TRAUTNER GEOTECH LLC
GEOTECHNICAL ENGINEERING, MATERIAL TESTING
AND ENGINEERING GEOLOGY

GEOTECHNICAL ENGINEERING STUDY

TOWN OF HOTCHKISS BARROW MESA SHOP PROJECT

Hotchkiss, Colorado

February 1, 2019

Prepared For:
Ms. Joanne Fagan, P.E.
Town of Hotchkiss Engineer
Project Number: 55531GE

1.0 REPORT INTRODUCTION 2
  1.1 *Scope of Project* 3
2.0 GEOTECHNICAL ENGINEERING STUDY 3
  2.1 *Geotechnical Engineering Study Scope of Service* 4
3.0 FIELD STUDY 5
  3.1 *Project Location* 5
  3.2 *Site Description and Geomorphology* 6
  3.3 *Subsurface Soil and Water Conditions* 7
  3.4 *Site Seismic Classification* 10
4.0 LABORATORY STUDY 10
  5.1 *Spread Footings* 11
6.0 RETAINING STRUCTURES 15
7.0 SUBSURFACE DRAIN SYSTEM 16
8.0 CONCRETE FLATWORK 17
  8.1 *Interior Concrete Slab-on-Grade Floors* 17
  8.2 Exterior Concrete Flatwork Considerations 19
  8.3 General Concrete Flatwork Comments 20
9.0 CONSTRUCTION CONSIDERATIONS 21
  9.1 *Fill Placement Recommendations* 21
    9.1.1 *Natural Soil Fill* 21
    9.1.2 *Granular Compacted Structural Fill* 22
  9.2 *Excavation Considerations* 23
    9.2.1 *Excavation Cut Slopes* 23
  9.3 *Utility Considerations* 23
  9.4 *Exterior Grading and Drainage Comments* 24
  9.5 *Landscaping Considerations* 24
  9.6 *Radon Issues* 26
10.0 CONSTRUCTION MONITORING AND TESTING 26
11.0 CONCLUSIONS AND CONSIDERATIONS 27

Appendix A: Logs of Test Borings
Appendix B: Laboratory Test Results

1.0 REPORT INTRODUCTION

This report presents our geotechnical engineering recommendations for the proposed Town of Hotchkiss Barrow Mesa Shop Project. This report was requested by Ms. Joanne Fagan, P.E., Town of Hotchkiss Engineer. The field study was completed on January 14, 2019. The laboratory study was completed on January 24, 2019.

We provided a previous geotechnical engineering report for a proposed shop structure located adjacent to the abandoned sewer treatment plant near the North Fork of the Gunnison River. The recommendations for this previous proposed project are presented in our November 12, 2018 report (PN: 55473GE). We understand that this project site will likely not be used for the shop structure due to costs associated with importing fill materials to raise the project site above potential flood plain elevations. For this reason, the Barrow Mesa site was explored.

The information provided in this report is applicable for the Barrow Mesa project site. Our field study consisted of observing the soils encountered in a number of backhoe advanced test holes, as well as referencing the subsurface logs and laboratory test data that we gathered for the new water tank structure project, located approximately 400 feet to the east of the proposed shop structure location. The logs of the subsurface conditions and laboratory test data for the water tank structure project may be found in our July 31, 2017 report (PN: 54812GE).

Geotechnical engineering is a discipline which provides insight into natural conditions and site characteristics such as; subsurface soil and water conditions, soil strength, swell (expansion) potential, consolidation (settlement) potential, and slope stability considerations (when needed). The information provided by the geotechnical engineer is utilized by many people including the project owner, architect or designer, structural engineer, civil engineer, the project builder and others. The information is used to help develop a design and subsequently implement construction strategies that are appropriate for the subsurface soil and water conditions, and slope stability considerations. It is important that the geotechnical engineer be consulted throughout the design and construction process to verify the implementation of the geotechnical engineering recommendations provided in this report. The recommendations and technical aspects of this report are intended for design and construction personnel who are familiar with construction concepts and techniques, and understand the terminology presented below.

The geotechnical engineering report is the beginning of a process involving the geotechnical engineering consultant on any project. It is common for unforeseen, or otherwise variable subsurface soil and water conditions to be encountered during construction. As discussed in our proposal for our services, it is imperative that we be contacted during the foundation excavation stage of the project to verify that the conditions encountered in our field exploration were representative of those encountered during construction. Compaction testing of fill material and testing of foundation concrete are equally important tasks that should be performed by the geotechnical engineering consultant during construction. We should be contacted during the construction phase of the project and/or if any questions or comments arise as a result of the information presented below.

The following outline provides a synopsis of the various portions of this report;

- Sections 1.0 and 2.0 provide an introduction and an establishment of our scope of service.
- Sections 3.0 and 4.0 of this report present our geotechnical engineering field and laboratory studies
- Sections 5.0 through 8.0 presents our geotechnical engineering design parameters and recommendations which are based on our engineering analysis of the data obtained.
- Section 9.0 provides a brief discussion of construction sequencing and strategies which may influence the geotechnical engineering characteristics of the site.

The discussion and construction recommendations presented in Section 9.0 are intended to help develop site soil conditions that are consistent with the geotechnical engineering recommendations presented previously in the report. Ancillary information such as some background information regarding soil corrosion and radon considerations is presented as general reference. The construction considerations section is not intended to address all of the construction planning and needs for the project site, but is intended to provide an overview to aid the owner, design team, and contractor in understanding some construction concepts that may influence some of the geotechnical engineering aspects of the site and proposed development.

The data used to generate our recommendations are presented throughout this report and in the attached figures.

1.1 *Scope of Project*

We understand that the proposed project will consist of designing and constructing an approximate 9,000 square foot shop structure that is supported by a steel reinforced concrete foundation system. The floor system of the shop will be concrete slab-on-grade. We understand that an equipment storage shed will also be constructed with the project.

2.0 GEOTECHNICAL ENGINEERING STUDY

Our services include a geotechnical engineering study of the subsurface soil and water conditions for development of the proposed industrial type use.

2.1 *Geotechnical Engineering Study Scope of Service*

The scope of our study which was delineated in our proposal for services, and the order of presentation of the information within this report, is outlined below.

Field Study

- We observed the subsurface conditions encountered in four backhoe advanced test holes. The test holes were advanced in our understanding of the vicinity of the shop structure.
- We have also utilized the logs of the subsurface conditions encountered for the water tank structure located about 400 feet to the east of the proposed shop structure. The logs of these test borings have been included with the logs of the test holes in Appendix A of this report.
- Select driven sleeve and bulk soil samples were obtained from the test holes and returned to our laboratory for testing.

Laboratory Study

- The laboratory testing and analysis of the samples obtained included;
    - Moisture content,
    - Estimates of soil strength parameters based on laboratory test results, to help establish a basis for development of soil bearing capacity and lateral earth pressure values,
    - Swell/consolidation tests to help assess the expansion and consolidation potential of the support soils on this site to help estimate potential uplift associated with expansive soils and to help estimate settlement of the foundation system,
    - Plastic and liquid limit tests to determine the Plasticity Index of the soil,
    - Sieve analysis tests, and,
    - Soluble Sulfates tests to assess the corrosion potential of the native soils on Portland cement concrete.

Geotechnical Engineering Recommendations

- This report addresses the geotechnical engineering aspects of the site and provides recommendations including;

    Geotechnical Engineering Section(s)

    - Subsurface soil and water conditions that may influence the project design and construction considerations.

- Geotechnical engineering design parameters including;
  - ✓ Viable foundation system concepts including soil bearing capacity values,
  - ✓ settlement considerations for the foundation system concepts that are viable for this project, and,
  - ✓ Lateral Earth Pressure values for design of retaining structures (if needed).
- Soil support considerations for interior and exterior concrete flatwork.

Construction Consideration Section

- Fill placement considerations including cursory comments regarding site preparation and grubbing operations,
- Considerations for excavation cut slopes,
- Natural soil preparation considerations for use as backfill on the site,
- Compaction recommendations for various types of backfill proposed at the site, and,
- Cursory exterior grading considerations.

- This report provides design parameters, but does not provide foundation design or design of structure components. The project architect, designer, structural engineer or builder may be contacted to provide a design based on the information presented in this report.
- Our subsurface exploration, laboratory study and engineering analysis do not address environmental or geologic hazard issues.

3.0 FIELD STUDY

3.1 *Project Location*

We understand that the water tank structure area has a designated address of 498 Clara Vista Drive. The proposed shop structure is located about 400 feet to the west of the existing water tank structures. The project site is access via a gravel road located at the east end of Clara Vista Drive, approximately 400 feet east of the intersection of Clara Vista Drive and Barrow Mesa Road. The approximate location of the project site is shown on Figure 3.1 below. The imagery used for Figure 3.1 was obtained from Google Earth (imagery date: 6/3/2014).

Figure 3.1: Approximate Project Location

3.2 *Site Description and Geomorphology*

The project site is situated on a broad mesa like feature. The ground surface in the vicinity of our understanding of the proposed shop structure slopes slightly down to the south-southwest with a slope inclination of about 15:1, horizontal to vertical (h:v) or flatter. Steeper slope surfaces exist below and to the west of the proposed shop structure (between Barrow Mesa Road and the project site), with slope inclinations down to the west ranging from about 1½:1 to 2:1 h:v, and a total vertical relief of about 20 feet. In addition, slope surfaces exist to the south of the project site with slope inclinations down to the south in the range of about 5:1 h:v to Clara Vista Drive. The total vertical relief of these slope surfaces is about 60 feet. We understand that the new tank structure will be located at least 60 feet away from the crest of the steeper slope surfaces that surround the south and west sides of the project site.

Numerous small to medium size deciduous trees exist in the area of the proposed structure. As discussed, the root zone and heavy organic matter that surrounds the root zone should be removed as part of the project excavation process.

The subsurface soil and rock deposits encountered in the vicinity of the project site generally consist of dense to very dense granular terrace gravel deposits that overlie the Mancos Shale Formation. A relatively shallow depth clay soil deposit exists above the dense gravel terrace deposits in the vicinity of the project site, such as in the area of the existing water tanks to the east of the proposed shop structure. The clay soil deposits may exhibit a moderate to high swell potential. The Mancos Shale formation that is encountered in the area consists primarily of shale and claystone materials, and often exhibits a high to very high swell potential.

3.3 *Subsurface Soil and Water Conditions*

We logged and sampled the subsurface conditions exposed in four backhoe advanced test holes that were advanced in the vicinity of the shop structure. These test holes have been designated as Test Holes TH-1 through TH-4. We also referenced the logs of the subsurface conditions that we encountered in Test Borings TB-1 and TB-2 advanced for the water tank structure project. The approximate locations of the test holes and previously advanced test borings are indicated on Figure 3.3 below. The imagery used for Figure 3.3 was obtained from Google Earth (imagery date: 6/3/2014). Note that the new water tank structure is not shown on the aerial imagery used. The logs of the soils encountered in Test Holes TH-1 through TH-4, and our previous Test Borings TB-1 and TB-2 are presented in Appendix A of this report.

Figure 3.3: Approximate Test Hole Locations and Previous Test Boring Locations

The approximate test hole and test boring locations shown on the figure above were prepared using notes taken during the field work and are intended to show the approximate test hole and test boring locations for reference purposes only.

In Test Holes TH-1 through TH-4 we generally encountered sandy clay and silt soil from the ground surface to depths ranging from about 1 to 2 feet below the ground surface elevation. Organic matter was encountered in the upper approximate 8 inches of the surface soils. Below this material we encountered dense to very dense gravel and cobbles with a sandy clay and silt soil matrix to the bottom of the test holes. The gravel content of the materials generally increased with depth. The test holes were advanced to depths ranging from about 4 to 5 feet below the ground surface elevation. The rubber tired backhoe used to advanced the test holes struggled somewhat with the excavation due to the very dense granular deposits. The sandy clay and silt soil matrix materials encountered and tested from the various test holes exhibited a low swell potential.

The test holes were loosely backfilled after completion of the test holes. Loose backfill associated with the test holes must be removed and replaced with compacted structural fill if the test holes are located under the structure or exterior concrete flatwork.

Test Borings TB-1 and TB-2 were advanced about 400 feet to the east of the proposed structure as part of our previous water tank geotechnical engineering study. In these test borings we generally encountered sandy clay soil with scattered gravel from the ground surface elevation to depths ranging from about 2 to 3 feet below the ground surface. At depths ranging from 2 to 3 feet below the ground surface elevation we encountered dense to very dense gravel and cobbles with a sandy clay soil matrix to depths ranging from about 16 to 18 feet below the ground surface elevation where we encountered the Mancos Shale Formation. It proved difficult to advance auger type borings through the very dense gravel and cobble deposits.

We encountered subsurface free water at a depth of about 12 feet below the ground surface elevation in both of our test borings. We suspect that the subsurface ground water elevation in the area is somewhat dependent on seasonal precipitation and snow melt conditions, and irrigation practices in areas up-gradient from the project site. We anticipate that the subsurface water elevation may be located at a shallower elevation in the vicinity of the proposed shop structure location.

The sandy clay soils encountered in the upper 2 to 3 feet of our test borings advanced for the water tank structure exhibited a high to very high swell potential when wetted. Although the upper surface soils encountered in the test holes advanced in the vicinity of the shop structure do not appear to be particularly expansive, we anticipate that expansive soil conditions may be present in the shallow soils in the general vicinity of the proposed shop structure. We recommend that the shallow fine-grained clay and/or silt soils be removed from areas under the proposed shop structure foundation system.

The logs of the subsurface soil conditions encountered in the test holes and our previously advanced test borings are presented in Appendix A. The logs present our interpretation of the subsurface conditions encountered exposed in the test holes and test borings at the time of our field work. Subsurface soil and water conditions are often variable across relatively short distances. It is likely that variable subsurface soil and water conditions will be encountered during construction. Laboratory soil classifications of samples obtained may differ from field classifications.

3.4 *Site Seismic Classification*

The seismic site class as defined by the 2009 International Building Code is based on some average values of select soil characteristics such as shear wave velocity, standard penetration test result values, undrained shear strength, and plasticity index.

Based on our standard penetration field tests and laboratory test results obtained from Test Borings TB-1 and TB-2, and the similar shallow subsurface conditions encountered in Test Holes TH-1 through TH-4, we feel that the subsurface conditions for the project are consistent with the criteria for a Site Class C designation as outlined in the 2009 International Building Code, Table 1613.5.2

4.0 LABORATORY STUDY

The laboratory study included tests to determine soils types, estimate the strength potential of the site soil materials, and swell and consolidation potential of the site soil materials. We performed the following tests on select samples obtained from the test borings.

Sieve Analysis and Atterberg Limits; the plastic limit, liquid limit and plasticity index as well as the material grading of select soil samples was determined. The results of the sieve analysis and Atterberg Limits tests are presented on Figures 4.1 through 4.3 of Appendix B.

The granular soil deposits that we encountered and tested at depths ranging from about 1 to 2 feet below the ground surface elevation to the bottom of the test holes generally classify as USCS type GM to GM-GP gravel with a silty sand matrix. The soil materials encountered from the ground surface to a depth of about 1 foot below the ground surface elevation in Test Hole TH-2 classified as a USCS to SM silty sand. It should be noted that more clayey soils were encountered in the upper portions of some of the test holes, and at our previous test boring locations.

Swell-Consolidation Tests; the one dimensional swell-consolidation potential of some of the samples obtained from the formational claystone materials was determined in general accordance with constant volume methodology. The soil samples tested were exposed to varying loads and inundated with water at surcharge loads of 100 and 500 pounds per square foot. The one-dimensional swell-consolidation response of the soil sample to the loads and water are represented graphically on Figures 4.4 through 4.9 of Appendix B. The samples tested exhibited a relatively low swell potential.

Soluble Sulfates Tests: We performed soluble sulfate content tests on soil samples obtained from select samples obtained from the test holes. The results of our tests are tabulated below.

Sample Designation	**Water Soluble Sulfate in Soil (percent by weight)**
TB-2, 36"-48"	< 0.01
TB-4, 12"-18"	< 0.01

The American Concrete Institute (ACI) indicates that soil with a soluble sulfate content of less than 0.1 percent constitutes a negligible exposure to sulfate attack on Portland cement concrete. However, based on our experience in the vicinity of the project, moderate to high sulfate content soils are commonly encountered. We recommend a maximum water/cement ratio of 0.45 and either a type II, IP(MS), IS(MS), P(MS), I(PM)(MS), or a I(SM)(MS) cement be used for the project.

5.0 FOUNDATION RECOMMENDATIONS

Based on the results of our field study and laboratory testing, the structures may be supported by conventional spread footings. Our recommendations for spread footings are provide in Section 5.1 below. We are available to provide recommendations for alternative types of foundation systems at your request.

The integrity and long-term performance of any type of foundation system is influenced by the quality of workmanship which is implemented during construction. It is imperative that all excavation and fill placement operations be conducted by qualified personnel using appropriate equipment and techniques to provide suitable support conditions for the foundation system.

The loose soil materials used to backfill the test holes that were advanced as part of our field study must be removed and replaced with compacted structural fill if the test holes are located within the building footprint area or exterior concrete flatwork areas.

5.1 *Spread Footings*

Properly designed and constructed continuous spread footings with stem walls (or beams) have the ability to distribute the forces associated with volume changes in the support soils. The rigidity of the system helps reduce differential movement and associated damage to the overlying structure. Volume changes in the soils supporting isolated pad footings will result in direct movement of the columns and structural components supported by the columns. If possible, we recommend that isolated pad footings be avoided and that the foundation system be designed as rigid as is reasonably possible.

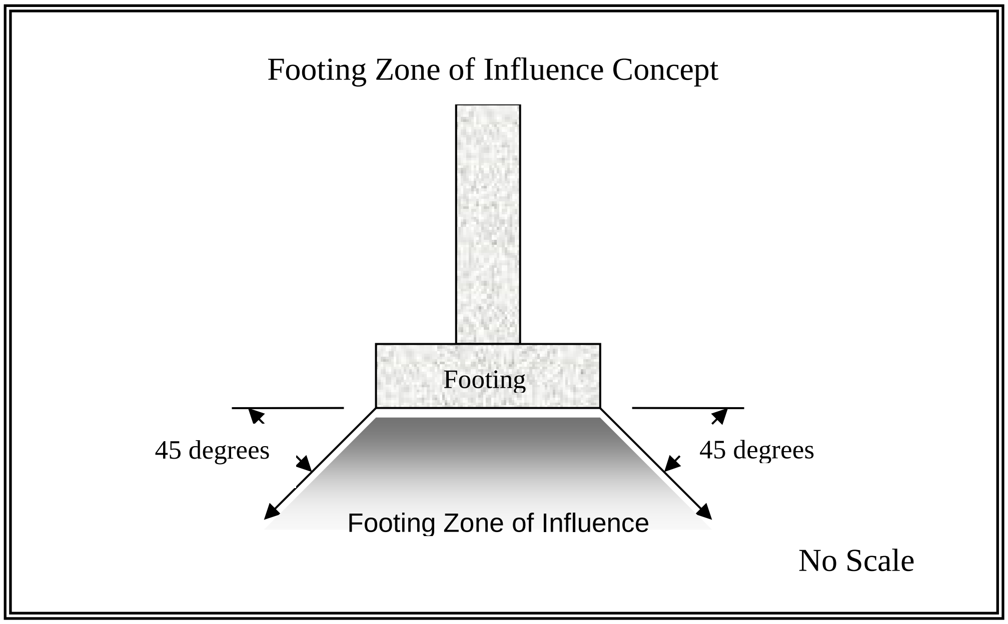
Spread footings should be supported by a leveling course of structural fill that extends to the dense gravel and cobble soils that we observed at depths ranging from about 1 to 2 feet below the ground surface elevation in the test holes. The primary reason for the structural fill leveling course is to provide more uniform support conditions immediately below the footings due to the cobble sized materials that will be encountered in the foundation excavations.

The following general construction procedures should be used to construct the spread footings;

- The foundation excavation should be excavated to the dense gravel and cobble materials, and to a depth of about 6 to 8 inches below the proposed bottom of footing elevation.
- The native gravel and cobble soils deposits should be scarified to a depth of about 8 inches and moisture conditioned to optimum to about 2 percent above optimum moisture content. The scarified and moisture conditioned soils should then be compacted.
- A 6 to 8 inch thick leveling course of structural fill should then be placed and compacted to establish the footing support elevation. The compacted structural fill should extend a minimum distance of at least 6 inches beyond each edge of the footings. Additional widths of structural fill may be needed if for some reason the depth of structural fill is increased. (see Figure 5.1 below).

The zone of influence of the footing (at elevations close to the bottom of the footing) is often approximated as being between two lines subtended at 45 degree angles from each bottom corner of the footing. The compacted structural fill should extend beyond the zone of influence of the footing as shown in Figure 5.1 below.

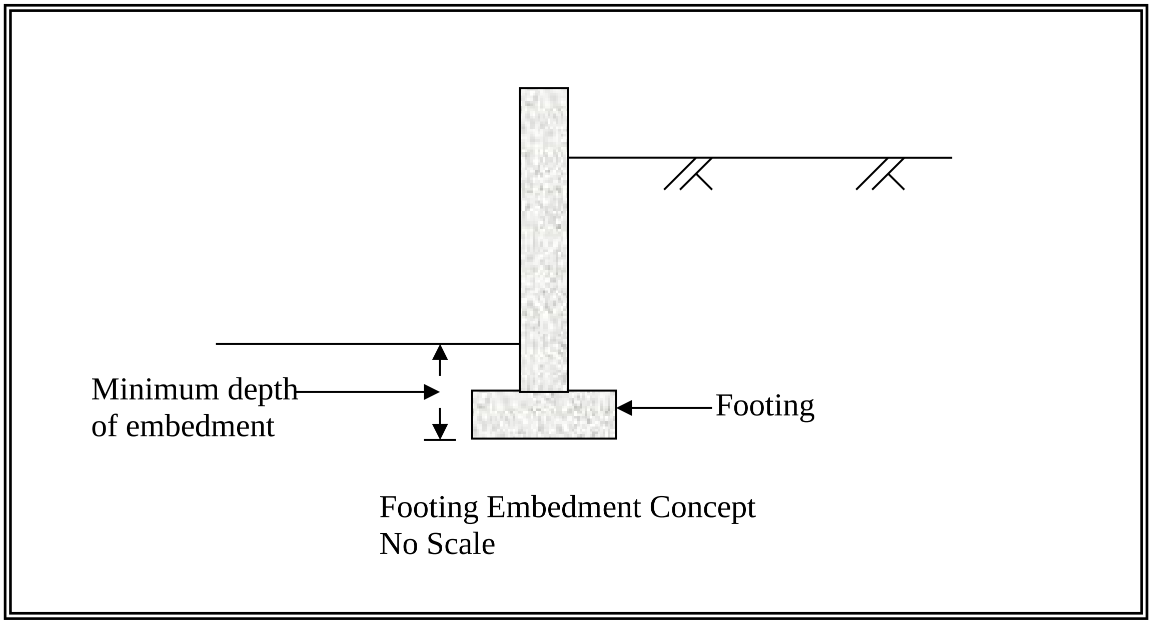
Figure 5.1: Structural Fill Zone of Influence Below Footings



A general and simple rule to apply to the geometry of the compacted structural fill blanket is that it should extend beyond each edge of the footing a distance which is equal to the fill thickness.

All footings should have a minimum depth of embedment of at least 1 foot. The embedment concept is shown below on Figure 5.2.

Figure 5.2: Footing Embedment



An allowable bearing capacity of 3,500 pounds per square foot may be used for the design of the project spread footings. This bearing capacity value is appropriate for continuous footing widths ranging from about 1.5 to 3 feet, and isolated footing widths ranging from about 3 to 5 feet. The bearing capacity value may be increased by 20 percent for transient conditions associated with wind and seismic loads. Snow loads are not transient loads. We estimate that the continuous spread footings designed and constructed above will have a total post construction settlement in the range of about 1/2 inch, while isolated footings may exhibit a post construction settlement in the range of about 1/2 to 2/3 inch.

All footings should be support at an elevation deeper than the maximum depth of frost penetration for the area. This recommendation includes exterior isolated footings and column supports. Please contact the local building department for specific frost depth requirements.

The post construction differential settlement may be reduced by designing footings that will apply relatively uniform loads on the support soils. Concentrated loads should be supported by footings that have been designed to impose similar loads as those imposed by adjacent footings.

Under no circumstances should any footing be supported by more than 3 feet of compacted structural fill material unless we are contacted to review the specific conditions supporting these footing locations.

The design concepts and parameters presented above are based on the soil conditions encountered in our test borings. We should be contacted during the initial phases of the foundation excavation at the site to assess the soil support conditions and to verify our recommendations.

Some movement and settlement of any shallow foundation system will occur after construction. Movement associated with swelling soils also occurs occasionally. Utility line connections through and foundation or structural component should be appropriately sleeved to reduce the potential for damage to the utility line. Flexible utility line connections will further reduce the potential for damage associated with movement of the structure.

6.0 RETAINING STRUCTURES

We understand that a basement level below the structure will not be constructed, however we anticipate that laterally loaded walls such as grease/oil pits may be constructed as part of this site development. We have provided lateral earth pressure values for both the native granular soils and imported granular soils if needed for the project. We must be contacted if extensive laterally loaded walls will be constructed as part of the project.

Lateral loads will be imposed on the retaining structures by the adjacent soils and, in some cases, surcharge loads on the retained soils. The loads imposed by the soil are commonly referred to as lateral earth pressures. The magnitude of the lateral earth pressure forces is partially dependent on the soil strength characteristics, the geometry of the ground surface adjacent to the retaining structure, the subsurface water conditions and on surcharge loads.

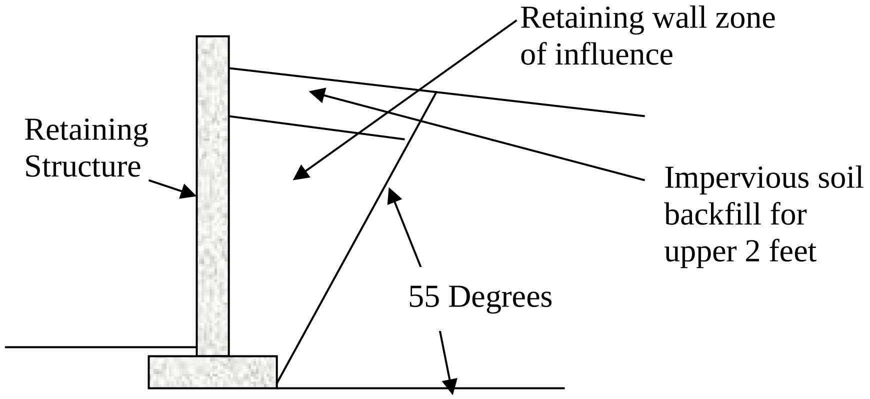
The retaining structures may be designed using the values tabulated below.

Lateral Earth Pressure Values

Type of Lateral Earth Pressure	Level Native Granular Soil Backfill (pounds per cubic foot/foot)*	Level Granular Soil Backfill (pounds per cubic foot/foot)
Active	40	35
At-rest	60	55
Passive	455	460
Allowable Coefficient of Friction	0.43	0.45

The values tabulated above are for well drained backfill soils. The values provided above do not include any forces due to adjacent surcharge loads or sloped soils. If the backfill soils become saturated the imposed lateral earth pressures will be significantly higher than those tabulated above.

The granular imported soil backfill values tabulated above are appropriate for material with an angle of internal friction of 35 degrees, or greater. The granular backfill must be placed within the retaining structure zone of influence as shown below in order for the lateral earth pressure values tabulated above for the granular material to be appropriate.



Retaining Structure Zone of Influence Concept, No Scale

If a granular backfill is chosen it should not extend to the ground surface. Some granular soils allow ready water migration which may result in increased water access to the foundation soils. The upper few feet of the backfill should be constructed using an impervious soil such as silty-clay and clay soils from the project site, if these soils are available.

Backfill should not be placed and compacted behind the retaining structure unless approved by the project structural engineer. Backfill placed prior to construction of all appropriate structural members such as floors, or prior to appropriate curing of the retaining wall concrete (if used) may result in severe damage and/or failure of the retaining structure.

7.0 SUBSURFACE DRAIN SYSTEM

Due to the relatively granular nature of the subsurface soils, low swell potential of the native soils, and lack of crawl space areas, we do not see the need for a subsurface drain system around the perimeter of the foundation system. Retaining structures should incorporate drain systems to reduce the potential for hydrostatic pressures to develop within the retained soils. Exterior retaining structures may be constructed with weep holes to allow subsurface water migration through the retaining structures.

8.0 CONCRETE FLATWORK

We understand that both interior and exterior concrete flatwork will be included in the project design. Concrete flatwork is typically lightly loaded and has a limited capability to resist shear forces associated with volume changes in the support soils, including frost heave. It is prudent for the design and construction of concrete flatwork on this project to be able to accommodate some movement associated with swelling soil conditions.

Based on our subsurface field study and laboratory test data, the subsurface materials encountered on the project site did not exhibit a substantial swell potential. We anticipate that the primary potential for movement of concrete flatwork on this project site is from consolidation of the upper sandy clay/silt soils that we encountered from the ground surface to depths ranging from about 1 to 2 feet below the ground surface elevation, or possibly movement from frost heave for exterior concrete flatwork. We have recommended that concrete flatwork be supported by a composite support section that consists of a layer of moisture conditioned native soils and a layer of compacted structural fill. Properly moisture conditioning and compacting the finer grain sandy silt and clay soils must be performed to help reduce the potential for movement of concrete flatwork on this project site. The potential for movement can be further reduced if the upper sandy silt/clay soils are removed from areas under concrete flatwork.

8.1 *Interior Concrete Slab-on-Grade Floors*

A primary goal for the design and construction of interior concrete slab-on-grade floors is to reduce the amount of post construction uplift associated with swelling soils, or downward movement due to consolidation of soft soils. A parallel goal is to reduce the potential for damage to the structure associated with any movement of the slab-on-grade which may occur. There are limited options available to help mitigate the influence of volume changes in the support soil for concrete slab-on-grade floors, these include;

- Preconstruction scarification, moisture conditioning and re-compaction of the natural soils in areas proposed for support of concrete flatwork, and/or,
- Placement and compaction of granular compacted structural fill material.

Damage associated with movement of interior concrete slab-on-grade floor can be reduced by designing the floors as “floating” slabs. Floating concrete slabs are not structurally tied to the foundations or the overlying structure. Interior walls or columns are not supported on the interior floor slabs with a true floating slab system. Interior walls may be structurally supported from framing above the floor, or interior walls and support columns may be supported on interior portions of the foundation system if a floating slab system is used.

The only means to completely mitigate the influence of volume changes on the performance of interior floors is to structurally support the floors. Floors that are suspended by the foundation system will not be influenced by volume changes in the site soils. The suggestions and recommendations presented below are intended to help reduce the influence of volume changes in the support soils on the performance of the concrete slab-on-grade floors.

Interior concrete slab-on-grade floors may be supported by a composite fill blanket which is composed of a 12 inch thick lower layer of scarified, moisture conditioned natural soil that is overlain by a 12 inch thick blanket of compacted structural fill. The scarified fill material and the compacted structural fill material should be constructed as discussed under the Construction Considerations, "*Fill Placement Considerations*" section of this report below."

The project structural engineer should be contacted regarding the structural characteristics and thickness of the interior shop floor slabs. We generally recommend that a minimum concrete thickness of 7 to 8 inches be used for areas that will be exposed to repeated heavy equipment loads. A modulus of subgrade reaction of 175 pounds per cubic inch may be used for the composite slab support section provided above.

Capillary and vapor moisture rise through the slab support soil may provide a source for moisture in the concrete slab-on-grade floor. This moisture may promote development of mold or mildew in poorly ventilated areas and may influence the performance of floor coverings and mastic placed directly on the floor slabs. The type of floor covering, adhesives used, and other considerations that are not related to the geotechnical engineering practice will influence the design. The architect, builder and particularly the floor covering/adhesive manufacturer should be contacted regarding the appropriate level of protection required for their products.

Comments for Reduction of Capillary Rise

One option to stop capillary rise through the floor slab is to place a layer of clean aggregate material, such as washed concrete aggregate for the upper 4 to 6 inches of fill material supporting the concrete slabs.

Comments for Reduction of Vapor Rise

To reduce vapor rise through the floors slab a moisture barrier such as a 6 mil (or thicker) plastic, or similar impervious geotextile material is often be placed below the floor slab. The material used should be protected from punctures that will occur during the construction process.

There are proprietary barriers that are puncture resistant that may not need the underlying layer of protective material. Some of these barriers are robust material that may be placed below the compacted structural fill layer. We do not recommend placement of the concrete directly on a moisture barrier unless the concrete contractor has had previous experience with curing of concrete placed in this manner. As mentioned above, the architect, builder and particularly the floor covering/adhesive manufacturer should be contacted regarding the appropriate level of moisture and vapor protection required for their products.

The project structural engineer should be contacted to provide steel reinforcement design considerations for the proposed floor slabs. Any steel reinforcement placed in the slab should be placed at the appropriate elevations to allow for proper interaction of the reinforcement with tensile stresses in the slab. Reinforcement steel that is allowed to cure at the bottom of the slab will not provide adequate reinforcement.

8.2 Exterior Concrete Flatwork Considerations

Exterior concrete flatwork includes concrete driveway slabs, aprons, patios, and walkways. The desired performance of exterior flatwork typically varies depending on the proposed use of the site and each owner's individual expectations. As with interior flatwork, exterior flatwork is particularly prone to movement and potential damage due to movement of the support soils. This movement and associated damage may be reduced by following the recommendations discussed under interior flatwork, above. Unlike interior flatwork, exterior flatwork may be exposed to frost heave, particularly on sites with high silt-content soils. It may be prudent to remove silt soils from exterior flatwork support areas where movement of exterior flatwork will adversely affect the project, such as near the interface between the driveway and the interior garage floor slab. If silt soils are encountered, they should be removed to the maximum depth of frost penetration for the area where movement of exterior flatwork is undesirable.

As discussed in Section 8.1 above, we recommend that a relatively thick concrete section be used for exterior concrete flatwork that will be exposed to heavy equipment loads. The project structural engineer should be contacted for the steel reinforcement design.

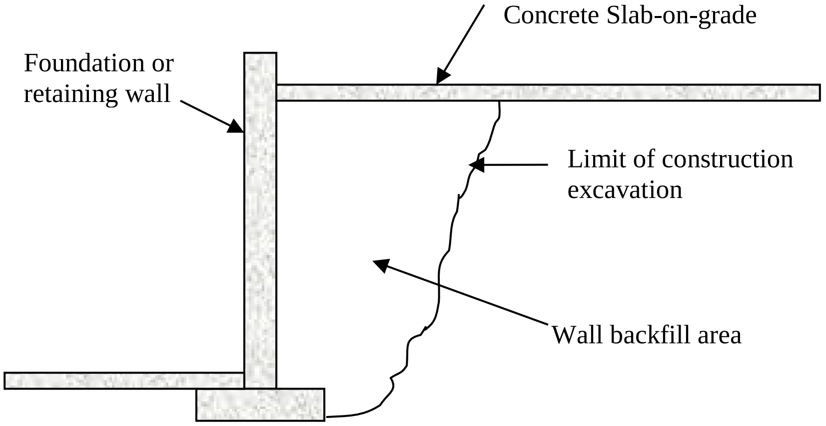
If some movement of exterior flatwork is acceptable, we suggest that the support areas be prepared by scarification, moisture conditioning and re-compaction of 8 inches of the natural soils followed by placement of at least 8 inches of compacted granular fill material for light duty exterior flatwork, and at least 12 inches of compacted structural fill for heavy duty exterior flatwork that will be subjected to heavy equipment loads. The scarified material and granular fill materials should be placed as discussed under the Construction Considerations, *"Fill Placement Recommendations"* section of this report, below.

It is important that exterior flatwork be separated from exterior column supports, masonry veneer, finishes and siding. No support columns, for the structure or exterior decks, should be placed on exterior concrete unless movement of the columns will not adversely affect the supported structural components. Movement of exterior flatwork may cause damage if it is in contact with portions of the structure exterior.

Exterior flatwork should not be placed on soils prepared for support of landscaping vegetation. Cultivated soils will not provide suitable support for concrete flatwork.

8.3 General Concrete Flatwork Comments

It is relatively common that both interior and exterior concrete flatwork is supported by areas of fill adjacent to either shallow foundation walls or basement retaining walls. A typical sketch of this condition is shown below.



Wall Backfill and Slab Support Sketch

No Scale

Settlement of the backfill shown above will create a void and lack of soil support for the portions of the slab over the backfill. Settlement of the fill supporting the concrete flatwork is likely to cause damage to the slab-on-grade. Settlement and associated damage to the concrete flatwork may occur when the backfill is relatively deep, <u>even if the backfill is compacted.</u>

If this condition is likely to exist on this site it may be prudent to design the slab to be structurally supported on the retaining or foundation wall and designed to span to areas away from the backfill area as designed by the project structural engineer. We are available to discuss this with you.

9.0 CONSTRUCTION CONSIDERATIONS

This section of the report provides comments, considerations and recommendations for aspects of the site construction which may influence, or be influenced by the geotechnical engineering considerations discussed above. The information presented below is not intended to discuss all aspects of the site construction conditions and considerations that may be encountered as the project progresses. If any questions arise as a result of our recommendations presented above, or if unexpected subsurface conditions are encountered during construction we should be contacted immediately.

9.1 *Fill Placement Recommendations*

There are several references throughout this report regarding both natural soil and compacted structural fill recommendations. The recommendations presented below are appropriate for the fill placement considerations discussed throughout the report above.

All areas to receive fill, structural components, or other site improvements should be properly prepared and grubbed at the initiation of the project construction. The grubbing operations should include scarification and removal of organic material and soil. No fill material or concrete should be placed in areas where existing vegetation or fill material exist.

We suspect that man-placed fill and subterranean structures may be encountered as the project construction progresses. All existing fill material including the loose fill materials used to backfill the test holes associated with this geotechnical engineering study, should be removed from areas planned for support of structural components. Excavated areas and subterranean voids should be backfilled with properly compacted fill material as discussed below.

9.1.1 *Natural Soil Fill*

Any natural soil used for any fill purpose should be free of all deleterious material, such as organic material and construction debris. Natural soil fill includes excavated and replaced material or in-place scarified material.

The natural soils should be moisture conditioned, either by addition of water to dry soils, or by processing to allow drying of wet soils. The proposed fill materials should be moisture conditioned to between about optimum and about 2 percent above optimum soil moisture content. This moisture content can be estimated in the field by squeezing a sample of the soil in the palm of the hand. If the material easily makes a cast of soil which remains in-tact, and a minor amount of surface moisture develops on the cast, the material is close to the desired moisture content. Material testing during construction is the best means to assess the soil moisture content.

Moisture conditioning of clay or silt soils may require many hours of processing. If possible, water should be added and thoroughly mixed into fine grained soil such as clay or silt the day prior to use of the material. This technique will allow for development of a more uniform moisture content and will allow for better compaction of the moisture conditioned materials.

The moisture conditioned soil should be placed in lifts that do not exceed the capabilities of the compaction equipment used and compacted to at least 90 percent of maximum dry density as defined by ASTM D1557, modified Proctor test. We typically recommend a maximum fill lift thickness of 6 inches for hand operated equipment and 8 to 10 inches for larger equipment. Care should be exercised in placement of utility trench backfill so that the compaction operations do not damage the underlying utilities. The maximum rock size should be less than about 3 inches.

The soils encountered in our test borings included cobbles and boulders that are larger than 3 inches. These larger rocks may be either be screened and removed from the natural soil prior to use as structural fill, or the soil may be processed and crushed with a portable on-site crusher to produce a material with no rocks larger than 3 inches.

9.1.2 *Granular Compacted Structural Fill*

Granular compacted structural fill is referenced in numerous locations throughout the text of this report. Granular compacted structural fill should be constructed using an imported commercially produced rock product such as aggregate road base. Many products other than road base, such as clean aggregate or select crusher fines may be suitable, depending on the intended use. If a specification is needed by the design professional for development of project specifications, a material conforming to the Colorado Department of Transportation (CDOT) “Class 6” aggregate road base material can be specified. This specification can include an option for testing and approval in the event the contractor’s desired material does not conform to the Class 6 aggregate specifications. We have provided the CDOT Specifications for Class 6 material below

Grading of CDOT Class 6 Aggregate Base-Course Material	
Sieve Size	Percent Passing Each Sieve
¾ inch	100
#4	30 – 65
#8	25 – 55
#200	3 – 12

Liquid Limit less than 30

All compacted structural fill should be moisture conditioned and compacted to at least 90 percent of maximum dry density as defined by ASTM D1557, modified Proctor test. Areas where the structural fill will support traffic loads under concrete slabs or asphalt concrete should be compacted to at least 95 percent of maximum dry density as defined by ASTM D1557, modified Proctor test.

9.2 *Excavation Considerations*

Unless a specific classification is performed, the site soils should be considered as an Occupational Safety and Health Administration (OSHA) Type C soil and should be sloped and/or benched according to the current OSHA regulations. Excavations should be sloped and benched to prevent wall collapse. Any soil can release suddenly and cave unexpectedly from excavation walls, particularly if the soils is very moist, or if fractures within the soil are present. Daily observations of the excavations should be conducted by OSHA competent site personnel to assess safety considerations.

If possible, excavations should be constructed to allow for water flow from the excavation the event of precipitation during construction. If this is not possible it may be necessary to remove water from snowmelt or precipitation from the foundation excavations to help reduce the influence of this water on the soil support conditions and the site construction characteristics.

9.2.1 *Excavation Cut Slopes*

We anticipate that some permanent excavation cut slopes may be included in the site development. Temporary cut slopes should not exceed 5 feet in height and should not be steeper than about 1:1, horizontal to vertical for most soils. Permanent cut slopes of greater than 5 feet or steeper than 2½:1, h:v must be analyzed on a site specific basis.

We did not observe evidence of existing unstable slope areas influencing the site, but due to the steepness and extent of the slopes in the area we suggest that the magnitude of the proposed excavation slopes be minimized and/or supported by retaining structures.

9.3 *Utility Considerations*

Subsurface utility trenches will be constructed as part of the site development. Utility line backfill often becomes a conduit for post construction water migration. If utility line trenches approach the proposed project site from above, water migrating along the utility line and/or backfill may have direct access to the portions of the proposed structure where the utility line penetrations are made through the foundation system. The foundation soils in the vicinity of the utility line penetration may be influenced by the additional subsurface water. There are a few options to help mitigate water migration along utility line backfill. Backfill bulkheads constructed with high clay content soils and/or placement of subsurface drains to promote utility line water discharge away from the foundation support soil.

Some movement of all structural components is normal and expected. The amount of movement may be greater on sites with problematic soil conditions. Utility line penetrations through any walls or floor slabs should be sleeved so that movement of the walls or slabs does not induce movement or stress in the utility line. Utility connections should be flexible to allow for some movement of the floor slab.

9.4 *Exterior Grading and Drainage Comments*

The ground surface adjacent to the structure should be sloped to promote water flow away from the foundation system and flatwork. Snow storage areas should not be located in areas which will allow for snowmelt water access to support soils for the foundation system or flatwork.

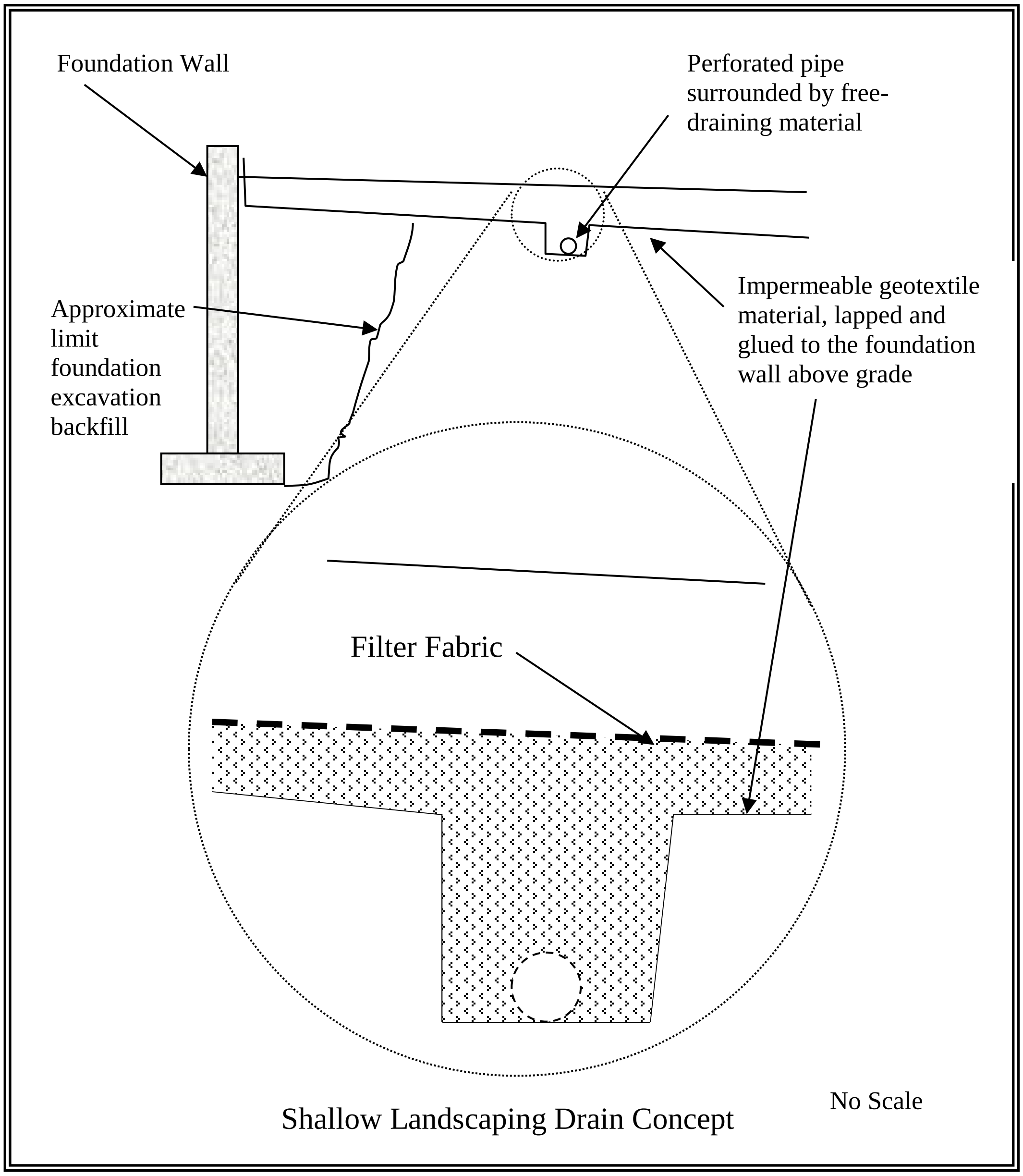
Water flow from the roof of the structure should be captured and directed away from the structure. If the roof water is collected in an eave gutter system, or similar, the discharge points of the system must be located away from areas where the water will have access to the foundation backfill or any structure support soils. If downspouts are used, provisions should be made to either collect or direct the water away from the structure.

The project civil engineering consultant or builder should develop a drainage scheme for the site. We typically suggest a minimum fall of about 8 to 10 percent away from the structure, in the absence of design criteria from others. Care should be taken to not direct water onto adjacent property or to areas that would negatively influence existing structures or improvements.

9.5 *Landscaping Considerations*

We recommend against construction of landscaping which requires excessive irrigation. Generally landscaping which uses abundant water requires that the landscaping contractor install topsoil which will retain moisture. The topsoil is often placed in flattened areas near the structure to further trap water and reduce water migration from away from the landscaped areas. Unfortunately almost all aspects of landscape construction and development of lush vegetation are contrary to the establishment of a relatively dry area adjacent to the foundation walls. Excess water from landscaped areas near the structure can migrate to the foundation system or flatwork support soils, which can result in volume changes in these soils.

A relatively common concept used to collect and subsequently reduce the amount of excess irrigation water is to glue or attach an impermeable geotextile fabric or heavy mill plastic to the foundation wall and extend it below the topsoil which is used to establish the landscape vegetation. A thin layer of sand can be placed on top of the geotextile material to both protect the geotextile from punctures and to serve as a medium to promote water migration to the collection trench and perforated pipe. The landscape architect or contractor should be contacted for additional information regarding specific construction considerations for this concept which is shown in the sketch below.



Shallow Landscaping Drain Concept

A free draining aggregate or sand may be placed in the collection trench around the perforated pipe. The perforated pipe should be graded to allow for positive flow of excess irrigation water away from the structure or other area where additional subsurface water is undesired. Preferably the geotextile material should extend at least ten (10) or more feet from the foundation system.

Care should be taken to not place exterior flatwork such as sidewalks or driveways on soils that have been tilled and prepared for landscaping. Tilled soils will settle which can cause damage to the overlying flatwork. Tilled soils placed on sloped areas often “creep” down-slope. Any structure or structural component placed on this material will move down-slope with the tilled soil and may become damaged.

9.6 *Radon Issues*

The requested scope of service of this report did not include assessment of the site soils for radon production. Many soils and formational materials in western Colorado produce Radon gas. The structure should be appropriately ventilated to reduce the accumulation of Radon gas in the structure. Several Federal Government agencies including the Environmental Protection Agency (EPA) have information and guidelines available for Radon considerations and home construction. If a radon survey of the site soils is desired, please contact us.

10.0 CONSTRUCTION MONITORING AND TESTING

Construction monitoring including engineering observations and materials testing during construction is a critical aspect of the geotechnical engineering contribution to any project. Unexpected subsurface conditions are often encountered during construction. The site foundation excavation should be observed by the geotechnical engineer or a representative during the early stages of the site construction to verify that the actual subsurface soil and water conditions were properly characterized as part of field exploration, laboratory testing and engineering analysis. If the subsurface conditions encountered during construction are different than those that were the basis of the geotechnical engineering report then modifications to the design may be implemented prior to placement of fill materials or foundation concrete.

Compaction testing of fill material should be performed throughout the project construction so that the engineer and contractor may monitor the quality of the fill placement techniques being used at the site. We recommend that compaction testing be performed for any fill material that is placed as part of the site development. Compaction tests should be performed on each lift of material placed in areas proposed for support of structural components. In addition to compaction testing we recommend that the grain size distribution, clay content and swell potential be evaluated for any imported materials that are planned for use on the site. Concrete tests should be performed on foundation concrete and flatwork.

We are available to provide testing of asphaltic concrete materials, if used. We are available to develop a testing program for soil, aggregate materials, concrete and asphaltic concrete for this project.

11.0 CONCLUSIONS AND CONSIDERATIONS

The information presented in this report is based on our understanding of the proposed construction that was provided to us and on the data obtained from our field and laboratory studies. We recommend that we be contacted during the design and construction phase of this project to aid in the implementation of our recommendations. Please contact us immediately if you have any questions, or if any of the information presented above is not appropriate for the proposed site construction.

The recommendations presented above are intended to be used only for this project site and the proposed construction which was provided to us. The recommendations presented above are not suitable for adjacent project sites, or for proposed construction that is different than that outlined for this study.

Our recommendations are based on limited field and laboratory sampling and testing. Unexpected subsurface conditions encountered during construction may alter our recommendations. We should be contacted during construction to observe the exposed subsurface soil conditions to provide comments and verification of our recommendations. We are available to review and tailor our recommendations as the project progresses and additional information which may influence our recommendations becomes available.

Please contact us if you have any questions, or if we may be of additional service.

Respectfully submitted,
TRAUTNER GEOTECH

COLORADO REGISTERED PROFESSIONAL ENGINEER
JONATHAN P. BUTLER
2/1/19

Jonathan P. Butler, P.E.
Senior Geotechnical Engineer

APPENDIX A

Logs of Test Borings

TRAUTNER GEOTECH LLC

Field Engineer : J. Butler
Drilling Method : Backhoe Pit
Sampling Method : Mod. California Sampler
Date Drilled : 1/14/2019
Total Depth : 4.5 feet
Location : See Figure

LOG OF BORING TH-1

Hotchkiss Barrow Mesa Shop Structure
Hotchkiss, CO
Ms. Joanne Fagan, P.E.
Town of Hotchkiss Engineer

PN: 55531GE

Sample Type
- ▦ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, organics, medium stiff, slightly moist, brown	CL					
1	GRAVEL, COBBLES, CLAY, sandy, dense, slightly moist, tan	GC/CL		▦	Hand drive		Some caliche material from 1 foot to 3 feet
2				▨			
3	GRAVEL, COBBLES, sandy, slightly clayey, very dense, moist, light brown	GP-GC		▨			
4							
	Bottom of test boring at 4.5 feet						
5							
6							

TRAUTNER GEOTECH LLC

Field Engineer : J. Butler
Drilling Method : Backhoe Pit
Sampling Method : Bag Sample
Date Drilled : 1/14/2019
Total Depth : 4.5 feet
Location : See Figure

LOG OF BORING TH-2

Hotchkiss Barrow Mesa Shop Structure
Hotchkiss, CO
Ms. Joanne Fagan, P.E.
Town of Hotchkiss Engineer

PN: 55531GE

Sample Type
- ▦ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, medium stiff, slightly moist, brown	CL	▨	▨			
1 2	GRAVEL, COBBLES, CLAY, sandy, dense, slightly moist, tan	GC	▨	▨			Caliche material at 14 inches
3 4	GRAVEL, COBBLES, sandy, slightly clayey, very dense, slightly moist, light brown	GP-GC	▨	▨			
5 6	Bottom of test boring at 4.5 feet						

TRAUTNER GEOTECH LLC

Field Engineer : J. Butler
Drilling Method : Backhoe Pit
Sampling Method : Bag Sample
Date Drilled : 1/14/2019
Total Depth : 5 feet
Location : See Figure

LOG OF BORING TH-3

Hotchkiss Barrow Mesa Shop Structure
Hotchkiss, CO
Ms. Joanne Fagan, P.E.
Town of Hotchkiss Engineer

PN: 55531GE

Sample Type
- ▦ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, organics, medium stiff, moist, brown	CL	▨				
1	GRAVEL, SAND, cobbles, clayey, dense, slightly moist, tan	GC	▨	▨ (1.5–2.5)			Some white chemical deposits from 1 foot to 5 feet
5	Bottom of test boring at 5 feet						
6							

LOG OF BORING TH-4

Field Engineer : J. Butler
Drilling Method : Backhoe Pit
Sampling Method : Bag Sample
Date Drilled : 1/14/2019
Total Depth : 4 feet
Location : See Figure

Hotchkiss Barrow Mesa Shop Structure
Hotchkiss, CO
Ms. Joanne Fagan, P.E.
Town of Hotchkiss Engineer

PN: 55531GE

Sample Type
▦ Mod. California Sampler
▨ Bag Sample
■ Standard Split Spoon

Water Level
▼ Water Level During Drilling
▽ Water Level After Drilling

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, organics, medium stiff, moist, brown	CL					
1	CLAY, sandy, chemical deposits, stiff, slightly moist, tan	CL		▨			
2	GRAVEL, CLAY, sandy, cobbles, dense, slightly moist, tan	GC					
3	GRAVEL, COBBLES, sandy, slightly clayey, very dense, slightly moist, light brown	GP-GC		▨			
4	Bottom of test boring at 4 feet						
5							
6							

TRAUTNER GEOTECH LLC

Field Engineer : J. Butler
Hole Diameter : 3.25 inch I.D. Hollow Stem
Drilling Method : Continuous Flight Auger
Sampling Method : Mod. California Sampler
Date Drilled : 6/27/2017
Total Depth (approx.) : 25 feet
Location : See Figure One

LOG OF BORING TB-1

Town of Hotchkiss Water Tank
Hotchkiss, Colorado
Ms. Joanne Fagan, P.E.
Town of Hotchkiss Engineering

Project Number: 54812GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling

Depth in feet	DESCRIPTION	USCS	GRAPHIC	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, few gravels, stiff, slightly moist, brown	CL		▨			
3	CLAY, GRAVEL, sandy, white chemical deposits at three (3) to five (5) feet, stiff/dense, slightly moist, tan to white	CL/GC		☒ ▨	14/6 35/6		
5	GRAVEL, COBBLES, sandy, clayey, very dense, moist, brown to tan	GC-GP		▨ ■ ▨	9/6 11/6 33/6	▽	Water level at eleven and seventy-five hundredths (11.75) feet after drilling
12	GRAVEL, COBBLES, sandy, clayey, very dense, wet, brown	GC-GP		▨ ■	7/6 13/6 14/6		
18	FORMATIONAL MATERIAL at eighteen (18) feet, Claystone, very hard, wet to nineteen (19) feet then moist, tan, Mancos Shale Formation	FX		☒ ☒	50/6 19/6 50/4		
25	Bottom of test boring at twenty-five (25) feet						

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

LOG OF BORING TB-2

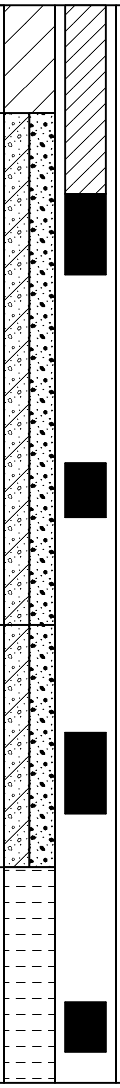
Field Engineer : J. Butler
Hole Diameter : 3.25 inch I.D. Hollow Stem
Drilling Method : Continuous Flight Auger
Sampling Method : Standard Split Spoon
Date Drilled : 6/27/2017
Total Depth (approx.) : 20 feet
Location : See Figure One

Town of Hotchkiss Water Tank
Hotchkiss, Colorado
Ms. Joanne Fagan, P.E.
Town of Hotchkiss Engineering

Project Number: 54812GE

Sample Type
- ☒ Mod. California Sampler
- ▨ Bag Sample
- ■ Standard Split Spoon

Water Level
- ▼ Water Level During Drilling
- ▽ Water Level After Drilling



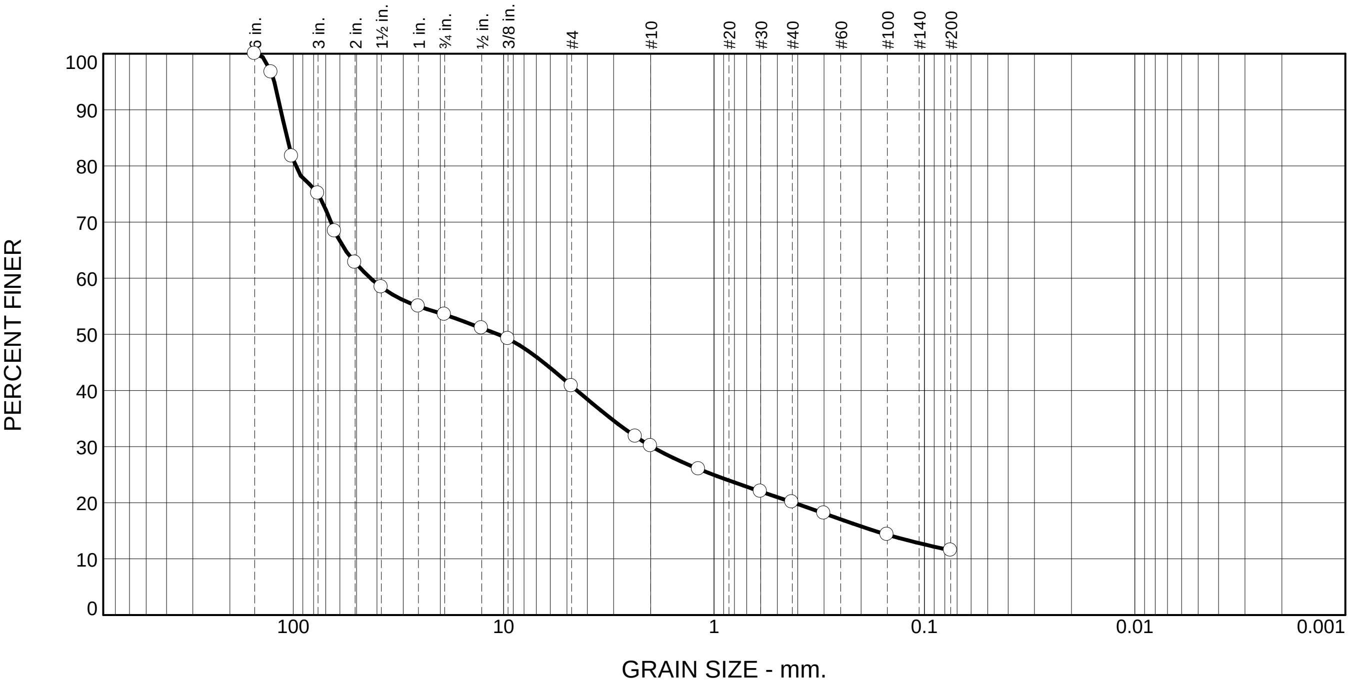
Depth in feet	DESCRIPTION	USCS	Samples	Blow Count	Water Level	REMARKS
0	CLAY, sandy, stiff, slightly moist, brown	CL	▨			
2	GRAVEL, COBBLES, clayey, sandy, white chemical deposits at two (2) feet, very dense, slightly moist, tan to white	GC-GP	▨ ■ ■	17/6 18/6 28/6 27/6 24/6 10/0 bounce		
	GRAVEL, COBBLES, clayey, sandy, very dense, wet, tan	GC-GP	■	15/6 15/6 11/6	▽	Water level at eleven and eight tenths (11.8) feet after drilling
16	FORMATIONAL MATERIAL at sixteen (16) feet, Claystone, hard to very hard, wet in upper one (1) to two (2) feet, Mancos Shale Formation	FX	■	24/6 50/5		
20	Bottom of test boring at twenty (20) feet					

APPENDIX B

Laboratory Test Result

ATTERBERG LIMITS AND SIEVE ANALYSES
SWELL-CONSOLIDATION TESTS

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
24.9	21.6	12.7	10.7	10.0	8.6	11.5	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
6	100.0		
5	96.7		
4	81.7		
3	75.1		
2.5	68.4		
2	62.8		
1.5	58.4		
1	55.0		
.75	53.5		
.50	51.1		
.375	49.2		
#4	40.8		
#8	31.8		
#10	30.1		
#16	26.0		
#30	22.0		
#40	20.1		
#50	18.1		
#100	14.3		
#200	11.5		

* (no specification provided)

Material Description

GM Silty gravel with sand

Atterberg Limits (ASTM D 4318)

PL= 33 **LL=** 44 **PI=** 11

Classification

USCS (D 2487)= GM **AASHTO (M 145)=** A-2-7(0)

Coefficients

D_{90}=	114.5745	D_{85}=	107.1174	D_{60}=	42.9250
D_{50}=	10.6207	D_{30}=	1.9791	D_{15}=	0.1727
D_{10}=		C_u=		C_c=	

Remarks

Date Received: 1/15/19 **Date Tested:** 1/23/19

Tested By: R. Barrett

Checked By: J. Butler

Title: P.E.

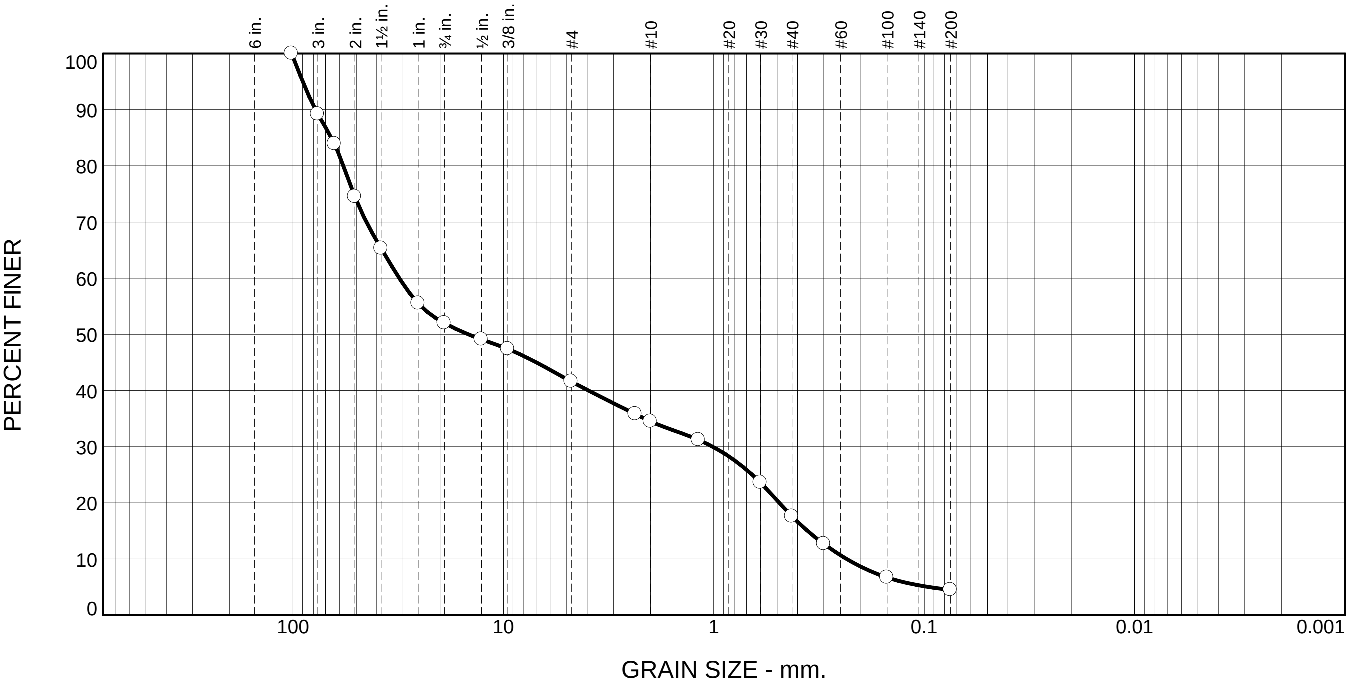
Location: TH-1
Sample Number: C10213-A **Depth:** 2'-3'
Date Sampled: 1/14/19

TRAUTNER GEOTECH LLC

Client: Ms. Joanne Fagan, P.E., Town of Hotchkiss Engineer
Project: Hotchkiss Barrow Mesa Shop Structure, Hotchkiss, CO

Project No: 55531GE **Figure** 4.1

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
10.8	37.2	10.4	7.1	16.9	13.1	4.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
4	100.0		
3	89.2		
2.5	83.9		
2	74.5		
1.5	65.3		
1	55.5		
.75	52.0		
.50	49.1		
.375	47.4		
#4	41.6		
#8	35.8		
#10	34.5		
#16	31.2		
#30	23.6		
#40	17.6		
#50	12.7		
#100	6.7		
#200	4.5		

* (no specification provided)

Material Description

GP-GM Poorly graded gravel with silt and sand

Atterberg Limits (ASTM D 4318)

PL= 0 **LL=** 0 **PI=** 0

Classification

USCS (D 2487)= GP-GM **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 78.2066 D_{85}= 65.6535 D_{60}= 31.2540
D_{50}= 14.6674 D_{30}= 1.0124 D_{15}= 0.3583
D_{10}= 0.2335 C_u= 133.84 C_c= 0.14

Remarks

Date Received: 1/15/19 **Date Tested:** 1/23/19
Tested By: R. Barrett
Checked By: J. Butler
Title: P.E.

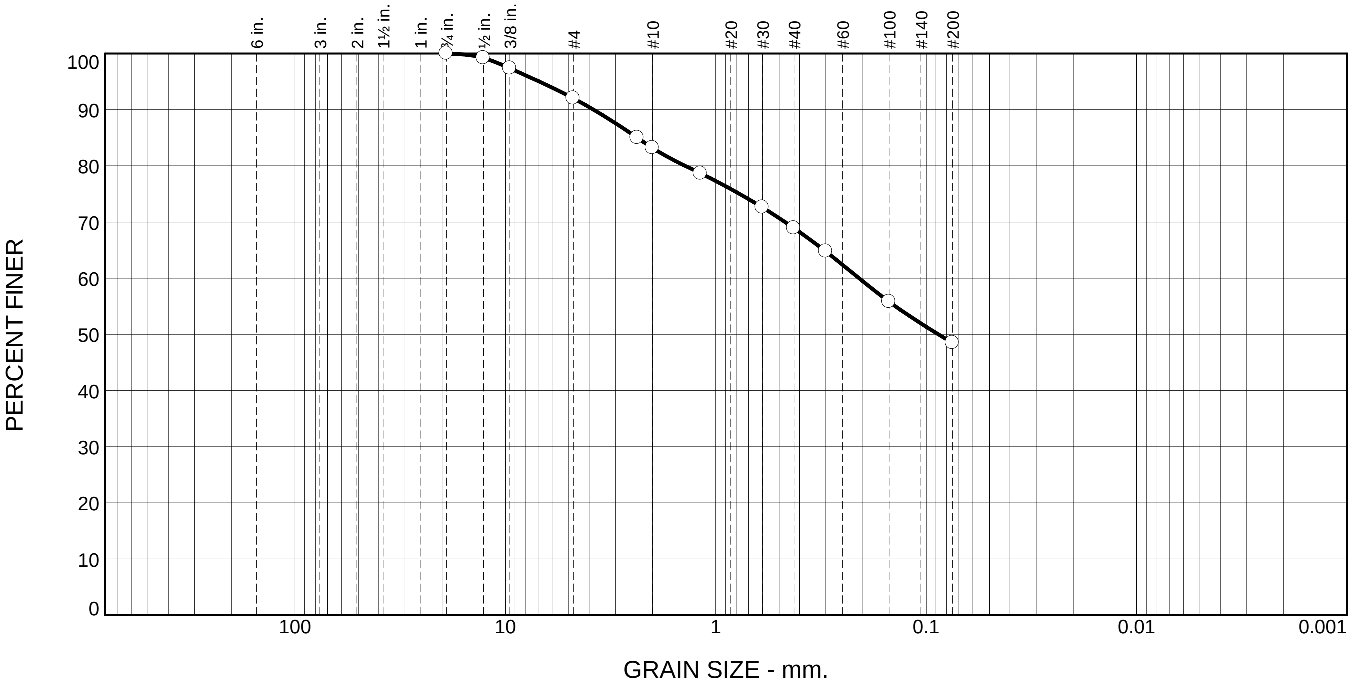
Location: TH-1
Sample Number: C10213-B **Depth:** 3'-4' **Date Sampled:** 1/14/19

TRAUTNER GEOTECH LLC

Client: Ms. Joanne Fagan, P.E., Town of Hotchkiss Engineer
Project: Hotchkiss Barrow Mesa Shop Structure, Hotchkiss, CO

Project No: 55531GE **Figure** 4.2

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	8.0	8.8	14.3	20.4	48.5	

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.75	100.0		
.50	99.2		
.375	97.4		
#4	92.0		
#8	85.0		
#10	83.2		
#16	78.7		
#30	72.6		
#40	68.9		
#50	64.8		
#100	55.8		
#200	48.5		

* (no specification provided)

Material Description

SM Silty sand

Atterberg Limits (ASTM D 4318)

PL= 27 **LL=** 40 **PI=** 13

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-6(4)

Coefficients

D_{90}= 3.8112 D_{85}= 2.3597 D_{60}= 0.2086
D_{50}= 0.0875 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 1/15/19 **Date Tested:** 1/23/19

Tested By: R. Barrett

Checked By: J. Butler

Title: P.E.

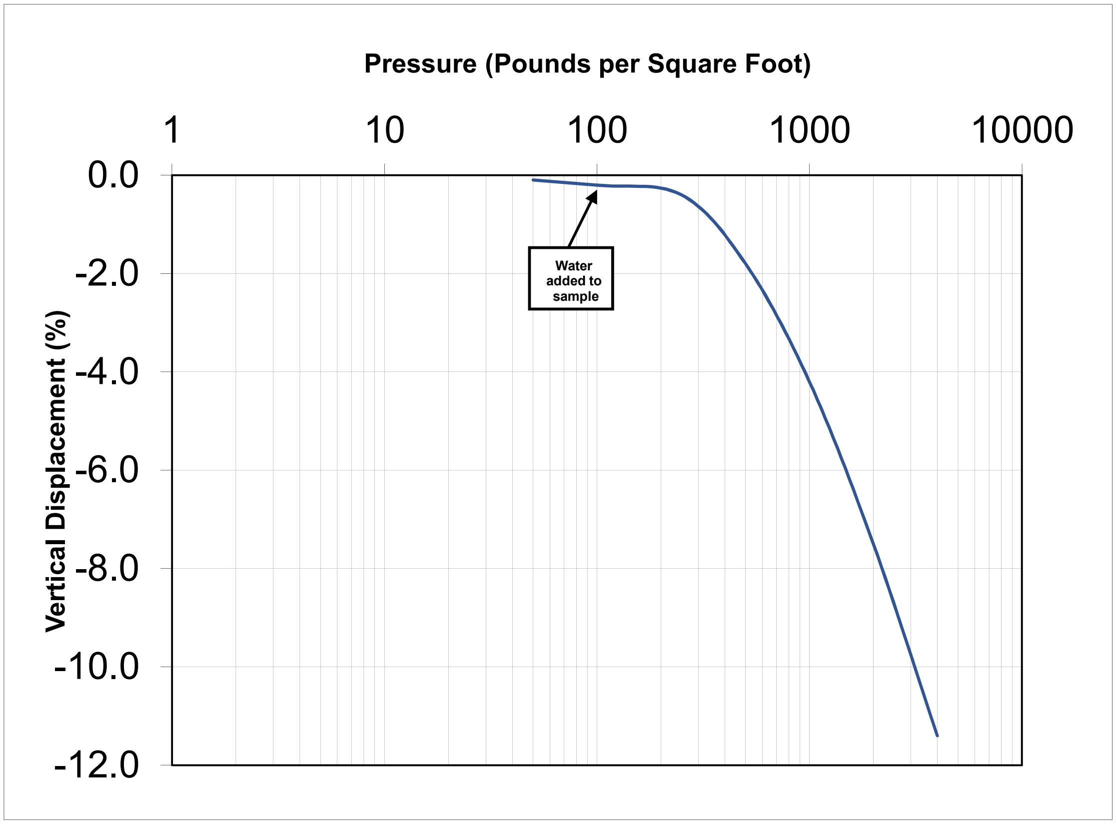
Location: TH-2
Sample Number: C10213-E **Depth:** 0'-1'
Date Sampled: 1/14/19

TRAUTNER GEOTECH LLC

Client: Ms. Joanne Fagan, P.E., Town of Hotchkiss Engineer
Project: Hotchkiss Barrow Mesa Shop Structure, Hotchkiss, CO

Project No: 55531GE **Figure** 4.3

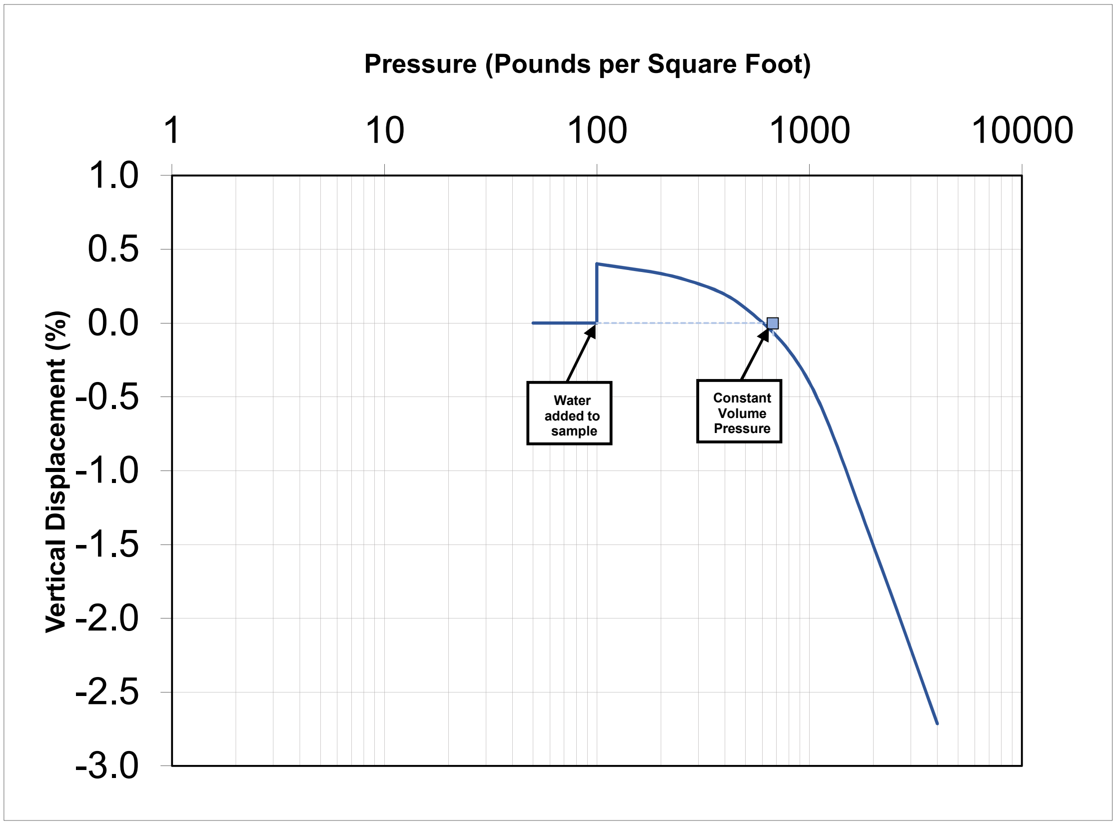
SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TH-1@1'	
Visual Soil Description:	SC Clayey Sand	
Swell Potential (%)	0.0%	
Constant Voume Swell Pressure (lb/ft^2):	350	
	Initial	**Final**
Moisture Content (%):	12.2	28.5
Dry Density (lb/ft^3):	84.9	95.3
Height (in.):	1.000	0.886
Diameter (in.):	1.94	1.94

Project Number:	55531GE
Sample ID:	C10213-C
Figure:	4.4

SWELL - CONSOLIDATION TEST

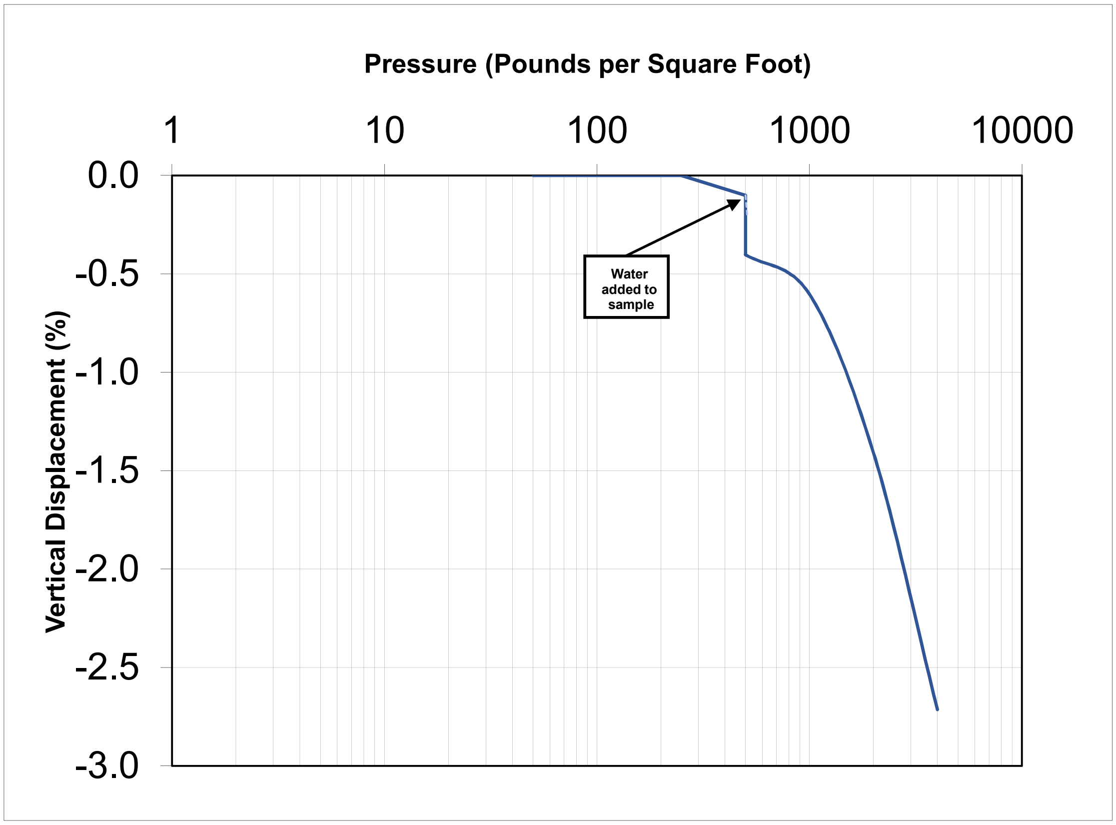


SUMMARY OF TEST RESULTS		
Sample Source:	TH-2@18"-30"	
Visual Soil Description:	CL Sandy lean clay	
Swell Potential (%)	0.4%	
Constant Voume Swell Pressure (lb/ft^2):	670	
	Initial	**Final**
Moisture Content (%):	8.9	28.9
Dry Density (lb/ft^3):	92.4	94.2
Height (in.):	0.995	0.968
Diameter (in.):	1.94	1.94

Note: Remolded Sample; Molded from the portion of sample passing a #10 sieve. Consolidated under 500 PSF prior to initiating load sequence and wetting. Initial values represent the conditions under 50 PSF following the pre-consolidation under 500 PSF.

Project Number:	55531GE
Sample ID:	C10213-F
Figure:	4.5

SWELL - CONSOLIDATION TEST

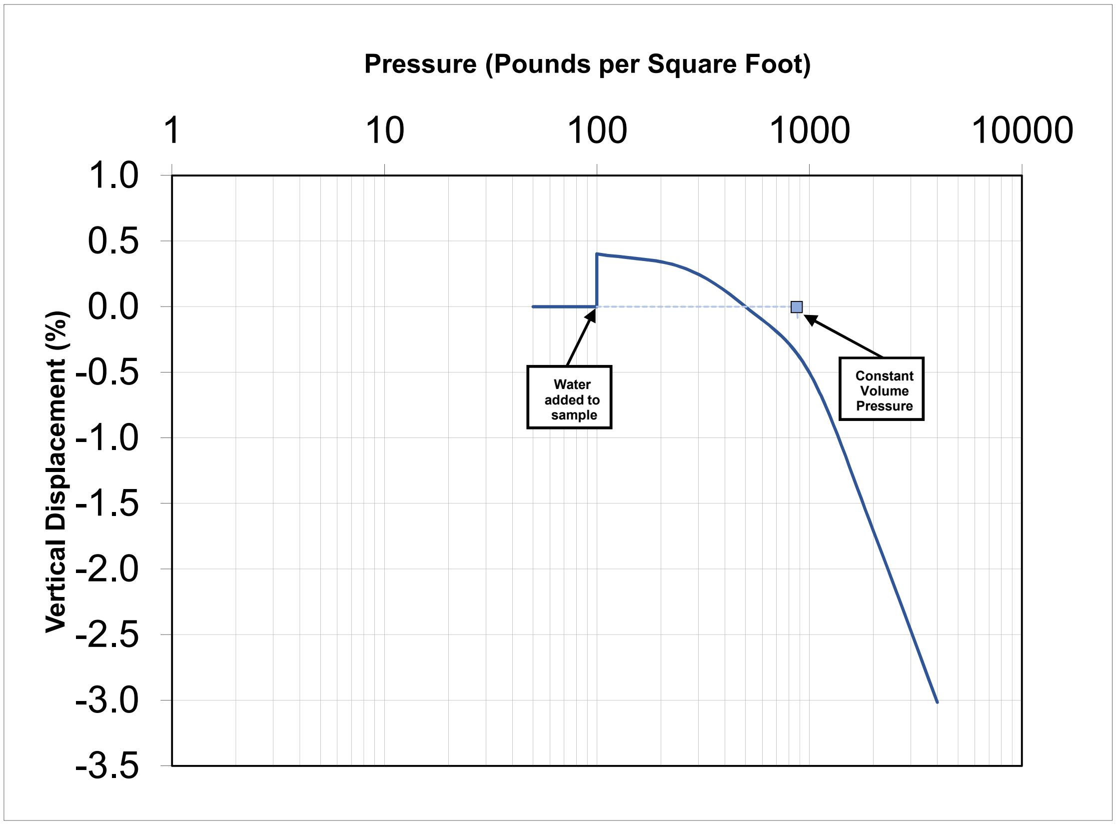


SUMMARY OF TEST RESULTS		
Sample Source:	TH-2@3'-4'	
Visual Soil Description:	SP Sand	
Swell Potential (%)	Consolidated	
Constant Voume Swell Pressure (lb/ft^2):	N/A	
	Initial	**Final**
Moisture Content (%):	6.5	21.5
Dry Density (lb/ft^3):	104.9	107.1
Height (in.):	0.995	0.968
Diameter (in.):	1.94	1.94

Note: Remolded Sample; Molded from the portion of sample passing a #10 sieve. Consolidated under 500 PSF prior to initiating load sequence and wetting. Initial values represent the conditions under 50 PSF following the pre-consolidation under 500 PSF.

Project Number:	55531GE
Sample ID:	C10213-G
Figure:	4.6

SWELL - CONSOLIDATION TEST

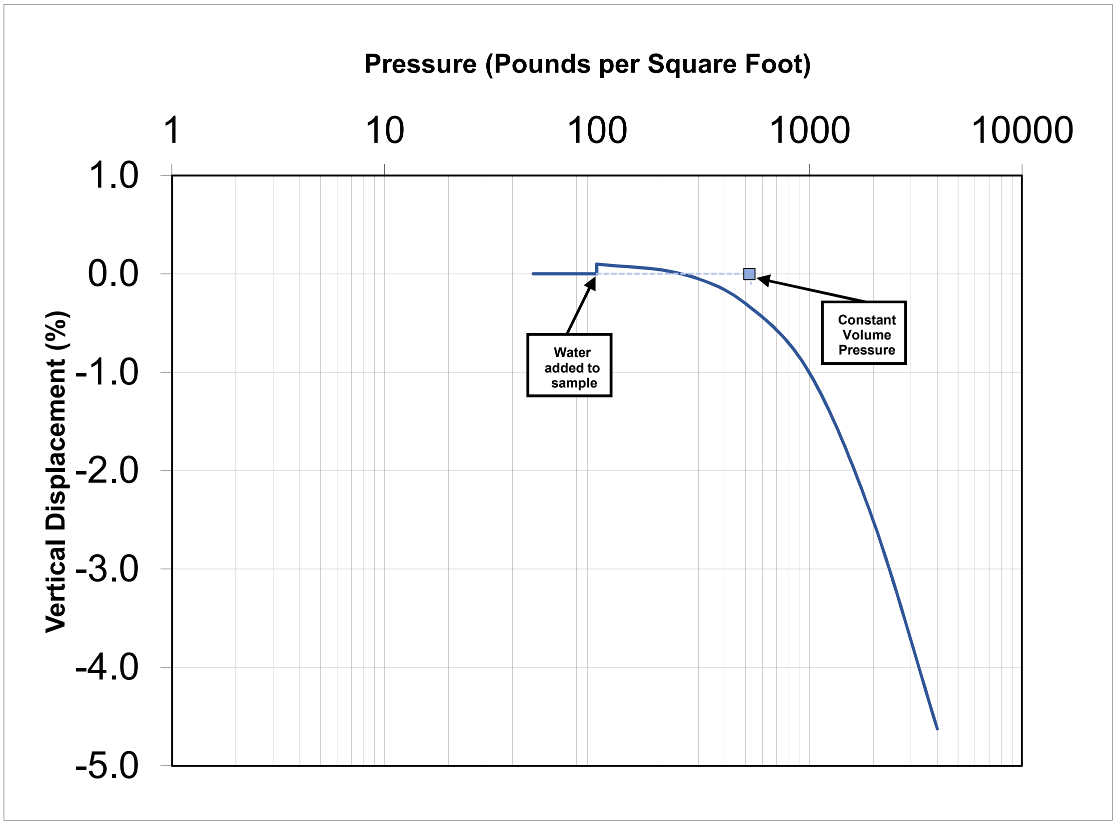


SUMMARY OF TEST RESULTS		
Sample Source:	TH-3@18"-30"	
Visual Soil Description:	SC Clayey Sand	
Swell Potential (%)	0.4%	
Constant Voume Swell Pressure (lb/ft^2):	870	
	Initial	**Final**
Moisture Content (%):	12.9	34.0
Dry Density (lb/ft^3):	85.9	88.1
Height (in.):	0.995	0.965
Diameter (in.):	1.94	1.94

Note: Remolded Sample; Molded from the portion of sample passing a #10 sieve. Consolidated under 500 PSF prior to initiating load sequence and wetting. Initial values represent the conditions under 50 PSF following the pre-consolidation under 500 PSF.

Project Number:	55531GE
Sample ID:	C10213-I
Figure:	4.7

SWELL - CONSOLIDATION TEST

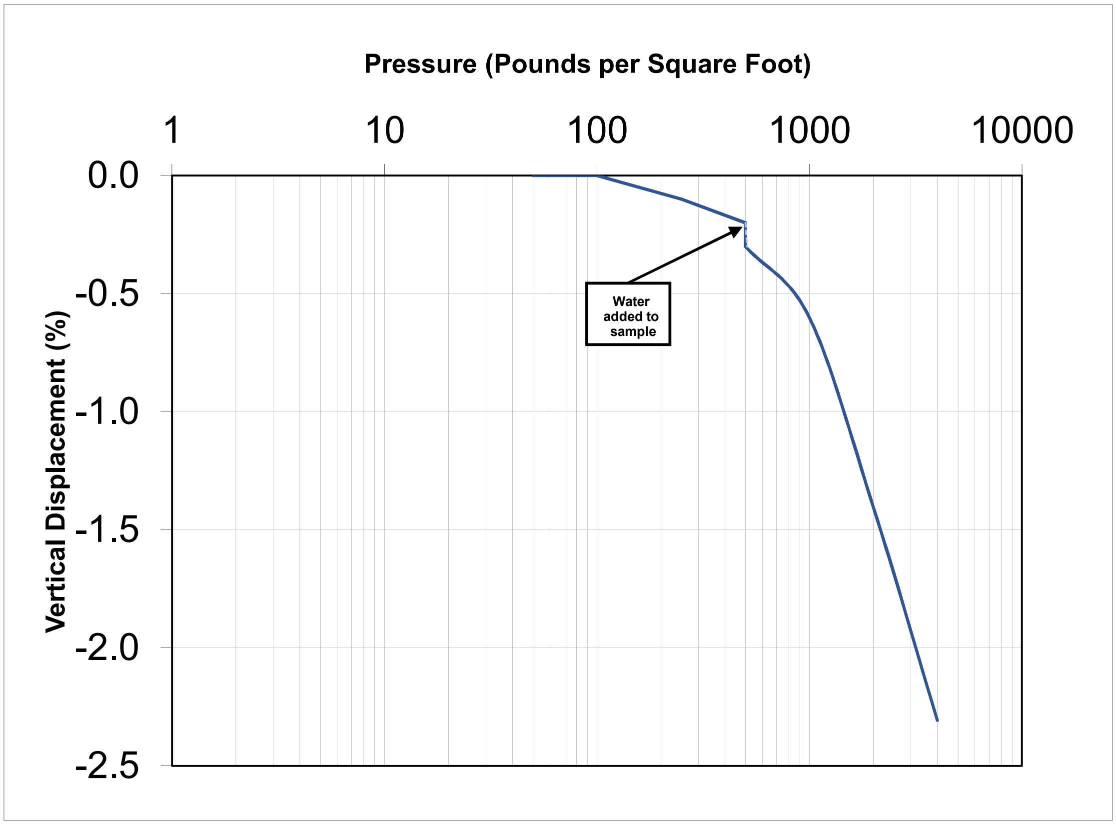


SUMMARY OF TEST RESULTS		
Sample Source:	TH-4@18"-30"	
Visual Soil Description:	CL-ML Silty Clay	
Swell Potential (%)	0.1%	
Constant Voume Swell Pressure (lb/ft^2):	520	
	Initial	**Final**
Moisture Content (%):	13.3	39.0
Dry Density (lb/ft^3):	77.4	80.6
Height (in.):	0.995	0.949
Diameter (in.):	1.94	1.94

Note: Remolded Sample; Molded from the portion of sample passing a #10 sieve. Consolidated under 500 PSF prior to initiating load sequence and wetting. Initial values represent the conditions under 50 PSF following the pre-consolidation under 500 PSF.

Project Number:	55531GE
Sample ID:	C10213-K
Figure:	4.8

SWELL - CONSOLIDATION TEST



SUMMARY OF TEST RESULTS		
Sample Source:	TH-4@36"-48"	
Visual Soil Description:	SC Clayey Sand	
Swell Potential (%)	Consolidated	
Constant Voume Swell Pressure (lb/ft^2):	N/A	
	Initial	**Final**
Moisture Content (%):	7.4	23.2
Dry Density (lb/ft^3):	103.0	104.3
Height (in.):	0.997	0.974
Diameter (in.):	1.94	1.94

Note: Remolded Sample; Molded from the portion of sample passing a #10 sieve. Consolidated under 500 PSF prior to initiating load sequence and wetting. Initial values represent the conditions under 50 PSF following the pre-consolidation under 500 PSF.

Project Number:	55531GE
Sample ID:	C10213-L
Figure:	4.9