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# SUBSURFACE SOIL INVESTIGATION
# FALCON FIRE STATION
# 7030 OLD MERIDIAN ROAD
# EL PASO COUNTY, COLORADO

Prepared for:

**Falcon Fire Department**
**3898 Maizeland Road**
**Colorado Springs, Colorado 80909**

**Attn: Trent Harwig**

April 20, 2020

Respectfully Submitted,

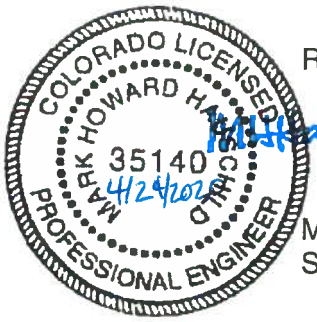
ENTECH ENGINEERING, INC.

Daniel P. Stegman

DPS/kah

Encl.

Entech Job No. 200569
AAprojects/2020/200569 ssi




Reviewed by:

Mark H. Hauschild, P.E.
Senior Engineer

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# SUBSURFACE SOIL INVESTIGATION
# FALCON FIRE STATION
# 7030 OLD MERIDIAN ROAD
# EL PASO COUNTY, COLORADO

## 1.0 INTRODUCTION

Falcon Fire District c/o LDC, Inc. is planning the redevelopment of the Falcon Fire Station property located at 7030 Old Meridian Road, in the southern portion of Falcon, in El Paso County, Colorado. The redevelopment consists of the construction of a new fire station and parking/drive areas. The approximate location of the project site is shown on the Vicinity Map, Figure 1. The proposed site plan is shown on Figure 2, the Test Boring Location Map.

This report describes the subsurface investigation conducted for the planned building and provides recommendations for foundation design and construction. The subsurface soil investigation included drilling test borings at seven locations: two in the footprint of the planned building, and five in the parking and drive areas, collecting samples of soil, and conducting a geotechnical evaluation of the investigation findings. A pavement design will be provided under separate cover. All drilling and subsurface investigation activities were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.0.

## 2.0 PROJECT AND SITE DESCRIPTION

It is our understanding that the project will consist of the redevelopment of the Falcon Fire Station, including the construction of a new fire station and associated site improvements. The building will utilize slab-on-grade floors. At the time of drilling, the proposed building site was vacant and vegetation consisted of weeds and grasses. The building area is relatively flat. The site is located at 7030 Old Meridian Road in Falcon, El Paso County, Colorado. Adjacent properties consist of open fields and Highway 24 to the south with the existing Falcon Fire Station located in the northeast portion of the site. Existing retail properties are located to the east and south of the site and a residence exists north of the site.

## 3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were investigated by drilling seven exploratory test borings: two within the proposed building footprint and five in the parking/drive areas, at the locations shown on Figure 2. The borings were drilled to 10 to 20 feet below the existing ground surface. The drilling was performed using a truck-mounted continuous flight auger-drilling rig supplied and operated by Entech Engineering, Inc. Boring Logs description of the subsurface conditions encountered during drilling is presented in Appendix A. At the conclusion of drilling and subsequent to drilling, observations of groundwater levels were made in each of the open borings.

Soil samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D-1586) using a 2-inch O.D. split-barrel sampler and a California Sampler. Results of the Standard Penetration Test (SPT) are included on the Test Boring Logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified and recorded on the Test Boring Logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the Test Boring Logs. The Test Boring Logs are presented in Appendix A.

Moisture Content, ASTM D-2216, was obtained in the laboratory for all recovered samples. Grain-Size testing, ASTM D-422 and Atterberg limits testing were performed on various samples for the purpose of classification and to obtain pertinent engineering characteristics. Volume change testing was performed on selected samples using Swell/Consolidation and FHA

Swell tests in order to evaluate potential expansion/compression characteristics of the soil. Soluble sulfate testing was performed on select samples to evaluate the corrosive characteristics of the soils. The Laboratory Test Results are included in Appendix B and summarized in Table 1.

## 4.0 SUBSURFACE CONDITIONS

Two soil types and two bedrock types were encountered in the borings drilled for the subsurface investigation: Type 1: silty and clayey to very clayey sand (SM, SC), Type 2: silty to sandy clay (CL), Type 3: silty sandstone and well-graded sandstone (SM, SW) and Type 4: silty to sandy claystone (CL). The soil and rock types were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

### 4.1 Soil

Soil Type 1 is a silty and clayey to very clayey sand (SM, SC). The sand was encountered in all of the test borings at the existing surface and extending to depths ranging from 9 feet to the termination of Test Boring Nos. 6 and 7, (10 feet bgs). Standard Penetration Testing on the sand resulted in N-values ranging from 4 to 36 bpf, which indicates loose to medium dense states. Water content and grain size analysis conducted on samples resulted in water contents of approximately 2 to 18 percent, with approximately 9 to 41 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing resulted in liquid limits of 14 and no value and plastic indexes of 9 and non-plastic. FHA Swell testing resulted in an expansion pressure of 180 psf, indicating low expansion potential. Sulfate testing resulted in 0.00 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 2 is a silty to sandy clay (CL). The clay was encountered in four of the test borings below the sand at 9 feet and extending to 14 to 18 feet bgs in Test Boring Nos. 1 and 2, and to the termination of Test Boring Nos. 3 and 5 (10 feet bgs). Standard Penetration Testing on the clay resulted in N-values ranged from 15 to 33 bpf, which indicates stiff to very stiff consistencies. Water content and grain size analysis conducted on samples resulted in water contents of approximately 14 to 20 percent, with approximately 88 percent of the soil size

particles passing the No. 200 sieve. Atterberg limits testing resulted in a liquid limit of 40 and a plastic index of 20. Swell/Consolidation testing on a sample of sandy clay resulted in a volume change of 0.6 percent, which indicates low expansion potential. Moderately to highly expansive clays have been encountered in the area. Sulfate testing resulted in 0.00 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 3 classified as a silty sandstone and well-graded sandstone (SM, SW). The sandstone was encountered in three of the test borings at depths ranging from 13 to 18 feet bgs and extending to the termination of the borings (20 feet bgs). Standard Penetration Testing on the sandstone resulted in N-values greater than 50 bpf, indicating very dense states. Water content and grain size testing resulted in water contents of 14 to 20 percent with approximately 5 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing indicated non-plastic results. Sulfate testing resulted in 0.00 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 2 is a silty to sandy claystone (CL). The claystone was encountered in two of the test borings at depths of 9 and 14 feet and extending to depths of 13 and 17 feet bgs. Standard Penetration Testing on the claystone resulted in N-values greater than 50 bpf, which indicates hard consistencies. Water content and grain size analysis conducted on samples resulted in water contents of approximately 13 and 16 percent, with approximately 94 percent of the soil size particles passing the No. 200 sieve. Atterberg limits testing resulted in a liquid limit of 38 and a plastic index of 16. Swell/Consolidation testing on a sample of sandy claystone resulted in a volume change of 1.6 percent, which indicates a moderate expansion potential. Highly expansive claystone is common in this area. Sulfate testing resulted in 0.00 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Additional descriptions and engineering properties of the soil encountered during drilling are included on the boring logs (Appendix A). Laboratory Testing Results are summarized on Table 1 and presented in Appendix B. It should be understood that the soil descriptions reported on the boring logs may vary between boring locations and sampling depths. Similarly, the lines of

stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual transitions between types may be more gradual or variable.

### 4.2 Groundwater

Groundwater was encountered in three of the test borings at 17 feet. Groundwater was not encountered in the test borings which were drilled to 10 feet. It is anticipated groundwater will not affect shallow foundations constructed on this site. Development of this and adjacent properties, as well as seasonal precipitation changes, and changes in runoff may affect groundwater elevations.

## 5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

*The following discussion is based on the subsurface conditions encountered in the borings drilled in the planned building footprint. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.*

The site will be developed by constructing a new fire station and associated site improvements. Given the subsurface conditions encountered at the time of drilling and the site development as described, it is anticipated that a shallow foundation resting on the native medium dense to dense sands, recompacted loose sands, or structural fill will be utilized. The native medium dense granular soils encountered in the test borings are suitable to support the shallow foundation. Expansive clay soils and claystone were encountered in Test Boring Nos. 1 through 5 at 9 feet. Additionally, very clayey sand lenses were encountered in the sand soil profile. Expansive soils are not expected at shallow foundation depths. If expansive soils are encountered at foundation or slab grade, they will require overexcavation and replacement with structural fill compacted according to the "Structural Fill" paragraph. SPT N-values measured in the sands indicated loose to medium dense conditions. Loose soils should be penetrated or removed and recompacted according to the "Structural Fill" paragraph. Design considerations are discussed in the following sections.

Groundwater was encountered in three of the test borings at 17 feet. Groundwater was not encountered in the test borings which were drilled to 10 feet. It is anticipated groundwater will not affect shallow foundations constructed on this site.

### 5.1 Subgrade Improvements and Bearing Capacity

The structure can be supported with shallow foundations resting on the medium dense native sands, recompacted loose sands, or structural fill. Observations should be made following excavation to evaluate the subgrade for loose soils or expansive clay soils. Loose soils or uncontrolled fill material encountered beneath foundation components or floor slabs, will require removal and recompaction. Any new fill should be placed to the requirements of the "Structural Fill" paragraph. On-site granular sands may be used as structural fill as approved by Entech. Any import material should be approved by Entech prior to hauling to the site.

Clay soils and claystone were at 9 feet bgs in Test Boring Nos. 1 through 5. Additionally, very clayey sand lenses were encountered at anticipated foundation grades in some of the test borings. The clay soils in the area are known to be expansive and would provide unequal soil bearing in comparison to the well compacted site sand soils. Expansive soils at or near slab or foundation grades should be penetrated or removed and replaced with structural fill or suitable site soils. The structural fill/site materials should be a non-expansive soil approved by Entech. An overexcavation depth of 3 to 4 feet, if required, is anticipated.

Provided the above recommendations are followed, an allowable bearing pressure of 2400 psf is recommended for structural fill, native medium dense sands or recompacted sands. For final design, continuous spread footings are recommended to have a minimum width of 16 inches, and individual column footings should have minimum plan dimensions of 24 inches on each side. Exterior footings should extend a minimum of 30 inches below the adjacent exterior surface grade for frost protection. Following the above foundation subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation designs, which should limit total and differential vertical movements up to 1 and ½ inches respectively.

Foundation excavations are recommended to extend at least 4 feet horizontally beyond the foundation wall limits (inside and outside) in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill. All foundation excavation side slopes should be inclined at angles of 1½ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe overexcavated subgrades as well as the overall foundation excavation subgrade and evaluate if the exposed conditions are consistent with those described in this report. Entech should also provide recommendations for overexcavation depth, if necessary, and the need for drain systems based on the excavation conditions observed at that time.

Foundation walls should be designed to resist lateral pressures generated by the soils on this site. An equivalent hydrostatic fluid pressure (in the active state) of 45 pcf is recommended for the granular site soils and is anticipated for imported granular structural fills. It should be noted that this value applies to level backfill conditions. If sloping backfill conditions exist, pressures will increase substantially depending on the conditions adjacent to the walls. Surcharge loading should also be considered in wall designs. Equivalent fluid pressures for sloping conditions should be determined on an individual basis.

### 5.2 Site Seismic Classification

Based on the subsurface conditions encountered at the site and in accordance with Section 1613 of the 2015 International Building Code (IBC), the site meets the conditions of a Site Class D.

### 5.3 On-Grade Floor Slabs

The floor slabs may be supported on structural fill, native sands or recompacted on-site sand. Slabs placed on loose or uncontrolled fill soils should be expected to experience movement. In areas of truck traffic, consideration should be given to placing at least 3 feet of imported or onsite granular fill below floor slabs to reduce slab movement. Clay soils encountered at or within 3 to 4 feet of floor slab grade it should be removed and replaced with a non-expansive on-site or imported structural fill. The depth of overexcavation should be determined at the time of the excavation observation. On-site or imported granular soils, as approved by Entech, may

be used as structural fill. Structural fill should be compacted to a minimum of 95 percent of its Maximum Modified Proctor Dry Density Test (ASTM D-1557). The fill should be moisture conditioned to ±2 percent of the optimum moisture content as determined to aid in compaction. All soil beneath the slab should be free of organics, debris and stone sized larger than 3 inches in diameter.

Grade supported floor slabs should be separated from other building structural components and utility penetrations to allow for possible future vertical movement unless they are designed as part of the foundation system. Interior partition walls should be constructed in such a manner so as not to transfer slab movement into the overlying floor(s) and/or roof members, should slab movement occur. Control joints in grade-supported slabs are recommended and should be placed according to ACI Guidelines.

### 5.4 Surface and Subsurface Drainage

Positive surface drainage must be maintained around the structure to minimize infiltration of surface water. A minimum gradient of 5 percent in the first 10 feet adjacent to foundation walls is recommended. A minimum gradient of 2 percent is recommended for paved areas. All grades should be directed away from the structure. All downspouts should be extended to discharge well beyond the backfill zone of the structure.

A subsurface perimeter drain is not required providing the slab is located above exterior grade, interior and exterior backfill is properly compacted, surface grading is maintained and irrigation is minimized. A subsurface perimeter drain is recommended for useable space below finished grade. A typical drain detail is shown in Figure 3. The drain should be provided with a free gravity outlet or be connected to a sewer underdrain. If such an outlet or connection is not available within a reasonable distance from the structure, a sump and pump system would be required.

To help minimize infiltration of water into the foundation zone, vegetative plantings placed close to foundation walls should be limited to those species having low watering requirements and irrigated grass should not be located within 5 feet of the foundation. Similarly, sprinklers are not recommended to discharge water within 5 feet of foundations. Irrigation near foundations

should be limited to the minimum amount sufficient to maintain vegetation. Application of more irrigation water than necessary can increase the potential for slab and foundation movement.

### 5.5 Concrete

Soluble sulfate testing was conducted on several samples of the site soils to evaluate the potential for sulfate attack on concrete placed below the surface grade. The test results indicated 0.00 percent soluble sulfate by weight for the site soils. The test results indicate the sulfate component of the in-place site soils present a negligible exposure threat to concrete placed below grade that comes into contact with the site soils.

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in the foundation excavation prior to the placement of concrete. If standing water is present in the foundation excavation, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

### 5.6 Foundation Excavation Observation

Subgrade preparation for building foundations should be observed by Entech Engineering prior to construction of the footings and floor slab in order to verify that (1) no anomalies are present, (2) materials of the proper bearing capacity have been encountered or placed, and (3) no soft, loose, uncontrolled fill material, expansive soil or debris are present in the foundation area prior to concrete placement or backfilling. Entech should make final recommendations for over-excavation, if required, and foundation drainage at the time of excavation observation, if necessary.

### 5.7 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The surface should be scarified and moisture conditioned to within ±2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified

Proctor Dry Density (ASTM D-1557) beneath footings or floor slabs prior to placing new fill. New fill beneath footings should be non-expansive and be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557). These materials should be placed at a moisture content conducive to compaction, usually ±2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site and on-site granular soils prior to placement.

Compacted, non-expansive granular soil, free of organics, debris and cobbles greater than 3-inches in diameter, is recommended for filling foundation components and for filling beneath floor slabs. All fill placed within the foundation area should be non-expansive and be compacted to a minimum of 95 percent of the soils maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Fill material placed beneath floor slabs should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of six inches or less. Fill should be placed at water contents conducive to achieving adequate compaction, usually within ±2 percent of the optimum water content as determined by ASTM D-1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at distance from foundation walls and below slab infrastructure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of foundation or floor slab fill material.

### 5.8 Utility Trench Backfill

Fill placed in utility trenches should be compacted to a minimum of 95 percent of its maximum dry density as determined by the Standard Proctor Test (ASTM D-698) for cohesive soils and 95 percent as determined by the Modified Proctor Test (ASTM D-1557) for cohesionless soils. Fill should be placed in horizontal lifts having a compacted thickness of six inches or less and at a water content conducive to adequate compaction, within ±2 percent of the optimum water content. Mechanical methods should be used for fill placement; however, heavy equipment should be kept at a distance from foundation walls. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

Trench backfill placement should be performed in accordance with El Paso County specifications. All excavation and excavation shoring/bracing should be performed in accordance with OSHA guidelines.

### 5.9 General Backfill

Any areas to receive fill outside the foundation limits should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 12-inches and moisture conditioned to ±2 percent of the optimum water content, and compacted to a minimum of 95 percent of the ASTM D-1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95 percent of the ASTM D-1557 maximum dry density. Fill material should be free of vegetation and other unsuitable material and shall not contain rocks or fragments greater than 3-inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches, beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

### 5.10 Excavation Stability

Excavation sidewalls must be properly sloped, benched and/or otherwise supported in order to maintain stable conditions. All excavation openings and work completed therein shall conform to OSHA Standards as put forward in CFR 29, Part 1926.650-652, (Subpart P).

### 5.11 Winter Construction

In the event construction of the planned facility occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the foundation subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to eliminate burial of snow, ice or frozen material within the planned construction area.

### 5.12 Construction Observations

It is recommended that Entech observe and document the following activities during construction of the building foundations.

- Excavated subgrades and subgrade preparation.
- Placement of drains (if installed).
- Placement/compaction of fill material for the foundation components or floor slab.
- Placement/compaction of utility bedding and trench backfill.

## 6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use by the Falcon Fire Department with application to the planned fire station to be located at 7030 Old Meridian Road, in Falcon, El Paso County, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

# TABLE

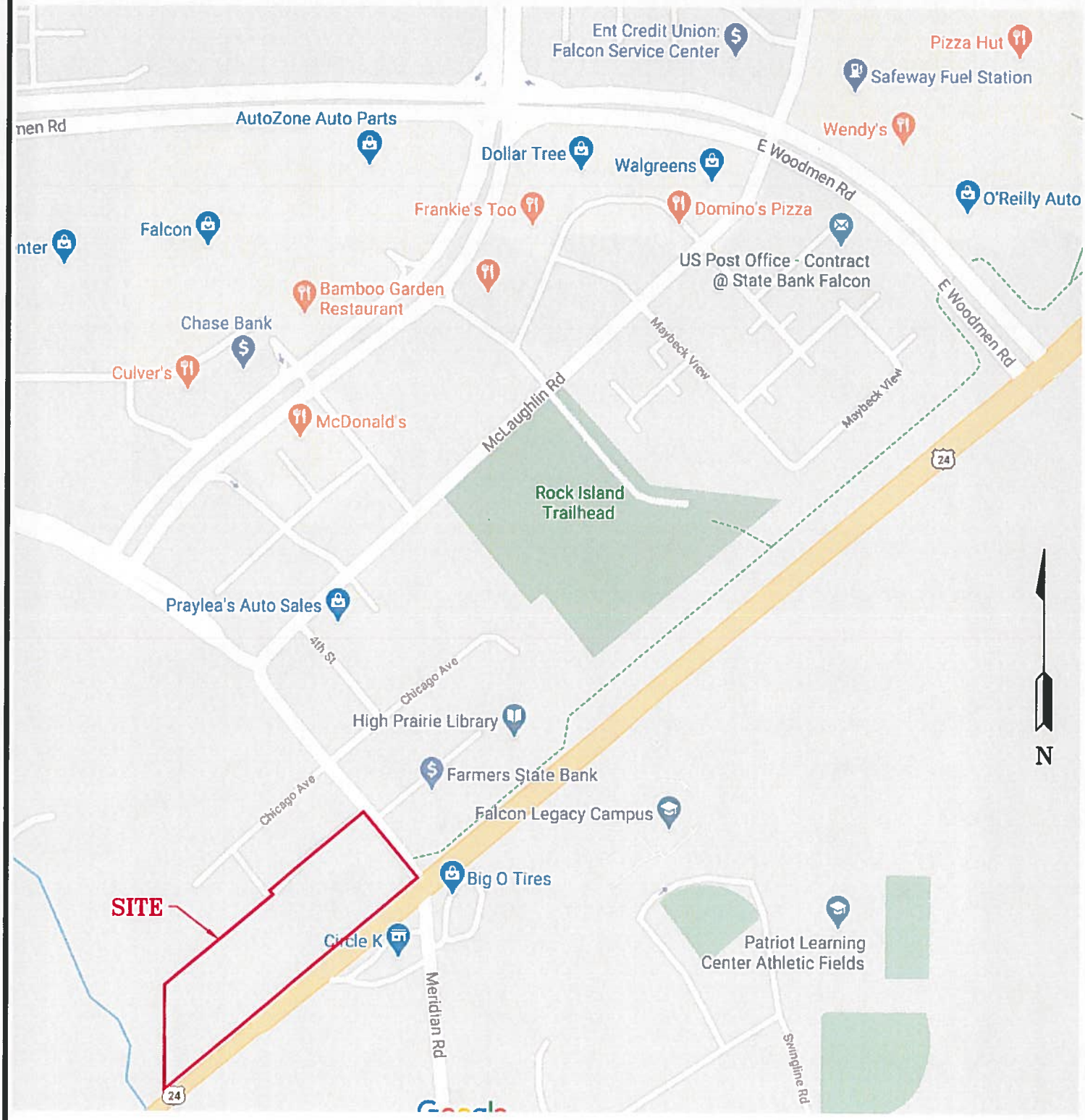
# TABLE 1

## SUMMARY OF LABORATORY TEST RESULTS

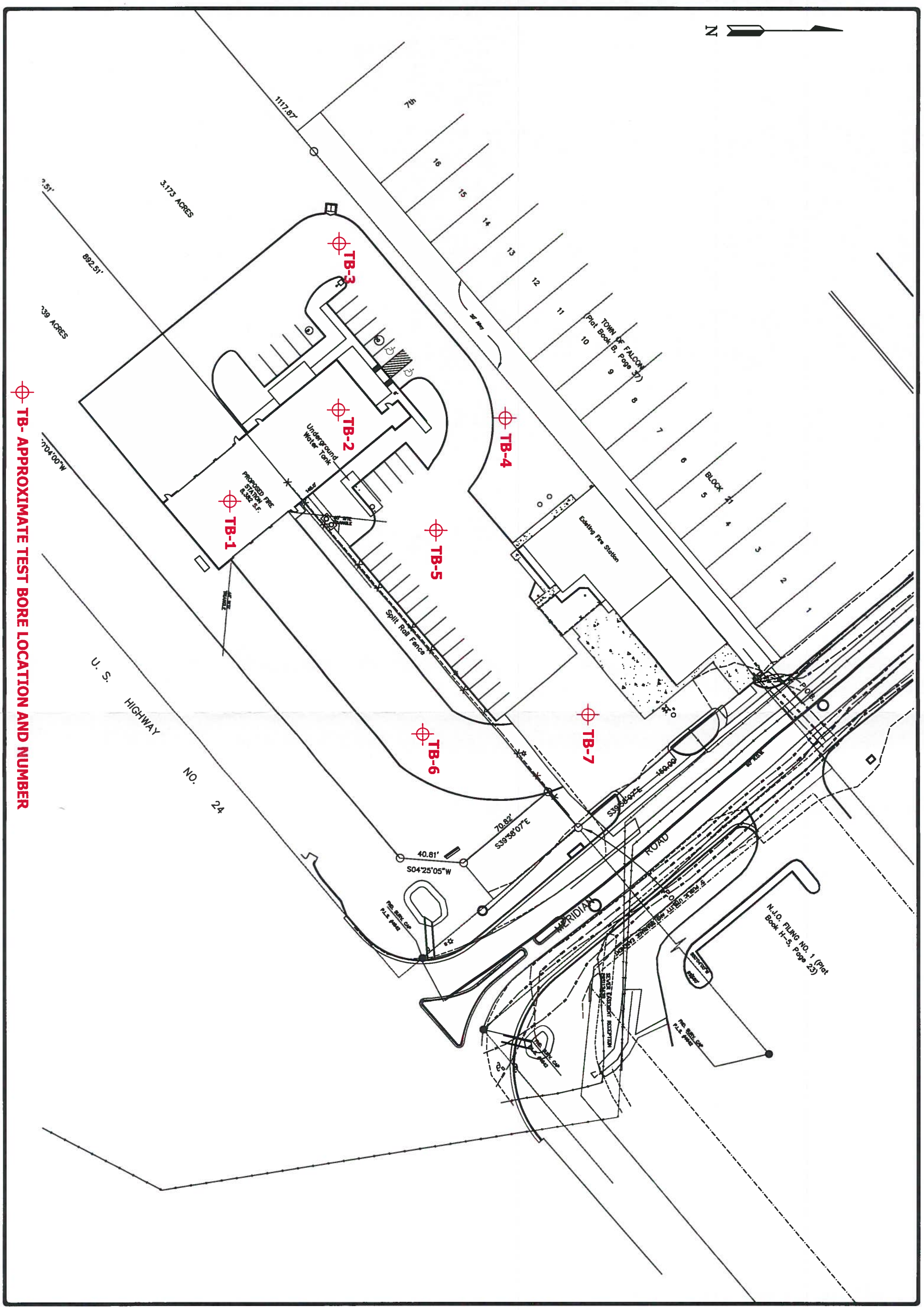
CLIENT FALCON FIRE DEPARTMENT
PROJECT 7030 OLD MERIDIAN ROAD
JOB NO. 200569

| SOIL TYPE | TEST BORING NO. | DEPTH (FT) | WATER (%) | DRY DENSITY (PCF) | PASSING NO. 200 SIEVE (%) | LIQUID LIMIT (%) | PLASTIC INDEX (%) | SULFATE (WT %) | FHA SWELL (PSF) | SWELL/ CONSOL (%) | UNIFIED CLASSIFICATION | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 5 | | | 34.6 | | | | 180 | | SC | SAND, CLAYEY |
| 1 | 2 | 2-3 | | | 22.0 | NV | NP | 0.00 | | | SM | SAND, SILTY |
| 1 | 3 | 1 | | | 23.5 | | | | | | SM | SAND, SILTY |
| 1 | 3 | 2 | | | 41.2 | 14 | 9 | | | | SC | SAND, VERY CLAYEY |
| 1 | 5 | 1-2 | | | 15.5 | NV | NP | 0.00 | | | SM | SAND, SILTY |
| 1 | 6 | 1-2 | | | 19.2 | NV | NP | | | | SM | SAND, SILTY |
| 1 | 7 | 1-2 | | | 9.3 | NV | NP | | | | SM-SW | SAND, SLIGHTLY SILTY |
| 2 | 2 | 10 | 17.2 | 112.6 | 88.0 | 40 | 20 | 0.00 | | 0.6 | CL | CLAY, SANDY |
| 3 | 1 | 20 | | | 4.9 | NV | NP | 0.00 | | | SW | SANDSTONE |
| 4 | 4 | 10 | 17.5 | 112.8 | 93.7 | 38 | 16 | 0.00 | | 1.6 | CL | CLAYSTONE, SANDY |

# FIGURES




| | | | |
|---|---|---|---|
| **ENTECH ENGINEERING, INC.** 505 ELKTON DRIVE COLORADO SPRINGS, CO. 80907 (719) 531-5599 | **Vicinity Map**<br>**7030 Old Meridian Road**<br>**Peyton, Colorado**<br>**For: Falcon Fire Dept. c/o LDC, Inc.** | | JOB NO.: 200569<br>FIG NO.: 1 |
| | DRAWN: JAC | DATE: 04/10/20 | CHECKED: DS | DATE: |

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DATE 05
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JOB NO. 200559
PAGE NO. 2

Test Boring Location Map
7030 Old Meridian Road
Peyton, Colorado
For: Falcon Fire Dept. c/o LDC, Inc.

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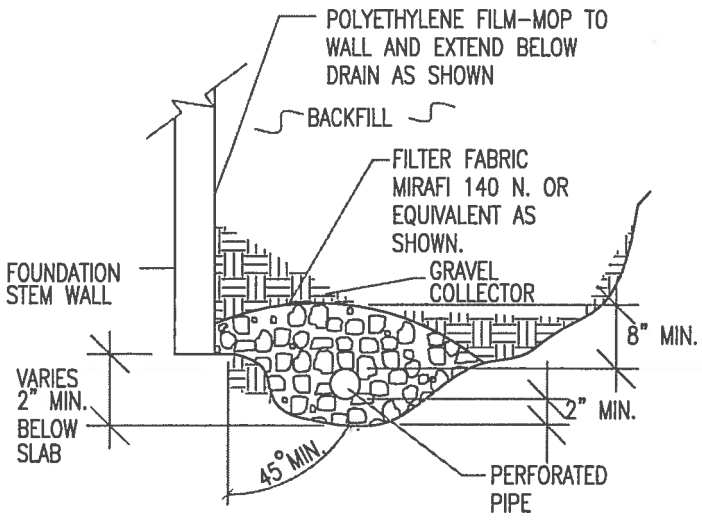
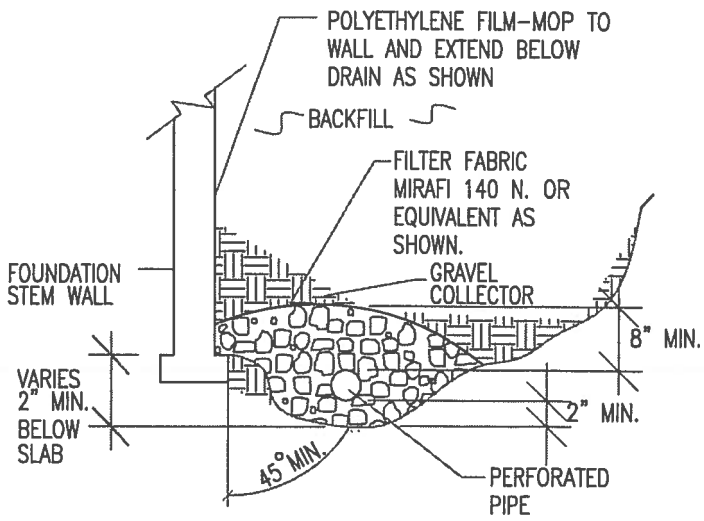
REVISION BY




NOTES:

–GRAVEL SIZE IS RELATED TO DIAMETER OF PIPE PERFORATIONS–85% GRAVEL GREATER THAN 2x PERFORATION DIAMETER.

–PIPE DIAMETER DEPENDS UPON EXPECTED SEEPAGE. 4–INCH DIAMETER IS MOST OFTEN USED.

–ALL PIPE SHALL BE PERFORATED PLASTIC. THE DISCHARGE PORTION OF THE PIPE SHOULD BE NON–PERFORATED PIPE.

–FLEXIBLE PIPE MAY BE USED UP TO 8 FEET IN DEPTH, IF SUCH PIPE IS DESIGNED TO WITHSTAND THE PRESSURES. RIGID PLASTIC PIPE WOULD OTHERWISE BE REQUIRED.

–MINIMUM GRADE FOR DRAIN PIPE TO BE 1% OR 3 INCHES OF FALL IN 25 FEET.

–DRAIN TO BE PROVIDED WITH A FREE GRAVITY OUTFALL, IF POSSIBLE. A SUMP AND PUMP MAY BE USED IF GRAVITY OUT FALL IS NOT AVAILABLE.

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

PERIMETER DRAIN DETAIL

| DRAWN: | DATE: | DESIGNED: DS | CHECKED: |
|---|---|---|---|

JOB NO.: 200569

FIG NO.: 3

# APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 3/20/2020
Job # 200569

| REMARKS | Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|---|
| WATER @ 17', 4/2/20 | | | | | | |
| SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN, LOOSE, MOIST | | | | 7 | 3.0 | 1 |
| SAND, CLAYEY, FINE TO MEDIUM GRAINED, BROWN, LOOSE, VERY MOIST | 5 | | | 8 | 14.2 | 1 |
| CLAY, SILTY TO SANDY, GRAY BROWN, STIFF, MOIST | 10 | | | 15 | 20.3 | 2 |
| CARBONACEOUS MATERIAL | 15 | | | 27 | 13.8 | 2 |
| SANDSTONE, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, WET | 20 | | | 50/10" | 13.7 | 3 |

TEST BORING NO. 2
DATE DRILLED 3/20/2020
CLIENT FALCON FIRE DEPARTMENT
LOCATION 7030 OLD MERIDIAN ROAD

| REMARKS | Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|---|
| WATER @ 17', 4/2/20 | | | | | | |
| SAND, SILTY, FINE TO COARSE GRAINED, BROWN, LOOSE, MOIST | | | | 6 | 10.7 | 1 |
| SLIGHTLY SILTY LENSES | 5 | | | 17 | 9.1 | 1 |
| CLAY, SANDY, GRAY BROWN, VERY STIFF, MOIST | 10 | | | 33 | 19.4 | 2 |
| CLAYSTONE, SILTY TO SANDY, GRAY BROWN, HARD, MOIST | 15 | | | 50/11" | 12.9 | 4 |
| SANDSTONE, SILTY, FINE TO MEDIUM GRAINED, BROWN, VERY DENSE, WET | 20 | | | 50/10" | 20.4 | 3 |


**ENTECH**
**ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907


**TEST BORING LOG**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | | 4/6/20 |

JOB NO.: 200569
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 3/20/2020
Job # 200569

REMARKS

DRY TO 10', 3/20/20

| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|
| | | | 14 | 2.4 | 1 |
| | | | | | |
| 5 | | | 24 | 3.8 | 1 |
| | | | | | |
| 10 | | | 32 | 14.5 | 2 |
| | | | | | |
| 15 | | | | | |
| | | | | | |
| 20 | | | | | |

SAND, SILTY WITH VERY CLAYEY LENSES, FINE TO COARSE GRAINED, TAN TO BROWN, MEDIUM DENSE, MOIST

CLAY, SANDY, BROWN, VERY STIFF, MOIST

TEST BORING NO. 4
DATE DRILLED 3/20/2020
CLIENT FALCON FIRE DEPARTMENT
LOCATION 7030 OLD MERIDIAN ROAD

REMARKS

WATER @ 17', 4/2/20

| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|
| | | | 10 | 13.9 | 1 |
| | | | | | |
| 5 | | | 12 | 17.6 | 1 |
| | | | | | |
| 10 | | | 50/7" | 16.1 | 4 |
| | | | | | |
| 15 | | | 50/7" | 20.1 | 3 |
| | | | | | |
| 20 | | | 50/4" | | 3 |

SAND, SILTY TO CLAYEY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST

CLAYSTONE, SANDY, GRAY BROWN, HARD, MOIST

SANDSTONE, SILTY, FINE TO MEDIUM GRAINED, DARK GRAY BROWN, VERY DENSE, MOIST

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COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 3/20/2020
Job # 200569

| REMARKS | Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|---|
| DRY TO 10', 3/20/20 | | | | | | |
| SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN, MEDIUM DENSE, MOIST | | | | 16 | 4.2 | 1 |
| | 5 | | | 19 | 3.8 | 1 |
| CLAY, SANDY, GRAY BROWN, STIFF, MOIST | 10 | | | 22 | 14.3 | 2 |
| | 15 | | | | | |
| | 20 | | | | | |

TEST BORING NO. 6
DATE DRILLED 3/20/2020
CLIENT FALCON FIRE DEPARTMENT
LOCATION 7030 OLD MERIDIAN ROAD

| REMARKS | Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|---|
| DRY TO 10', 3/20/20 | | | | | | |
| SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN TO TAN, LOOSE TO DENSE, MOIST | | | | 13 | 5.8 | 1 |
| | 5 | | | 5 | 7.8 | 1 |
| COARSE GRAINED LENSES | 10 | | | 36 | 8.8 | 1 |
| | 15 | | | | | |
| | 20 | | | | | |

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**TEST BORING LOG**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | | 4/6/20 |

JOB NO.: 200569
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 3/20/2020
Job # 200569

REMARKS

DRY TO 10', 3/20/20

| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type | |
|---|---|---|---|---|---|---|
| | | | 4 | 6.2 | 1 | SAND, SILTY, FINE TO MEDIUM GRAINED, BROWN TO TAN, LOOSE TO MEDIUM DENSE, MOIST |
| 5 | | | 8 | 11.2 | 1 | |
| 10 | | | 28 | 8.3 | 1 | COARSE GRAINED LENSES |
| 15 | | | | | | |
| 20 | | | | | | |

TEST BORING NO.
DATE DRILLED
CLIENT FALCON FIRE DEPARTMENT
LOCATION 7030 OLD MERIDIAN ROAD

REMARKS

| Depth (ft) | Symbol | Samples | Blows per foot | Watercontent % | Soil Type |
|---|---|---|---|---|---|
| 5 | | | | | |
| 10 | | | | | |
| 15 | | | | | |
| 20 | | | | | |

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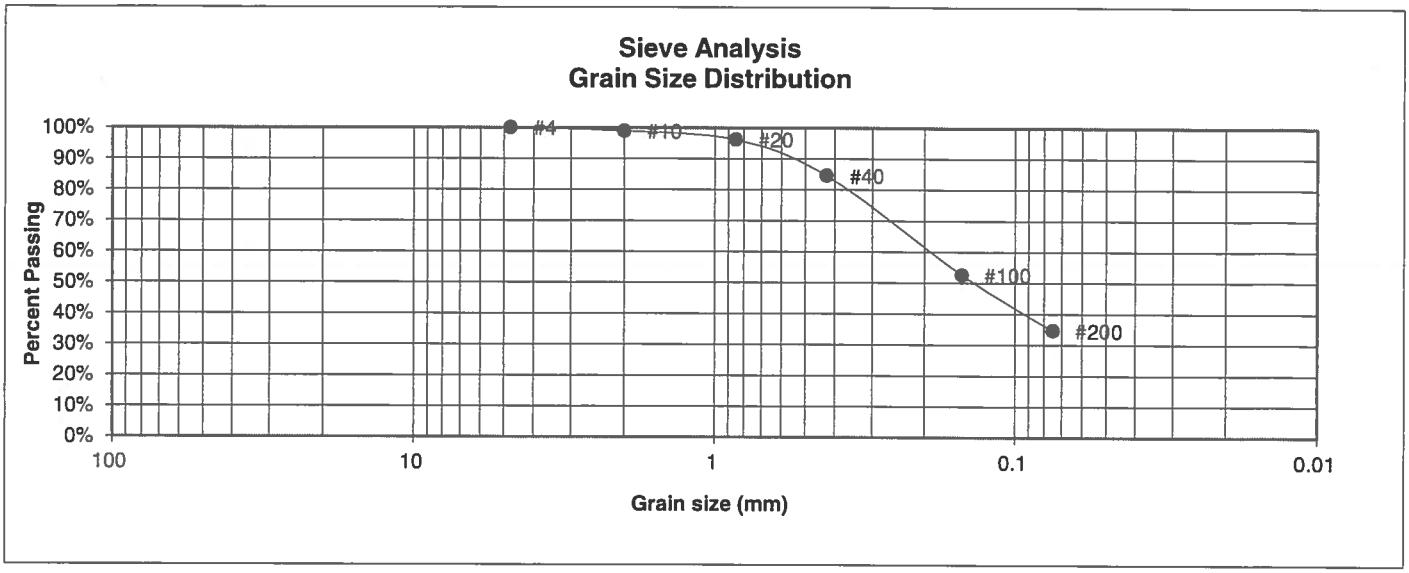
TEST BORING LOG

| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569
FIG NO.: A- 4

# APPENDIX B: Laboratory Testing Results

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SC | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 1 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 1 | JOB NO. | 200569 |
| DEPTH (FT) | 5 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | |
| 4 | 100.0% |
| 10 | 98.9% |
| 20 | 96.1% |
| 40 | 84.5% |
| 100 | 52.6% |
| 200 | 34.6% |

Atterberg Limits

| | |
|---|---|
| Plastic Limit | |
| Liquid Limit | |
| Plastic Index | |

Swell

| | |
|---|---|
| Moisture at start | 11.3% |
| Moisture at finish | 17.2% |
| Moisture increase | 5.9% |
| Initial dry density (pcf) | 104 |
| Swell (psf) | 180 |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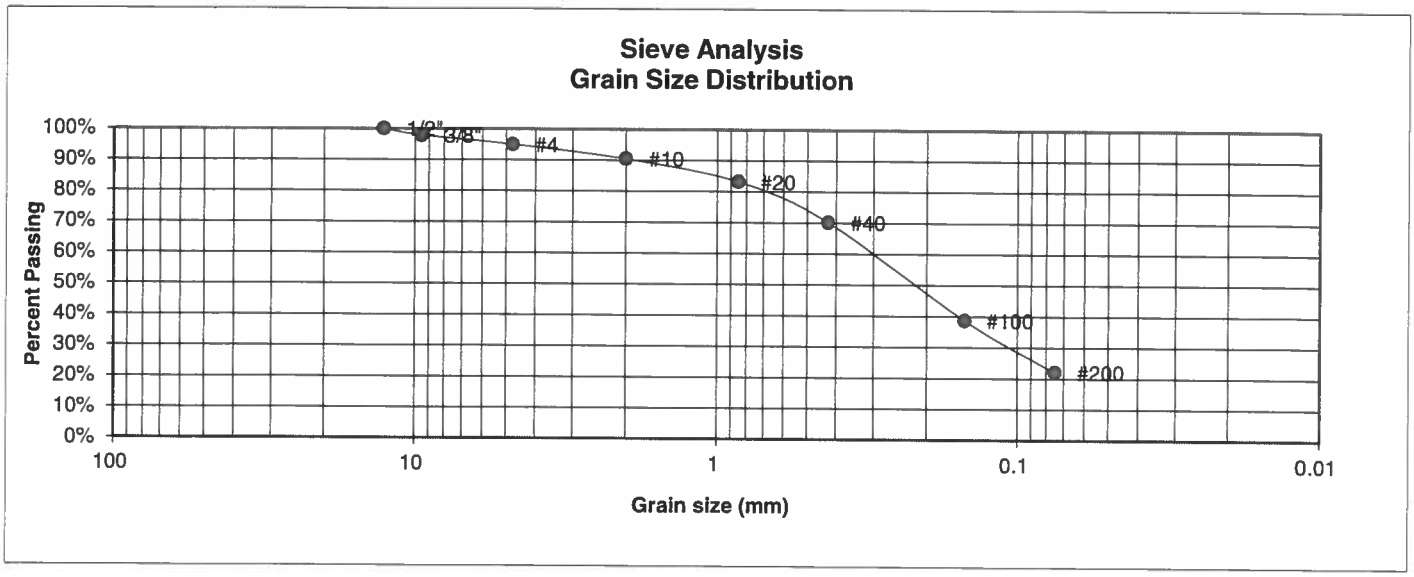
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569

FIG NO.: B-1

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 1 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 2 | JOB NO. | 200569 |
| DEPTH (FT) | 2-3 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | 100.0% |
| 3/8" | 97.8% |
| 4 | 95.0% |
| 10 | 90.5% |
| 20 | 83.2% |
| 40 | 70.1% |
| 100 | 38.7% |
| 200 | 22.0% |

Atterberg Limits

| | |
|---|---|
| Plastic Limit | NP |
| Liquid Limit | NV |
| Plastic Index | NP |

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)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COLORADO SPRINGS, COLORADO 80907

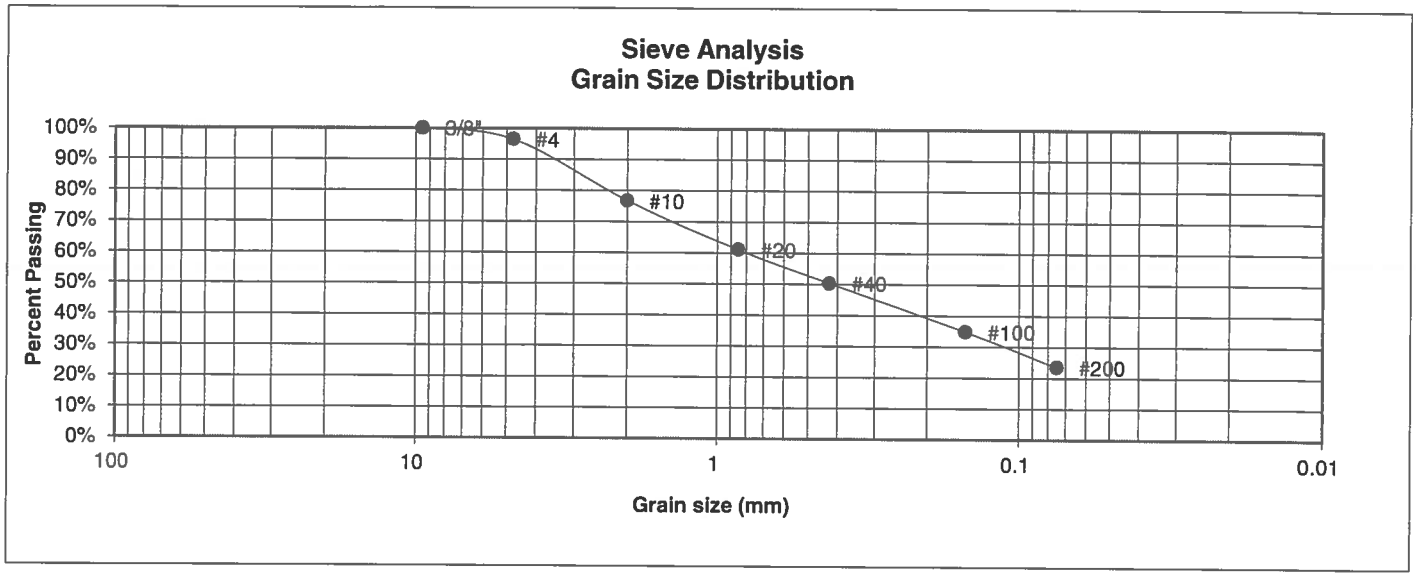

LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | h | 4/6/20 |

JOB NO.: 200569

FIG NO.: B-2

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 1 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 3 | JOB NO. | 200569 |
| DEPTH (FT) | 1 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 96.5% |
| 10 | 76.7% |
| 20 | 61.0% |
| 40 | 50.3% |
| 100 | 34.9% |
| 200 | 23.5% |

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

**ENTECH ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

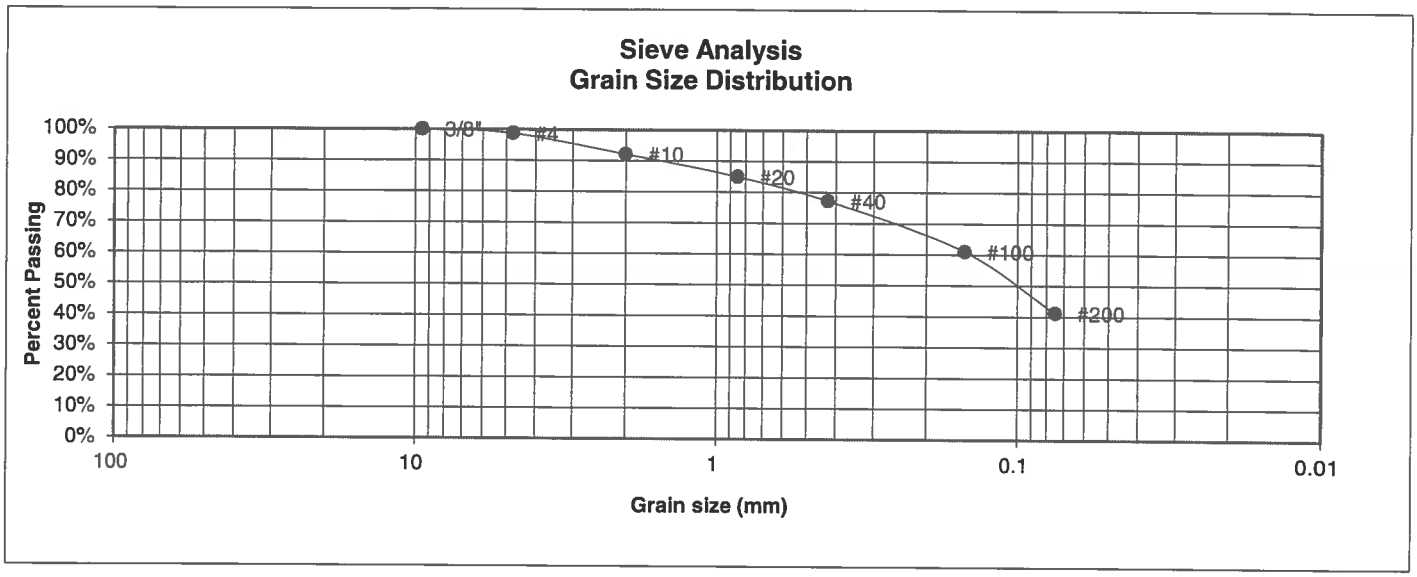
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569

FIG NO.: B-3

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SC | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 1 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 3 | JOB NO. | 200569 |
| DEPTH (FT) | 2 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 98.7% |
| 10 | 92.1% |
| 20 | 84.9% |
| 40 | 77.2% |
| 100 | 61.0% |
| 200 | 41.2% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 5 |
| Liquid Limit | 14 |
| Plastic Index | 9 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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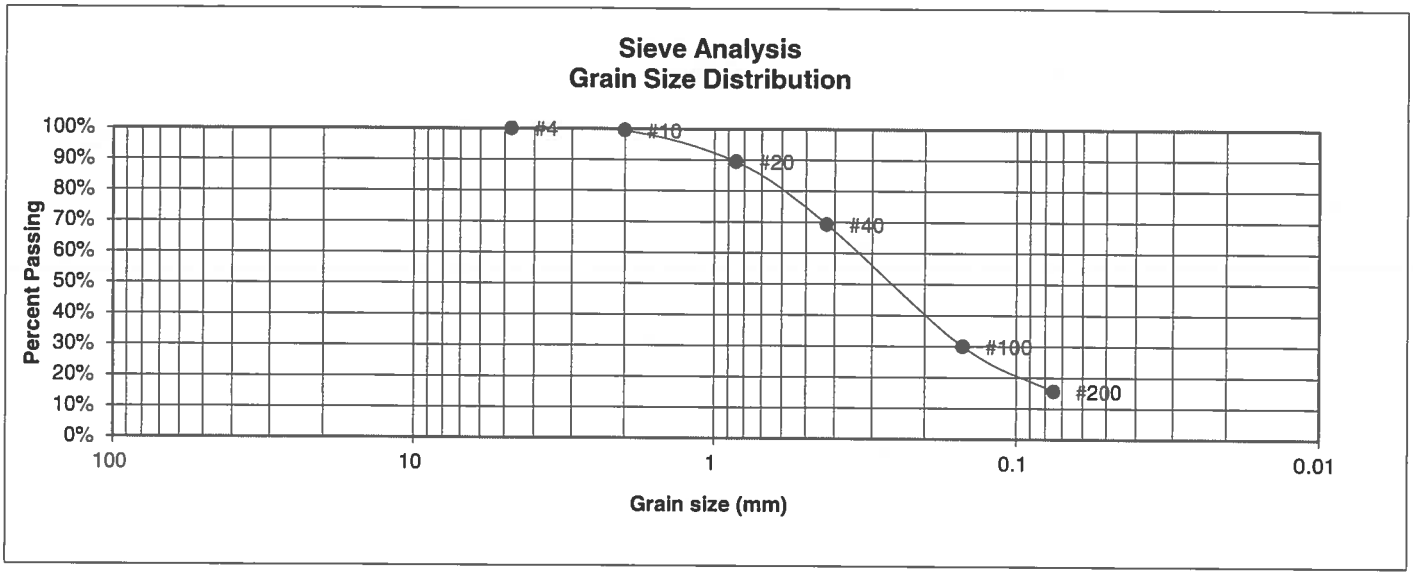
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | | 4/6/20 |

JOB NO.: 200569

FIG NO.: B-4

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 1 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 5 | JOB NO. | 200569 |
| DEPTH (FT) | 1-2 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | |
| 4 | 100.0% |
| 10 | 99.4% |
| 20 | 89.4% |
| 40 | 69.2% |
| 100 | 30.0% |
| 200 | 15.5% |

Atterberg Limits

| | |
|---|---|
| Plastic Limit | NP |
| Liquid Limit | NV |
| Plastic Index | NP |

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)


**ENTECH ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

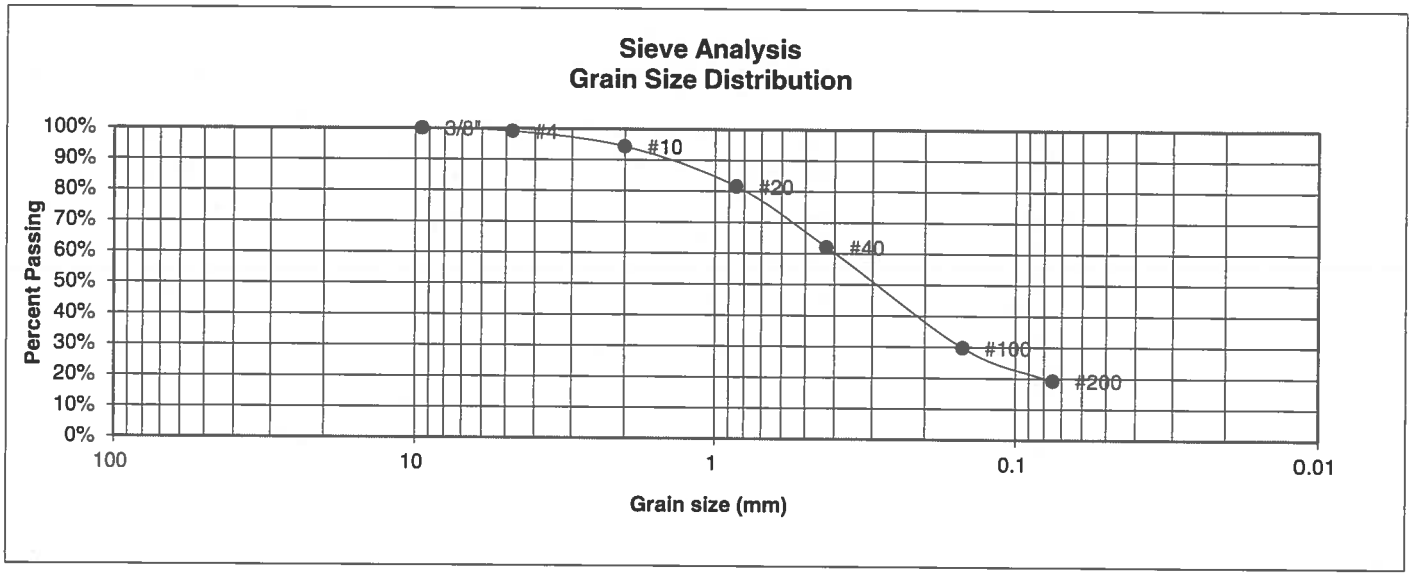

LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | G | 9/16/20 |

JOB NO.: 200569

FIG NO.: B-5

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 1 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 6 | JOB NO. | 200569 |
| DEPTH (FT) | 1-2 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 99.1% |
| 10 | 94.3% |
| 20 | 81.6% |
| 40 | 62.1% |
| 100 | 29.8% |
| 200 | 19.2% |

Atterberg Limits

| | |
|---|---|
| Plastic Limit | NP |
| Liquid Limit | NV |
| Plastic Index | NP |

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

**ENTECH ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

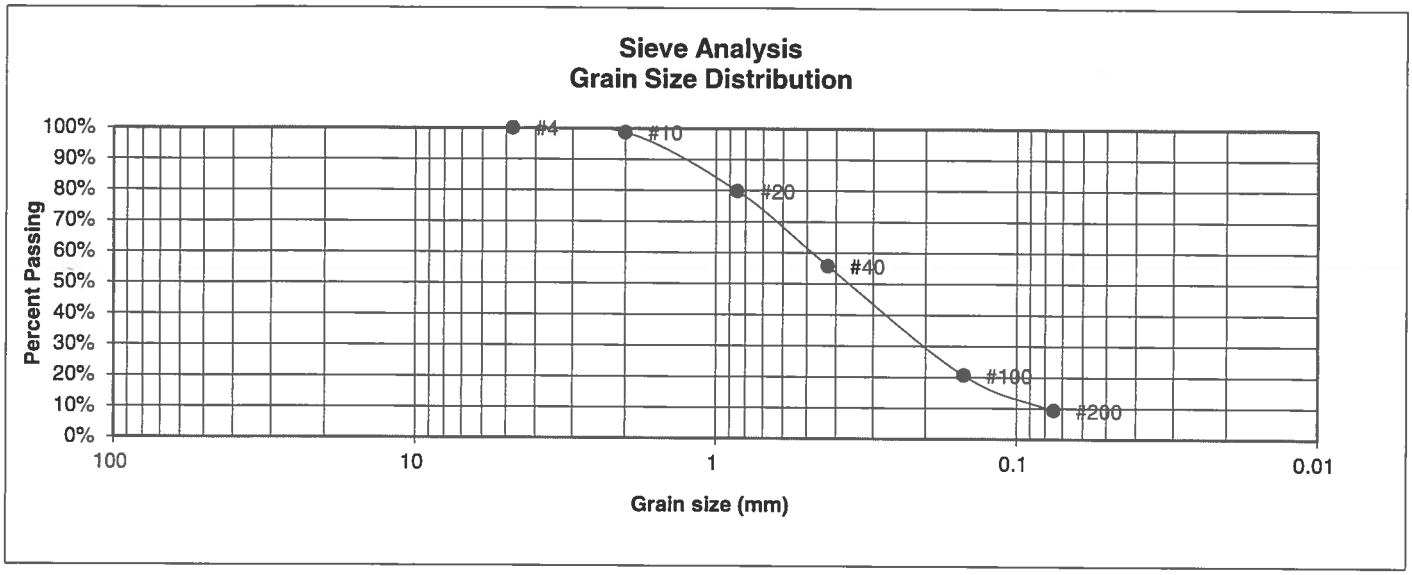
LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569

FIG NO.: B-6

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SM-SW | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 1 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 7 | JOB NO. | 200569 |
| DEPTH (FT) | 1-2 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | |
| 4 | 100.0% |
| 10 | 98.7% |
| 20 | 79.8% |
| 40 | 55.7% |
| 100 | 20.6% |
| 200 | 9.3% |

Atterberg Limits

| | |
|---|---|
| Plastic Limit | NP |
| Liquid Limit | NV |
| Plastic Index | NP |

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)


**ENTECH ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

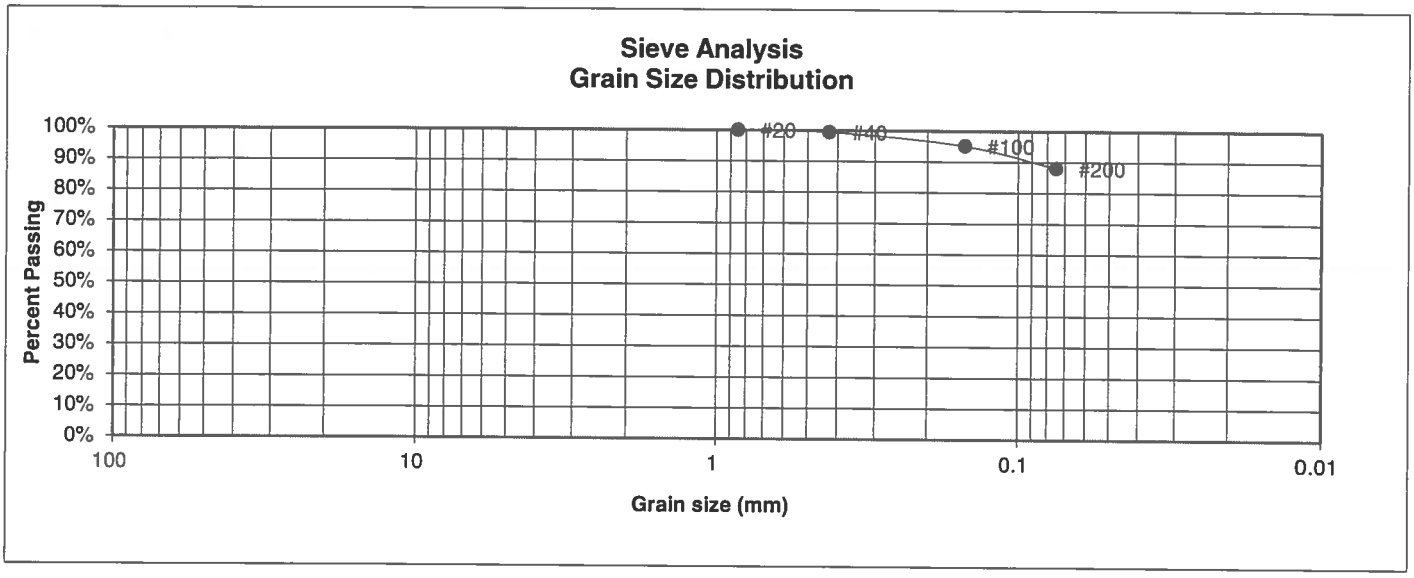

LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | | 4/6/20 |

JOB NO.: 200569

FIG NO.: B-7

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | CL | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 2 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 2 | JOB NO. | 200569 |
| DEPTH (FT) | 10 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | |
| 4 | |
| 10 | |
| 20 | 100.0% |
| 40 | 99.4% |
| 100 | 95.2% |
| 200 | 88.0% |

| Atterberg Limits | |
|---|---|
| Plastic Limit | 20 |
| Liquid Limit | 40 |
| Plastic Index | 20 |

| Swell | |
|---|---|
| Moisture at start | |
| Moisture at finish | |
| Moisture increase | |
| Initial dry density (pcf) | |
| Swell (psf) | |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COLORADO SPRINGS, COLORADO 80907

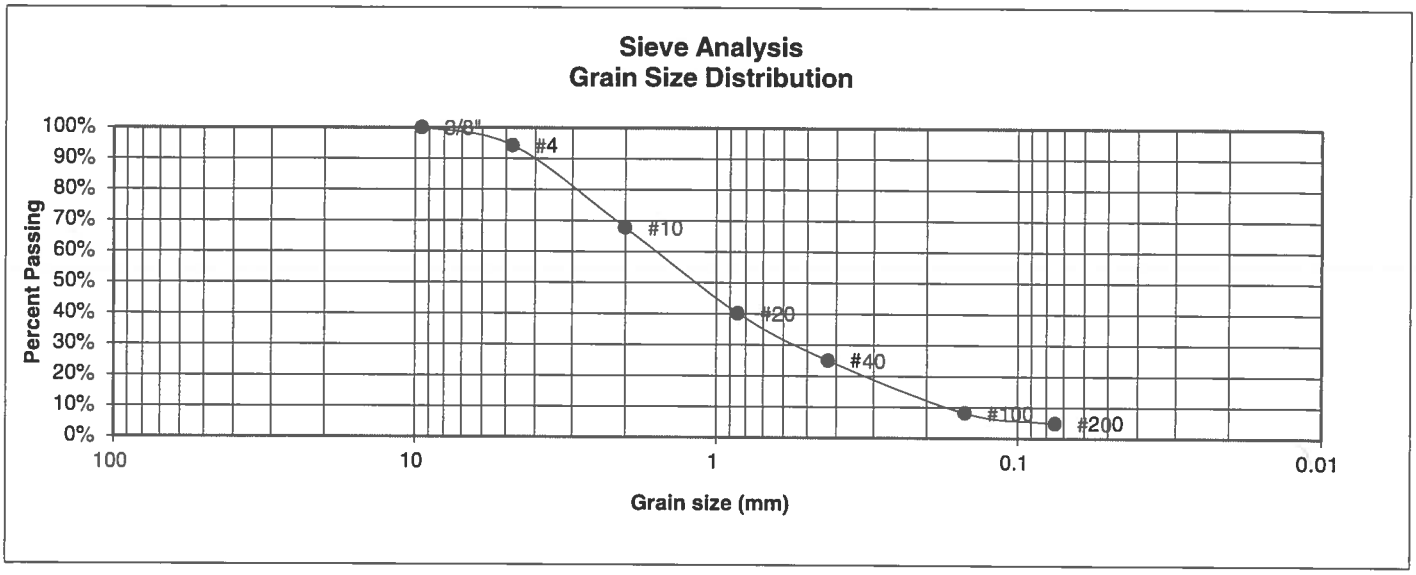

LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569

FIG NO.: B-8

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | SW | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 3 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 1 | JOB NO. | 200569 |
| DEPTH (FT) | 20 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | 100.0% |
| 4 | 94.2% |
| 10 | 67.8% |
| 20 | 40.2% |
| 40 | 25.0% |
| 100 | 8.2% |
| 200 | 4.9% |

Atterberg Limits

| | |
|---|---|
| Plastic Limit | NP |
| Liquid Limit | NV |
| Plastic Index | NP |

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

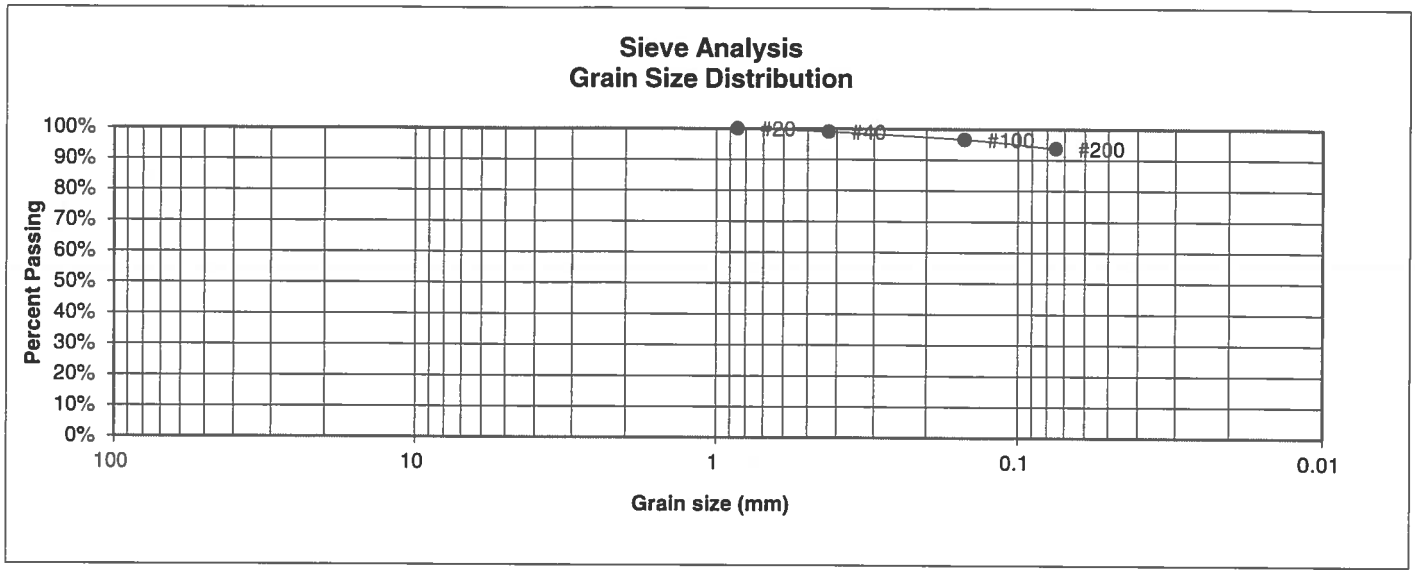

LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | | 4/6/20 |

JOB NO.: 200569

FIG NO.: B-9

| | | | |
|---|---|---|---|
| UNIFIED CLASSIFICATION | CL | CLIENT | FALCON FIRE DEPARTMENT |
| SOIL TYPE # | 4 | PROJECT | 7030 OLD MERIDIAN ROAD |
| TEST BORING # | 4 | JOB NO. | 200569 |
| DEPTH (FT) | 10 | TEST BY | BL |




| U.S. Sieve # | Percent Finer |
|---|---|
| 3" | |
| 1 1/2" | |
| 3/4" | |
| 1/2" | |
| 3/8" | |
| 4 | |
| 10 | |
| 20 | 100.0% |
| 40 | 99.0% |
| 100 | 96.6% |
| 200 | 93.7% |

Atterberg Limits

| | |
|---|---|
| Plastic Limit | 22 |
| Liquid Limit | 38 |
| Plastic Index | 16 |

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)


**ENTECH ENGINEERING, INC.**
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907


LABORATORY TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | | 4/6/22 |

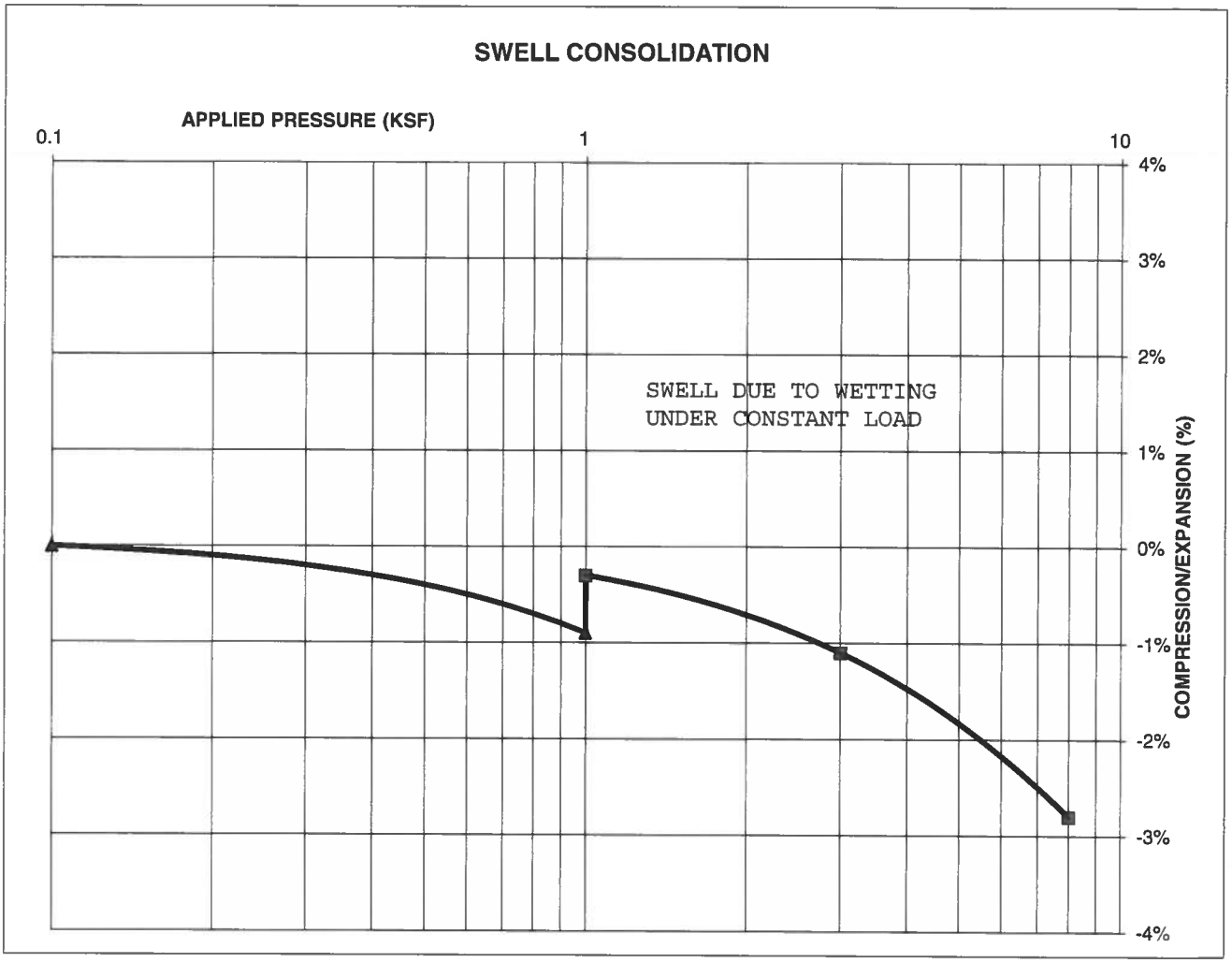
JOB NO.: 200569

FIG NO.: B-10

***CONSOLIDATION TEST RESULTS***

| | | | |
|---|---|---|---|
| TEST BORING # | 2 | DEPTH(ft) | 10 |
| DESCRIPTION | CL | SOIL TYPE | 2 |
| NATURAL UNIT DRY WEIGHT (PCF) | | | 113 |
| NATURAL MOISTURE CONTENT | | | 17.2% |
| SWELL/CONSOLIDATION (%) | | | 0.6% |

JOB NO. 200569
CLIENT FALCON FIRE DEPARTMENT
PROJECT 7030 OLD MERIDIAN ROAD

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SWELL CONSOLIDATION
TEST RESULTS

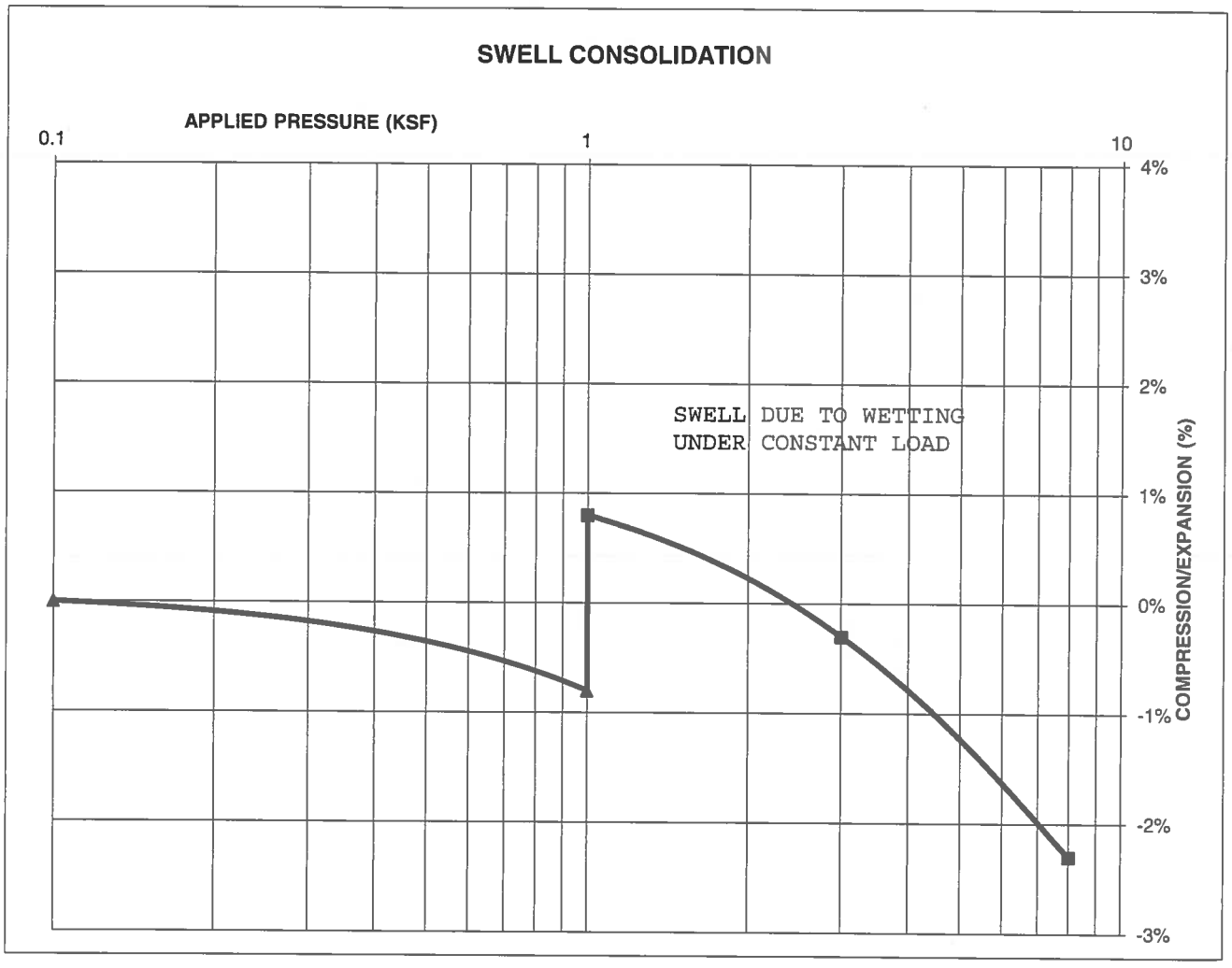
| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569
FIG NO.: B-11

***CONSOLIDATION TEST RESULTS***

| | | | |
|---|---|---|---|
| TEST BORING # | 4 | DEPTH(ft) | 10 |
| DESCRIPTION | CL | SOIL TYPE | 4 |
| NATURAL UNIT DRY WEIGHT (PCF) | | | 113 |
| NATURAL MOISTURE CONTENT | | | 17.5% |
| SWELL/CONSOLIDATION (%) | | | 1.6% |

JOB NO. 200569
CLIENT FALCON FIRE DEPARTMENT
PROJECT 7030 OLD MERIDIAN ROAD

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COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

| DRAWN: | DATE: | CHECKED: | DATE: 4/6/20 |
|---|---|---|---|

JOB NO.: 200569
FIG NO.: B-12

| | | | |
|---|---|---|---|
| CLIENT | FALCON FIRE DEPARTMENT | JOB NO. | 200569 |
| PROJECT | 7030 OLD MERIDIAN ROAD | DATE | 3/31/2020 |
| LOCATION | 7030 OLD MERIDIAN ROAD | TEST BY | BL |

| BORING NUMBER | DEPTH, (ft) | SOIL TYPE NUMBER | UNIFIED CLASSIFICATION | WATER SOLUBLE SULFATE, (wt%) |
|---|---|---|---|---|
| TB-1 | 20 | 3 | SW | 0.00 |
| TB-2 | 2-3 | 1 | SM | 0.00 |
| TB-2 | 10 | 2 | CL | 0.00 |
| TB-4 | 10 | 4 | CL | 0.00 |
| TB-5 | 1-2 | 1 | SM | 0.00 |
| | | | | |
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COLORADO SPRINGS, COLORADO 80907

**LABORATORY TEST SULFATE RESULTS**

| DRAWN: | DATE: | CHECKED: | DATE: |
|---|---|---|---|
| | | | 4/6/20 |

JOB NO.: 200569

FIG NO.: B-13