AGEC

Applied GeoTech

GEOTECHNICAL INVESTIGATION

PROPOSED 15,OOO-GALLON WATER TANK
CAMP ATOKA

10700 EAST SOUTH FORK CANYON

HUNTSVILLE, UTAH

PREPARED FOR:

THE CHURCH OF JESUS CHRIST OF LATTER-DAY SAINTS
C/O MONTGOMERY WATSON HARZA
2890 EAST COTTONWOOD PARKWAY, SUITE 300
SALT LAKE CITY, UTAH 84121

ATTENTION: TONI MEHRABAN

PROJECT NO. 1130110 **JULY 19, 2013**

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EXECUTIVE SUMMARY

1. The subsurface soils encountered at the site consist of approximately 1 ½ feet of topsoil overlying clayey gravel that extends to a depth of approximately 10 feet below the ground surface. Fat clay was encountered below the gravel and extends to the maximum depth investigated, approximately 14 feet.

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

3. The natural hillside at the site appears to have a stable geologic history. In our professional opinion, the site is suitable for the proposed construction.

4. Backfill of the proposed tank should meet the tank manufacturer's specifications. The on-site soil may be considered for use as retaining wall backfill if topsoil, organics, and other deleterious materials are removed.

5. Temporary, unretained cut slopes up to approximately 10 feet in height may be constructed at 1 horizontal to 1 vertical or flatter. Permanent cut slopes are not recommended unless properly retained. Permanent, unretained fill slopes up to approximately 15 feet in height may be constructed at 2 horizontal to 1 vertical or flatter assuming that they are constructed using granular fill consisting of angular gravel having less than 15 percent passing the No. 200 sieve and a maximum particle size of 4 inches. Fill slopes should be constructed by placing fill in horizontal lifts and benching the material into the natural slope with a bench for at least every 2 feet in vertical rise.

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

SCOPE

This report presents the results of a geotechnical investigation for the proposed 15,000-gallon water tank to be constructed at Camp Atoka located at 10700 East South Fork Canyon (SR-39) in Huntsville, Utah. The report presents the subsurface conditions encountered, laboratory test results and recommendations for the proposed water tank. The study was conducted in general accordance with our proposal dated February 22, 2013. The study was conducted in accordance with our master services agreement and an authorization from Brent Bigelow dated March 11, 2013.

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 the conditions at the site for our engineering analysis. Results of the field exploration and laboratory tests were analyzed to develop recommendations for the proposed water tank.

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

The area of the proposed water tank is located on a hillside southeast of the camp improvements. The natural slope is on the order of 3 horizontal to 1 vertical.

The slope is vegetated with brush and relatively small trees.

The girls camp improvements are situated near the base of the slope to the northwest of the tank location. The camp is located along the south fork of the Ogden River.

FIELD STUDY

The field study was conducted on March 28, 2013. A test pit was excavated at the approximate location indicated on Figure 1 using a trackhoe. The test pit was logged and soil samples obtained by an engineer from AGEC. A log of the subsurface conditions encountered in the test pit is shown on Figure 2.

The test pit was backfilled without significant compaction. The backfill in the test pit should be properly compacted where it would support the tank or other improvements.

SUBSURFACE CONDITIONS

The subsurface soils encountered at the site consist of approximately 1½ feet of topsoil overlying clayey gravel that extends to a depth of approximately 10 feet below the ground surface. Fat clay was encountered below the gravel and extends to the maximum depth investigated, approximately 14 feet.

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

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

Clayey Gravel with Sand - The gravel is dense, slightly moist to moist and brown. The gravel contains cobbles and boulders up to approximately 4 feet in size.

Fat Clay - The clay contains small to moderate amounts of gravel with cobbles up to approximately 10 inches in size. The clay is very stiff, moist and brown.

Laboratory tests conducted on samples of the clay indicate a natural moisture content of 19 percent and a natural dry density of 99 pounds per cubic foot (pcf).

A consolidation test conducted on a sample of the clay indicates that the soil will compress a small amount with the addition of light to moderate loads. The sample tested expanded a small amount when wetted under a constant pressure of 1,000 psf. Results of the consolidation test are presented on Figure 3.

Results of the laboratory tests are presented on Table I and are included on the log of the test pit.

SUBSURFACE WATER

No subsurface water was encountered in the test pit at the time of excavation to the maximum depth investigated, approximately 14 feet.

PROPOSED CONSTRUCTION

We understand that a 15,000-gallon, FRP water tank and associated piping are to be installed at the site. We anticipate that the tank will be installed to depths on the order of 10 to 15 feet below the ground surface. We understand that the tank will be approximately 30 feet long and 8 to 10 feet in diameter.

We anticipate that the tank will be buried in the hillside with a level area created above the tank. We anticipate that approximately 3 to 4 feet of soil cover will be provided above the tank.

We understand that a 3-inch diameter, HDPE pipe will extend down the slope from the tank to the camp facilities. We anticipate that pipe will have approximately 4 feet of soil cover.

If the proposed construction 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 that there will be cut and/or fill to provide a level area above the tank.

1. Excavation

   We anticipate that excavation for the tank and water line can be accomplished with typical excavation equipment.

2. Cut and Fill Slopes

   Temporary, unretained cut slopes up to approximately 10 feet in height may be constructed at 1 horizontal to 1 vertical or flatter.

   Permanent cut slopes are not recommended unless properly retained.

Permanent, unretained fill slopes up to approximately 15 feet in height may be constructed at 2 horizontal to 1 vertical or flatter assuming that they are constructed using granular fill consisting of angular gravel having less than 15 percent passing the No. 200 sieve and a maximum particle size of 4 inches. Fill slopes should be constructed by placing fill in horizontal lifts and benching the material into the natural slope with a bench for at least every 2 feet in vertical rise.

Grading should be planned to direct surface runoff away from the fill slopes. Fill slopes should be protected from erosion by revegetation or other methods.

AGEC should provide a review of the grading plan and slope retention when the plans are available.

3. Shoring

Care should be taken to maintain stability of excavations during construction. Proper side slopes or shoring should be provided for safety of workers. Shoring and trench boxes should be designed to restrain the soil mass along with the surcharge from construction equipment, fill piles and other loads.

4. Subgrade Preparation

Topsoil, organics, unsuitable fill and other deleterious materials should be removed from the proposed tank area and from the areas of proposed retaining structures.

5. 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 D 1557.

Fill To Support	Compaction
Foundations	≥ 95%
Fill Slopes	≥ 90%
Retaining Wall Backfill	85 - 90%

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

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

6. Materials

Materials placed as structural fill, such as fill placed below the tank or below retaining wall foundations, should consist of nonexpansive granular soil with less than 35 percent passing the No. 200 sieve and a maximum size of 4 inches. The natural gravel, exclusive of over-sized materials, may be used as structural fill if it meets the criteria given above.

Tank backfill should meet the recommendations of the tank manufacturer.

Fill slopes should be constructed using angular gravel with no more than 15 percent passing the No. 200 sieve and a maximum particle size of 4 inches.

The on-site soil may be considered for use as retaining wall backfill if topsoil, organics, debris, over-sized particles and other deleterious materials are removed.

The moisture of the soil used as backfill should be adjusted to within 2 percent of optimum to facilitate compaction. This may require wetting or

drying of the soil. Drying of the soil may not be practical during cold or wet times of the year.

7. Drainage

The ground surface of the tank site should have a gentle slope to provide appropriate drainage away from the area of the tank and associated retaining structures.

B. Foundations

1. Bearing Material

With the proposed construction and the subsurface conditions encountered, proposed foundations such as retaining walls may be supported on at least 2 feet of undisturbed natural gravel or at least 2 feet of compacted structural fill extending down to the undisturbed natural gravel or clay.

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

2. Bearing Pressure

Spread footings bearing on the undisturbed natural gravel or on compacted structural fill may be designed using an allowable net bearing pressure of 3,500 pounds per square foot.

3. Temporary Loading Conditions

The allowable bearing pressure may be increased by ½ for temporary loading conditions such as wind and seismic loads.

4. Settlement

We estimate that total and differential settlement will be less than ½ inch for foundations designed as outlined above.

5. Lateral Resistance

Lateral resistance for spread footings placed on the natural sand or gravel, or on 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.

6. Frost Depth

Footings should extend at least 30 inches below grade for frost protection.

7. Foundation Base

The base of foundation excavations should be cleared of loose or deleterious material or the loose material should be compacted.

8. Construction Observation

A representative of the geotechnical engineer should observe footing excavations prior to structural fill and concrete placement.

C. Lateral Earth Pressures

1. 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.

Slope	Backfill Type	Active	At-rest	Passive
Horizontal	Sand and Gravel	40 pcf	55 pcf	300 pcf
	Clay and Silt	50 pcf	65 pcf	250 pcf
2H:1V	Sand and Gravel	65 pcf	115 pcf	—
	Clay and Silt	100 pcf	145 pcf	—

2. Seismic Conditions

Under seismic conditions the equivalent fluid weight should be increased by 22 pcf and 7 pcf for active and at-rest conditions, respectively, and decreased by 22 pcf for the passive condition. This assumes a peak horizontal ground acceleration of 0.35g which represents a 2 percent probability of exceedance in a 50-year period (IBC 2012).

3. Safety Factors

The values recommended above 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.

D. Seismicity, Faulting and Liquefaction

1. Seismicity

Listed below is a summary of the site parameters for the 2012 International Building Code:

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	0.74g
c.	One Second Period Spectral Response Acceleration, S_1	0.25g

2. Faulting

The closest mapped fault considered to be active is the Wasatch Fault located approximately 13 miles to the east of the site (Black and others, 2003).

3. Liquefaction

Based on our understanding of the geologic conditions at the site, liquefaction is not a hazard for the proposed tank.

E. Tank and Pipe Support

The soils encountered at the site are suitable for support of the proposed tank and water pipe.

1. Settlement

The soils at the tank and pipe bearing level will experience little, if any, increase in stress due to the proposed construction. Thus, settlement of the proposed tank and water line will be a function of disturbance of the soil beneath the tank and pipe. Disturbance may result from excavation or construction activities. Care should be taken to minimize disturbance of the soil below the tank and pipe so that settlement can be maintained within tolerable limits.

2. Tank and Pipe Bedding

Bedding materials should be placed on the undisturbed natural soil. If bearing materials are disturbed, they should be removed and replaced with compacted bedding material. The tank and pipe bedding should meet the criteria given by the tank and pipe manufacturers.

F. Water Soluble Sulfates

One sample of the natural soil was tested in the laboratory for water soluble sulfate content. The test results 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. The concentration of water soluble sulfates present in the soil at the site indicate that sulfate resistant cement is not needed for concrete placed in contact with the soil. Other conditions may dictate the type of cement to be used in concrete for the project.

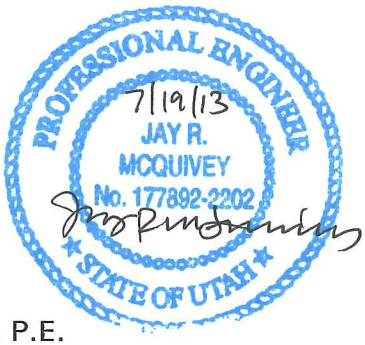
G. Subsurface Drains

Consideration should be given to providing a subsurface drain around the perimeter of the tank to remove water that may collect around the tank. The drain should discharge to a suitable location beyond the base of the slope.

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 pit excavated at the approximate location indicated on Figure 1 and data obtained from laboratory testing. Variations in the subsurface conditions may not become evident until additional exploration or excavation is conducted. If the subsurface soil or groundwater conditions are found to be different from those described in this report, we should be notified to reevaluate the recommendations given.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.



Jay R. McQuivey, P.E.

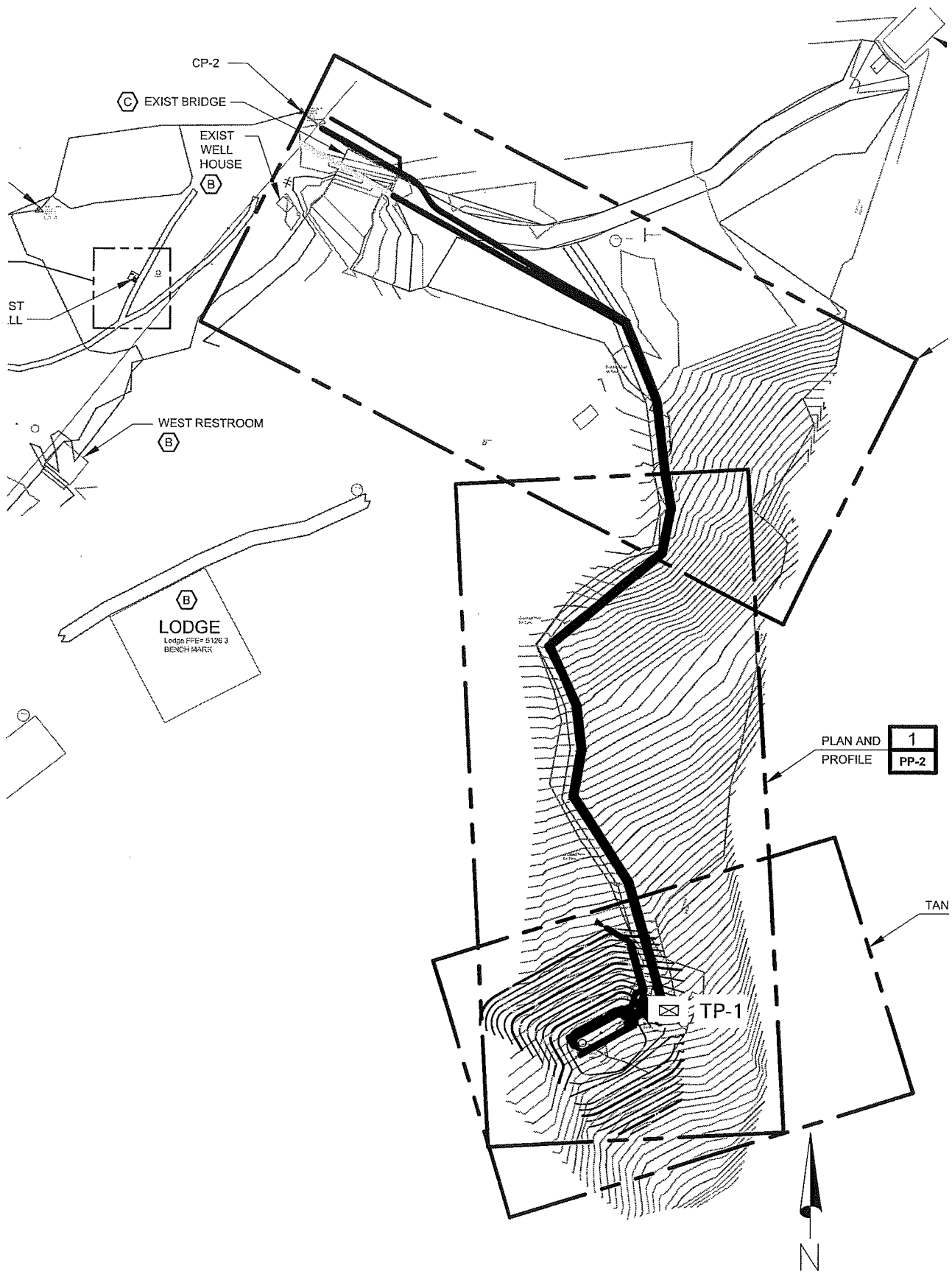
Reviewed by Douglas R. Hawkes, P.E., P.G.

JRM/dc

REFERENCES

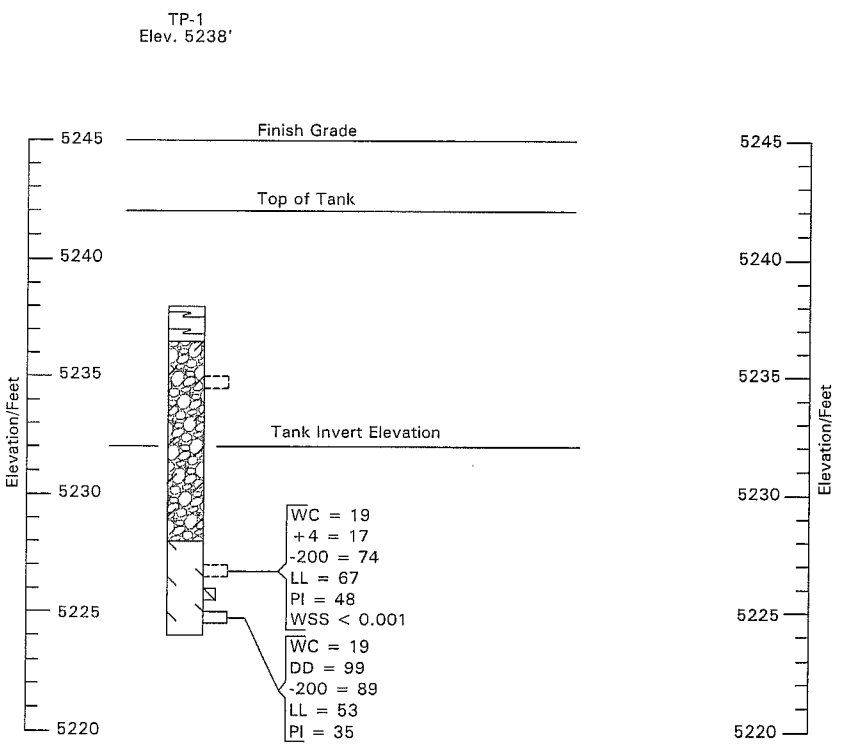
Black, B.D., Hecker, S., Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003; Quaternary fault and fold database and map of Utah; Utah Geological Survey Map 193DM.

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



PROPOSED WATER TANK
10700 EAST SOUTH FORK CANYON (SR-39)
HUNTSVILLE, UTAH

1130110	AGEC Applied GeoTech	Location of Test Pit	Figure 1



Approximate Vertical Scale 1" = 8'

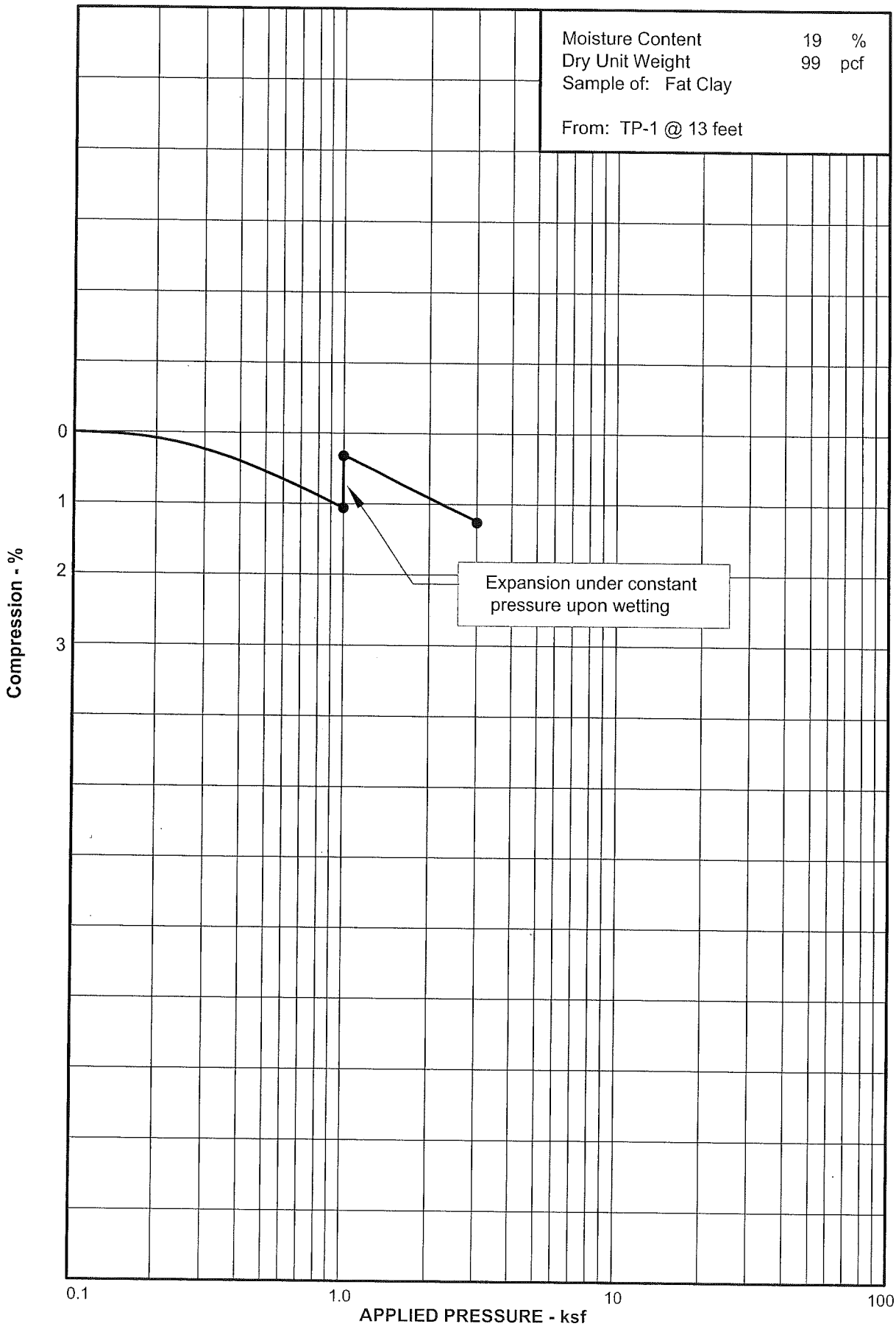
LEGEND:

- Topsoil; sandy lean clay, moist, dark brown, roots and organics.
- Clayey Gravel with Sand (GC); dense, slightly moist to moist, brown, cobbles and boulders up to 4 feet in size.
- Fat Clay (CH); small to moderate amount of gravel, cobbles up to approximately 10 inches in size, very stiff, moist, brown.
- Indicates relatively undisturbed hand drive sample taken.
- Indicates disturbed sample taken.
- Indicates relatively undisturbed block sample taken.

NOTES:

1. The test pit was excavated on March 28, 2013 with a tracked excavator.
2. The location of the test pit was measured by pacing from features shown on the site plan provided.
3. The elevation of the test pit was determined from the contours shown on Figure 1.
4. The test pit location and elevation should be considered accurate only to the degree implied by the method used.
5. The lines between the materials shown on the test pit log represent the approximate boundaries between material types and the transitions may be gradual.
6. No free water was encountered in the test pit at the time of excavation.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   +4 = Percent Retained on No. 4 Sieve;
   -200 = Percent Passing No. 200 Sieve;
   LL = Liquid Limit (%);
   PI = Plasticity Index (%);
   WSS = Water Soluble Sulfates (%).

Applied Geotechnical Engineering Consultants, Inc.



Project No. 1130110

CONSOLIDATION TEST RESULTS

Figure 3

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I

SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER 1130110

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	11	19		17	9	74	67	48		<0.001	Fat Clay with Gravel
	13	19	99			89	53	35			Fat Clay