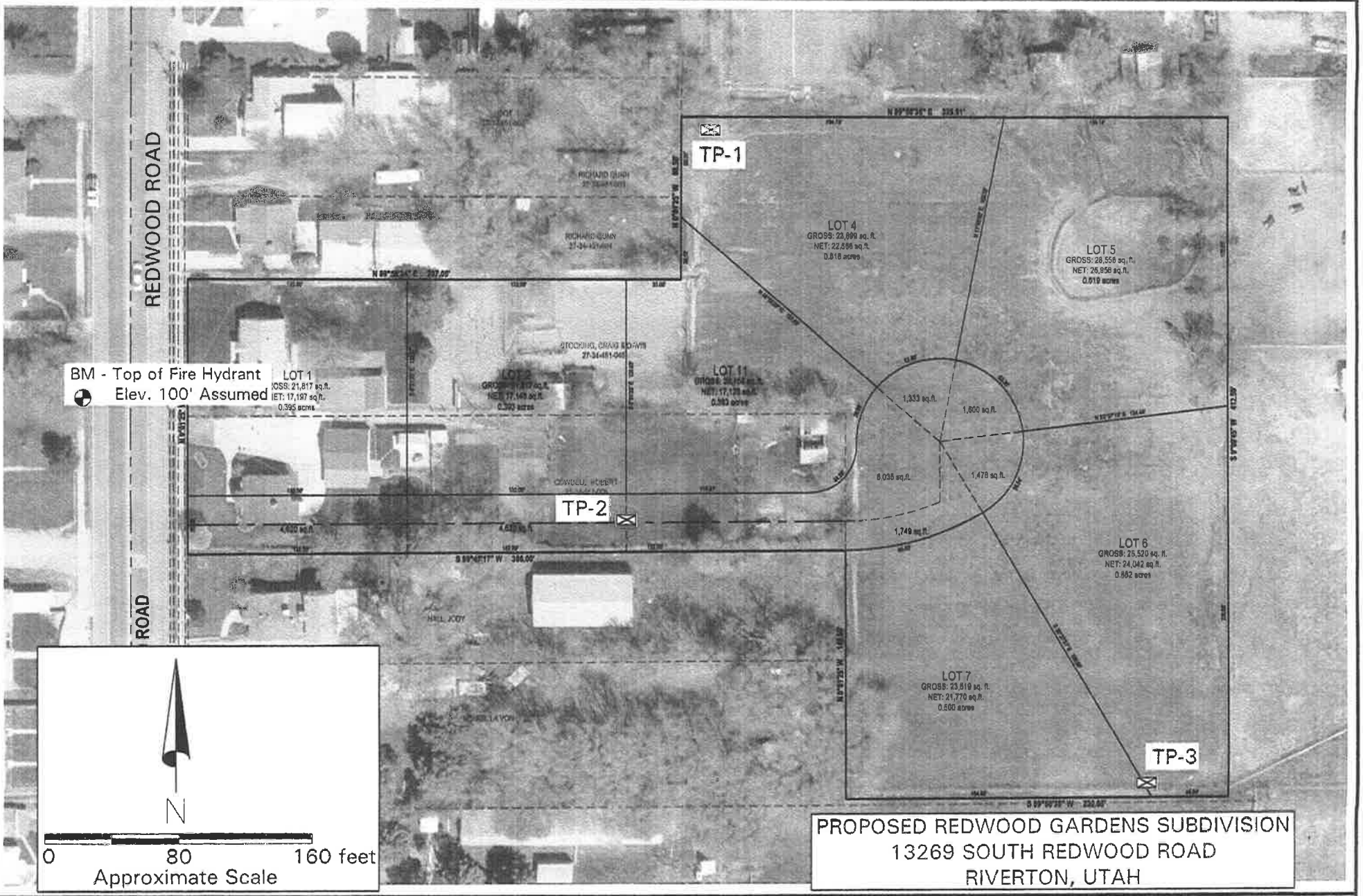
Reviewed by Douglas R. Hawkes, P.E., P.G.

JSE/rs

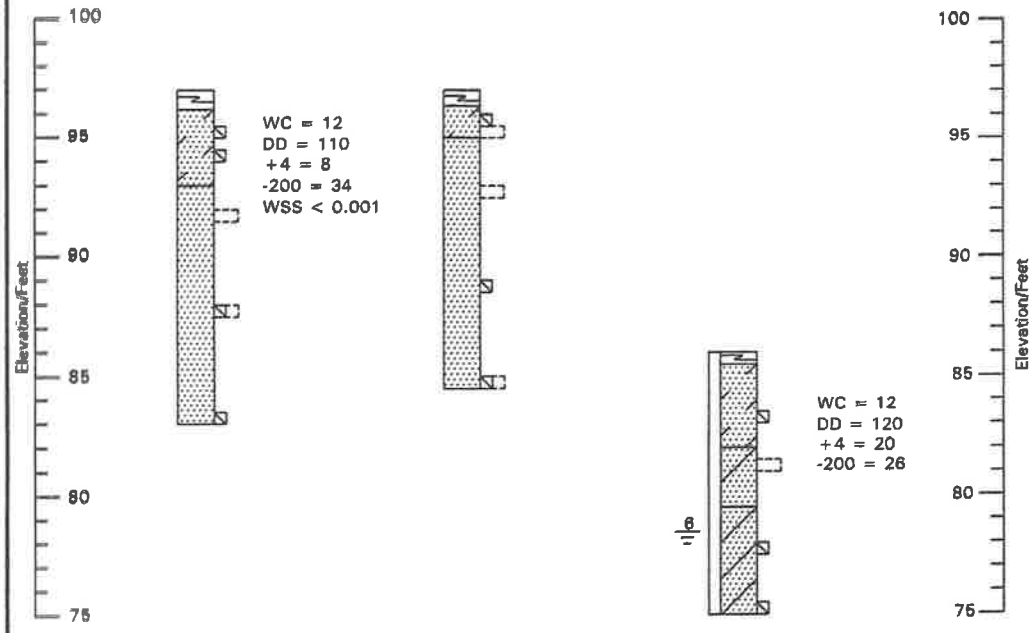
REFERENCES

International Building Codes, 2009 and 2012; International Code Council, Inc., Falls Church, Virginia.

Salt Lake County, 1995; Surface Rupture and Liquefaction Potential Special Study Areas Map, Salt Lake County, Utah, adopted March 31, 1989, revised 1995, Salt Lake County Public Works - Planning Division, 2001 South State Street, Salt Lake City, Utah.



1120308	AGEC Applied GeoTech	Locations of Test Pits	Figure 1



Approximate Vertical Scale 1" = 8'

LEGEND:

- Topsoil; clayey sand to sandy lean clay, moist, dark brown to brown, roots, organics.
- Clayey Sand (SC); some gravel, medium dense, moist, brown to light brown.
- Silty Sand (SM); small to moderate amount of silt, some clayey sand and clean sand layers, medium dense, moist, wet, brown to light brown.
- Poorly Graded Sand with Silt (SP-SM); some gravel, medium dense, moist to wet, light brown.
- Poorly Graded Sand (SP); some gravel in TP-2, medium dense, moist, light brown.
- Indicates relatively undisturbed hand drive sample taken.
- Indicates disturbed sample taken.
- Indicates slotted 1½ inch PVC pipe installed in the test pit to the depth shown.
- 6 — Indicates the depth to free water and the number of days after excavating the measurement was taken.

NOTES:

1. Test pits were excavated on February 27, 2013 with a rubber-tired backhoe.
2. Locations of test pits were measured approximately by pacing from features shown on the site plan provided.
3. Elevations of test pits were measured by automatic level and refer to the bench mark shown on Figure 1.
4. The test pit locations and elevations should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the test pit logs represent the approximate boundaries between material types and the transitions may be gradual.
6. Water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water level may occur with time.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   -200 = Percent Passing No. 200 Sieve;
   +4 = Percent Retained on the No. 4 Sieve;
   WSS = Water Soluble Sulfates (%).

1120308	AGEC Applied GeoTech	Logs, Legend and Notes of Test Pits	Figure 2

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1120308

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATE (%)	SAMPLE CLASSIFICATION
TEST PIT	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TP-1	1½	12	110	8	58	34				<0.001	Clayey Sand (SC)
TP-3	2½	12	120	20	54	26					Clayey Sand with Gravel (SC)