AGEC
Applied GeoTech

#1
Due 6/15

GEOTECHNICAL INVESTIGATION

PROPOSED COPPER VIEW ANIMAL HOSPITAL

13199 SOUTH 3600 WEST

RIVERTON, UTAH

PREPARED FOR:

ROGER KNIGHT CONSTRUCTION
2590 SOUTH 2660 WEST
WEST VALLEY CITY, UTAH 84119

ATTENTION: DAVE FRAMPTON

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PROJECT NO. 1180277 **APRIL 20, 2018**

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EXECUTIVE SUMMARY

1. Moisture-sensitive (collapsible) soil was encountered in the test pits excavated at the site. Samples of the clay and silt tested collapsed up to approximately 3.2 percent under a constant pressure of 1,000 pounds per square foot and became more compressible when wetted. The collapsible soil extends to depths of approximately 8½, 7 and 16 feet below the ground surface in Test Pits TP-1, TP-2 and TP-3, respectively.

   Leaving the moisture-sensitive soil in-place below the proposed improvements could result in significant settlement (approximately 2½ to 6 inches) depending on the thickness of collapsible soil below the building when the soil below the building becomes wetted. **It is our professional opinion that the moisture-sensitive soil should be removed from below the proposed building area.** There is a risk of a similar amount of differential settlement for pavement and exterior concrete flatwork where they are constructed above moisture-sensitive soil when the soil becomes wetted. If the owner understands the risk for potential differential movement due to the moisture sensitive soil, partial or full removal of the moisture-sensitive soil may be considered to reduce the amount of differential settlement. Removal and replacement of increased thicknesses of moisture-sensitive soil will further reduce the amount of potential differential settlement. Additional information with respect to construction in areas of moisture-sensitive soil is presented in the report.

2. Up to approximately 3 feet of fill was encountered in the upper portion of the test pits excavated at the site. Natural lean clay was encountered below the fill and extends to depths ranging from approximately 7 to 9 feet below the ground surface. Layers of clay, sand and gravel were encountered below the clay extending the full depth investigated in Test Pits TP-1 and TP-2. Silt was encountered below the clay in Test Pit TP-3 and extends to a depth of approximately 16 feet where gravel was encountered.

3. No subsurface water was encountered in the test pits at the time of excavation to the maximum depth investigated, approximately 17 feet.

4. Once the moisture-sensitive soil has been removed from below the proposed building, the areas may be filled with the excavated soil by moisture conditioning the soil, placing it in thin enough lifts to allow for proper compaction and compacting the soil to at least 95 percent of the maximum dry density as determined by ASTM D 1557. This may not be practical during cold or wet times of the year. Granular structural fill may be needed

Executive Summary (continued)

during such weather conditions. After removal of the moisture-sensitive soil, the proposed building may be supported on spread footings bearing on at least 2 and 3 feet of compacted structural fill may be designed using allowable net bearing pressures of 2,500 and 3,500 pounds per square foot, respectively.

As an alternative to removing and replacing the moisture-sensitive soil, consideration may be given to supporting the building on deep foundations such as helical piers, micropiles or other systems that extend the foundation support down below the moisture-sensitive soil. If a deep foundation system is used to support the building, a structural floor should be constructed.

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

SCOPE

This report presents the results of a geotechnical investigation for the proposed Copper View Animal Hospital to be located at 13199 South 3600 West in Riverton. Utah. The report presents the subsurface conditions encountered, laboratory test results, and recommendations for foundations and pavements. The study was conducted in general accordance with our proposal dated March 30, 2018.

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 investigations was used to define conditions at the site for our engineering analysis and to develop recommendations for the proposed foundations.

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 site consists of an undeveloped parcel of land. There are no permanent structures or pavements at the site.

The ground surface at the site is relatively flat with a gentle slope down to the east. Vegetation at the site consists primarily of weeds.

There is an office/warehouse, slab-on-grade building to the south of the site. The building is surrounded by asphalt pavement. The east side of the site is bounded by 3600 West Street, which is an asphalt-paved road in good condition. The north and west sides of the site are bounded by 13175 South Street.

FIELD STUDY

Three test pits (TP-1 through TP-3) were excavated at the approximate locations indicated on Figure 1 on April 5, 2018. The test pits were excavated using a rubber-tired backhoe. The test pits were logged and soil samples obtained by a representative from AGEC. Logs of the subsurface conditions are graphically shown on Figure 2 with legend and notes on Figure 3.

The test pits were backfilled with the excavated material without significant compaction. The backfill in the test pits should be removed and properly compacted where it will support the proposed building, floor slabs, pavements or other settlement-sensitive site improvements.

SUBSURFACE CONDITIONS

Up to approximately 3 feet of fill was encountered in the upper portion of the test pits excavated at the site. Natural lean clay was encountered below the fill and extends to depths ranging from approximately 7 to 9 feet below the ground surface. Layers of clay, sand and gravel were encountered below the clay extending the full depth investigated in Test Pits TP-1 and TP-2. Silt was encountered below the clay in Test Pit TP-3 and extends to a depth of approximately 16 feet where gravel was encountered.

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

Fill - The fill consists of clayey sand and gravel. It is moist, brown.

Lean Clay - The clay contains small amounts of sand. The upper portion of the clay has a porous to slightly porous structure. It is stiff, slightly moist to moist and brown to light brown.

Laboratory tests conducted on samples of the clay indicate that it has natural moisture contents of 13 to 20 percent and natural dry densities ranging from 78 to 93 pounds per cubic foot (pcf).

Consolidation tests conducted on samples of clay indicate that the soil tested collapsed up to approximately 3.2 percent under a constant pressure of 1,000 psf, and became more compressible when wetted. Results of the consolidation tests are presented on Figures 3 through 5.

Silt - The silt contains small to moderate amounts of sand and some thin layers of clay. It is medium stiff to stiff, slightly moist to moist and light brown.

Laboratory tests conducted on a sample of the silt indicate that it has a natural moisture content of 16 percent and a natural dry density of 85 pcf.

A consolidation test conducted on a sample of silt with sand obtained from Test Pit TP-3 at a depth of approximately 11 feet indicates that the soil tested collapsed approximately 2.4 percent under a constant pressure of 1,000 psf and became more compressible when wetted. Results of the consolidation test are presented on Figure 6.

Silty Sand - The silty sand contains some clayey sand. The sand is medium dense, slightly moist to moist and brown.

Poorly-graded Gravel with Silt and Sand - The gravel contains small to moderate amounts of silt and sand. The gravel is dense, slightly moist and brown.

Results of the laboratory tests are summarized on Table I and are included on the logs of the exploratory test pits, Figure 2.

SUBSURFACE WATER

No subsurface water was encountered in the test pits at the time of excavation to the maximum depth investigated, approximately 17 feet.

PROPOSED CONSTRUCTION

We understand that the proposed building is planned to be a single story, slab-on-grade structure. We have assumed building loads will consist of wall loads up to 3 kips per linear foot and columns loads up to 30 kips.

Paved parking is planned to extend along the north, west and south sides of the building. An access road is planned adjacent the east side of the building. We have assumed traffic conditions for pavements to consist of relatively light passenger vehicles, occasional delivery trucks and 2 garbage trucks per week. The traffic conditions are for one-way traffic with an average gross weight of 20 kips for trucks.

Final site grading plans were not provided at the time of our investigation. We anticipate that minimal site grading (less than 3 feet) will be required for the site.

If the proposed construction, building loads or anticipated 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 subsoil conditions encountered, laboratory test results, and the proposed construction, the following recommendations are given:

A. Moisture-Sensitive Soil

Moisture-sensitive (collapsible) soil was encountered in the test pits excavated at the site. Samples of the clay and silt tested collapsed up to approximately 3.2 percent under a constant pressure of 1,000 pounds per square foot and became more compressible when wetted. The collapsible soil extends to depths of up to approximately 8½, 7 and 16 feet below the ground surface in Test Pits TP-1, TP-2 and TP-3, respectively.

Leaving the moisture-sensitive soil in-place below the proposed improvements could result in significant settlement (approximately 2½ to 6 inches) depending on the thickness of collapsible soil below the building) when the soil below the building becomes wetted. **It is our professional opinion that the moisture-sensitive soil should be removed from below the proposed building area.** There is a risk of a similar amount of differential settlement for pavement and exterior concrete flatwork where they are constructed above moisture-sensitive soil when the soil becomes wetted. If the owner understands the risk for potential differential movement due to the moisture sensitive soil, partial or full removal of the moisture-sensitive soil may be considered to reduce the amount of differential settlement. Removal and replacement of increased thicknesses of moisture-sensitive soil will further reduce the amount of potential differential settlement.

The following table summarizes the estimated potential settlement for the conditions indicated.

Thickness of Collapsible Soil Left In-place	Estimated Potential Settlement
16 feet	6″
8 feet	3″
2 feet	¾″

B. Site Grading

Site grading fill should be placed well in advance of building construction. If the site will be raised more than 3 feet, we should be notified so that we can reevaluate our recommendations.

1. Excavation

   Excavation at the site can be accomplished with typical excavation equipment.

2. Pavement Subgrade Preparation

   After removal of the owner-selected amount of moisture-sensitive soil, the subgrade in proposed pavement areas should be scarified to a depth of approximately 8 inches, the moisture adjusted to within 2 percent of the optimum moisture content and the subgrade compacted to at least 90 percent of the maximum dry density as determined by ASTM D 1557. The subgrade should then be proof-rolled to identify soft areas. Soft areas should be removed and replaced with properly compacted fill.

   Construction equipment access difficulties can be expected for rubber-tired construction equipment when the subgrade is very moist to wet, such as in the winter or spring. Placement of 1½ to 2 feet of granular fill will provide equipment access for rubber construction equipment above a very moist to wet clay subgrade.

3. Materials

Materials used as fill for the project are anticipated to consist of imported fill and the on-site soil. Recommendations for these materials are shown below.

a. Imported Fill

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

b. On-Site Soil

Ideally, fill placed below building areas would consist of granular soil as indicated above. However, if removal and replacement of the moisture-sensitive soil is selected to mitigate the moisture-sensitive soil concern, the natural clay and silt may be considered for reuse as structural fill below the proposed building. The moisture of the soil to be used as fill should be adjusted to within 2 percent of the optimum moisture content and the fill compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557. If the fine-grained soil is used as fill for the project, full-time observation and testing should be provided by representatives of AGEC. Use of the on-site, fine-grained soil as structural fill may not be practical during cold or wet times of the year.

If the on-site, fine-grained soil is used as fill below the structures, the fill should be placed and compacted as indicated above and at least 2 feet of properly compacted granular structural fill should be placed below the proposed footings.

The on-site soil may also be used as site grading fill below areas of proposed pavement or other site improvements or as utility trench or foundation wall backfill.

d. Moisture Conditioning

Where fine-grained soil such as the on-site clay and silt is used as fill, the moisture content of the soil should be adjusted to within 2 percent of the optimum moisture content to facilitate compaction. This will likely require significant moisture conditioning (wetting or drying) depending on whether the moisture of the soil is above or below the optimum moisture content at the time of construction. Drying of the soil may not be practical during cold or wet times 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 and Pavement	≥ 90%
Landscaping	≥ 85%
Retaining Wall Backfill	85 - 90%

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 placed for the project should be frequently tested for compaction. Fill should be placed in lifts thin enough to allow for adequate compaction. Full-time testing and observation should be provided if the on-site soil is used as structural fill for the project.

5. Drainage

The ground surface surrounding the proposed building should be sloped away from the building in all directions with a slope of at least 6 inches in 10 feet for a distance of at least 10 feet away from the structure. Roof down spouts should discharge beyond the limits of backfill. The upper 2 feet of foundation wall backfill should consist of compacted low-permeable soil.

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.

C. Foundations

1. Bearing Material

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

Moisture-sensitive soil, topsoil, organics, unsuitable fill, debris and other deleterious materials should be removed from below proposed footing areas.

2. <u>Bearing Pressure</u>

   Footings bearing on at least 2 and 3 feet of compacted granular structural fill extending down to undisturbed natural soil or properly compacted fill may be designed using allowable net bearing pressures of 2,500 and 3,500 pounds per square foot, respectively.

   Footings should have a minimum width of 1½ feet and a minimum depth of embedment of 1 foot.

3. <u>Settlement</u>

   We estimate that total settlement will be on the order of 1 inch or less for foundations designed and constructed as described above. Differential settlement is estimated to be on the order of ¾ inch..

4. <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.

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 and Testing</u>

   A representative of the geotechnical engineer should observe subgrade area prior to placement of site grading fill and observe foundation excavations prior to placement of structural fill or concrete. This is particularly important where moisture-sensitive soils were encountered throughout the site.

D. 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 once the moisture-sensitive soil has been removed from below proposed building areas.

   Moisture-sensitive soil, topsoil, organics, materials, unsuitable fill 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 the concrete slabs for ease of construction and to promote even curing of the slab concrete.

3. Vapor Barrier

   A vapor barrier should be placed under the concrete floor if the floor will receive an impermeable floor covering. The barrier will reduce the amount of water vapor passing from below the slab to the floor covering.

E. Lateral Earth Pressures

1. Lateral Resistance for Footings

   Lateral resistance for spread footings placed on compacted structural fill is controlled by sliding resistance between the footing and the foundation soil. A friction value of 0.45 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 top and bottom of 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 30 pcf for active and 15 pcf for at-rest conditions and decreased by 30 pcf for the passive condition. This assumes a peak ground acceleration of 0.50g, which represents a 2 percent probability of exceedance in a 50-year period (IBC, 2015).

4. 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.

F. Seismicity Faulting and Liquefaction

1. Seismicity

Listed below is a summary of the site parameters for the International Building Code, 2015.

a.	Site Class	D
b.	Short Period Spectral Response Acceleration, S_S	1.22g
c.	One Second Period Spectral Response Acceleration, S_1	0.41g

2. Faulting

There are no mapped active faults extending near or through the project site. The closest mapped fault considered to be active is the Wasatch fault located 7.2 miles east of the site (UGS, 2018).

3. Liquefaction

The site is located in an area mapped as having a "very low" potential for liquefaction (Salt Lake County, 2002).

Based on the subsurface conditions encountered to the depth investigated and our understanding of geologic conditions in the area, it is our professional opinion that liquefaction is not a hazard at the site.

G. 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. Sulfate resistant cement is not needed for concrete placed on 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 indicated in the Proposed Construction section of the report, the following pavement recommendations are given:

1. Subgrade Support

The near surface soil consists primarily of 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 8 inches of high quality base course is calculated. Alternatively a rigid pavement section consisting of 5 inches of Portland cement concrete may be used.

The base course thickness may be reduced to 6 inches in areas with no truck traffic and in areas where at least 6 inches of granular fill with a CBR of at least 20 percent is placed below the base course.

Thicker pavement sections may be considered for areas of concentrated traffic or heavier vehicles such as near entry ways and adjacent trash enclosures. A concrete approach slab consisting of 6½ inches of Portland cement concrete overlying 4 inches of base course is recommended at trash enclosures.

3. Pavement Materials and Construction

a. Flexible Pavement (Asphaltic Concrete)

The pavement materials should meet the 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 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 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 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.

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

LICENSED PROFESSIONAL ENGINEER
4-20-18
No. 264455
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STATE OF UTAH

Christopher J. Beckman, P.E.

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

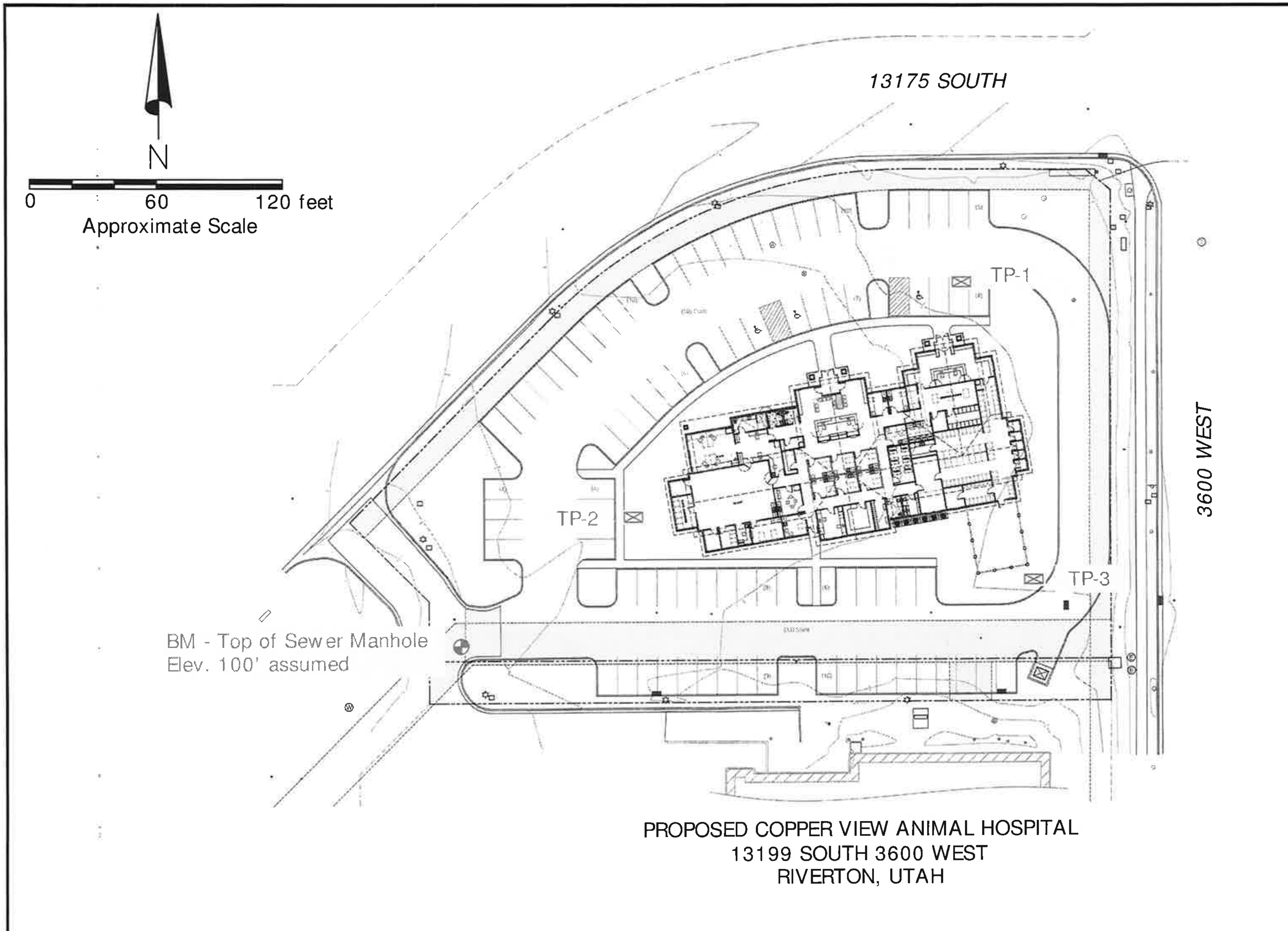
CJB/rs

REFERENCES

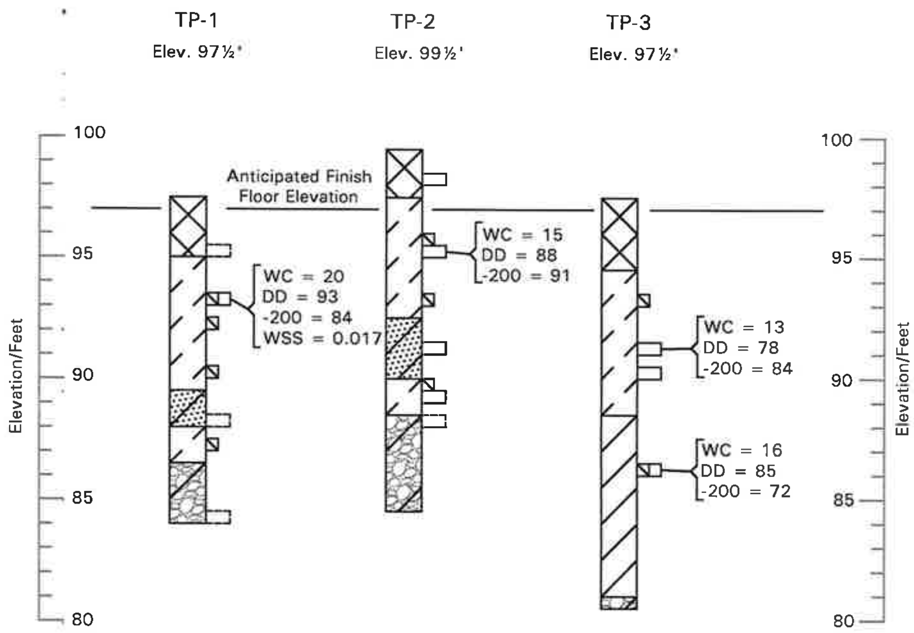
International Building Code, 2015; International Code Council, Inc. Falls Church, Virginia.

Salt Lake County, 2002; Surface Rupture and Liquefaction Potential Special Study Areas Map, Salt Lake County, Utah, adopted March 31, 1989, updated March 2002, Salt Lake County Public Works - Planning Division, 2001 South State Street, Salt Lake City, Utah.

Utah Geological Survey, 2018; Utah Quaternary Fault and Fold Database, http://geology.utah.gov/resources/data-databases/qfaults/ Accessed January 4, 2018.



1180277	AGEC	Test Pit Locations	Figure 1



Approximate Vertical Scale 1" = 8'

LEGEND:

- Fill; clayey sand and gravel, moist, brown.
- Lean Clay (CL); small amounts of sand, upper portion slightly porous to porous, stiff, slightly moist to moist, light brown to brown.
- Silt (ML); small to moderate amounts of sand, some thin clay layers, medium stiff to stiff, slightly moist to moist, light brown.
- Silty Sand (SM); some clayey sand, medium dense, slightly moist to moist, brown.
- Poorly-graded Gravel with Silt and Sand (GP-GM); small to moderate amounts of silt and sand, dense, slightly moist, brown.
- Indicates relatively undisturbed hand drive sample taken.
- Indicates disturbed sample taken.
- Indicates relatively undisturbed block sample taken.

NOTES :

1. The test pits were excavated on April 5, 2018 with a backhoe.
2. The locations of the test pits were measured by pacing from features shown on the site plan provided.
3. The elevations of the test pits were measured by hand 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. No free water was encountered in the test pits at the time of excavation.
7. WC = Water Content (%);
   DD = Dry Density (pcf);
   -200 = Percent Passing the No. 200 Sieve;
   WSS = Water Soluble Sulfates (%).

1180277	AGEC	Test Pit Logs, Legend and Notes	Figure 2

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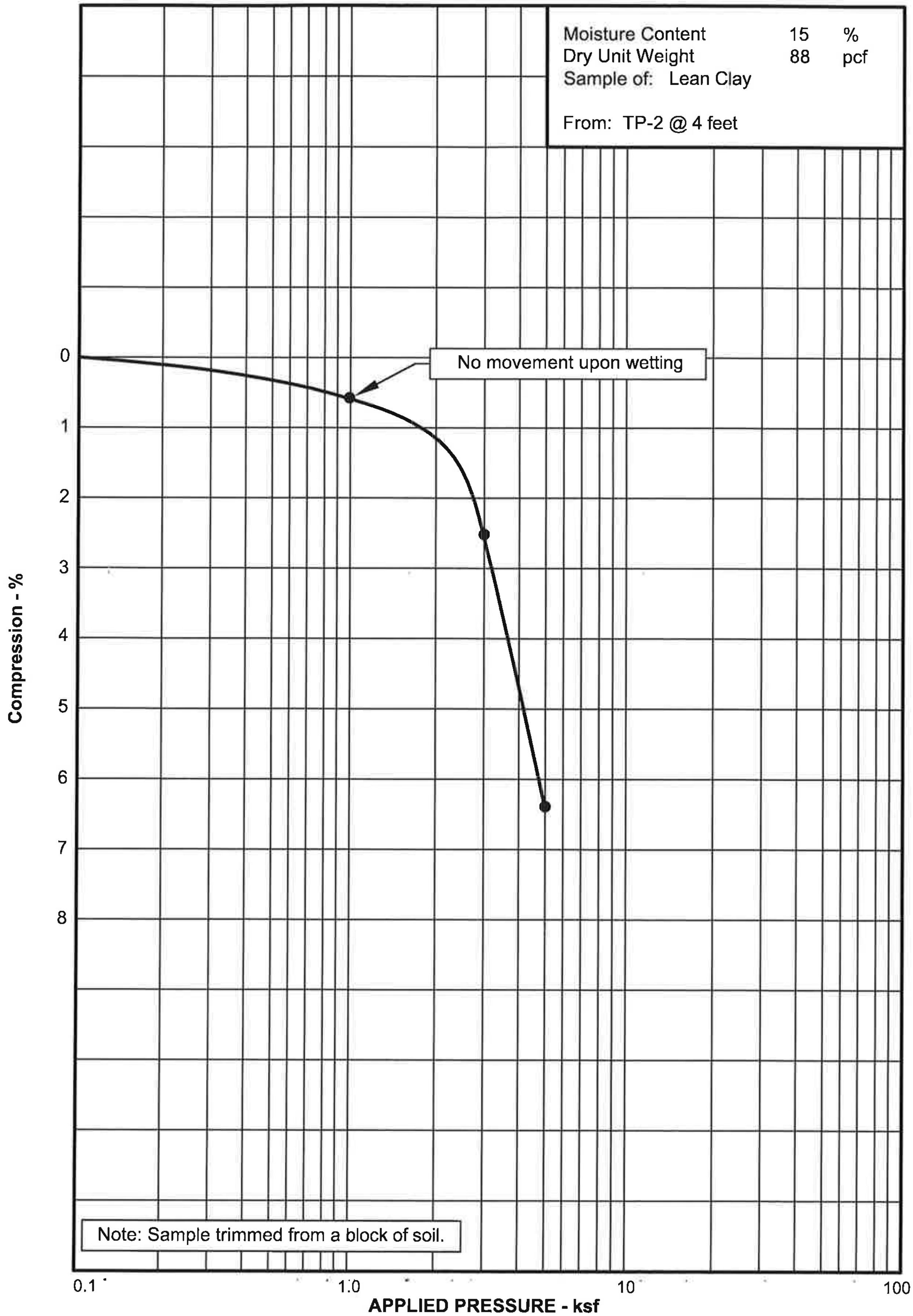

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

PROJECT NUMBER: 1180277

SAMPLE LOCATION		NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (PCF)	GRADATION			ATTERBERG LIMITS		UNCONFINED COMPRESSIVE STREGTH (PSF)	WATER SOLUBLE SULFATE (%)	SAMPLE CLASSIFICATION
TEST PIT	DEPTH (FEET)			GRAVEL (%)	SAND (%)	SILT/ CLAY (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)			
TP-1	4	20	93			84				0.017	Lean Clay with Sand (CL)
TP-2	4	15	88			91					Lean Clay (CL)
TP-3	6	13	78			84					Lean Clay with Sand (CL)
	11	16	85			72					Silt with Sand (ML)