Geotechnical Engineering Study

Pearsons Ministries Facility Improvements

Green Mountain Falls, Colorado

Yeh Project No.: 219-217

July 22, 2019
Revised November 21, 2019

Prepared for:

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PCD File No. PPR1933

Previous Review comments:
This report does not provide recommendations for the detention facility. Per Chapter 11, section 11.3.3 of the El Paso County Drainage Criteria Manual a Geotechnical report with recommendations for the foundation preparation and embankment construction shall be submitted with the complete design analysis for all permanent detention facilities. Please provide the appropriate recommendations for the detention facilities per DCM Vol. 1 Section 11.3.3.

Review 4: Unresolved.

Yeh and Associates, Inc.
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Prepared by:

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Reviewed by:

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COLORADO LICENSED HAI MING LIM 51650 11-21-19 PROFESSIONAL ENGINEER

Yeh and Associates, Inc.
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1. PURPOSE AND SCOPE OF STUDY

This report presents the results of Yeh and Associates, Inc. (Yeh) geotechnical engineering study for the proposed drive lanes and parking lot improvements at the existing facility located at 10460 West Highway 24, Green Mountain Falls, Colorado. Figure 1 shows the location of the project site.

The purpose of our study was to evaluate the subsurface conditions at the project site and provide geotechnical engineering recommendations and pavement thickness design for the drive lanes and parking lot pavement, and design parameters for a small retaining wall.

This report has been prepared in general accordance with our approved proposal for geotechnical engineering services, dated June 5, 2019. Our scope of services consisted of the following:

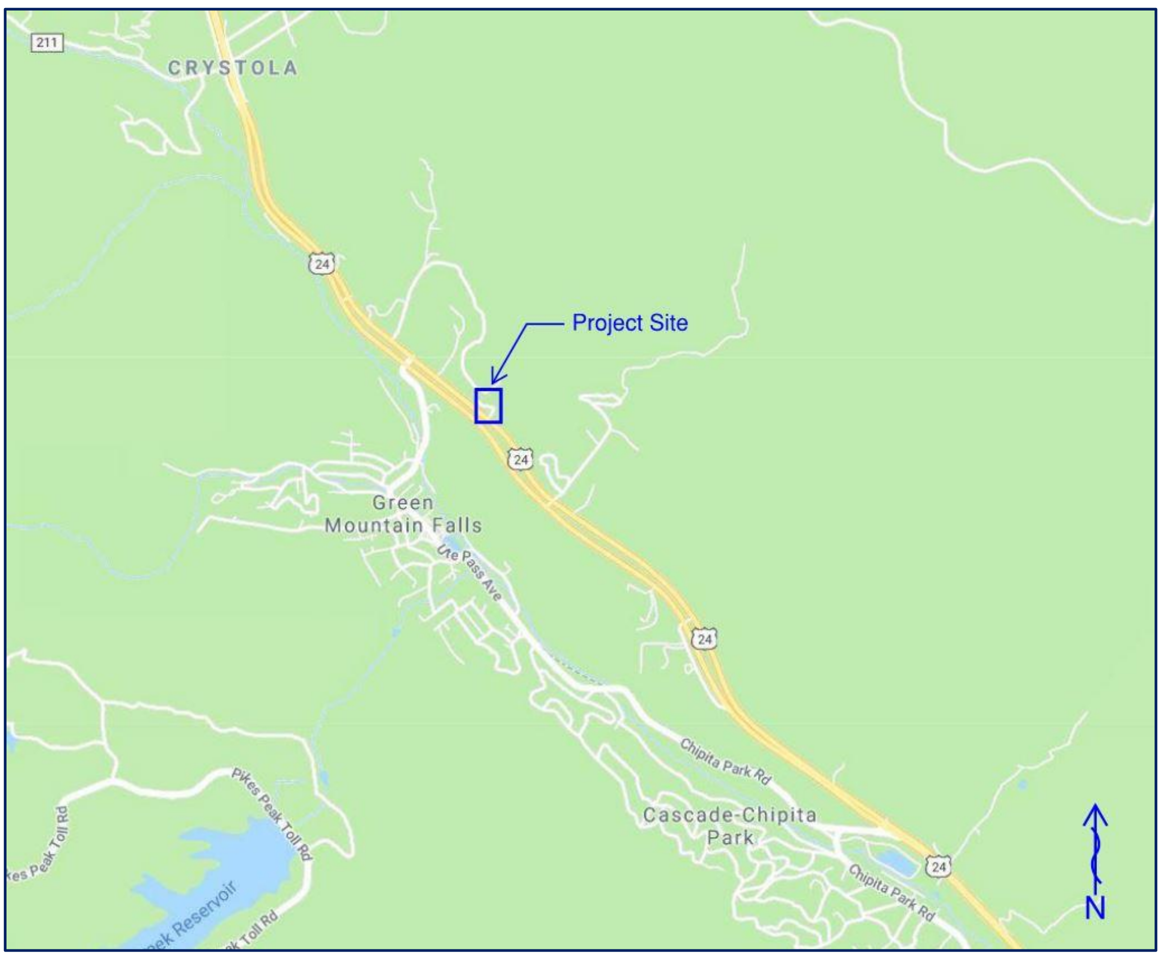

Figure 1. Project Location

- Review available mapped geology at the site.
- Conduct a site observation and subsurface exploration to evaluate the existing subsurface conditions. The subsurface exploration included 12 geotechnical borings performed at the approximate locations shown on Figure A-1 in Appendix A.
- Perform laboratory testing on soil samples obtained during the subsurface exploration to evaluate the engineering characteristics.
- Prepare a report that presents the results of our geotechnical engineering analyses, geotechnical feasibility, encountered site and subsurface conditions, and design and construction recommendations for drive lane and parking lot pavement thickness.
- Provide geotechnical engineering parameters and construction recommendations for small, four feet tall retaining wall. Wall design and stability analysis including global stability of the wall is not included in our scope of services and should be completed during design phase of the project.

The conclusions and recommendations presented herein are based on our limited site explorations and the subsurface conditions encountered at our boring locations during the time of our exploration. Our findings, conclusions, and recommendations should not be extrapolated to other areas of the site or used for other projects without our prior review. Additionally, they should not be used if the site has been altered or if more than two years has elapsed since the date of our final report without our prior review to determine if they remain valid.

1.1 Project Understanding

Based on our discussions with the project team we understand Pearsons Ministries recently purchased the property at the project site and plans to renovate the existing 30,000 SF building into a new Church. Additional planned improvements at the site include paving the existing dirt/gravel parking lot and drive lanes with asphalt concrete pavement, replace the existing pavement on the southwest side of the building, and potentially a block-type retaining wall up to 4-feet tall southwest of the existing building. Site grades will remain similar to existing grade and new asphalt concrete pavement will be within the parking lot and drive lanes.

If the proposed construction is different than as described above, we should be contacted and provided the opportunity to evaluate our recommendations presented herein and evaluate if they remain valid based on the proposed construction.

2. Subsurface Exploration

2.1 Field Exploration

Our field exploration program consisted of advancing 12 borings at the approximate locations shown on Figure A-1 in Appendix A. 11 borings (P-1 to P-11) were performed in the pavement and drive lanes areas, and one boring (WB-1) was performed in the vicinity of the potential retaining wall. The borings were advanced with a truck mounted drill rig equipped with 4-inch diameter solid stem, continuous flight auger. Pavement borings were advanced to a maximum depth of five feet below the existing ground surface (BGS) and the wall boring was advanced to a depth of 10 feet BGS. Subsurface soil samples were collected at 1 and 4 feet BGS in each of the pavement borings and at four samples were collected in the wall boring. Samples were collected by driving a standard penetration test (SPT) or modified California split barrel sampler into the strata with a 140-pound hammer falling 30-inches. Bulk samples of the auger cuttings were also collected at each pavement boring.

The SPT is a 1.375-inch I.D. standard split barrel sampler following ASTM D1586. The blows required to drive the sampler the final 12-inches is known as the SPT N-value. The Modified California Sampler is a 2.5-inch OD, 2.0-inch ID (1.95-inch ID with liners), split barrel sampler with internal liners, following ASTM D3550. The Modified California Sampler drive length is 12 inches and “Penetration Resistance” refers to the sum of all blows. The Penetration Resistance and SPT N-value represent the consistency or relative density the strata.

The boring logs and key to the boring logs are presented in Appendix B.

2.2 Laboratory Testing

Representative soil samples were selected for laboratory testing that was completed following industry standards and consistent with local practice. Laboratory soil testing included the following:

- Natural moisture-density;
- gradation analysis;
- Atterberg limits;
- Hveem Stabilometer, R-value;
- water soluble sulfates and chlorides; soil resistivity; pH.

Results of the laboratory tests are shown on the boring logs and are presented in the Laboratory Summary in Appendix C.

3. Site and Subsurface Conditions

3.1 Site Conditions

The project site is located off State Highway 24 (HWY 24), about 11 miles west of Colorado Springs. Surrounding development is sparse and generally consists of residential and light commercial/retail along HWY 24. The site is in a mountainous valley, north of Pikes Peak and surrounded by Pike National Forest.

The project site consists of an existing two-story building with approximately 30,000 SF in area, and mostly unpaved dirt/gravel parking lot and drive lanes. There is an asphaltic concrete apron on the northwest and southwest side of the existing building with Portland cement concrete pavement (PCCP) accessible parking stalls adjacent to the building. The existing building appeared to be vacant at the time of our exploration and the asphalt concrete pavement was generally in fair to poor condition. The site generally slopes from north to south with about 10 to 15 feet of relief from the parking lot north of the building to the parking lot south of the building. The drive lanes show signs of erosion including relatively large rills along the drive lane southeast of the building. Several areas of ponding water were observed in the parking lot, especially north of the existing building.

Vegetation surrounding the building is sparse and consists of overgrown weeds and grasses. The slope in front of the building to the southwest is covered in tall grass and slopes from north to south. Based on our limited visual observation of the slope in front of the building we did not observe any obvious signs of slope instability or movement.

Photographs 1-4 below show the site and pavement conditions at the time of our exploration.

Photograph 1. Parking Lot North of Building - Looking Southeast

Photograph 2. Erosion of Existing Roadway Southeast of Building - Looking West

Photograph 3. PCC/AC Apron Southwest of Existing Building - Looking Southeast

Photograph 4. View of Southwest Side of Existing Building – Looking North

3.2 Geologic Setting

Review of available geologic maps, *Reconnaissance Geologic Map of the Woodland Park Quadrangle, Teller County, Colorado* (Scott, 1977), indicates bedrock is near the surface. The project site is mapped as Pikes Peak Granite, with pink to reddish, medium to coarse grained massive biotite or hornblende biotite granite. The granite weathers to rounded outcrops and coarse, angular sand and gravel; and deeply weathered where it underlies erosion surface of late Eocene age.

3.3 Subsurface Conditions

The subsurface soils encountered in our borings are generally consistent with the mapped geology. Asphalt concrete was encountered at the surface in two borings, P-07 and P-11 and was 6- and 2-inch thick, respectively. Below the pavement and at the surface of the remaining 10 borings, sand was encountered with varying amounts of silt, clay and gravel. The sand was observed to be reddish brown to brown, fine to coarse grained, subangular to angular, and loose to medium dense. The sand was present to the maximum exploration depth in the pavement borings and Granite bedrock was encountered beneath the sand in Boring WB-1.

The boring logs in Appendix B present detailed results of our subsurface exploration.

3.4 Groundwater

All borings were dry during our exploration. Groundwater observations are representative of conditions at the time of our field exploration, and therefore may not be indicative of groundwater levels at other times of the year or at other locations across the site. Groundwater conditions may fluctuate with seasonal precipitation, site grading and improvements, and local irrigation practices.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results of our subsurface exploration, laboratory testing, and engineering analysis, it is our opinion that the project is geotechnically feasible provided the recommendations presented in the following sections are incorporated into the design and construction of the project.

4.1 Construction Considerations

Site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, state, or federal guidelines.

4.1.1 Site Subgrade Preparation

Unsuitable materials including existing asphalt and Portland cement concrete pavement, organic materials, and construction debris should be stripped from the site and completely removed. The stripped materials should be removed for offsite disposal in accordance with local laws and regulations.

Following initial stripping and grading, areas to receive new pavement should be scarified to a depth of 8-inches, moisture conditioned, and compacted to a firm and uniform condition. Following subgrade preparation and prior to placement of pavement materials including aggregate base course, the subgrade should be evaluated by observation of a proof roll. Proof roll should be completed by heavily loaded, pneumatic tired, dump truck or similar weight equipment. Areas which deform non-uniformly under heavy wheel loads should either be moisture conditioned and re-compacted or excavated and replaced with structural fill. The depth of over-excavation, if required, should be determined during construction. We recommend that the proof rolling, and visual inspection of the subgrade be observed and evaluated by an experienced geotechnical engineer or engineer's representative.

If areas found to be unsuitable for re-work, additional stabilization will be required. If additional stabilization is required, Yeh should be contacted to evaluate the conditions in field, and a suitable stabilization method can be provided. In addition, any soft and/or wet areas exposed during the excavation may need to be stabilized prior to the placement of new fill and pavement sections to create a stable, firm construction platform. A typical stabilization method may include utilizing gravel with the combination of geo-grid (e.g. Tensar TX160) to create a stable base. Other stabilization methods may also be appropriate.

4.1.2 Earthwork

We anticipate excavation depths on the order of 2 to 3 feet will be required for retaining wall construction. Sandy soils encountered in our borings may be excavated using conventional heavy-duty earth working equipment. Groundwater was not encountered during our exploration and is not anticipated within the excavation depths.

Hard bedrock was encountered in boring WB-1 at about 5 feet below the existing ground surface, if excavations are planned to a depth greater than about 5 feet below the existing ground surface, the contractor should be prepared for excavation through granite bedrock. Excavation through hard granite will be difficult and may require equipment and rippers designed for excavation in rock. The contractor should review our boring logs prior to site mobilization in order to determine appropriate equipment.

All site excavation and grading should conform to local, State and Federal safety regulations, and particularly with the excavation standards of the Occupational Safety and Health Administration (OSHA).

Positive drainage should be provided during construction and maintained throughout the life of the proposed structures. Design of drainage should include prevention of ponding of water on or immediately adjacent to pavement areas. Surface features that could retain water in areas adjacent to the structures should be sealed or eliminated.

We recommend that all permanent un-retained cut and fill slopes be constructed no steeper than 2.5 H: 1 V. Cut slopes should be protected from surface water runoff to prevent erosion and slope failure. Landscape sprinklers should be frequently checked for leaks and maintained in good working order. Surface drainage should be provided around all permanent cuts and fills to direct surface runoff away from the slope faces. Fill slopes, cut slopes, and other stripped areas should be protected against erosion by re-vegetation or other methods. Concentrated runoff should be prevented in areas susceptible to erosion or slope instability.

4.1.3 Structural Fill Material and Compaction Requirements

Imported structural fill, if needed, should consist of low to non-expansive granular material meeting the following criteria in Table 4-1:

Table 4-1 Imported Structural Fill Criteria

Gradation Requirements	
Standard Sieve Size	Percent Passing
2 inch	100
No. 200	10 - 30
Plasticity Requirements (Atterberg Limits)	
Liquid Limit	30 or less
Plasticity Index	6 or less

Onsite granular soils are suitable for re-use as structural fill. Soil and aggregate base materials should be placed in horizontal loose lifts not to exceed 8-inches in thickness, unless otherwise accepted by the geotechnical engineer. Materials should be moisture-conditioned and compacted according to the following criteria.

Table 4-2 Subgrade Preparation and Fill Placement Criteria

Fill Location	Material Type	Percent Compaction (ASTM Method)	Moisture Content
Pavement Subgrade	On Site Soils/Imported Structural Fill	95 minimum (ASTM D1557)	± 2 % of optimum
Aggregate Base (ABC)	Imported CDOT Class 5 or 6 ABC (See Section 4.2.3.1)	95 minimum (ASTM D1557)	± 2 % of optimum

4.1.4 Construction in Wet or Cold Weather

Grading fill, structural fill or other fill should not be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to placement of fill. A good practice is to cover the compacted fill with a “blanket” of loose fill to help prevent the compacted fill from freezing.

Concrete and asphalt structures should not be constructed on frozen soil. Frozen soil should be completely removed from beneath the concrete elements, or thawed, scarified and re-compacted. The amount of time passing between excavation or subgrade preparation and placing concrete should be minimized during freezing conditions to prevent the prepared soils from freezing. Blankets, soil cover, or heating as required may be utilized to prevent the subgrade from freezing.

4.2 PAVEMENT SECTION DESIGN RECOMMENDATIONS

Our pavement evaluation and thickness design were performed in general accordance with the AASHTO 1993 pavement design guidelines. Because of the inconsistent thickness, distress, and damages experienced by the existing pavement structures, we recommend removing the existing pavement structures and reconstruct with new asphalt or Portland cement concrete pavement.

4.2.1 Anticipated Pavement Subgrade

The anticipated pavement subgrade materials encountered in our borings consist of sand with gravel and varying amounts of silt and clay. Based on lab results of a combined bulk sample of the subgrade soils, an R-value of 36 was used in our pavement thickness design.

4.2.2 Traffic Loading

Design traffic loading assumes 500 vehicles and 20 trucks per day. This information was used to calculate the Average Annual Daily Traffic (AADT) and estimate the 18-kip Equivalent Single Axle Loads (ESAL) loading for a 20-year design period. Based on these assumptions, an ESAL of 52,000 is estimated for the flexible pavement design.

Recommended pavement sections are presented below in Table 4-2.

Table 4-3. Recommended Minimum Pavement Sections

Pavement Area	Minimum Asphaltic Concrete (AC) Design Thickness	Minimum Portland Cement Concrete (PCC) Design Thickness
New Pavement	- 4.0 inches HMA - 6.0 inches Aggregate Base - 8.0 inches Compacted Subgrade	- 5.0 inches PCC - 6.0 inches Aggregate Base - 8.0 inches Compacted Subgrade

HMA= Hot Mix Asphalt
PCC= Portland Cement Concrete

We recommend PCC be placed in trash/dumpster areas or other areas where large/heavy trucks frequently stop or turn.

4.2.3 Pavement Materials

4.2.3.1 Base Course

We recommend Coarse Aggregate Type Class 5 or 6 to be used for the aggregate base materials. The material should be placed in a uniform layer without segregation of size and compacted in loose lifts not to exceed 8-inches. The material should be compacted as recommended in Section 4.1.3 of this report.

4.2.3.2 Hot Mix Asphalt

Hot mix asphalt materials, placement procedures, and testing should follow The Pike Peak Region Asphalt Specification. We recommend PG 58-28 HMA binder with Grading S or SX aggregate.

4.2.3.3 Portland Cement Concrete

The Portland Cement Concrete (PCC) shall conform to the requirements for Portland Cement Concrete Pavement, have a minimum 28-day flexural strength of at least 600 pounds per square inch (psi), and have a required minimum 28-day compressive strength of 4,200 psi.

The concentration of water-soluble sulfates measured on a subsurface sample of onsite soil was 0.003 percent. Based on sulfate concentration in the tested soil, Type II, low alkali Portland cement may be used in pavement concrete.

4.2.4 Drainage

Proper drainage is of paramount importance in pavement performance. To avoid distress to pavement from wet, soft subgrade soils, we recommend the maintenance of good drainage away from all pavements. Possible water sources include storm runoff, irrigation of landscaping adjacent the pavement and localized groundwater seepage, among others. Joints in the pavement or at asphalt/concrete interfaces should be sealed. Any cracks or openings in the finished pavement surface should be sealed and/or repaired as quickly as possible.

4.2.5 Pavement Maintenance

Annual maintenance generally refers to crack filling and general surface sealers. We recommend implementation of an at least annual if not more frequent flatwork/pavement crack sealing program. This is very important to prevent surface water (especially from slow infiltration from sources such as snow melt and surface run-off) from entering cracks and wetting the subgrade. Any cracks or openings in the finished pavement surface should be sealed and/or repaired as quickly as possible.

4.3 Retaining Wall Recommendations

We understand a block retaining wall up to 4 feet tall may be required as part of the facility improvements southwest of the existing building. Our boring WB-1 was drilled at the anticipated wall location based on our discussion with the project team.

The wall is anticipated to be a block wall and design of the wall will be completed by others. We have provided general recommendations for wall foundation preparation, and anticipated soil parameters to be used in design of the wall. Design of the wall should include global stability, external wall stability, and internal stability of the wall.

4.3.1 Retaining Wall Foundation

Based on the results of our subsurface exploration we anticipate the retaining wall foundation subgrade will consist of clayey sand soils. Prior to placement of wall elements or structural fill the wall subgrade should be prepared in accordance with section 4.1.1.

Walls founded on properly prepared foundation soils may be designed with an allowable bearing capacity of 2,500 pounds per square foot (psf).

4.3.2 Wall Design Parameters

We anticipate the walls will be backfilled with imported materials meeting the requirements of CDOT Class 1 Structural Backfill, or equivalent granular materials encountered on site and approved by Yeh engineer during construction phase. Walls that allow slight wall rotation may be designed with an “active” earth pressure. Based on the soils encountered in boring WB-1 we have provided the following parameters to be used for design of the retaining wall.

Table 4-4. Soil Shear Strength for Wall Design

Soil Type	Effective Shear Strength		Unit Weight, pcf	Coefficient of Active Pressure (K_a)	Coefficient of Passive Pressure (K_p)[2]	Friction Coefficient[3]
On Site Clayey Sand (SC)	Φ' = 30°	c’ = 50 psf [1]	125	0.33	3.00	0.57

1. Cohesion (c’) should be ignored in global stability analysis
2. The passive resistance of the top 3 feet, or the height of the slope in front of the wall, whichever is greater, should be neglected while applying the passive pressure.
3. A factor of safety of 2.5 should be applied for sliding capacity calculations.

4.4 Corrosivity Test Results

Analytical testing was completed on one sample collected during our exploration. The results of the testing are presented below and should be reviewed by a qualified corrosion engineer to determine appropriate concrete and corrosion protection measures as needed.

Table 4-5. Corrosivity Test Results

Sample	Water Soluble Sulfates (%)	Water Soluble Chlorides (%)	pH Units	Resistivity (Ohm.cm)
P-1, -3, -6, -7, -8, -11 combined sample	.003	.0112	7.6	4708

5. LIMITATIONS

The findings and recommendations presented in this report are based upon data obtained from borings, field observations, laboratory testing, our understanding of proposed construction, and other sources of information referenced in this report. It is possible that subsurface conditions may vary between or beyond the locations explored. The nature and extent of such variations may not become evident until construction. If during construction conditions appear to be different from those described herein, Yeh should be advised and provided the opportunity to observe and evaluate those conditions and provide additional recommendations, as necessary. Yeh should also be contacted if the scope of construction changes from that generally described within this report. The conclusions and recommendations contained in this report shall not be considered valid unless Yeh reviews all proposed construction changes and either verifies or modifies the conclusions of this report in writing.

This report was prepared in in a manner consistent with that level of care and skill ordinarily exercised by other members of Yeh's profession practicing in the same locality, under similar conditions and at the date the services are provided. Yeh makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

Appendix A

FIGURE A-1 EXOLORATION LOCATION PLAN

● APPROXIMATE EXPLORATION LOCATION

Yeh and Associates, Inc. Geotechnical · Geological · Construction Services	DRAWN BY: MJW — DATE: 7/18/2019	EXPLORATION LOCATION PLAN	FIGURE
	CHECKED BY: JTM — DATE: 7/18/2019		A-1
	DESIGNED FOR:	PEARSONS MINISTRIES FACILITY IMPROVEMENTS 10460 WEST HIGHWAY 24 GREEN MOUNTAIN FALLS, COLORADO	
	PROJECT NUMBER: 219-217		
	SCALE		
	HORIZ: 1:1 VERT:		

Appendix B

KEY TO BORING LOGS

BORING LOGS

Legend for Symbols Used on Borehole Logs

Sample Types

Bulk Sample of auger/odex cuttings

Modified California Sampler (2.5 inch OD, 2.0 inch ID)

Standard Penetration Test (ASTM D1586)

Drilling Methods

SOLID-STEM AUGER

Lithology Symbols (see Boring Logs for complete descriptions)

Asphalt

USCS Clayey Sand

USCS Clayey Sand

USCS Silty Sand

Granite

Lab Test Standards

Moisture Content	ASTM D2216
Dry Density	ASTM D7263
Sand/Fines Content	ASTM D421, ASTM C136, ASTM D1140
Atterberg Limits	ASTM D4318
AASHTO Class.	AASHTO M145, ASTM D3282
USCS Class.	ASTM D2487

(Fines = % Passing #200 Sieve
Sand = % Passing #4 Sieve, but not passing #200 Sieve)

Other Lab Test Abbreviations

pH	Soil pH (AASHTO T289-91)
S	Water-Soluble Sulfate Content (AASHTO T290-91, ASTM D4327)
Chl	Water-Soluble Chloride Content (AASHTO T291-91, ASTM D4327)
S/C	Swell/Collapse (ASTM D4546)
UCCS	Unconfined Compressive Strength (ASTM D2166)
R-Value	Resistance R-Value (ASTM D2844)
DS (C)	Direct Shear cohesion (ASTM D3080)
DS (phi)	Direct Shear friction angle (ASTM D3080)
Re	Electrical Resistivity (AASHTO T288-91)
PtL	Point Load Strength Index (ASTM D5731)

Notes

1. Visual classifications are in general accordance with ASTM D2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)".
2. "Penetration Resistance" on the Boring Logs refers to the uncorrected N value for SPT samples only, as per ASTM D1586. For samples obtained with a Modified California (MC) sampler, drive depth is 12 inches, and "Penetration Resistance" refers to the sum of all blows. Where blow counts were > 50 for the 3rd increment (SPT) or 2nd increment (MC), "Penetration Resistance" combines the last and 2nd-to-last blows and lengths; for other increments with > 50 blows, the blows for the last increment are reported.
3. The Modified California sampler used to obtain samples is a 2.5-inch OD, 2.0-inch ID (1.95-inch ID with liners), split-barrel sampler with internal liners, as per ASTM D3550. Sampler is driven with a 140-pound hammer, dropped 30 inches per blow.
4. "ER" for the hammer is the Reported Calibrated Energy Transfer Ratio for that specific hammer, as provided by the drilling company.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Pearson Ministries Facility	*PAGE* *1 of 1*
	Project Number: 219-217	*Boring No.:* **P-01**

Boring Began: 9:50:00 AM
Boring Completed: 9:55:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.93956891 Long: -105.0117606
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 45 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
							0.0 - 5.5 ft. Silty, clayey SAND (SC-SM), dark brown, moist, medium dense.							
				15-10-9	19									
	5			8-6-6	12									

Bottom of Hole at 5.5 ft.

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Project Name: Pearson Ministries Facility

Project Number: 219-217 *Boring No.:* **P-02**

Boring Began: 9:40:00 AM
Boring Completed: 9:45:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.93997218 Long: -105.0117075
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
							0.0 - 5.5 ft. Silty SAND with gravel (SM), reddish brown, moist, medium dense.							
				8-7-5	12			5.2		22.3	22	7	A-2-4 (0) SC-SM	
	5			4-6-5	11			5.9						

Bottom of Hole at 5.5 ft.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Pearson Ministries Facility	*PAGE* *1 of 1*
	Project Number: 219-217	*Boring No.:* **P-03**

Boring Began: 9:30:00 AM
Boring Completed: 9:35:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94021324 Long: -105.0124363
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
							0.0 - 5.5 ft. Silty SAND with gravel (SM), reddish brown, moist, loose to medium dense.									
				10-4-5	9			4.5		18	66	15.9	22	3	A-1-b (0) SM	
	5			6-5-5	10			4.6								

Bottom of Hole at 5.5 ft.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Pearson Ministries Facility	*PAGE 1 of 1*
	Project Number: 219-217	*Boring No.:* **P-04**

Boring Began: 9:20:00 AM
Boring Completed: 9:25:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94068835 Long: -105.0125464
Location:

Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
							0.0 - 5.5 ft. Silty SAND with gravel (SM), reddish brown, moist, medium dense to loose.							
				5-5-6	11									
	5			7-4-4	8			6.0		25.3	17	1	A-2-4 (0) SM	

Bottom of Hole at 5.5 ft.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	Project Name: Pearson Ministries Facility	PAGE 1 of 1
	Project Number: 219-217	Boring No.: **P-05**

Boring Began: 9:10:00 AM
Boring Completed: 9:15:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94097081 Long: -105.0125626
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 60 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
							0.0 - 5.5 ft. Silty SAND with gravel (SM), reddish brown, moist, loose to very loose.							
				4-3-2	5			5.8						
	5			1-0-1	1			3.6						

Bottom of Hole at 5.5 ft.

BORING LOG 2019 - SPT CDOT STYLE 219_217 PEARSON MINISTRIES FACILITY.GPJ 2019 YEH COLORADO TEMPLATE.GDT 2019 YEH COLORADO LIBRARY.GLB 7/22/19

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

Project Name: Pearson Ministries Facility

Project Number: 219-217 *Boring No.:* **P-06**

Boring Began: 8:40:00 AM
Boring Completed: 8:45:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94133641 Long: -105.0127934
Location:

Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 55 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
							0.0 - 5.5 ft. Silty SAND with gravel (SM), dark brown, moist, medium dense.							
				4-6-6	12			3.6						
	5			9-10-14	24			4.8		20				

Bottom of Hole at 5.5 ft.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	Project Name: Pearson Ministries Facility	PAGE 1 of 1
	Project Number: 219-217	Boring No.: **P-07**

Boring Began: 8:30:00 AM
Boring Completed: 8:35:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94153402 Long: -105.0126483
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 55 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
							0.0 - 0.5 ft. Asphalt Concrete Pavment (6 inches).							
							0.5 - 5.5 ft. Silty SAND (SM), reddish brown, moist, loose.							
				4-5-4	9									
	5			3-2-2	4			5.6		15.2				

Bottom of Hole at 5.5 ft.

BORING LOG 2019 - SPT CDOT STYLE 219_217 PEARSON MINISTRIES FACILITY.GPJ 2019 YEH COLORADO TEMPLATE.GDT 2019 YEH COLORADO LIBRARY.GLB 7/22/19

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Pearson Ministries Facility	*PAGE 1 of 1*
	Project Number: 219-217	*Boring No.:* **P-08**

Boring Began: 8:20:00 AM
Boring Completed: 8:25:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.9414086 Long: -105.0121652
Location:

Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 50 F
Inclination from Horiz.: Vertical

Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
							0.5 - 5.5 ft. Clayey SAND (SC), reddish brown, moist, medium dense.							
				11-12-12	24			5.6						
	5			5-7-6	13			7.3		22.7	25	9	A-2-4 (0) SC	

Bottom of Hole at 5.5 ft.

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

Project Name: Pearson Ministries Facility

Project Number: 219-217 *Boring No.:* **P-09**

Boring Began: 8:10:00 AM
Boring Completed: 8:15:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94106806 Long: -105.0117768
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 50 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
							0.0 - 5.5 ft. Silty SAND with gravel (SM), dark brown, moist, loose.							
				7-7-6	13			7.4						
	5			3-2-2	4									

Bottom of Hole at 5.5 ft.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Pearson Ministries Facility	*PAGE* *1 of 1*
	Project Number: 219-217	*Boring No.:* **P-10**

Boring Began: 8:00:00 AM
Boring Completed: 8:05:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94087306 Long: -105.0116288
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 50 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
							0.0 - 3.0 ft. Clayey SAND (SC), reddish brown, moist, loose.							
				3-3-4	7			8.9		34.6	31	12	A-2-6 (0) SC	
							3.0 - 5.5 ft. Silty SAND with gravel (SM), reddish brown, moist, loose.							
	5			5-2-2	4									

Bottom of Hole at 5.5 ft.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Pearson Ministries Facility	*PAGE 1 of 1*
	Project Number: 219-217	*Boring No.:* **P-11**

Boring Began: 7:45:00 AM
Boring Completed: 7:50:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 5.5 ft
Ground Elevation:
Coordinates: Lat: 38.94063309 Long: -105.0120094
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 50 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
							0.0 - 0.2 ft. Asphalt Concrete Pavement (2 inches).							
							0.2 - 5.5 ft. Silty SAND with gravel (SM), reddish brown, moist, loose.							
				5-4-5	9			2.8		12.6				
	5			4-3-3	6			5.5						

Bottom of Hole at 5.5 ft.

Project Name: Pearson Ministries Facility

Project Number: 219-217 *Boring No.:* **WB-1**

Boring Began: 8:50:00 AM
Boring Completed: 8:55:00 AM
Drilling Method(s): Solid-Stem Auger
Driller: Vine Laboratories
Drill Rig: CME 55
Hammer: Automatic (hydraulic), ER: %

Total Depth: 9.1 ft
Ground Elevation:
Coordinates: Lat: 38.94116794 Long: -105.0129184
Location:
Logged By: L. Southerland
Final By: J. McCall

Weather Notes: Clear, 60 F
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
							0.0 - 3.0 ft. Clayey SAND (SC), reddish brown, moist, medium dense.							
				4-5-8	13			21.5		27.1	28	10	A-2-4 (0) SC	
							3.0 - 5.0 ft. Silty SAND with gravel (SM), reddish brown, dry, very dense.							
				50:5"	50:5"									
	5						**5.0 - 9.1 ft. GRANITE**, reddish brown, moderately weathered to fresh.							
				50:1"	50:1"									
				50:1"	50:1"									

Bottom of Hole at 9.1 ft.

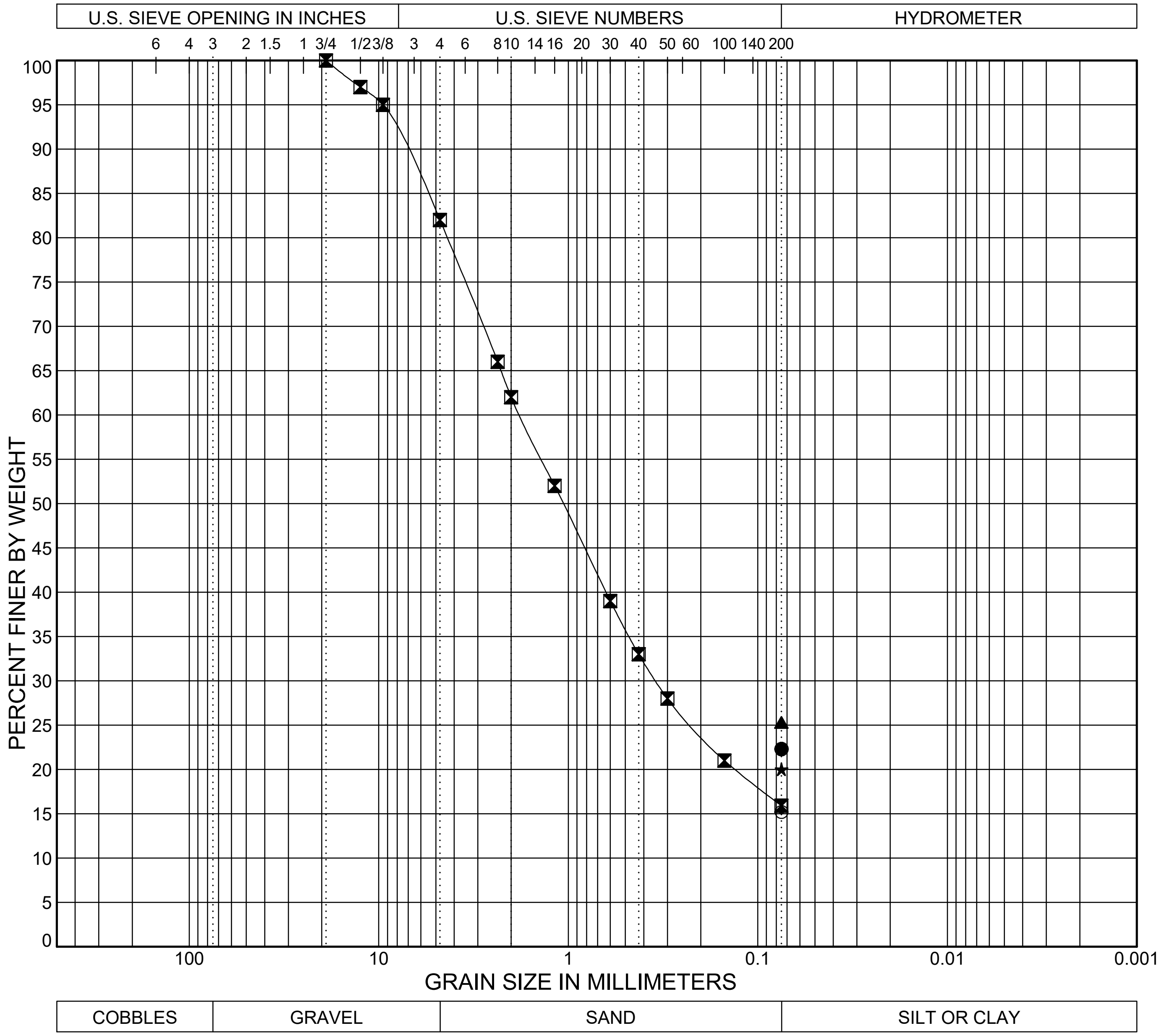
Appendix C

LABORATORY TEST RESULTS

Summary of Laboratory Test Results

Project No: 219-217 Project Name: Pearson Ministries Facility Date: 07-19-2019

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate (%)	Water Soluble Chloride (%)	Resistivity (ohm-cm)	Swell (+) / Collapse (-) (% at psf)	Unconf. Comp. Strength ()	R-Value	Classification	
Boring No.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI								AASHTO	USCS
P-02	1	SPT	5.2				22.3	22	15	7								A-2-4 (0)	SC-SM
P-02	4	SPT	5.9																
P-03	1	SPT	4.5		18.0	66.1	15.9	22	19	3								A-1-b (0)	SM
P-03	4	SPT	4.6																
P-04	4	SPT	6				25.3	17	16	1								A-2-4 (0)	SM
P-05	1	SPT	5.8																
P-05	4	SPT	3.6																
P-06	1	SPT	3.6																
P-06	4	SPT	4.8				20												
P-07	4	SPT	5.6				15.2												
P-08	1	SPT	5.6																
P-08	4	SPT	7.3				22.7	25	16	9								A-2-4 (0)	SC
P-09	1	SPT	7.4																
P-10	1	SPT	8.9				34.6	31	19	12								A-2-6 (0)	SC
P-11	1	SPT	2.8				12.6												
P-11	4	SPT	5.5																
P-1-3-6-7-8-11	0	BULK	5.3		19.0	55.1	25.9	24	15	9	7.6	.003	.0112	4708			36	A-2-4 (0)	SC
WB-1	1	SPT	21.5				27.1	28	18	10								A-2-4 (0)	SC



	BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines: %Silt	%Fines: %Clay
●	P-02	1.0	A-2-4 (0)	SC-SM	22	15	7			22.3	
⧗	P-03	1.0	A-1-b (0)	SM	22	19	3	18.0	66.1	15.9	
▲	P-04	4.0	A-2-4 (0)	SM	17	16	1			25.3	
★	P-06	4.0								20.0	
⊙	P-07	4.0								15.2	

Yeh and Associates, Inc.
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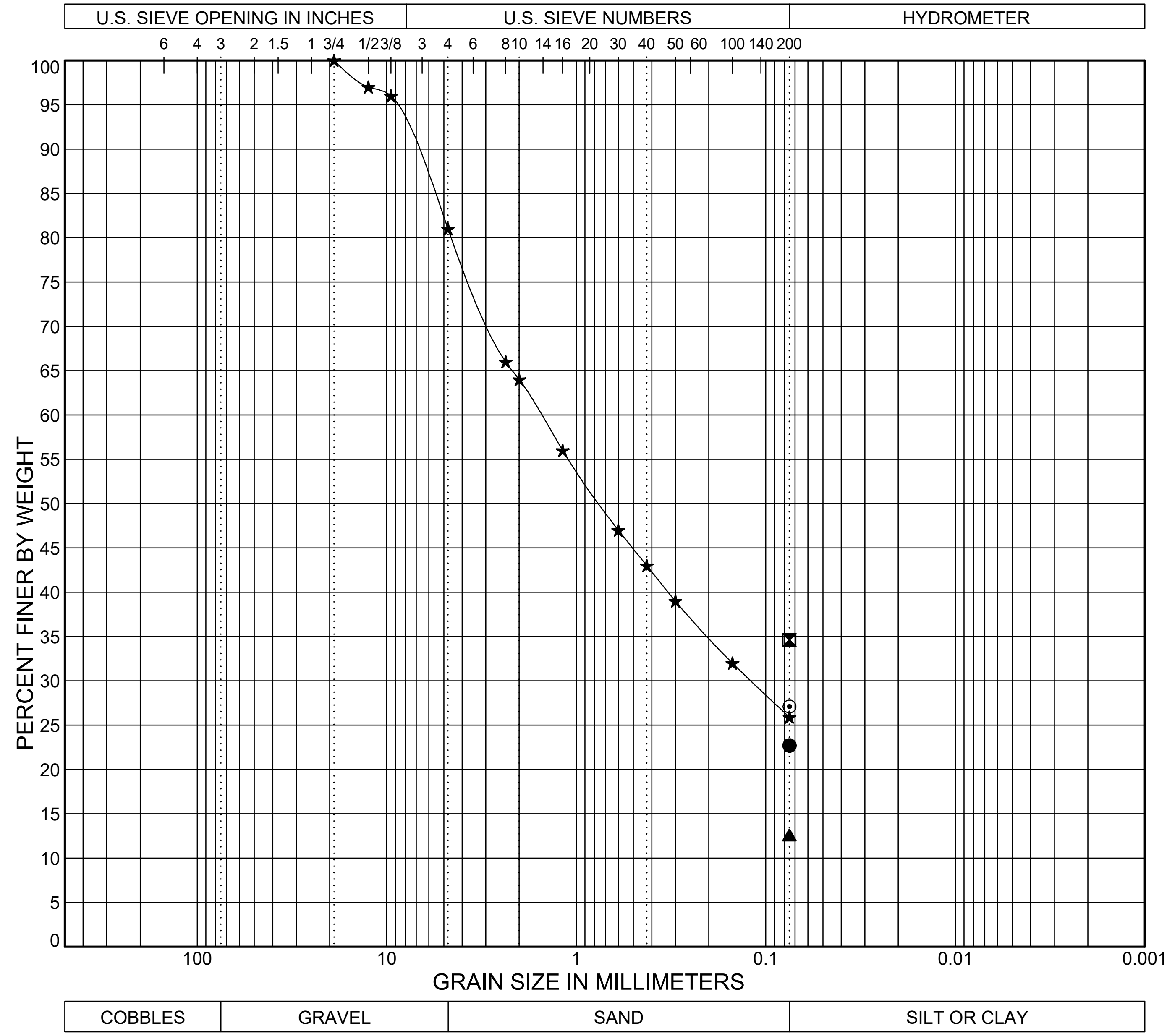
SIEVE ANALYSIS

FIGURE C- 2

Project No. 219-217 Date: 07-19-2019
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Pearson Ministries Facility
Green Mountain Falls, CO

03 GRAIN SIZE YEH 219_217 PEARSON MINISTRIES FACILITY.GPJ 2019 YEH COLORADO LIBRARY.GLB 2019 YEH COLORADO TEMPLATE.GDT 7/19/19



	BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines	
										%Silt	%Clay
●	**P-08**	**4.0**	**A-2-4 (0)**	**SC**	**25**	**16**	**9**			**22.7**	
⧗	**P-10**	**1.0**	**A-2-6 (0)**	**SC**	**31**	**19**	**12**			**34.6**	
▲	**P-11**	**1.0**								**12.6**	
★	**P-1-3-6-7-8-11**	**0.0**	**A-2-4 (0)**	**SC**	**24**	**15**	**9**	**19.0**	**55.1**	**25.9**	
⊙	**WB-1**	**1.0**	**A-2-4 (0)**	**SC**	**28**	**18**	**10**			**27.1**	

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

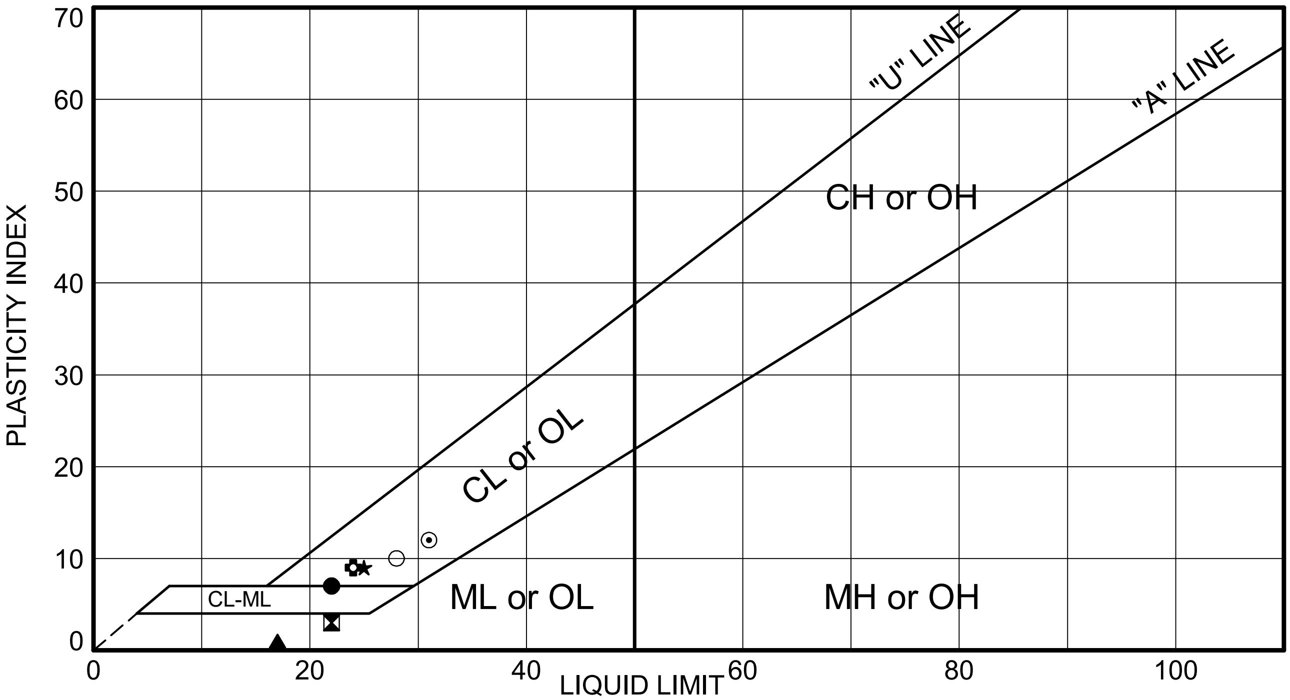
SIEVE ANALYSIS

FIGURE

C- 3

Project No. 219-217 Date: 07-19-2019
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Pearson Ministries Facility
Green Mountain Falls, CO



	BOREHOLE	DEPTH	LL	PL	PI	Passing #200	USCS Sample Description and Symbol	AASHTO Class.
●	**P-02**	**1.0**	**22**	**15**	**7**	**22**	**SILTY, CLAYEY SAND (SC-SM)**	**A-2-4 (0)**
⊠	**P-03**	**1.0**	**22**	**19**	**3**	**16**	**SILTY SAND with GRAVEL (SM)**	**A-1-b (0)**
▲	**P-04**	**4.0**	**17**	**16**	**1**	**25**	**SILTY SAND (SM)**	**A-2-4 (0)**
★	**P-08**	**4.0**	**25**	**16**	**9**	**23**	**CLAYEY SAND (SC)**	**A-2-4 (0)**
⊙	**P-10**	**1.0**	**31**	**19**	**12**	**35**	**CLAYEY SAND (SC)**	**A-2-6 (0)**
✿	**P-1-3-6-7-8-11**	**0.0**	**24**	**15**	**9**	**26**	**CLAYEY SAND with GRAVEL (SC)**	**A-2-4 (0)**
○	**WB-1**	**1.0**	**28**	**18**	**10**	**27**	**CLAYEY SAND (SC)**	**A-2-4 (0)**

Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

ATTERBERG LIMITS

Pearson Ministries Facility
Green Mountain Falls, CO

FIGURE C - 4

Project No. 219-217 Date: 07-19-2019
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Colorado Analytical LABORATORIES, INC.

Analytical Results

TASK NO: 190709011

Report To: Mustapha Aichiouene
Company: Yeh & Associates, Inc.
2000 Clay Street
Suite 200
Denver CO 80211

Bill To: Mustapha Aichiouene
Company: Yeh & Associates, Inc.
2000 Clay Street
Suite 200
Denver CO 80211

Task No.: 190709011
Client PO:
Client Project: Pearsons Ministries 219-217

Date Received: 7/9/19
Date Reported: 7/15/19
Matrix: Soil - Geotech

Customer Sample ID P-1-3-6-7-8-11
Lab Number: 190709011-01

Test	Result	Method
Chloride - Water Soluble	**0.0112 %**	AASHTO T291-91/ ASTM D4327
pH	**7.6 units**	ASTM G51-77
Resistivity	**4708 ohm.cm**	AASHTO T288-91
Sulfate - Water Soluble	**0.003 %**	AASHTO T290-91/ ASTM D4327

Abbreviations/ References:

AASHTO - American Association of State Highway and Transportation Officials.
ASTM - American Society for Testing and Materials.
ASA - American Society of Agronomy.
DIPRA - Ductile Iron Pipe Research Association Handbook of Ductile Iron Pipe.

DATA APPROVED FOR RELEASE BY