Applied GeoTech

GEOTECHNICAL INVESTIGATION

PROPOSED SUBDIVISION

4500 WEST 2200 SOUTH

OGDEN, UTAH

PREPARED FOR:

REP17, LLC
2205 SOUTH 400 EAST
CLEARFIELD, UTAH 84015

ATTN: CHAD BUCK

PROJECT NO. 1210818 **OCTOBER 20, 2021**

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EXECUTIVE SUMMARY

1. Approximately 1½ feet of topsoil overlying clay was encountered in Test Pits TP-1, TP-2 and TP-4 and sand in Test Pit TP-3. Interlayered clay and sand was encountered below the clay in Test Pits TP-1 and TP-2 at a depth of approximately 4½ feet and overlies sand at depths of approximately 7 and 6 feet, extending the full depth of the two test pits. The sand extended the full depth of Test Pit TP-3. Sand was encountered below the clay in Test Pit TP-4 at a depth of approximately 6 feet and extended the full depth of the test pit.

2. Subsurface water was encountered at depths of approximately 5.5, 5.4, 4.7 and 4.8 feet in Test Pits TP-1 through TP-4, respectively, on October 15, 2021. Fluctuations in the water level should be expected over time. An evaluation of such water level fluctuations is beyond the scope of this report.

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 and may be designed for a net allowable bearing pressure of 1,000 pounds per square foot. Footings bearing on at least 2 feet of compacted structural fill may be designed for a net allowable bearing pressure of 2,000 pounds per square foot.

4. The upper soil consists predominantly of clay. The clay can result in construction equipment access difficulties when it is very moist to wet such as in the winter and spring and at times of prolonged rainfall. Placement of 1 to 2 feet of gravel will provide limited support for construction equipment over a very moist to wet clay subgrade.

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 subdivision at 4500 West 2200 South in Ogden, 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 September 7, 2021.

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

At the time of our field study, the site was a cultivated field. There were no permanent structures or pavement on the property.

The ground surface at the site is relatively flat with a gentle slope down toward the west.

Vegetation consists of a recently cut hay crop.

The surrounding areas are fields. There is 2200 South Street on the south side of the property and a farm residence to the east.

FIELD STUDY

The field study was conducted on October 4, 2021. Four 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 with legend and notes on Figure 3.

The test pits were backfilled without significant compaction. The backfill should be removed and replaced with properly compacted fill where it will support proposed buildings, slabs, pavement and other settlement-sensitive improvements.

SUBSURFACE CONDITIONS

Approximately 1½ feet of topsoil overlying clay was encountered in Test Pits TP-1, TP-2 and TP-4 and sand in Test Pit TP-3. Interlayered clay and sand was encountered below the clay in Test Pits TP-1 and TP-2 at a depth of approximately 4½ feet and overlies sand at depths of approximately 7 and 6 feet, extending the full depth of the two test pits. The sand extended the full depth of Test Pit TP-3. Sand was encountered below the clay in Test Pit TP-4 at a depth of approximately 6 feet and extended the full depth of the test pit.

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

> Topsoil - The topsoil consists of sandy lean clay to clayey sand. It is moist, dark brown and contains organics.
>
> Sandy Lean Clay - The clay contains clayey sand zones. It is medium stiff to stiff, moist to wet and brown.

Laboratory tests performed on samples of the clay and clayey sand indicate it has natural moisture contents of 18 to 22 percent and natural dry densities of 101 to 110 pounds per cubic foot (pcf).

Results of a consolidation test performed on a sample of the clay indicate it will compress a small to moderate amount with the addition of light to moderate loads. Results of the consolidation test are presented on Figure 4.

Interlayered Lean Clay and Silty Sand - The interlayered soil is medium stiff, medium dense, very moist to wet and brown.

Silty Sand - The sand contains occasional clay layers. It is medium dense, moist to wet and brown to gray.

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 at depths of approximately 5.5, 5.4, 4.7 and 4.8 feet in Test Pits TP-1 through TP-4, respectively, on October 15, 2021. Fluctuations in the water level should be expected over time. An evaluation of such water level fluctuations is beyond the scope of this report.

PROPOSED CONSTRUCTION

We understand that the property is planned to be subdivided for single-family residential lots. We anticipate that buildings will be one to two-story, wood-frame structures with the potential for basements. We have assumed maximum column loads of 30 kips and maximum wall loads of 2½ kips per lineal foot.

Roads are planned to extend into the proposed subdivision. We have assumed traffic for roads consisting of 500 cars and 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 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

We anticipate there will be small amounts of cut and fill for the project. We have assumed the site will not be raised more than 3 feet above the existing ground surface. If the site will be raised more than this, the settlement from the fill load should be monitored to determine when building construction can begin.

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 near surface soil consists predominantly of clay, which can result in access difficulties when the clay is very moist to wet such as in the winter or spring, after periods of prolonged rainfall or irrigation and where excavation extends down to very moist to wet clay. Placement of 1 to 2 feet of granular fill may be needed to provide construction equipment access and to facilitate construction of the pavement when the subgrade consists of very moist to wet clay.

2. Excavation

We anticipate that excavation at the site can be accomplished with conventional excavation equipment. A flat cutting edge should be used when excavating for foundations to reduce disturbance of the bearing soil.

Excavations that extend below the water level should be dewatered prior to fill or concrete placement.

3. Materials

Listed below are materials recommended for imported structural fill.

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

The clay and sand are not recommended for use as structural fill below proposed building areas. They may be used as site grading fill and as utility trench backfill outside of proposed building areas if the topsoil, organics and other deleterious materials are removed or they may be used as fill in landscape areas.

Free-draining gravel should be used as fill below the original water level. A filter fabric should be placed between the natural soil and fill.

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 times of the year.

4. Compaction

Compaction of fill 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 D1557.

Fill To Support	Compaction
Foundations	≥ 95%
Concrete Flatwork	≥ 90%
Pavement	
Base Course	≥ 95%
Fill Placed Below Base Course	≥ 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.

Fill and pavement materials placed for the project should be frequently tested for compaction.

5. Drainage

The ground surface surrounding the proposed buildings should be sloped away from the buildings in all directions. Roof down spouts 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 compacted structural fill extending down to the undisturbed natural soil. A layer of free-draining gravel may be needed to facilitate construction of footings where excavations extend down near or below the water level. Structural fill placed below footings should extend out away from the footings at least a distance equal to the depth of fill beneath footings.

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

2. Bearing Pressure

Spread footings bearing on the undisturbed natural soil or on compacted structural fill may be designed using an allowable net bearing pressure of 1,000 psf. Footings bearing on at least 2 feet of compacted structural fill may be designed using an allowable net bearing pressure of 2,000 psf. Footings should have a width of at least 18 inches and a depth of embedment of at least 10 inches.

3. <u>Temporary Loading Conditions</u>

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

4. <u>Settlement</u>

We estimate that total and differential settlement will be less than 1 inch and ¾ inch, respectively, for footings bearing on the natural soil.

5. <u>Frost Depth</u>

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

6. <u>Foundation Base</u>

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

7. <u>Construction Observation</u>

A representative of AGEC should observe the base of footing excavations prior to structural fill or concrete placement.

C. Concrete Slab-on-Grade

1. <u>Slab Support</u>

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

Topsoil, unsuitable 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 for ease of construction and to promote even curing of the slab concrete.

D. Lateral Earth Pressures

1. Lateral Resistance for Footings

Lateral resistance for spread 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 for footings.

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
Clay and Silt	50 pcf	65 pcf	250 pcf
Sand and Gravel	40 pcf	55 pcf	300 pcf

3. Seismic Conditions

Under seismic conditions, the equivalent fluid weight should be increased by 35 pcf for the active condition and 20 pcf for the at-rest condition and decreased by 35 pcf for the passive condition. This assumes a soil-adjusted, peak ground acceleration of 0.59g for a 2 percent probability of exceedance in a 50-year period (ICC, 2017).

4. Safety Factors

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

E. Seismicity, Liquefaction and Faulting

1. Seismicity

Listed below is a summary of the site parameters that may be used with the 2018 International Building Code:

Description	Value[1]
Site Class	Default D[2]
S_s - MCE_R ground motion (period = 0.2s)	1.12g
S_1 - MCE_R ground motion (period = 1.0s)	0.40g
F_a - Site amplification factor at 0.2s	1.2
PGA - MCE_G peak ground acceleration	0.49g
PGA_M - Site modified peak ground acceleration	0.59g

[1]*Values obtained from information provided by the Applied Technology Council at https://hazards.atcouncil.org*

[2]*Site Class Default D was selected based on the lack of subsurface information. Site Class F may apply to this site if liquefaction is found to be a significant hazard.*

2. Liquefaction

The site is located in an area mapped as having “high" liquefaction potential (Anderson and others, 1994). Based on the subsurface conditions encountered to the depth investigated there may be a potential for liquefaction-induced settlement to occur during the 2018 IBC seismic event. Deeper subsurface investigation using drilling or cone penetration testing would be needed to evaluate the liquefaction potential at the site.

3. Faulting

There are no mapped active faults extending through the property. The closest surface trace of a mapped active fault is that of the Wasatch Fault located approximately 8 miles to the east of the site (Utah Geological Survey, 2021).

F. Subsurface Drains

If the lowest floor level of a residence extends below the natural ground surface, the subgrade floor portion of the residence should be protected with a perimeter drain system. The perimeter drain system should consist of at least the following items:

1. The underdrain system should consist of a perforated pipe installed in a free-draining gravel filled trench around the perimeter of the below grade floor portion of the building.

2. The flow line of the pipe should be placed at least 18 inches below the finished floor level and should slope to a sump or outlet where water can be removed by pumping or by gravity flow.

3. If placing the gravel and drain pipe requires excavation below the bearing level of the footing, the excavation for the drain pipe and gravel should have a slope no steeper than 1 horizontal to 1 vertical away from the edge of the footing to avoid disturbing the soil below the footing.

4. A filter fabric should be placed between the natural soil and the drain gravel. This will help reduce the potential for fine-grained material filling in the void spaces of the gravel.

5. The subgrade floor slab should have at least 6 inches of free-draining gravel placed below it and the underslab gravel should connect to the perimeter drain.

6. Consideration should be given to installing cleanouts to allow access into the perimeter drain, should cleaning of the pipe be required in the future.

G. Water Soluble Sulfates

One sample of the natural soil was tested for water soluble sulfate content. Results of the test indicate there was less than 0.1 percent water soluble sulfate in the sample tested. Based on the results of the test and published literature, 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.

H. Pavement

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

1. Subgrade Support
Most of the near surface soil consists of lean clay. A California Bearing Ratio of 3 percent was used in the analysis which assumes a clay subgrade.

2. Pavement Thickness
Based on the subsoil conditions, assumed traffic, a design life of 20 years for flexible pavement and 30 years for rigid pavement and methods presented by AASHTO, a flexible pavement section consisting of 3 inches of asphaltic concrete overlying 8 inches of high-quality base course is calculated.

Alternatively, a rigid pavement section consisting of 5 inches of Portland cement concrete placed on a prepared subgrade may be used.

Granular borrow may be needed to construct the pavement when the subgrade consists of very moist to wet clay as discussed in the Subgrade Preparation section of the report. The base course thickness may be reduced to 6 inches where at least 6 inches of granular borrow is placed.

3. Pavement Materials and Construction

a. Flexible Pavement (Asphaltic Concrete)

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

b. Rigid Pavement (Portland Cement Concrete)

The pavement thickness indicated 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 5,000 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.

I. Preconstruction Meeting

A preconstruction meeting should be held with representatives of the owner, project architect, geotechnical engineer, general contractor, earthwork contractor and other members of the design team to review construction plans, specifications, methods and schedule.

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 in the report, we should be notified to reevaluate our recommendations.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

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

Reviewed by Jay R. McQuivey, P.E.

DRH/rs

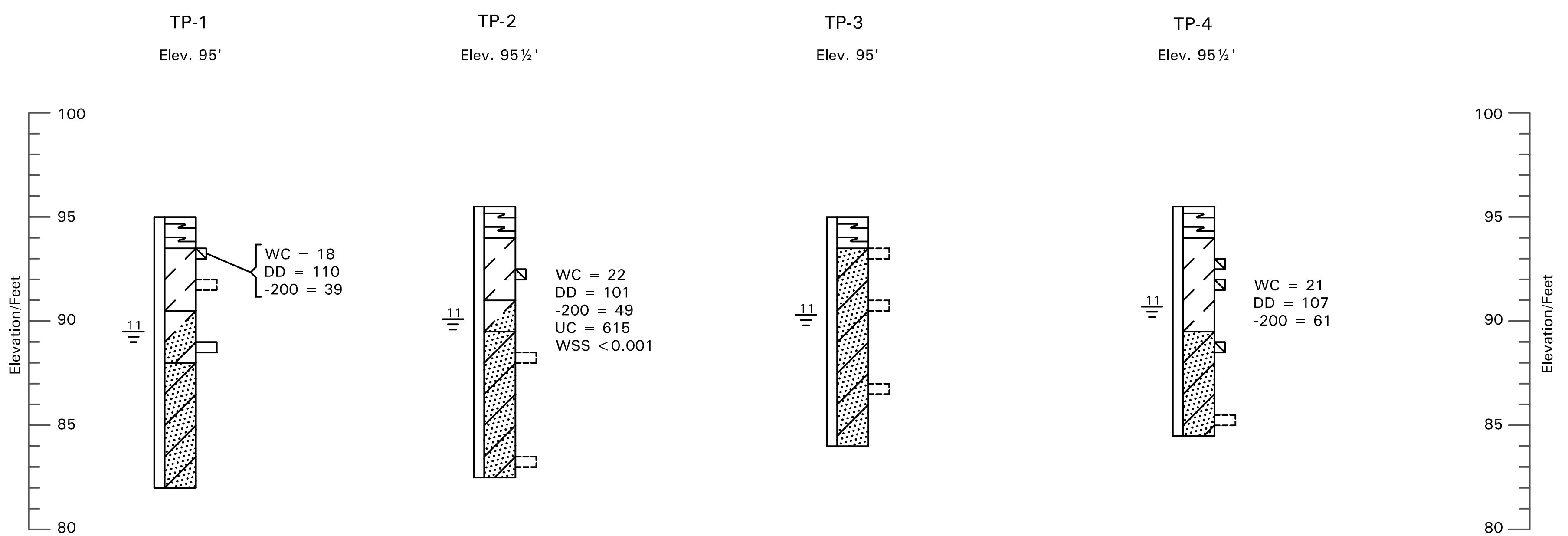
REFERENCES

Anderson, L.R., Keaton, J.R., and Bay, J., 1994; Liquefaction Potential Map for Weber County, Utah; Utah Geological Survey Contract Report 94-1.

International Code Council, 2017; 2018 International Building Code, Falls Church, Virginia.

Utah Geological Survey, 2021; Utah Quaternary Fault and Fold Database, https://geology.utah.gov/apps/qfaults/index.html accessed October 19, 2021.

1210818	AGEC	Test Pit Locations	Figure 1



Approximate Vertical Scale 1" = 8'

See Figure 3 for Legend and Notes

1210818	AGEC	Test Pit Logs	Figure 2

LEGEND:

Topsoil; sandy lean clay to clayey sand, moist, dark brown, organics.

Sandy Lean Clay (CL); clayey sand zones, medium stiff to stiff, moist to wet, brown.

Interlayered Lean Clay and Silty Sand (CL/SM); medium stiff, medium dense, very moist to wet, brown.

Silty Sand (SM); occasional clay layers, medium dense, moist to wet, brown to gray.

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.

11 — Indicates the depth to free water and the number of days after drilling the measurement was taken.

NOTES :

1. The test pit were excavated on October 4, 2021 with a rubber-tired backhoe.
2. The locations of the test pits were measured by pacing from features shown on Figure 1.
3. The elevations of the test pits were measured by automatic level and refer to the benchmark 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 materials shown on the test pit log represent the approximate boundaries between materials and the transitions may be gradual.
6. The water level readings shown on the logs were made at the time and under the conditions indicated. Fluctuations in the water level will occur with time.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   -200 = Percent Passing the No. 200 Sieve;
   UC = Unconfined Compressive Strength (psf);
   WSS = Water Soluble Sulfates (%).

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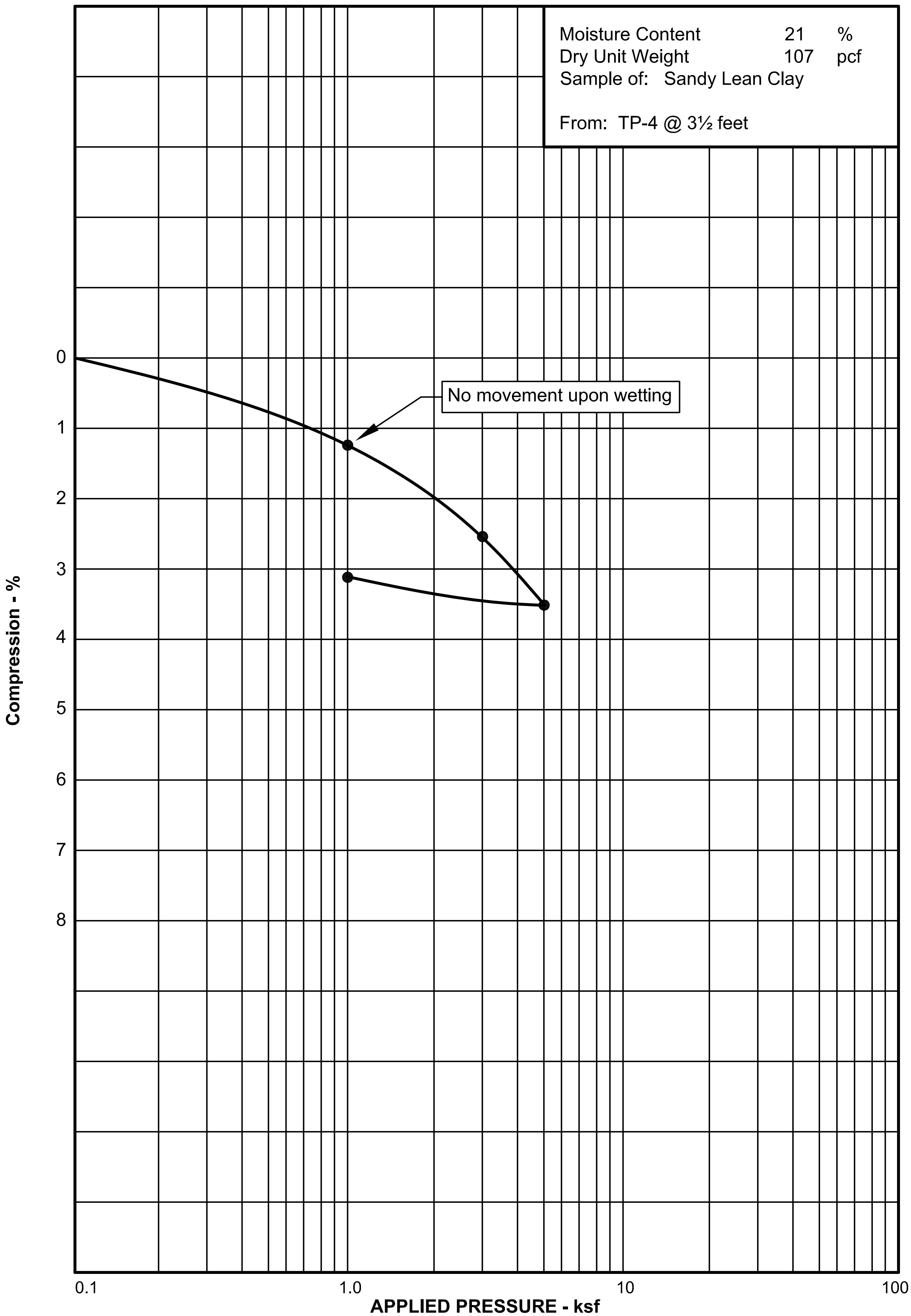

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TABLE I
SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER: 1210818

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	18	110			39					Clayey Sand
TP-2	3	22	101			49			615	<0.001	Clayey Sand
TP-4	3½	21	107			61					Sandy Lean Clay