Applied Geotechnical Engineering Consultants, Inc.

GEOTECHNICAL INVESTIGATION

PROPOSED SUBDIVISION

12296 SOUTH 2700 WEST

RIVERTON, UTAH

PREPARED FOR:

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PROJECT NO. 1070434

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EXECUTIVE SUMMARY

1. Subsurface materials encountered in the test pits consist of approximately 1 foot of topsoil overlying lean clay. The lean clay is underlain by clayey sand and gravel at depths ranging from 6 to10 feet below the ground surface. The clayey sand and gravel extend to the maximum depth investigated, approximately 14 feet.

2. No subsurface water was encountered in the test pits at the time of excavation.

3. The proposed residences may be supported on spread footings bearing on the undisturbed natural soil or on compacted structural fill extending down to the undisturbed natural soil. Spread footings bearing on the undisturbed natural soil or on compacted structural fill may be designed for a net allowable bearing pressure of 1,500 pounds per square foot.

4. The upper natural soil generally consists of clay. The clay may result in construction equipment access difficulties when it is very moist to wet such as in the winter or spring or at times of prolonged rainfall. Placement of 1 to 2 feet of granular fill will improve site access for rubber-tired construction equipment and may be needed to facilitate pavement construction when the upper soil is very moist to wet.

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

SCOPE

This report presents the results of a geotechnical investigation for the proposed subdivision to be located at 12296 South 2700 West 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 24, 2007.

Field exploration was conducted to obtain information on the subsurface conditions and to obtain samples for laboratory testing. Information obtained from the field and laboratory was used to define conditions at the site 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

At the time of our investigation, the site consisted of residential properties with a number of structures including a single-family home, a mobile trailer and numerous barns and garages. A paved driveway exists in the southern portion of the site.

Vegetation at the site consists of grass and weeds with a few small to medium trees.

The ground surface at the site is relatively flat and slopes gently down to the northeast.

The property is bordered to the east by 2700 West, a two-lane, asphalt-paved road. The property is bordered to the south by 12320 South, a two-lane, asphalt-paved road. The site is bordered to the north and west by residential construction.

FIELD STUDY

Test pits were excavated on May 15 and 16, 2007. 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 buildings, floor slabs or pavement.

SUBSURFACE CONDITIONS

Subsurface materials encountered in the test pits consist of approximately 1 foot of topsoil overlying lean clay. The lean clay is underlain by clayey sand and gravel at depths ranging from 6 to10 feet below the ground surface. The clayey sand and gravel extend to the maximum depth investigated, approximately 14 feet.

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

> Topsoil - The topsoil consists of lean clay which is moist, brown and contains roots and organics.
>
> Lean Clay - The clay contains a small amount of sand. It is stiff, moist and brown.

Laboratory tests conducted on samples of the clay indicate that the natural moisture contents range from 15 to 16 percent and natural dry densities range from 87 to 97 pounds per cubic foot (pcf).

An unconfined compressive strength of 1,180 pounds per square foot (psf) was measured for a sample of the clay tested in the laboratory.

A consolidation test was conducted on a sample of the clay and indicates that the soil will compress a small to moderate amount with the addition of light to moderate loads. Results of the consolidation test are presented on Figure 3.

Clayey Sand - The sand contains a small amount of gravel and is medium dense, slightly moist and brown.

Clayey Gravel with Sand - The gravel is medium dense to dense, slightly moist and brown.

Laboratory tests conducted on samples of the gravel indicate that the natural moisture contents range from 3 to 4 percent.

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

SUBSURFACE WATER

No subsurface water was encountered in the test pits at the time of excavation. Fluctuations in the water level will occur over time. An evaluation of such fluctuations is beyond the scope of this report.

PROPOSED CONSTRUCTION

We understand that the site will be developed for five, single-family residences. We anticipate that the residences will consist of one to two-story, wood-frame structures with basements.

We have assumed building loads consisting of wall loads up to 2½ kips per lineal foot and column loads up to 25 kips based on typical residential construction.

We have assumed traffic for the roads consisting predominantly of cars with one delivery truck per day and two garbage trucks per week.

If the proposed construction, building loads or traffic is significantly different from what is described above, we should be notified so that we can reevaluate our recommendations.

RECOMMENDATIONS

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

A. Site Grading

Preliminary site grading plans indicate that up to approximately 3 feet of fill is anticipated for the roadway. Fill to be placed around houses at the site should be placed as soon as possible prior to building construction to allow the significant portion of the settlement of the underlying soil induced by the load of the fill to occur prior to building construction.

1. Excavation

We anticipate that excavation can be accomplished with typical excavation equipment.

2. Subgrade Preparation

Prior to placing grading fill, the topsoil, organics, unsuitable fill, debris and other deleterious material should be removed.

The upper soil consists of lean clay that will result in construction access difficulties for rubber-tired construction equipment when it is very moist to wet such as in the winter or spring or during times of prolonged rainfall. Care will be required to minimize disturbance of the natural soil during construction. Placement of granular fill will generally improve site access for construction equipment. Generally, 1 to 2 feet of granular fill is needed to support limited traffic for moderately loaded rubber-tired construction equipment above very moist to wet clay.

3. 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

The upper on-site soil consists predominantly of clay. The clay is not recommended for use as structural fill but may be used as site grading fill, utility trench and wall backfill if the topsoil, organics, debris and other deleterious material are removed or it may be used in landscape areas. The sand and gravel may be used as structural fill or as site grading fill.

The natural soil will likely require moisture conditioning (wetting or drying) prior to use as fill. Drying of the soil may not be practical during cold or wet periods of the year.

4. 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 Slabs	≥ 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.

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

Fill placed for the project should be frequently tested during construction for compaction.

5. Drainage

The ground surface surrounding the proposed residences should be sloped away from the residences 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 Material

With the proposed construction and the subsurface conditions encountered, the residences may be supported on spread footings bearing on the undisturbed natural soil or on structural fill. Structural fill should extend down to the undisturbed natural soil and should extend out away from the edge of footings a distance at least equal to the depth of fill beneath footings.

Unsuitable fill, topsoil, organics and other deleterious materials should be removed from below proposed foundations.

2. Bearing Pressure

Spread footings bearing on the undisturbed natural soil or on structural fill extending down to the natural soil may be designed using an allowable net bearing pressure of 1,500 psf.

Footings should have a width of at least 1½ feet 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 inch for footings bearing on the natural soil or on compacted structural fill.

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 foundation excavations should be cleared of loose or deleterious material prior to fill or concrete placement.

7. Construction Observation

A representative of the geotechnical engineer should observe footing excavations 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.

Unsuitable fill, topsoil, organics and other deleterious materials should be removed from below proposed slab areas.

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 floor slabs for ease of construction and to promote even curing of the slab concrete.

D. Lateral Earth Pressure

1. Lateral Resistance for Footings

Lateral resistance for footings placed on the natural soil or on compacted structural fill is controlled by sliding resistance between the footing and the foundation soils. A friction value of 0.35 may be used in design for ultimate lateral resistance.

2. Subgrade Walls and Retaining Structures

The following equivalent fluid weights are given for the 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
Clay & Silt	50 pcf	65 pcf	250 pcf
Sand & Gravel	40 pcf	55 pcf	300 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 28 pcf for active and at-rest conditions and decreased by 28 pcf for passive conditions. This assumes a short period spectral response acceleration of 1.16g for a 2 percent probability of exceedance in a 50-year period (IBC, 2006).

4. Safety Factors

The values recommended above assume mobilization of the soil to achieve the soil strength under active and passive conditions. 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. Seismicity

Listed below is a summary of the site parameters for the 2006 International Building Code.

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.16g
c.	One Second Period Spectral Response Acceleration, S_1	0.47g

2. Faulting

The closest mapped active fault to the site is the Wasatch Fault located approximately 6 miles to the east (Salt Lake County, 1995).

3. Liquefaction

The site is located within an area mapped as having a "very low" potential for liquefaction (Salt Lake County, 1995). Research indicates that the soil type most susceptible to liquefaction during a large magnitude earthquake is loose, clean sand. In order for liquefaction to occur, the soil must be saturated. The liquefaction potential for soil tends to decrease with an increase in fines content and density. Based on our experience in the area and the subsurface soils encountered at the site to the depth investigated, we do not believe that liquefaction is a hazard for the site. Investigation to a greater depth would be needed to further evaluate the liquefaction potential at the 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. Test results indicate that there is less than 0.1 percent water soluble sulfate in the sample tested. Based on the test results and published literature, sulfate resistant cement is not needed 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 subsurface conditions encountered, laboratory test results and the assumed traffic, the following pavement support recommendations are given:

1. Subgrade Support
   The near surface soil consists primarily of lean clay and silt. A California Bearing Ratio (CBR) value of 3 percent was used in the analysis which assumes a clay subgrade.

2. Pavement Thickness
   Based on the subsoil conditions encountered at the site, assumed traffic as described in the Proposed Construction section of the report, a design life of 20 years for flexible pavement and 30 years for rigid pavement 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.

Approximately 1 to 2 feet of granular borrow may be needed to support construction traffic if construction occurs when the upper soil is very moist to wet. This is 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 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 rigid pavement thickness given above 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 specifications for the applicable jurisdiction. The pavement thickness indicated above assumes that the concrete will have a 28-day compressive strength of 4,000 pounds per square inch. 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 approximate locations indicated on Figure 1 and the data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until additional exploration or excavation is conducted. If the subsurface conditions or groundwater level is found to be significantly different from what is described above, we should be notified to reevaluate our recommendations.

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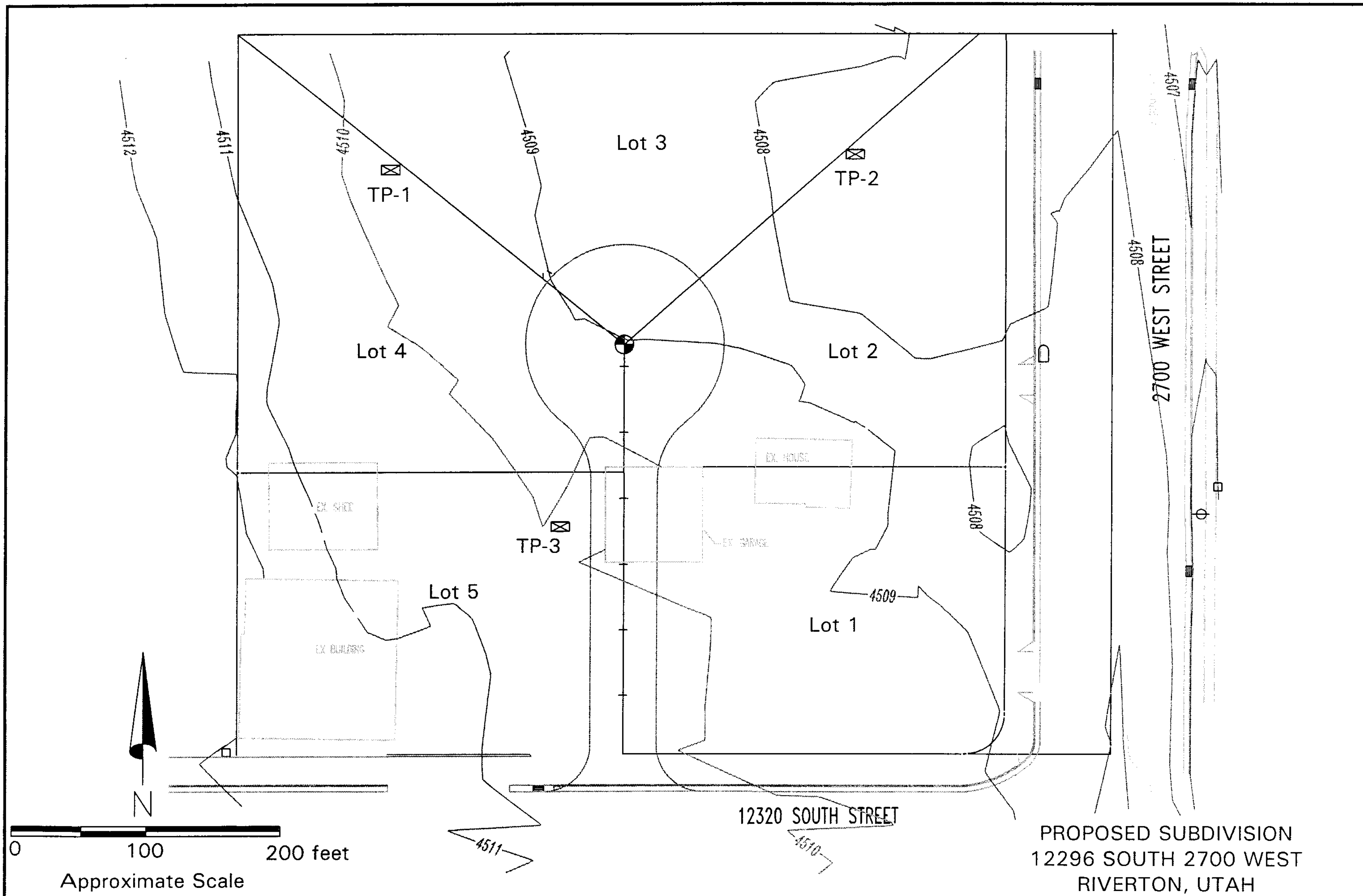
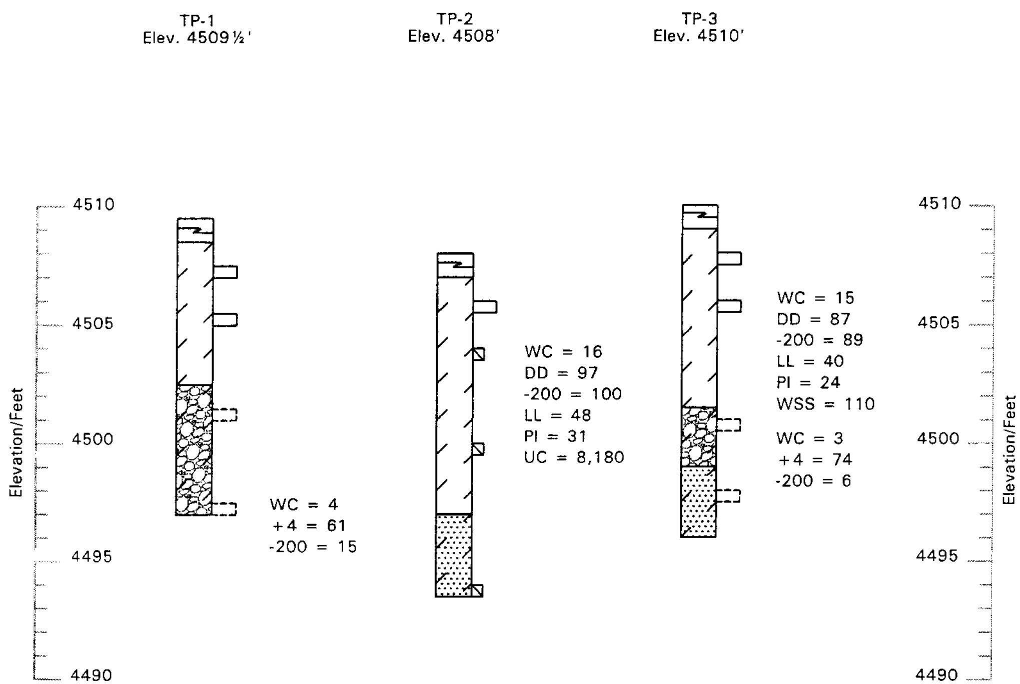
International Building Code, 2006; International Code Council, Inc. Falls Church, Virginia.

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



1070434	AGEC	Locations of Test Pits	Figure 1



LEGEND:

Topsoil; lean clay, moist, brown, roots, organics.

Lean Clay (CL); small amount of sand, stiff, moist, brown.

Clayey Sand (SC); small amount of gravel, medium dense, slightly moist, brown.

Clayey Gravel with Sand (GC); medium dense to dense, slightly moist, brown.

Indicates relatively undisturbed hand drive sample taken.

Indicates disturbed sample taken.

Indicates relatively undisturbed block sample taken.

NOTES:

1. Test pits were excavated on May 15 and 16, 2007 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 interpolated from contours 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. No free water was encountered in the test pits at the time of excavation.
7. WC = Water Content (%);
DD = Dry Density (pcf);
+4 = Percent Retained on the No. 4 Sieve;
-200 = Percent Passing No. 200 Sieve;
LL = Liquid Limit (%);
PI = Plasticity Index (%);
UC = Unconfined Compressive Strength (psf);
WSS = Water Soluble Sulfates (ppm).

Approximate Vertical Scale 1" = 8'

1070434	AGEC	Logs, Legend and Notes of Test Pits	Figure 2

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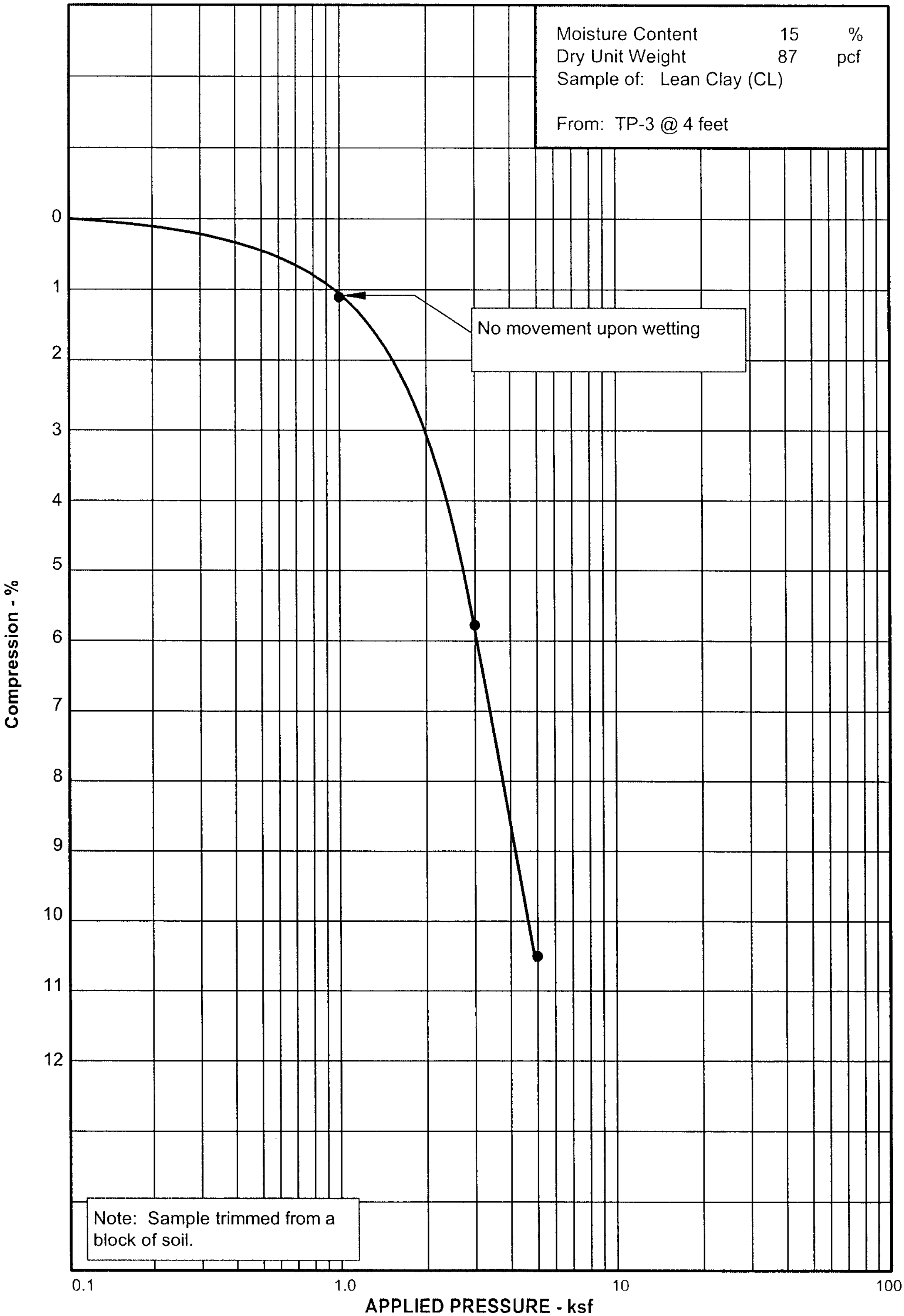

Project No. 1070434 CONSOLIDATION TEST RESULTS Figure 3

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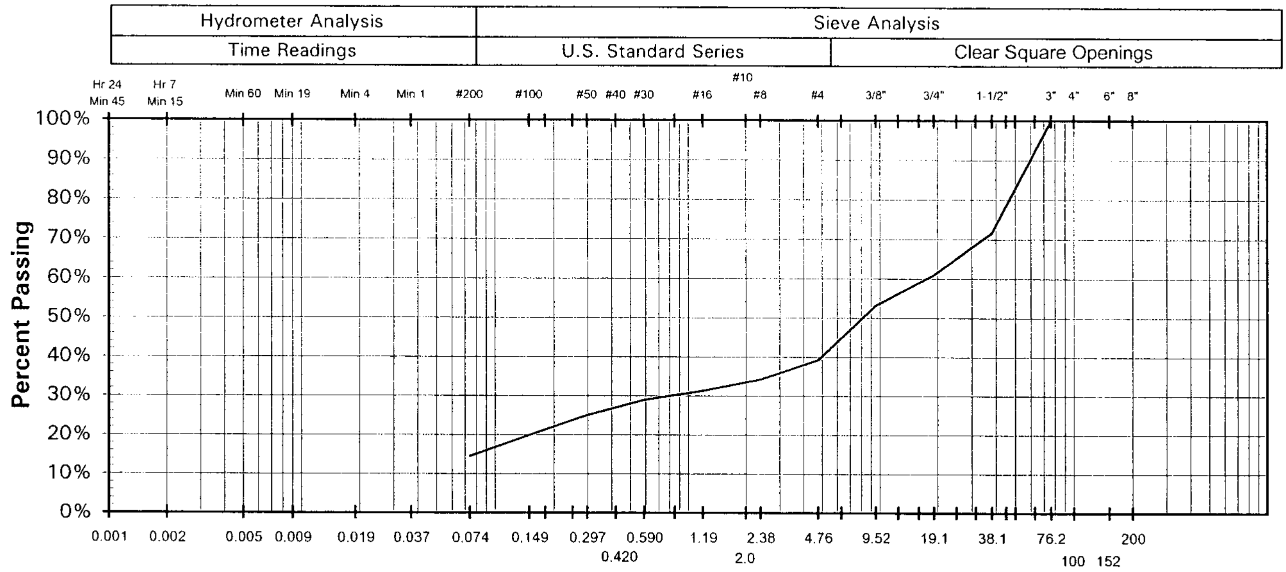
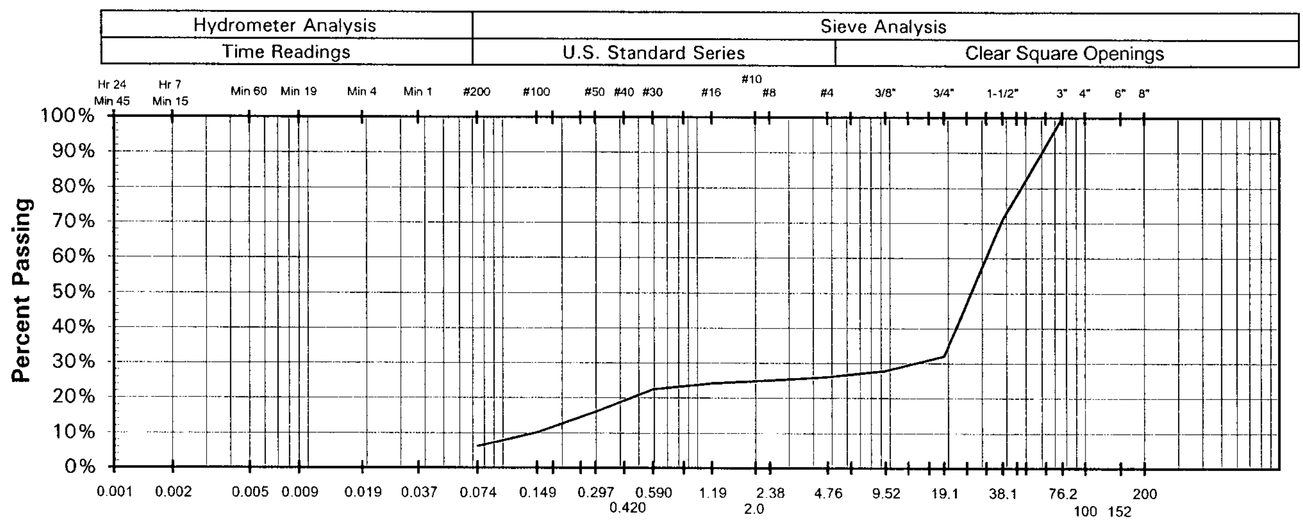


Clay to Silt	Sand			Gravel		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

Gravel 61%
Sand 24%
Silt and Clay 15%
Sample Description Clayey Gravel with Sand (GC)

Liquid Limit -
Plasticity Index -
Sample Location TP-1 @ 12 feet



Clay to Silt	Sand			Gravel		Cobbles	Boulders
	Fine	Medium	Coarse	Fine	Coarse		

Gravel 74%
Sand 20%
Silt and Clay 6%
Sample Description Poorly Graded Gravel with Clay and Sand (GP-GC)

Liquid Limit -
Plasticity Index -
Sample Location TP-3 @ 9 feet

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TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1070434

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STRENGTH (PSF)	WATER SOLUBLE SULFATE (ppm)	SAMPLE CLASSIFICATION
TEST PIT	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX			
TP-1	12	4		61	24	15					Clayey Gravel with Sand (GC)
TP-2	4	16	97			100	48	31	8,180		Lean Clay (CL)
TP-3	4	15	87			89	40	24		110	Lean Clay (CL)
	9	3		74	20	6					Poorly Graded Gravel with Clay and Sand (GP-GC)