EPC STORMWATER REVIEW COMMENTS ARE SHOWN IN ORANGE BOXES WITH BLACK TEXT

TRI-STATE GENERATION & TRANSMISSION, INC.

FOX RUN SUBSTATION DRAINAGE REPORT

Revise to "Final Drainage Report"

Add PCD File # PPR-22-044

December 16, 2021

Prepared by:

DEL-MONT CONSULTANTS, INC.
ENGINEERING ▾ SURVEYING
125 Colorado Ave. ▾ Montrose, CO 81401 ▾ (970) 249-2251 ▾ (970) 249-2342 FAX
www.del-mont.com ▾ service@del-mont.com

TRI-STATE GENERATION & TRANSMISSION, INC.

FOX RUN SUBSTATION
DRAINAGE REPORT

ENGINEER'S CERTIFICATION

I hereby certify that this drainage report for the drainage design of the Fox Run Substation was prepared by me (or under my direct supervision) in accordance with the common engineering practices for the owners thereof. I understand that El Paso County does not and will not assume liability for drainage facilities designed by others, including the designs presented in this report.

Include page for standard signature blocks for Drainage Reports See paperclip pg 2

____

David Schieldt
Registered Professional Engineer
State of Colorado No. 47195

TABLE OF CONTENTS

Submit Appdx B GEOTECH report as a separate document and reference in the drainage report

1.0 General Location and Description

Tri-State Generation and Transmission (TSGT) in coordination with Del-Mont Consultants, Inc. (DMC) is in the process of designing a new substation yard. The scope of work includes the construction of the substation yard & retaining walls, driveway, detention pond and swales, installation of new perimeter fence, and the addition of high voltage electrical equipment and facilities. The purpose of this report is to present the findings from the hydrologic and hydraulic analyses that were performed on the existing property as well as present the results from a detailed analysis performed on the proposed improvements to the property.

1.1 Site Location

The proposed substation yard is located on a 14.92-acre parcel owned by TSGT, situated in the NW ¼ of Section 21, Township 11 South, Range 66 West, 6th Principal Meridian in El Paso County, Colorado. The substation site is accessed from Shahara Road.

1.2 Site Description

The site naturally drains to the northeast and is currently covered in various grasses. There are currently no features on the site to provide water quality or quantity treatment for discharge from the site. Site layout details will be discussed in more detail in **Section 2**.

There are developments on the properties to the south and the west of the site. MVEA Substation located on the neighboring property to the south, and Jackson Ranch Subdivision to the west. No wetlands are present on the site and the site is not located within a floodplain.

Identify the property is located in West Cherry Creek drainage basin

Reference should be made to major drainageway planning studies; Such as Drainage Basin Planning Studies; Flood Hazard delineation reports, and flood insurance studies or maps if available.

2.0 Drainage Basins and Sub-Basins

The property functions overall as one large basin, flowing to the northeast into a drainage on the east edge of the property. Proposed conditions produce several smaller sub-basins and will be discussed in detail in the following sections.

2.1 Existing Drainage Sub-Basins

The existing site was analyzed as one basin. A small portion of the existing site was unanalyzed as it did not affect the majority of the site. A map illustrating the delineation of the existing property can be found in **Appendix A**. There are developments on the properties to the south and the west of the site. MVEA Substation located on the neighboring property to the south, and Jackson Ranch Subdivision to the west. **Table 2-1** presents the existing basin and its corresponding acreage. The existing member substation was not analyzed as a part of this project.

Table 2-1: Existing Basin Acreages

Sub-Basin	Total Area (Acres)
Existing	14.38
Unanalyzed	0.54

2.2 Proposed Drainage Sub-Basins

The proposed conditions will produce several different sub-basins. The proposed site is divided into three different sub-basins; Yard Area, Proposed North, and Proposed South. A map illustrating the delineation of the sub-basins can be found in **Appendix A**. The Yard Area contains the entirety of the yard and the detention pond. The Proposed North and Proposed South areas contain swales that will route any run-on around the substation site, returning to historical discharge patterns. **Table 2-2** presents the proposed sub-basins and their corresponding acreages.

Table 2-2: Proposed Sub-Basin Acreages

Sub-Basin	Total Area (Acres)
Yard Area	5.23
Proposed North	6.70
Proposed South	2.44

Provide discussion of offsite drainage flow patterns and their impact on the development and show on an existing conditions drainage map

3.0 Drainage Design Criteria

Revise design method to Rational Method

3.1 Methodology

The El Paso County Drainage Criteria Manual calls for use of the rational method on sites under 100 acres. However, in the Volume One Update, Chapter 6, 1.4, the EPA SWMM method is noted to be better suited to more complex systems. Due to the complex nature of the drainage system, the hydrologic/hydraulic analysis of the site was performed using the Autodesk Storm and Sanitary analysis utilizing the SWMM engine platform model for a 10-year, 24-hour rainfall event of 3.01 total inches and a 100-year, 24-hour rainfall event of 5.15 total inches. The Curve Number method of determining rainfall losses due to infiltration was used. Runoff for all site conditions was computed for both the 10-year and 100-year, 24-hour storms. Rainfall depths were obtained for the region from NOAA Atlas 14, Volume 8, Version 2 and rainfall distribution curves were developed using a 24-hour rainfall distribution. Modeling results are presented in **Appendix D**.

Design rainfall to use DCM Vol I Update Chpt 6 Section 3.3 and Fig 6-5

The Mile High Flood District *Detention Basin Design Workbook* was utilized to determine the required water quality capture volume (WQCV) and to aid in the design the outlet structure. The spreadsheets/worksheets can be found in **Appendix C** and are discussed in more detail in **Section 4.0**.

WQCV and flood control detention

Soil data was obtained from a USDA Soils Report and gives a hydrologic soil group B for the site. The soils report is included in **Appendix B**.

The described methods/tools used in the analysis, are in accordance with common engineering practices and guidelines.

3.2 Land Cover Hydrologic Properties

Curve numbers and corresponding Manning's N values, for hydrologic soil group B, were assigned to the various land cover types found on the project, both existing and proposed, and are presented in **Table 3-1**.

Table 3-1: Land Cover Hydrologic Properties

Land Cover Type	Curve Number	Manning's N
Pasture or Range Land, Poor Condition (Existing Site)	69	0.15
Open Graded Aggregate Topping Over Compacted Base (Yard)	85	0.024
Compacted Base Material (Driveways)	85	0.024
Pavement/Concrete	98	0.015

3.3 Weighted Design Values

Utilizing the land cover hydrologic properties presented above, a weighted curve number and Manning's N value was calculated for each of the sub-basins, presented in **Section 2.0** to be used for analysis. **Table 3-2** presents the weighted design values for existing conditions and **Table 3-3** presents the weighted design values for proposed conditions. Detailed calculations can be found in **Appendix C**.

Table 3-2: Existing Sub-Basin Weighted Design Values

Sub-Basin	Total Area (Acres)	Weighted Manning's N	Weighted Curve Number
Existing	14.38	0.150	69

Table 3-3: Proposed Sub-Basin Weighted Design Values

Sub-Basin	Total Area (Acres)	Weighted Manning's N	Weighted Curve Number
Yard Area	5.23	0.058	84.59
Proposed North	6.70	0.15	69
Proposed South	2.44	0.146	69.52

Provide copy of submitted State Non-Jurisdictional Water Impoundment Structure application form. See paperclip

Provide discussion of maintenance access and aspects of the design.

An O&M agreement and maintenance manual will need to be submitted. EPC has standard agreement to be submitted. https://planningdevelopment.elpasoco.com/planning-development-forms/#1584029763943-19bc4c03-3586

Please provide following documents

-SDI Worksheet https://maperture.digitaldataservices.com/gvh/?viewer=cswdif

- MS4 Post Construction Detention / Water Quality Facility Documentation Form

Provide discussion and analysis of existing and proposed downstream drainage facilities and their ability to convey developed runoff from the proposed development.

Provide presentation of an accurate, complete current estimate of cost of proposed facilties. A FAE is required with surety

ESQCP form is missing

Explain all drainage basin fees and bridge fees for the property in question as applicable. A statement must be added even if not applicable due to no platting action

4.0 Drainage Facility Design

4.1 Historical Drainage

Per common practice, the 100-year historical discharge value for the site shall be used to determine the allowable discharge from the site for the proposed conditions. Values presented in **Table 3-2** were used in the model to calculate a historic existing property. **Table 4-1** presents the discharge rate for the exist 10-year and 100-year 24-hour storm events although the design is b discharge values.

Be advise County only requires minor storm to be analyzed with the 5-year design storm. Provide a statement to explain why you elect to design to the 10-yr storm.

Table 4-1: Existing Property Discharge Values

Sub-Basin	10-Year Discharge (CFS)	100-Year Discharge (CFS)
Existing	20.08	53.82

4.2 Proposed Drainage

Values presented in **Table 3-3** were utilized in the model to calculate the runoff for the proposed conditions. The Mile High Flood District *Detention Basin Design Workbook* was utilized to determine the WQCV in conjunction with the model to size the detention pond. Once the pond was sized, the Mile High Flood District *Detention Basin Design Workbook* was utilized to estimate required orifice sizes in the outlet structure to provide water quality treatment. The model was then used to verify all design elements of the pond and the outlet structure to ensure the pond not only retained the correct WQCV but to also discharge at or less than the required 100-year historic discharge rate presented in **Table 4-1** as well as drain the pond in less than the allowable time per State Requirements**.** The spreadsheet showing the detailed calculations can be found in **Appendix C.** The design of the outlet structure is detailed in the grading drawings.

The proposed detention pond was designed to provide water quality treatment as well as detain the 100-year storm event while maintaining the required 1-foot of freeboard. The proposed detention pond stage-storage curve is presented in **Table 4-2**.

Table 4-2: Detention Pond Stage-Storage Table

Elevation	Surface Area (Sq. Ft.)
7444	0
7445	20,284
7446	23,645
7447	26,149
7448	28,766

The model of the proposed site conditions was utilized to calculate discharge flow rates from the outlet structure in order to size the pond discharge culvert. **Table 4-3** presents the hydraulic capacity of the culvert and the required capacity to discharge flow from the outlet structure for the 100-year event. Detailed design of the pipe is provided in **Appendix A**.

Per DCMv2 Section 4.3, outlet pipe should be 18" minimum. (UD Figure 6-a)

Table 4-3: Outlet Pipe Hydraulic Capacity (100-year event)

Drainage Feature	Pipe Diameter (in)	Total Capacity (cfs)	Required Flow Capacity (cfs)	Remaining Capacity (cfs)
Pond Outlet	12	2.73	1.84	0.89

Table 4-4 presents the discharge rates for the proposed sub-basins for both the 25-year and 100-year 1-hour storm events prior to detention. This discharge value represents the flow rate that the pond is receiving. The discharge from the pond and other basins (total discharge from site) is summarized in **Table 5-1.**

Table 4-4: Proposed Sub-Basin Discharge Values (Pre-Detention)

Sub-Basin	10-Year Discharge (CFS)	100-Year Discharge (CFS)
Yard Area	14.07	28.42
Proposed North	10.03	26.75
Proposed South	5.58	12.04

Utilizing the flow rates presented above, the model was utilized to analyze the flow path of water through the piping and pond system. With the installation of the outlet structure, the pond was designed to pass both the 10-year and 100-year events, treat the required WQCV, and slowly release the water in the required length of time after the end of an event set forth by the State. The entire substation drains to the pond and the discharge rate leaving the pond is presented in **Table 5-1.**

Provide and explain Four Step Process
1. Runoff reduction proposed
2. Stabilization of drainage ways proposed/discussed
3. Proposed Stormwater Quality Capture Volume (WQCV) proposed
4. Identify Best Management Practices (BMP's) to be used to control industrial and commercial pollutants

A floodplain statement shall be provided indicating whether any portion of the development is in a designated floodplain as delineated on the current FEMA mapping.

5.0 Conclusions

5.1 Drainage Concept

The drainage design has been prepared using sound engineering judgement and practices and will provide an effective means of controlling runoff on the project site as well as protect the site from damage. The design has been completed according to common engineering practices and will result in no downstream impacts to any people or structures. Historic flow paths, discharge rates, and water quality have been maintained or improved.

5.2 Compliance with Common Practices

Per common practices, the historical discharge rate from the 100-year – 24-hour storm shall be utilized to determine the allowable discharge rate for the proposed improvements. To demonstrate compliance with this requirement, both the existing and proposed conditions were combined into one overall sub-basin. **Table 5-1** presents the overall discharge rates for the overall basin as well as the individual basins.

Table 5-1: Overall Sub-Basin Discharge Values (Post Detention)

Basin	10-Year Discharge (CFS)		100-Year Discharge (CFS)	
	Existing	Proposed	Existing	Proposed
Yard Area (Pond Outlet)	20.08	0.30	53.82	1.84
North		10.03		26.75
South		5.58		12.04
Total	20.08	15.91	53.82	40.63

The pond outlet structure was sized according to common practices so that the proposed condition 100-year discharge rate is less than the required discharge rate from the 100-year, 24-hour storm event, resulting in compliance with common practices.

The detention pond was also sized according to UDFCD requirements to treat the WQCV, detain the 100-year event, maintain 1 foot of freeboard, and maintain historical discharge patterns resulting in no downstream impacts.

Inspections of the pond and outlet structure will be conducted by the owner on an annual basis as well as after large storm events. If deficiencies are identified or if maintenance is required, maintenance of the outlet structure will be performed by the owner of the property in an effort to return the structure to its original level of functionality. Maintenance may involve cleaning of sediment and debris from the facility, maintaining vegetation growth around the structure, and performing any additional maintenance required.

Delete

6.0 References

~~*NOAA Atlas 14, Volume 8, Precipitation-Frequency Atlas of the United States*. U.S~~. Department of Commerce, 2013.

United States Department of Agriculture Natural Resources Conservation Service. Web Soil Survey

Mile High Flood District and Flood Control District. *Detention Basin Design Workbook,* Version 4.04, February 2021.

Urban Drainage and Flood Control District. *Urban Storm Drainage Criteria Manual,* Volume *1-3*, June 2001.

El Paso County, Colorado, *Drainage Criteria Manual*, Volume 1-2, October 31, 2018

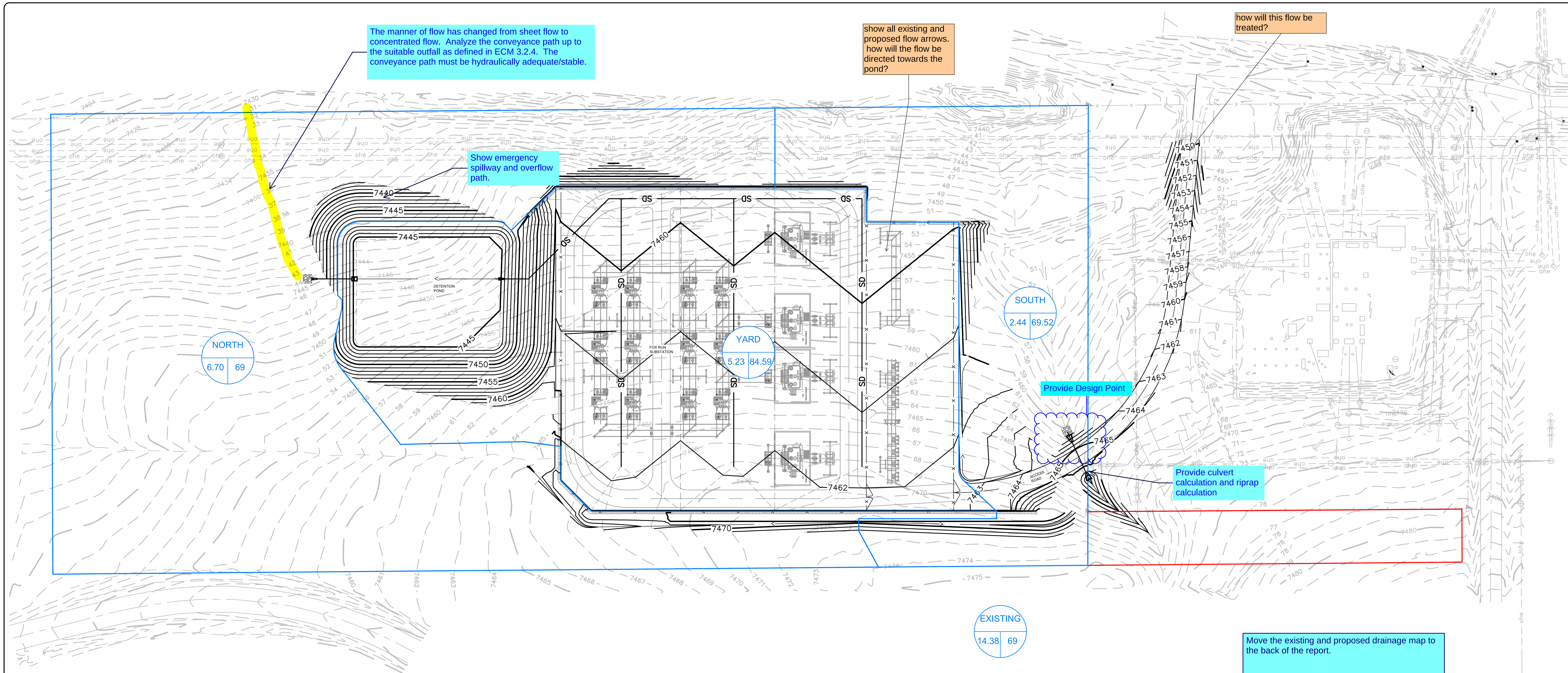
Add El Paso County Engineering Criteria Manual

Provide drainage ditch calculations and riprap outlet protection calculations

include MHFD BMP Spreadsheet for forebay, trickle channel, and micropool calculations.

Appendix A

Site Maps & Design Drawings



1" = 60'

Scale in feet

60' 0 60' 120'

LEGEND

- 5800 / 5798 — EXISTING INDEX CONTOUR / EXISTING INTERMEDIATE CONTOUR
- 5800 / 5796 — PROPOSED INDEX CONTOUR / PROPOSED INTERMEDIATE CONTOUR
- PROPOSED DRAINAGE FLOWLINE
- PROPOSED DRAINAGE BASIN
- UNANALYZED DRAINAGE AREA = 0.60 ACRES

A = BASIN
B = AREA IN ACRES
C = WEIGHTED RUNOFF COEFFICIENT

PLOTTED BY TCLEMENT, FILE PATH & NAME = \\DMS14\PROJECTS\ACTIVE PROJECTS\2021\21036-TSGT MONUMENT SUB SURVEY & CIVIL\FACILITY\CIVIL\MODEL\21036C_BASE.DWG, PLOT DATE = 12/16/2021 10:31 AM

NO	DATE	REVISIONS	BY

DEL-MONT CONSULTANTS, INC.
ENGINEERING & SURVEYING

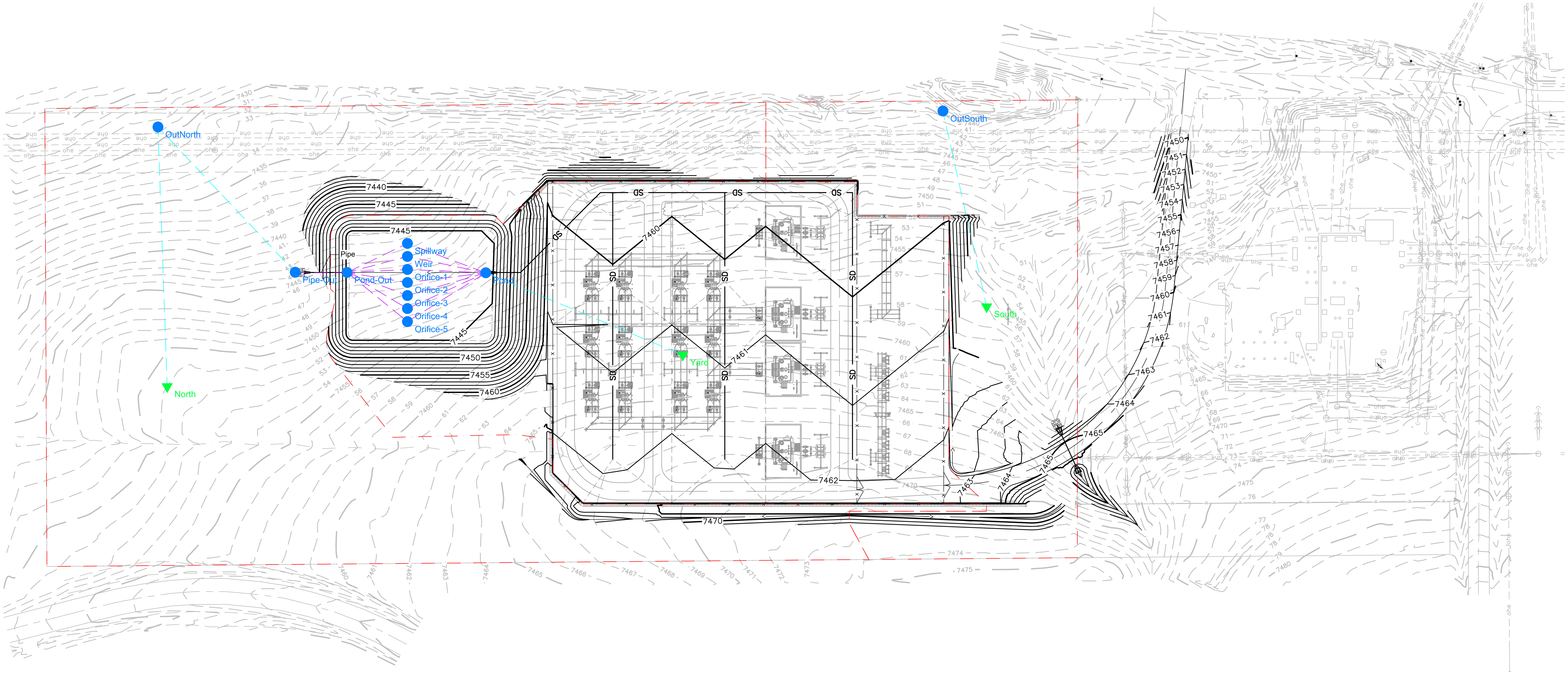
DESIGNED BY: TMC	CHECKED BY: DWS
DRAWN BY: TMC	SCALE: AS NOTED
FILE NAME: 21036C_BASE.DWG	DATE ISSUED: 12/16/21

TRI-STATE GENERATION & TRANSMISSION
FOX RUN SUBSTATION
MONUMENT, CO

DRAINAGE BASIN DELINEATION

DMC JOB NO.: 21036

SHEET NO.: A-1



Drainage Plan: Map(s) of the proposed development at a scale of 1"=20' to 1"=200' shall be included to identify existing and proposed conditions on or adjacent to the site in question. It shall include a minimum of:
Existing and proposed contours at 2 feet maximum intervals. For subdivisions involving rural lots greater than 1.0 acre, the maximum interval may be 5 feet where approved. In terrain greater than 10% the intervals should be 10 foot intervals.
Property lines and existing or proposed easements with purposes noted.
All Streets
Existing drainage facilities and structures, including irrigation ditches roadside ditches, drainageways, gutters and culverts, all indicating flow direction. All pertinent information such as material, size, shape, slope and locations shall also be included.
Overall drainage area boundary and drainage sub-area boundaries relating to the subdivision.
Proposed type of street sections (i.e., vertical or ramp curb and gutters, roadside ditch, gutter flow and/or cross pans).
Proposed storm sewers and open drainageways, including inlets, manholes, culverts, and other appurtenances.
Proposed outfall point for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties.
Routing and summary of initial and major flow rates at various design points for all storm runoff associated with the property.
Path (s) chosen for computation of time of concentration.
Details of and design computations for detention storage facilities including outlet.
Location and elevations of all defined 100-year floodplains affecting the property.
Location of all existing and proposed utilities affected by or affecting the drainage design.

N

1" = 60'

Scale in feet

60' 0 60' 120'

LEGEND

5800	PROPOSED INDEX CONTOUR
5796	PROPOSED INTERMEDIATE CONTOUR
	PROPOSED DRAINAGE FLOWLINE
STM	PROPOSED STORM PIPE
	DRAINAGE LINK
	DIRECT LINK
	DRAINAGE BASIN
Pond	DRAINAGE NODE
Yard	SUB-BASIN

NO | DATE | REVISIONS | BY

DMC
DEL-MONT CONSULTANTS, INC.
ENGINEERING ▼ SURVEYING

DESIGNED BY: TMC | CHECKED BY: DWS
DRAWN BY: TMC | SCALE: AS NOTED | FILE NAME: 21036C_BASE.DWG | DATE ISSUED: 12/16/21

TRI-STATE GENERATION & TRANSMISSION
FOX RUN SUBSTATION
MONUMENT, CO

DRAINAGE MODEL SCHEMATIC

DMC JOB NO.: 21036

SHEET NO.: A-2

PLOTTED BY TCLEMENT, FILE PATH & NAME = \\DMS14\PROJECTS\ACTIVE PROJECTS\2021\21036-TSGT MONUMENT SUB SURVEY & CIVIL\FACILITY\CIVIL\MODEL\21036C_BASE.DWG, PLOT DATE = 12/16/2021 10:31 AM

Remove Geotech report from the drainage report and submit as a separate document on eDARP.

Appendix B

Geotechnical Engineering Study

Include a section in the geotech report addressing the following section of the Drainage Criteria manual.

Geotechnical Engineering Study

11.2.2 Detention Facility Construction

The construction of detention facilities which multi-use benefits can provide significant benefits when properly planned and designed. Controlled outlets for flood surcharge storage should be provided, and it is required that such outlets be designed to release at a rate that does not exceed the peak rate estimated under natural conditions for the design storms, or other discharge established by policy and/or the drainage basin planning study.

Adequate safety measures shall be provided with all detention facilities. A minimum 15-foot maintenance easement shall be provided around the perimeter of the impoundment and embankment areas. Access to the bottom of the pond from a public road shall be provided via a minimum 15-foot wide ramp at a slope no greater than twelve (12) percent.

The geologic conditions of the site shall be investigated in sufficient detail to determine the suitability for impoundment of surface water. Ground water level increases downstream of the geologic investigation should be consistent with the class of structure and the complexity of the local site geology.

Guidelines for conducting geotechnical investigations for State of Colorado jurisdictional dams are presented in the draft "Design Review Manual" for dams and dam safety (Colorado Office of the State Engineer, July 31, 1986).

A design engineer check list for State of Colorado jurisdictional dams is included as Attachment A of this chapter. For non-jurisdictional dams i.e., those that do not or would not fall under State of Colorado purview, the designer must evaluate the appropriate factors identified, in the engineer check list, for the hazard rating presented as Attachment A and as otherwise required by the City/County.

9/30/90

11.3.3 Embankment Structures

The width of the top of the embankment structure shall be a minimum of 12 feet for embankments less than 25 feet in height. Also, side slopes on embankment structures will vary with materials types used and shall be designed to produce a stable and easily maintained structure. A slope stability analysis shall be required on all Class 1 structures.

An allowance for settlement shall also be factored into the design for all embankment structures. Consideration shall also be given to limiting excessive seepage through the embankment and foundation that may lead to embankment erosion and structure instability for all Class 1 structures.

A geotechnical analysis and report prepared by a Colorado Professional Engineer with recommendations for the foundation preparation and embankment construction shall be submitted to the City/County Engineer with the complete design analysis for all permanent detention facilities.

11.4 Hydraulic Design Methods

Geotechnical Engineering Study

Fox Run Substation

Monument, Colorado

Yeh Project No.: 221-290

November 11, 2021

Prepared by:

Brett Lykins
Staff Engineer

Reviewed by:

COLORADO LICENSED PROFESSIONAL ENGINEER JG THOMAS MCCALL 56485 11-11-2021

JG T. McCall, PE
Senior Project Engineer

Independent Review By:

Samantha C. Sherwood, PE
Project Manager

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

Table Of Contents

List Of Figures

List Of Tables

List Of Appendices

1. Purpose and Scope of Study

This report presents the results of Yeh and Associates, Inc. (Yeh) geotechnical engineering study for the proposed Fox Run substation in Monument, Colorado. Figure 1 shows the approximate location of the project site.

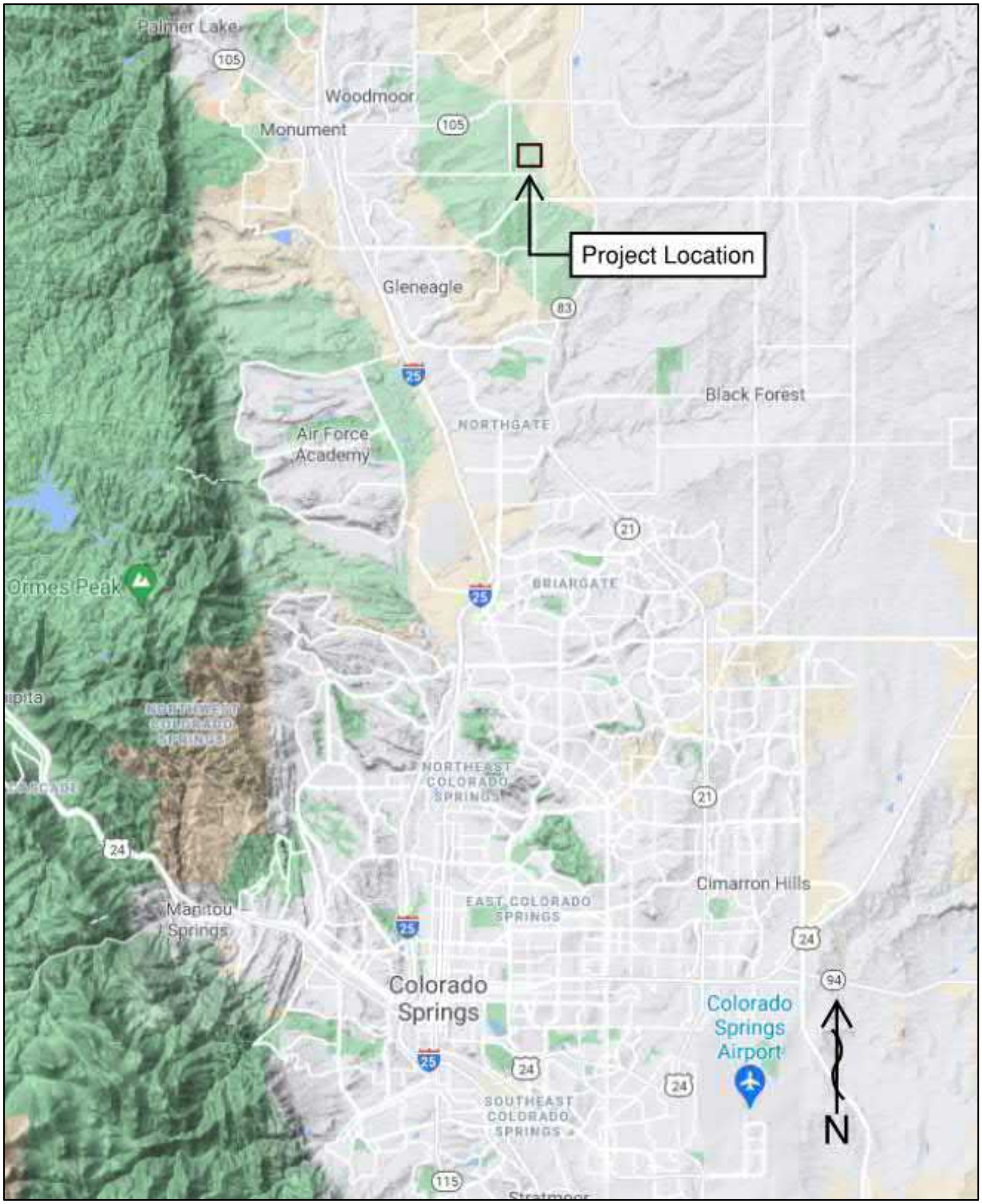


Figure 1. Project Location

The purpose of our study was to evaluate the subsurface conditions at the project site and provide geotechnical engineering recommendations for design and construction of the proposed substation project.

This report has been prepared in general accordance with our proposal for geotechnical engineering services, dated June 30, 2021. Our scope of services consisted of the following:

- Review available mapped geology at the site.
- Conduct a site observation and subsurface exploration to evaluate the existing subsurface conditions. The subsurface exploration included 16 geotechnical borings, 6 pressuremeter tests, and 1 soil electrical resistivity test performed at the approximate locations shown on Figure A-1 in Appendix A. The plans provided by Del-Mont Consultants, Inc. are included in Appendix A and present surveyed elevation data and northing and easting coordinates.
- Perform one Wenner 4-point resistivity test with an "a" spacing up to 500 feet
- 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, encountered site and subsurface conditions, recommendations for the foundation design, LPile and MFAD parameters, and earthwork recommendations.

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 the information provided, it is our understanding that the proposed project is for the design and construction of a new substation, Fox Run Substation, just north of the existing Monument Substation. The project is located in Monument, Colorado. We anticipate that site grading (cut and fill) of up to 2 feet will be required to achieve the final grade.

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 16 borings to 30 feet below ground surface (BGS), one test pit, one electrical resistivity test, and 6 pressuremeter tests at the approximate locations shown on Figure A-1 in Appendix A. The boring locations were staked on site prior to the start of drilling operations. The plans provided by Del-Mont Consultants, Inc. are included in Appendix A and present surveyed elevation data and northing and easting coordinates. The borings were advanced with a truck-mounted drill rig equipped with both 4-inch diameter solid stem and 6-inch diameter hollow stem, continuous flight augers. Borings were advanced to an approximate depth of 30 feet below the existing ground surface (BGS). For each boring, 4 samples were collected within the upper 10 feet, and then at 5 feet intervals to the terminal depth. Samples were collected by driving either a standard penetration test (SPT) or Modified California (MC) split barrel sampler into the strata with a 140-pound hammer falling 30-inches. Pressuremeter tests were performed within the vicinity of Borings B-1, B-8, B-13, B-16, and the test pit location at selected depths to test the different strata encountered.

The SPT is a 2.0-inch O.D., 1.375-inch I.D. standard split barrel sampler following ASTM D1586. The Modified California (MC) Sampler is a 2.5-inch O.D., 2.0-inch I.D. (1.95-inch I.D. with liners), split barrel sampler with internal liners, following ASTM D3550. The blows required to drive the SPT sampler the final 12-inches is known as the SPT N-value. The MC Sampler “Penetration Resistance” refers to the sum of all blows required to drive the sampler the drive length of 12 inches or portion thereof. The SPT N-value and the MC penetration resistance 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;
- Swell analysis testing;
- Analytical tests including water soluble sulfates and chlorides, soil resistivity, and 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 proposed Fox Run substation project site is located northwest of the intersection of Higby Road and Shahara Road in Monument, Colorado. The project site is bounded to the south by the existing Monument Substation. The area surrounding the project site primarily consists of single-family housing and undeveloped lots. Vegetation consists of native grasses, weeds, and sparse pine trees. The project site is currently undeveloped and grades down from west to east.

Photographs 1 through 5 show the site conditions at the time of our exploration.

Photograph 1. Looking northeast from the southwest corner of proposed substation

Photograph 2. Looking southeast from Boring B-13

Photograph 3. Looking northwest from Boring B-16

Photograph 4. Looking south from Boring B-4

Photograph 5. Looking west from Boring B-12

3.2 Geologic Setting

Review of the "Geologic Map of the Monument Quadrangle, El Paso County, Colorado, Thorson, J.P., and Madole, R.F., Colorado Geological Survey, 2004" indicates that the geology at the project sites consists of the Dawson Formation. This unit consists of alluvial fan and fluvial deposits containing sands, gravels and varying amounts of clay that accumulated at the foot of the growing Rocky Mountain Front Ranges. This unit is characterized by white to light-tan, fine-to-medium grained sandstone that is poorly sorted with high clay content and is known to contain interbeds of thin to very thinly bedded gray claystone and sandy claystone. The geologic units mapped at the project site are presented in Figure 2.

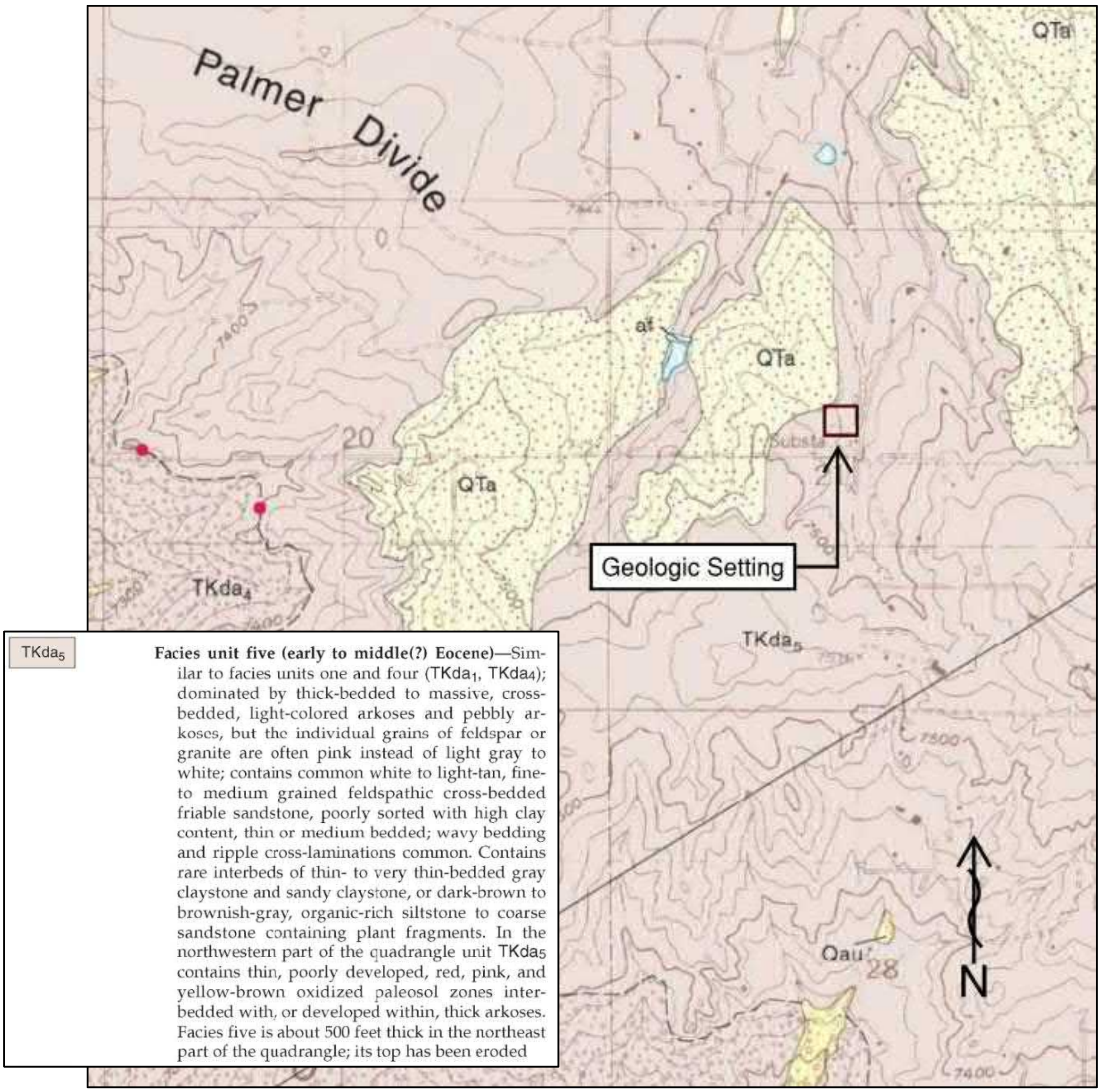


Figure 2. Geologic Setting

3.3 Subsurface Conditions

The subsurface soils encountered in our borings are generally consistent with the mapped geology. Sand, silt, and clay soils were encountered from the surface and extended to the termination depths of approximately 30 feet BGS in the borings. The sand soils encountered were tan, light brown to brown, white, and pale red with a loose to dense relative density. The silt and clay soils were white to tan, moist to dry, and soft to very stiff.

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

3.4 Groundwater

Groundwater was not observed during drilling operation. 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 water level in the nearby drainage ditch and creek.

4. Geologic Hazards

The geologic hazards at the site have been evaluated based on the results of the subsurface exploration and laboratory testing, review of pertinent information and publications available for the site. The geologic hazards that are addressed as part of this report include the following items:

Expansive/Collapsible soil and expansive bedrock: Based on the results of the field investigation and laboratory testing, the soils encountered in the borings do not have a swell or collapse potential.

Unstable or potentially unstable slopes: The project site grades from west to east. No unstable slope was observed.

Landslide areas or potential landslide areas: The terrain at the project site and in the vicinity grades down from west to east. No landslide or potential landslide area was observed.

Debris fans: The site is not located on a debris fan and is not subject to debris flow.

Rockfall: The site is not located in a rockfall area.

Subsidence: The site is outside the limits of the known subsidence risk area. There was no underground mining operation identified in this area.

Shallow groundwater tables: Groundwater was not encountered to the termination depth of 30 feet BGS in the test borings. These observations represent groundwater conditions at the time of subsurface exploration and may not be indicative of other times or other locations.

Groundwater springs or seeps: No evidence of springs or seeps was observed on the site during our field exploration.

Flood prone areas: Flood mapping is not available at the time of this report. The project site is not included in current mapping for the 100-year flood hazard map from Federal Emergency Management Agency (FEMA). A 100-year flood has a 1% chance of occurring every year and 39% chance every 50 years.

Collapsing Soils: Laboratory testing did not show the encountered soils having a high collapse potential.

Faults: There are no known faults mapped in the vicinity of the project site.

Steeply dipping bedrock: Based on the map of steeply dipping bedrock prepared by Colorado Geologic Survey in 1999, the site is not within mapped zone of susceptible to differential heave from expansive, steeply dipping bedrock.

Elevated radioactivity: No radon testing was performed on site. However, the proposed development is a substation and has no enclosed building.

Conclusion: Based on the information presented above, the project site is considered to possess a low potential for geologic hazards for the proposed development.

5. CONSTRUCTION RECOMMENDATIONS

Site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, state, or federal guidelines. Earthwork on the project should be observed and evaluated by Yeh. The evaluation of earthwork should include observation and testing of engineered fills, subgrade preparation, foundation bearing soils, and other geotechnical conditions exposed during the construction of the project.

5.1 Site Preparation and Grading

Site preparation should begin by stripping and removal of existing vegetation, topsoil, and other deleterious materials from proposed structure areas. Stripped materials consisting of vegetation and organic materials should be wasted from the site or used to revegetate landscaped areas after completion of grading operations. All exposed surfaces should be free of mounds and depressions, which could prevent uniform compaction.

Following initial stripping and grading, all exposed areas which will receive fill or support structures, once properly cleared, should be scarified to a minimum depth of 8 inches, moisture conditioned, and compacted according to Section 5.4 of this report. Following any required undercutting and moisture conditioning, and prior to placement of structural fill, it is recommended that the exposed soil subgrade be proofrolled. Proofrolling of the subgrade aids in identifying soft or disturbed areas. Unsuitable areas identified by the proofrolling operation should be undercut and replaced with structural fill. Proofrolling can be accomplished through use of a fully-loaded, tandem-axle dump truck or similar equipment providing an equivalent subgrade loading.

Suitable structural fill should be placed to design grade as soon as practical after reworking the subgrade to avoid moisture changes in the underlying soils. Any fill materials should be placed on a horizontal plane and placed in loose lifts not to exceed 8-inches in thickness, unless otherwise accepted by Yeh. The moisture content and compaction of subgrade soils and structural fill should be maintained until slab construction or placement of pavement structures.

Based upon the subsurface conditions encountered, subgrade soils exposed during construction are anticipated to be relatively stable. However, the stability of the subgrade may be affected by precipitation, repetitive construction traffic and other factors. If unstable conditions are encountered or develop during construction, stability may be improved by scarifying and drying the subgrade soils. Over excavation of wet zones and replacement with structural fill or crushed rock may be necessary. 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.

5.2 Excavation and Trench Construction

Excavations into the on-site soils will encounter a variety of conditions. All excavations must comply with the applicable local, State, and Federal safety regulations, and particularly with the excavation standards of the Occupational Safety and Health Administration (OSHA). Construction site safety, including excavation safety, is the sole responsibility of the Contractor as part of its overall responsibility for the means, methods, and sequencing of construction operations. Yeh's recommendations for excavation support is provided for the Client's sole use in planning the project, in no way do they relieve the Contractor of its responsibility to construct, support, and maintain safe slopes. Under no circumstances should the following recommendations be interpreted to mean that Yeh is assuming responsibility for either construction site safety or the Contractor's activities.

We believe the overburden soil encountered above groundwater level on this site will classify as a Type C material, using OSHA criteria. OSHA requires that unsupported cuts be no steeper than 1½:1 for Type C for unbraced excavations up to 20 feet in height. In general, we believe that these slope ratios will be temporarily stable under unsaturated conditions. Flattened slopes will be required if excavations extended below groundwater, or the slopes will be exposed for an extended period of time. Please note that the Contractor's OSHA-qualified "competent person" must make the actual determination of soil type and allowable sloping in the field.

The soils encountered by the proposed excavations may vary significantly across the site. The preliminary classifications presented above are based solely on the materials encountered in our exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation.

As a safety measure, it is recommended that all vehicles and soil piles be kept to a lateral distance equal to at least the depth of the excavation from the crest of the slope. The exposed slope face should be protected against the elements and monitored by the contractor on at least a daily basis.

5.3 Structural Fill Requirements

Based on our laboratory test results, the on-site sand and silt soils may be utilized as structural fill. Additional imported structural fill, if required, should consist of non-expansive granular material meeting the criteria presented in Table 5-1. The onsite sandy soils encountered are suitable for reuse as structural fill.

Table 5-1 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

We recommend that a qualified representative of Yeh visit the site during excavation and during placement of the structural fill to verify the soils exposed in the excavations are consistent with those encountered during our subsurface exploration and that proper foundation subgrade preparation and placement is performed.

All fill placed on this site should be compacted according to the recommendations in Section 5.4 of this report. Fill to be placed at this site during leveling/grading operations should be placed under controlled conditions. A sample of any imported fill material, if required, should be submitted to our office for approval and testing at least 3 days prior to stockpiling at the site.

5.4 Compaction Requirements

Much of the sand, silty sand, and clayey sand soils encountered during our exploration are suitable for use as structural fill materials provided organics and other deleterious material are removed following section 5.1 above. Table 5-2, below, presents the fill placement criteria.

Structural fill should be placed in level lifts not exceeding 8-inches in loose thickness and compacted to the specified percent compaction to produce a firm and unyielding surface. If field density tests indicate the required percent compaction has not been obtained, the fill material should be reconditioned as necessary and re-compacted to the required percent compaction before placing any additional material.

Table 5-2 Subgrade Preparation and Fill Placement Criteria

Fill Location	Material Type	Percent Compaction (ASTM Method)	Moisture Content
Foundation Subgrade Soils	On Site Sandy Soils	95 minimum (ASTM D698)	± 2 % of OMC[1]
	Imported Structural Fill	95 minimum (ASTM D1557)	± 2 % of OMC[1]
Trench Backfill	On Site Sandy Soils	90 minimum (ASTM D698)	0 to +2 % of OMC

1.OMC = Optimum Moisture Content determined from Proctor Test

5.5 Utility Trench Backfill

On-site soils may be utilized as backfill material in utility trenches provided the backfill is essentially free of plant matter, organic soil, debris, trash, other deleterious matter, and rock particles larger than 2-inches in diameter. Backfill should be placed in lifts of 8-inches or less and compacted with appropriate trench equipment. Utility trench backfill should be compacted as recommended in Section 5.4 of this report.

5.6 Drainage Considerations

Positive drainage should be provided during construction and maintained throughout the life of the proposed project. Proper design of drainage should include prevention of ponding water on or immediately adjacent to the structures. Surface features that could retain water in areas adjacent to the structures should be sealed or eliminated. Backfill against any kind of structure and in utility line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration and migration. Concentrated runoff should be avoided in areas susceptible to erosion and slope instability. Slopes and other stripped areas should be protected against erosion by re-vegetation or other methods.

5.7 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 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.

5.8 Chemical Sulfate Susceptibility and Concrete Type

The concentration of water-soluble sulfates measured in samples obtained from the borings was observed to be from less than 0.001% to .006%. This concentration of water-soluble sulfates represents a Class 0 degree of sulfate attack on concrete exposed to the soils tested. The degree of attack is based on a range of Class 0 (negligible) to Class 3 (very severe) as described in the American Concrete Institute (ACI) Standard 201.2R, "Guide to Durable Concrete".

Sulfate resistant cement in accordance with Section 601.04 of the 2021 CDOT Standard Specifications for Road and Bridge Construction should be utilized for all concrete elements on this project.

5.9 Corrosion Potential

Analytical testing was completed on representative samples from the geotechnical borings. Test results are presented in Table 5-3.

Table 5-3. Analytical Test Results

Sample Location	Soil Type	Water Soluble Chlorides (%)	pH	Resistivity (ohm-cm)	Water Soluble Sulfates (%)
B-3 @ 4 ft	Silty Sand	0.0002	7.0	9,308	<0.001
B-6 @ 4 ft	Silty Sand	0.0006	7.2	5,435	0.006
B-11 @ 4 ft	Silty Sand	0.0004	7.1	9,223	<0.001

Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from metal into the soil. As resistivity decreases, the corrosivity of the soil increases. The following table provides a correlation between soil resistivity and corrosivity towards ferrous metal, as recommended by "Underground Corrosion, NBS Circular 579", Melvin Romanoff, 1957.

Table 5-4. Resistivity and Corrosivity Categories

Resistivity in Ohm-centimeters	Corrosivity Category
0 to 1,000	Severely Corrosive
1,000 to 2,000	Corrosive
2,000 to 10,000	Moderately Corrosive
Greater than 10,000	Mildly Corrosive

Based on the resistivity test results, the existing soils are anticipated to be moderately corrosive to unprotected iron or steel structures. A qualified corrosion engineer should review this data to determine the appropriate corrosion protection measures at the site.

6. Foundation Design Recommendations

The site appears suitable for the proposed construction based upon geotechnical conditions encountered in the borings. Based on the geotechnical engineering analyses, subsurface exploration, and laboratory test results, we recommend that the structures be supported on a spread footing or a mat foundation system bearing on properly prepared on-site soils, or properly compacted imported structural fill. Design details for shallow foundations are provided following Allowable Stress Design (ASD).

6.1 Spread Footings

The proposed structures may be supported on shallow spread footings or mat foundations, that are founded on properly prepared and compacted structural fill or native sand and clayey sand soils. Footings placed on properly prepared subgrade soils may be designed as follows.

1. The maximum allowable bearing pressure for spread footings founded on properly prepared subgrade soils is 3,500 pounds per square foot (psf). The allowable bearing pressure is based on a factor of safety (F.O.S.) of approximately three with respect to shear failure of the foundation bearing materials. A one third increase in the allowable bearing pressure may be used for the maximum allowable bearing pressure for temporary loading conditions including wind or seismic conditions.

2. Lateral capacity of the footings may be derived from passive resistance along the vertical face of the footings, and friction between the bottom of the footings and the foundation soils. An allowable passive resistance using an equivalent fluid pressure of 185 pcf (F.O.S. of 2) may be used to calculate passive earth pressure. Passive pressure should be ignored in the upper 30-inches below exposed ground surface. An allowable coefficient of friction of 0.32 (F.O.S. of 1.5) between the bottom of the footings and the on-site/ /structural fill may be used for the sliding resistance.

3. For the uplift capacity, it is recommended that the combined weight of the footing plus the soil immediately above it exceeds twice the maximum uplift forces. The weight of the soil immediately above the footings may be designed using a unit weight of 125 pcf.

4. All footings should be founded a minimum of 30-inches below the final grade to provide protection against frost penetration. Isolated spread footings should have a minimum width of 18 inches.

Footings should be proportioned to reduce differential foundation movement. Proportioning on the basis of equal total movement is recommended; however, proportioning to relative constant dead load pressure will also reduce differential movement between adjacent footings. Total vertical movement is estimated to be on the order of 1-inch or less. Differential settlement is anticipated to be on the order of ½ to ¾ of the estimated total vertical movement. Additional foundation movements could occur if water from any source infiltrates the foundation soils, therefore, proper drainage should be provided in the design and during construction.

If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

An allowable modulus of subgrade reaction, K_{V1}, of 100 pounds per cubic inch may be used for design of mat foundations. K_{V1} refers to a 1-foot square plate and should be adjusted for actual foundation dimensions using the following equation (B is foundation width in feet):

$$K_V = K_{V1}\left(\frac{B+1}{2B}\right)^2$$

Footings and foundations should be reinforced as necessary to reduce the potential for distress caused by differential foundation movement. Foundation excavations should be observed by the geotechnical engineer. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required.

6.2 Drilled Shaft Foundation System

We understand support towers may be founded on drilled shaft foundations. Tri-State uses the software package MFAD and LPile for foundation analysis and design.

6.2.1 Axial Capacity

The design criteria presented below are recommended for a straight-shaft pier foundation system.

1. Drilled piers founded a minimum of 15 feet below existing ground surface may be designed for an allowable end bearing pressure and side skin friction as presented in Table 6-1.

Table 6-1. Allowable Drilled Shaft Axial Capacity

Material	Allowable End Bearing Capacity (ksf)[1]	Allowable Side Skin Friction[2,3]	
		Compression (ksf)	Uplift (ksf)
Sand	6.8	0.85	0.62
Clay	6.0	0.65	0.55
Dawson Formation	8.8	0.96	0.77

[1] Factor of Safety (FOS)= 3
[2] FOS= 2.5
[3] Upper 5 feet should be ignored for side friction.

2. For drilled foundations constructed in accordance with the recommendations presented in Table 6-1, total foundation settlement should be less than 1-inch.

3. A minimum pier diameter of 18 inches is recommended to facilitate proper cleaning and observation of pier hole. Piers should be spaced apart at least 3 pier diameters from center to center. Piers should be reinforced for their full length designed to resist the deficit between the design dead load on the pier and the uplift pressures acting on the pier perimeter.

4. In our experience, the onsite soils can be vulnerable to caving, especially if groundwater is present. The contractor should plan on temporary casing being required to complete the pier holes.

5. Pier holes should be properly cleaned prior to placement of concrete. Concrete should be placed in piers the same day they are drilled. Failure to place concrete the day of drilling will normally result in a requirement for lengthening the pier penetration. The presence of groundwater or caving soils may require that concrete be placed immediately after the pier hole drilling is completed. The Contractor should take care to prevent enlargement of the excavation at the tops of piers, which could result in mushrooming of the pier top.

6. Concrete utilized in the piers should be a fluid mix with sufficient slump so that it will fill the void between reinforcing steel and the pier hole wall. We recommend the concrete have a minimum slump in the range of 5 to 7 inches. For dry excavation, concrete can be placed by either tremie or free fall methods using hopper or other approved equipment. Wet excavated shafts will require concrete placement using tremie or pumping methods. The tremie pipe should be clean and have a suitable inside diameter for use with the specific concrete mix, but not less than 8 inches. The discharge end of the tremie should allow free radial flow of the concrete and be immersed in concrete and maintain a positive pressure differential at all times during placement to prevent water or slurry intrusion.

7. The pier drilling Contractor should mobilize equipment of sufficient size and operating capability to achieve the required penetration into the very dense, cemented sand soils. If refusal is encountered in these materials, the Geotechnical Engineer should evaluate the conditions to establish that true refusal has been met with adequate drilling equipment. A representative of the Geotechnical Engineer should be retained to observe pier drilling operations on a full-time basis.

6.2.2 Lateral Capacity

We understand that computer programs MFAD and LPILE will be used for the design of the drilled pier foundation systems. The following tables present the recommended soil engineering properties for use with MFAD and LPILE. Figure A-3 to A-6 presents a subsurface profile along the Fox Run Substation and the MFAD parameters for each layer. The lateral resistance of the soil should be ignored within the upper 5 feet of the ground surface.

Table 6-2. MFAD Parameters for Design of Drilled Shaft Foundations

MFAD Parameter Designation	Materials	Total Unit Weight (pcf)	Deformation Modulus, E_p	Ultimate Rock Concrete Bond Strength (ksf)	Friction Angle (°)	Cohesion (psf)
A	Silty SAND	125	1,339 psi	N/A	30	0
B	Clayey SAND	125	1,341 psi	N/A	32	0
C	Sandy Lean CLAY	120	3,114 psi	N/A	0	2,000
D	Sandy SILT	120	850 psi	N/A	0	500
E	Poorly Graded SAND w/ Silt	125	1,068 psi	N/A	32	0

Table 6-3. LPILE Parameters for Design of Drilled Shaft Foundations

Materials	Soil Model	Total Unit Weight (pcf)	Soil Modulus K (pci)	Strain Factor, ε_{50}	Friction Angle (°)	Cohesion (psf)
Sandy Soils	Sand (Reese)	125	90	N/A	32	0
Silty Sand	Sand (Reese	125	25	N/A	30	0
Clay	Stiff Clay	120	N/A	0.007	0	2,000
Silt	Soft Clay	120	N/A	.020	0	500

7. SEISMICITY

No current active faults are known to exist in the immediate vicinity of the proposed project location. Based on the site class definitions from IBC 2015, this site can be categorized as a Site Class D. The project site can be categorized as Risk Category I.

The peak ground acceleration and the short- and long- period spectral acceleration coefficients for a Site Class B (reference site class), site factors for site class D, and site-specific elastic response coefficients were determined using the seismic design maps from the USGS website. The seismic design parameters for the reference site and site class D are shown below.

Table 7-1. Seismic Design Parameters

S_S	F_a	S_{MS} ($S_{MS} = F_aS_S$)	S_{DS} (S_{DS} = 2/3 S_{MS})
0.182	1.6	0.291	0.194
S_1	F_V	S_{M1} ($S_{M1} = F_vS_1$)	S_{D1} (S_{D1} = 2/3 S_{M1})
0.06	2.4	0.143	0.096

S_S = The mapped spectral accelerations for short periods (U.S. Geological Survey Web Page, 2021
F_a = Site coefficient from Table 1613.5.3(1), 2015 IBC
S_{MS} = The maximum considered earthquake spectral response accelerations for short periods
S_{DS} = 5-percent damped design spectral response acceleration at short periods
S_1 = The mapped spectral accelerations for 1-second period (U.S. Geological Survey Web Page, 2021)
F_v = Site coefficient from Table 1613.5.3(2), 2015 IBC
S_{M1} = The maximum considered earthquake spectral response accelerations for 1-second period
S_{D1} = 5-percent damped design spectral response acceleration at 1-second period

8. IN-SITU SOIL RESISTIVITY TESTING

Field soil resistivity test was performed at the project site of the proposed substation by Mapes In-Situ, Inc. using the Wenner four-point method in accordance with ASTM G57-06. The equipment used was a Terrameter SAS 1000, manufactured by ABEM.

The Wenner method uses four equally-spaced metal probes or electrodes driven into the ground, along a straight line. An alternating current is applied across the outer two probes, and voltage is measured across the inner probes. Using Ohm's Law (R=V/I), the resistance value is calculated. The apparent soil resistivity is the average resistance of the soil mass along the electrical field lines from the ground surface to a depth approximately equal to the distance between probes, and calculated as following:

$$\rho = A \, 2 \, \pi \, R$$

Where: ρ = apparent soil resistivity (ohm-cm)

A = distance between the electrodes (cm)

R = measured resistance (ohms)

π = constant pi (3.1416)

Resistance measurements were conducted with probe spacings of 2, 3, 5, 7, 10, 20, 30, 50, 70,100, 200, 300, and 500 feet in the NW-SE and NE-SW orientations. The probes used in the field soil resistivity tests are metal probes with a diameter of 0.375-inch, and height of 18-inch. The probes were driven into the ground with a penetration of 1.5, 3, 6, 9, and 12 inches, depending on the "A" spacing length. The Terrameter SAS 1000 resistivity meter emits a 200 mA direct current four (4) separate times to produce 4 readings during the measurement and the averaged values are recorded. The results of the field resistivity tests are presented in the table below and in Appendix B.

Table 8-1 Field Resistivity Results

"A" Spacing (feet)	NW-SE Line		NE-SW Line	
	Field Resistance (ohm)	Apparent Resistivity (ohm-cm)	Field Resistance (ohm)	Apparent Resistivity (ohm-cm)
2	78.996	30,255	72.614	27,811
3	44.925	25,809	43.917	25,230
5	19.364	18,800	19.396	18,572
7	15.529	16,795	12.230	16,394
10	7.950	15,223	7.709	14,764
20	3.354	12,844	3.220	12,333
30	2.119	12,173	2.029	11,654
50	1.387	13,277	1.347	12,896
70	1.082	14,503	1.071	14,354
100	0.840	16,093	0.815	15,616
200	0.422	16,161	0.431	16,508
300	*	*	0.225	12,950
500	*	*	*	*

* Obstructed by property fence line

9. 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.

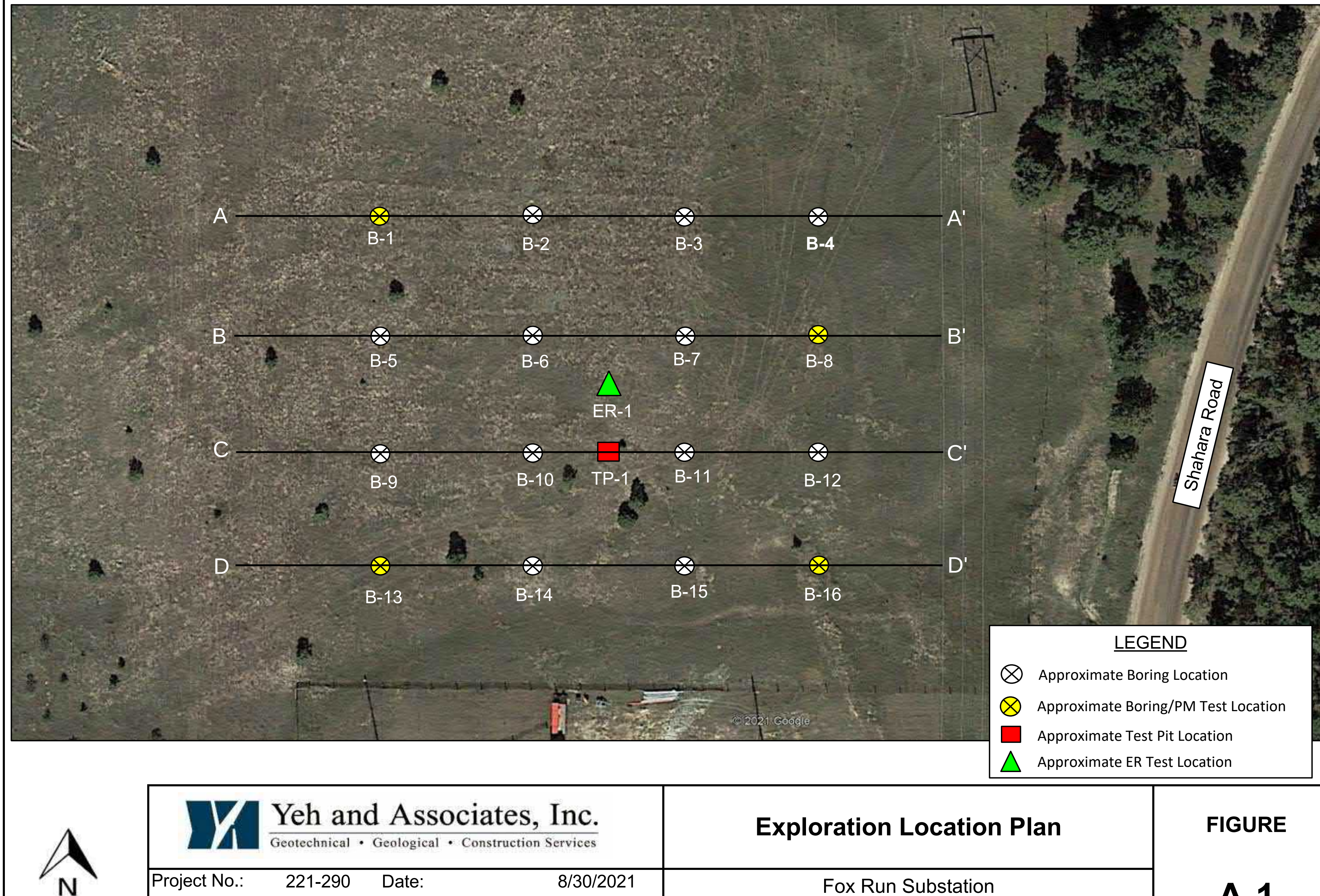
This report was prepared in in a manner consistent with that level of care and skill ordinarily exercised by other members of the profession practicing in the same locality, under similar conditions and at the date the services are provided. Yeh makes no other representation, guarantee, or warranty, 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 EXPLORATION LOCATION PLAN

FIGURE A-3 TO A-6 SUBSURFACE PROFILES



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

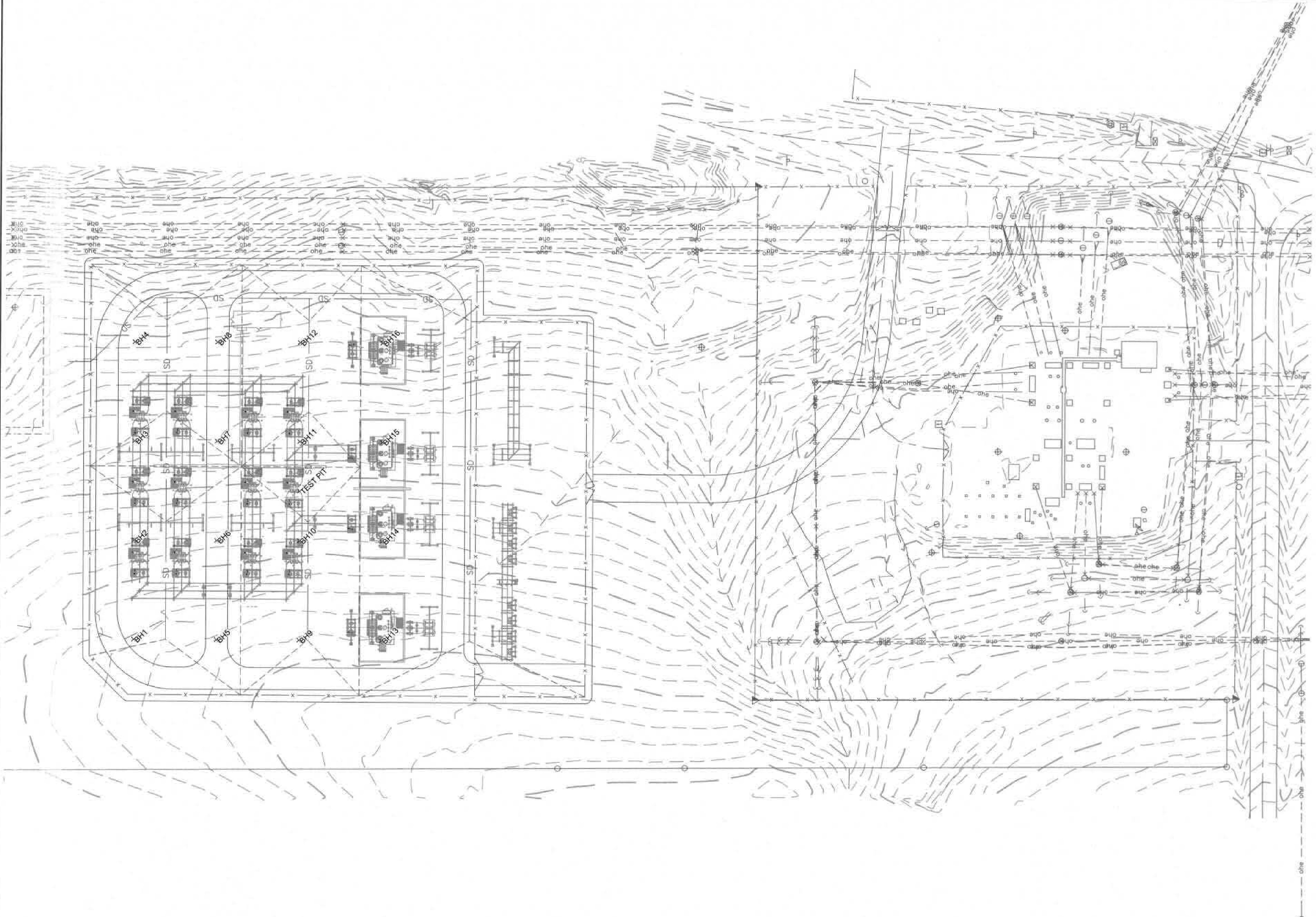
Project No.:	221-290	Date:	8/30/2021
Figure By:	BHL	Yeh Office:	Colorado Springs
Checked By:	JTM		

Exploration Location Plan

Fox Run Substation
Monument, Colorado

FIGURE

A-1



Point Table				
Point #	Northing	Easting	Elevation	Raw Description
25000	1455857.301	3203913.800	7466.83	BH1
25001	1455857.301	3204003.800	7462.87	BH2
25002	1455857.301	3204093.800	7457.02	BH3
25003	1455857.301	3204183.800	7450.52	BH4
25004	1455782.301	3203913.800	7468.15	BH5
25005	1455782.301	3204003.800	7463.54	BH6
25006	1455782.301	3204093.800	7457.10	BH7
25007	1455782.301	3204183.800	7451.11	BH8
25008	1455707.301	3203913.800	7469.08	BH9
25009	1455707.301	3204003.800	7464.01	BH10
25010	1455707.301	3204093.800	7457.65	BH11
25011	1455707.301	3204183.800	7451.81	BH12
25012	1455632.301	3203913.800	7469.07	BH13
25013	1455632.301	3204003.800	7463.92	BH14
25014	1455632.301	3204093.800	7457.96	BH15
25015	1455632.301	3204183.800	7451.19	BH16
25016	1455707.301	3204048.800	7460.60	TEST PIT

POINT FILE ~SO21036_2021-07-21_BH_TMC.txt

STAKING POINTS CHECK BY

NAME: Robert D. Dunn (signature) DATE: 2021-07-21

1" = 50'
Scale in feet
50' 0 50' 100'

NO | DATE | REVISIONS | BY

DEL-MONT CONSULTANTS, INC.
ENGINEERING ▼ SURVEYING

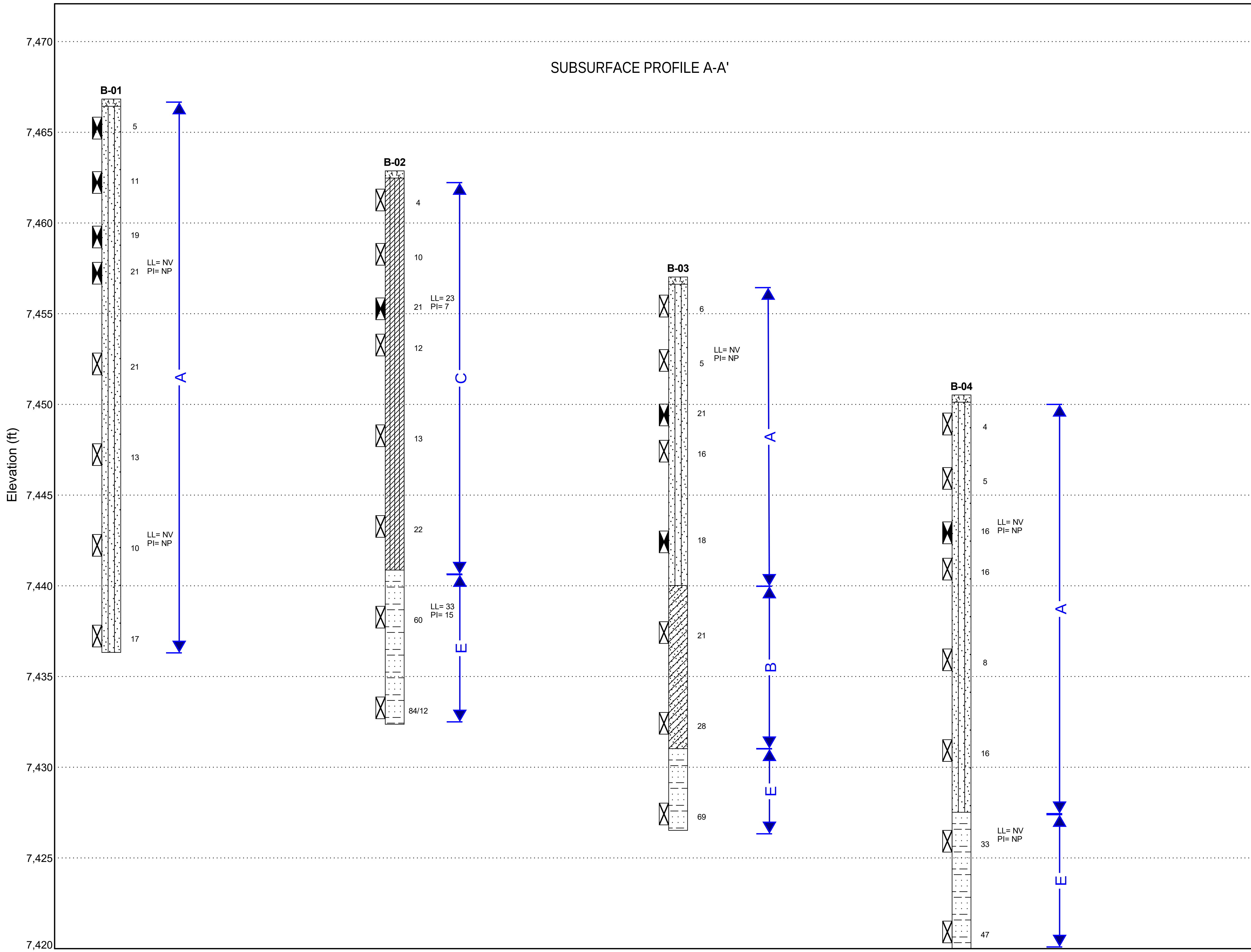
DESIGNED BY: TMC | SCALE: AS NOTED | CHECKED BY: DWS
DRAWN BY: TMC | DATE ISSUED: MM/DD/YY

TRI-STATE GENERATION & TRANSMISSION
FOX RUN SUBSTATION
MONUMENT, CO

BOREHOLE STAKING

DMC JOB NO: 21036

SHEET NO: STKG-1



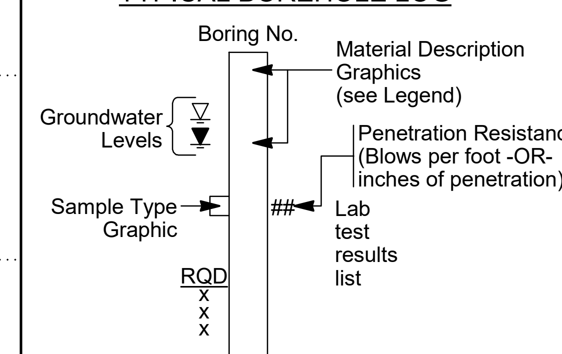
LEGEND

Soil Lithology

- Topsoil
- Silty Sand (SM)
- Silty Clay (CL-ML)
- Interbedded claystone and sandstone
- Clayey Sand (SC)

Rock Lithology

TYPICAL BOREHOLE LOG



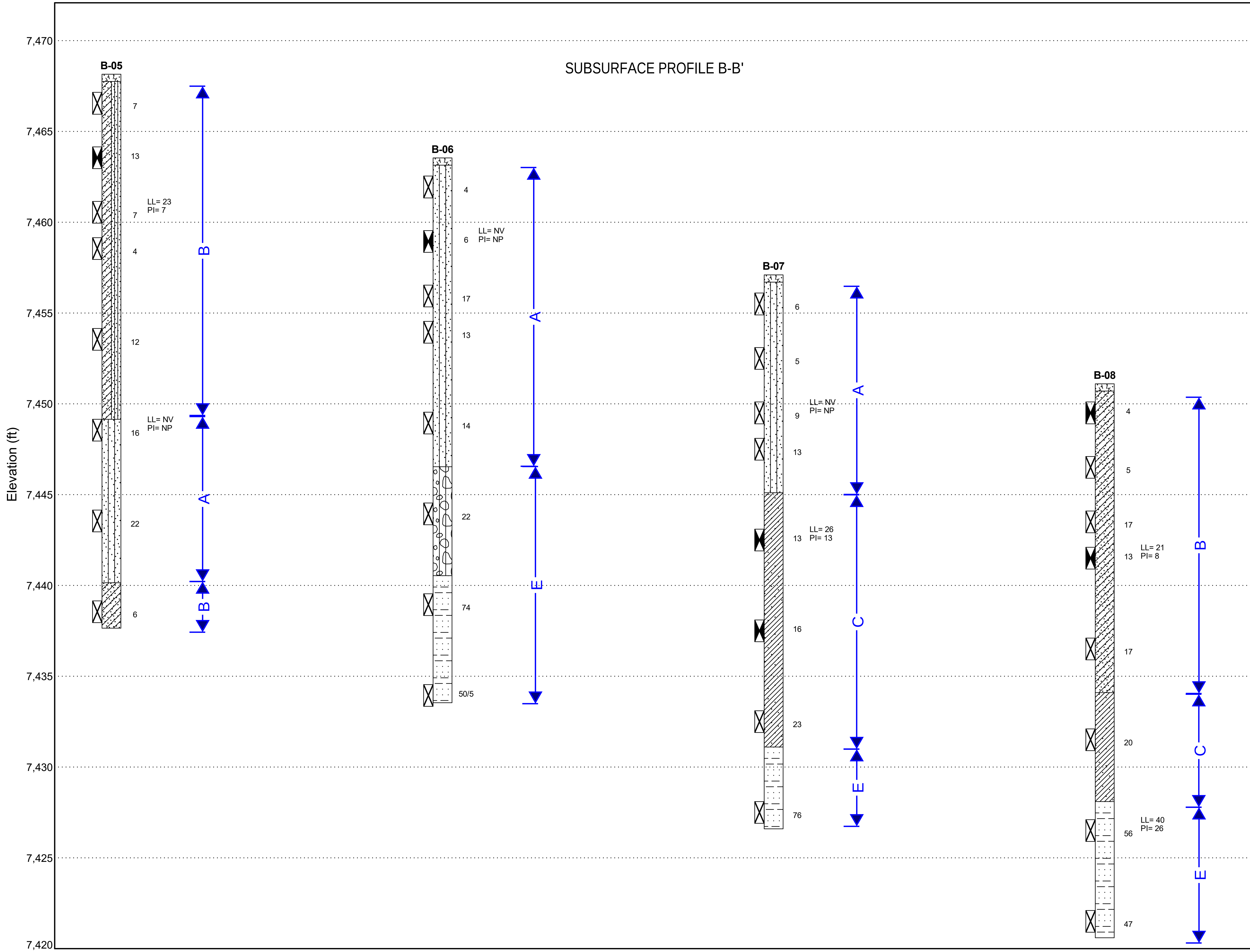
*e.g. A value of 50/3" or 50:3" indicates that 50 blows were applied to the sampler, with a penetration of 3 inches.

For additional information, refer to Geotechnical Report, prepared by Yeh and Associates, Inc.

Tri-State Fox Run Substation

Project Number: 221-290

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



LEGEND

Soil Lithology

- Topsoil
- Silty, Clayey Sand (SC-SM)
- Silty Sand (SM)
- Clayey Sand (SC)
- Silty Gravel (GM)
- Interbedded claystone and sandstone
- Sandy Lean Clay (CL)

Rock Lithology

TYPICAL BOREHOLE LOG

Boring No.
Material Description Graphics (see Legend)
Groundwater Levels
Penetration Resistance (Blows per foot -OR- inches of penetration)*
Sample Type Graphic
##
Lab test results list
RQD
x
x
x

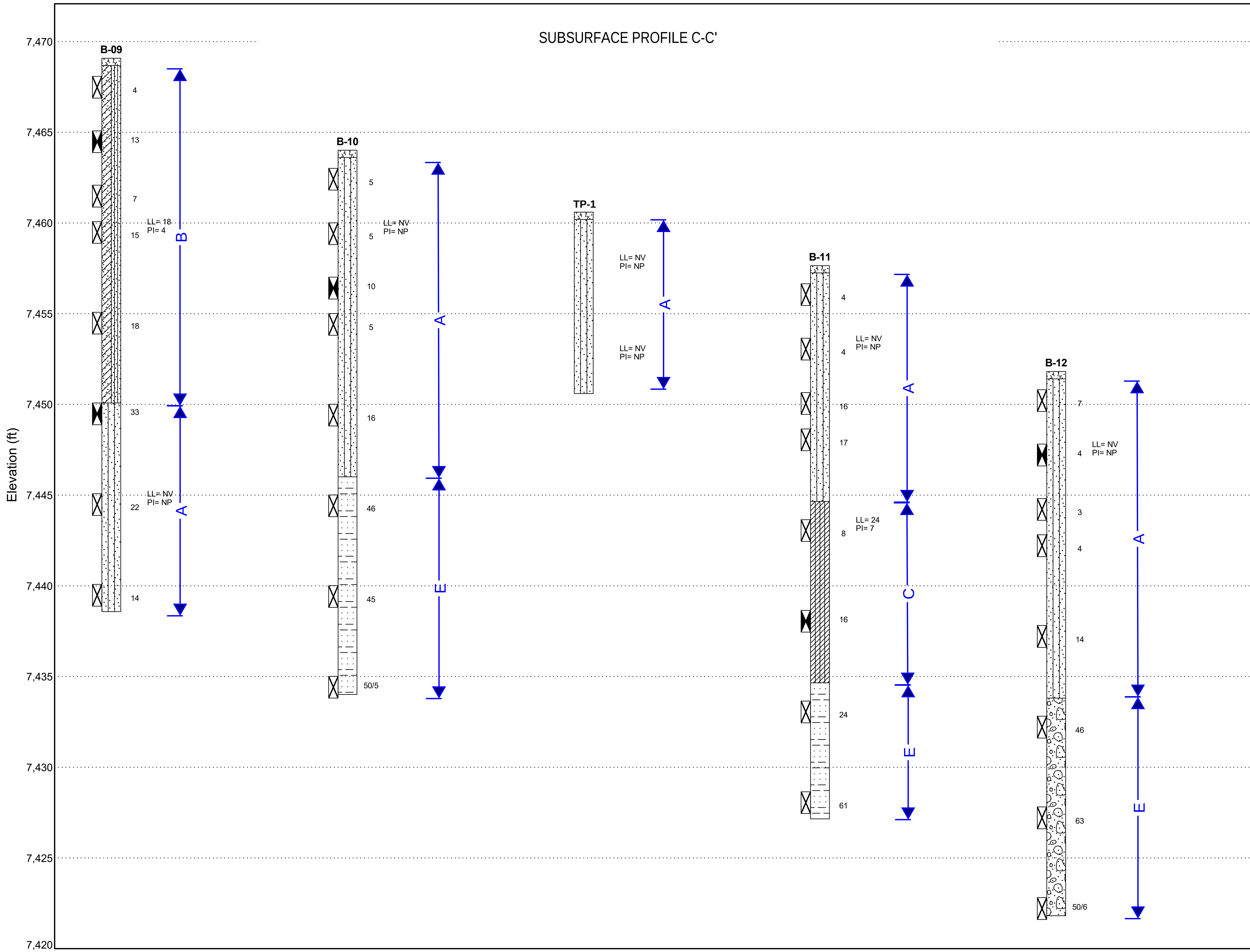
*e.g. A value of 50/3" or 50:3" indicates that 50 blows were applied to the sampler, with a penetration of 3 inches.

For additional information, refer to Geotechnical Report, prepared by Yeh and Associates, Inc.

Tri-State Fox Run Substation

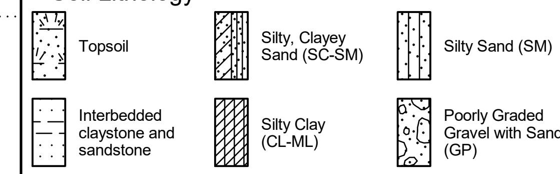
Project Number: 221-290

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



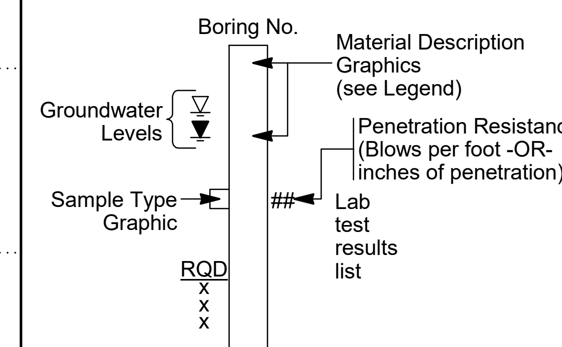
LEGEND

Soil Lithology



Rock Lithology

TYPICAL BOREHOLE LOG



*e.g. A value of 50/3" or 50:3" indicates that 50 blows were applied to the sampler, with a penetration of 3 inches.

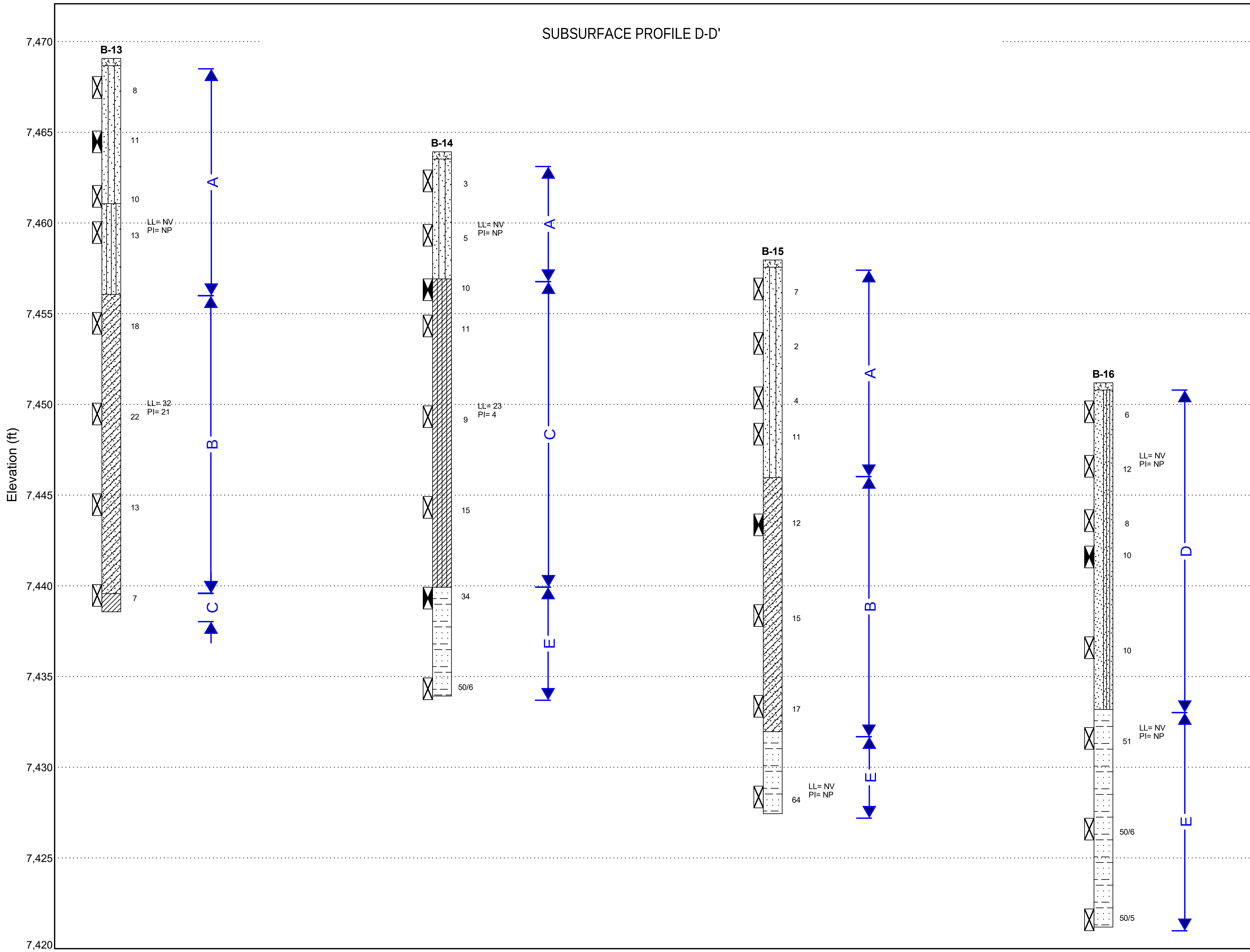
For additional information, refer to Geotechnical Report, prepared by Yeh and Associates, Inc.

Tri-State Fox Run Substation

Project Number: 221-290

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

SUBSURFACE PROFILE D-D'



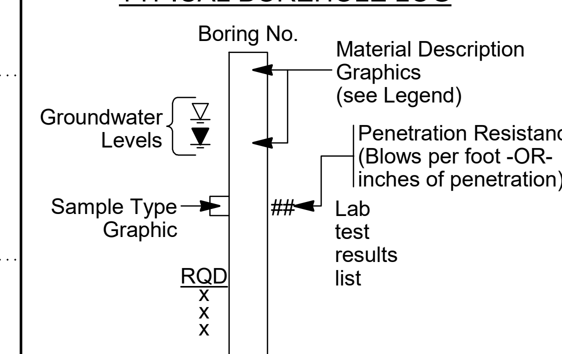
LEGEND

Soil Lithology

- Topsoil
- Silty Sand (SM)
- Sandy Silt
- Clayey Sand (SC)
- Lean Clay (CL)
- Silty Clay (CL-ML)
- Interbedded claystone and sandstone
- Poorly Graded Sand with Silt (SP-SM)

Rock Lithology

TYPICAL BOREHOLE LOG



*e.g. A value of 50/3" or 50:3" indicates that 50 blows were applied to the sampler, with a penetration of 3 inches.

For additional information, refer to Geotechnical Report, prepared by Yeh and Associates, Inc.

Tri-State Fox Run Substation

Project Number: 221-290

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

Appendix B

KEY TO BORING LOGS

BORING LOGS

PRESSUREMETER TEST RESULTS

ELECTRICAL RESISTIVITY TEST RESULTS

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

Project: Tri-State Fox Run Substation

Project Number: 221-290

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

- HOLLOW-STEM AUGER
- SOLID-STEM AUGER

Lithology Symbols

(see Boring Logs for complete descriptions)

- Clayey Sand (SC)
- Lean Clay (CL)
- Poorly Graded Gravel with Sand (GP)
- Poorly Graded Sand with Silt (SP-SM)
- Interbedded claystone and sandstone
- Sandy Lean Clay (CL)
- Sandy Silt
- Silty Clay (CL-ML)
- Silty, Clayey Sand (SC-SM)
- Silty Gravel (GM)
- Silty Sand (SM)
- Topsoil

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 (Soil - ASTM D2166, Rock - ASTM D7012)
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: Tri-State Fox Run Substation

Project Number: 221-290 Boring No.: **B-01**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger

Total Depth: 30.5 ft
Ground Elevation: 7466.8 ft
Coordinates: N: 1455857.3 E: 3203913.8
Location: Substation

Weather Notes: Sunny/64°F
Inclination from Horiz.: Vertical
Night Work: ☐

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Logged By: B. Lykins
Final By: J. McCall

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

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Blows per 6 in / Recovery	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
	0						**0.0 - 0.4 ft. Poorly graded SAND (SP) (5 in)**, dark brown, moist, loose.									
7465				2-3 70%	5		**0.4 - 30.5 ft. Silty SAND (SM)**, light brown, moist, loose to medium dense.									
	5			6-5 70%	11											
7460				7-12 70%	19											
	10			9-12 70%	21			1.8		5.0	67.0	28.0	NV	NP	A-2-4 (0) SM	
7455																
7450	15			11-11-10 100%	21											
7445	20			6-6-7 100%	13											
	25			6-6-4 100%	10			7.9		5.0	67.0	28.0	NV	NP	A-2-4 (0) SM	
7440																
	30			7-7-10 100%	17											
7435							Bottom of Hole at 30.5 ft.									

Pressuremeter test performed at 24 ft BGS witihn 5 ft radius of B-1

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290 *Boring No.:* **B-02**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger

Total Depth: 30.5 ft
Ground Elevation: 7462.9 ft
Coordinates: N: 1455857.3 E: 3204003.8
Location: Substation

Weather Notes: Sunny/63°F
Inclination from Horiz.: Vertical
Night Work: ☐

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Logged By: B. Lykins
Final By: J. McCall

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

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in / Recovery	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 Classifications	Field Notes and Other Lab Tests
	0						**0.0 - 0.4 ft. Silty SAND (SM) (5in)**, brown, moist, loose.									
							0.4 - 22.0 ft. Sandy silty CLAY (CL-ML), light brown, moist, medium stiff.									
				2-2-2 100%	4											
7460																
	5			4-5-5 100%	10											
7455				6-15 70%	21			7.7		3.0	40.0	57.0	23	7	A-4 (1) CL-ML	
	10			4-6-6 100%	12											
7450																
	15			6-6-7 100%	13											
7445																
	20			10-11-11 100%	22											
							22.0 - 30.5 ft. Clayey SAND with gravel (SC) (Dawson Formation), tan-white, moist, very dense.									
7440																
	25			15-25-35 100%	60			4.1		7.0	73.0	20.0	33	15	A-2-6 (0) SC	
7435																
	30			29-34-50/6 100%	84/12											

Bottom of Hole at 30.5 ft.

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

Project Name: Tri-State Fox Run Substation	Project Number: 221-290	Boring No.: **B-03**

Boring Began: 8/3/2021	**Total Depth: 30.5 ft**	Weather Notes: Sunny/70°F
Boring Completed: 8/3/2021	Ground Elevation: 7457.0 ft	Inclination from Horiz.: Vertical
Drilling Method(s): Solid-Stem Auger	Coordinates: N: 1455857.3 E: 3204093.8	
	Location: Substation	Night Work: ☐
Driller: Drilling Engineers, Inc.		
Drill Rig: CME 75 Truck	Logged By: B. Lykins	
Hammer: Automatic (hydraulic), ER: 80%	Final By: J. McCall	

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

Elevation (feet)	Depth (feet)	Blows per 6 in / Recovery	Penetration Resistance	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
7457.0	0.0			**0.0 - 0.4 ft. Silty SAND (SM) (5 in)**, brown, moist, loose.									
	0.4			**0.4 - 17.0 ft. Silty SAND (SM)**, light brown, moist, loose to medium dense.									
7455		2-3-3 100%	6										
	5	2-2-3 100%	5		8.9			80.0	20.0	NV	NP	A-2-4 (0) SM	pH=7.0 S=<0.001% Chl=0.0002% Re=9308ohm·cm
7450		9-12 70%	21										
	10	8-8-8 100%	16										
7445													
	15	7-11 70%	18										
7440	17.0			**17.0 - 26.0 ft. Clayey SAND (SC)**, brown, moist, medium dense.									
	20	9-9-12 100%	21										
7435													
	25	8-11-17 100%	28										
	26.0			**26.0 - 30.5 ft. Poorly graded SAND with gravel (SP) (Dawson Formation)**, white-brown with reddish brown, moist, dense.									
7430													
	30	27-32-37 100%	69										
7425				Bottom of Hole at 30.5 ft.									

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290

Boring No.: **B-04**

Boring Began: 8/4/2021
Boring Completed: 8/4/2021
Drilling Method(s): Solid-Stem Auger

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.5 ft
Ground Elevation: 7450.5 ft
Coordinates: N: 1455857.3 E: 3204183.8
Location: Substation

Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Overcast/57°F
Inclination from Horiz.: Vertical
Night Work: ☐

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

Elevation (feet)	Depth (feet)	Blows per 6 in / Recovery	Penetration Resistance	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
7450				**0.0 - 0.4 ft. Silty SAND (SM) (5 in)**, dark brown, moist, loose.									
		2-2-2 / 100%	4	**0.4 - 23.0 ft. Silty SAND (SM)**, light brown, moist, loose to medium dense.									
7445	5	2-2-3 / 100%	5										
		5-11 / 70%	16		6.4			83.0	16.0	NV	NP	A-2-4 (0) SM	
7440	10	10-8-8 / 100%	16										
7435	15	3-4-4 / 100%	8										
7430	20	5-7-9 / 100%	16										
				23.0 - 30.5 ft. Silty SAND with gravel (SM) (Dawson Formation), white-brown with reddish brown, moist, dense.									
7425	25	7-13-20 / 100%	33		3.6		8.0	78.0	14.0	NV	NP	A-1-b (0) SM	
7420	30	15-21-26 / 100%	47										

Bottom of Hole at 30.5 ft.

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

Project Name:	Tri-State Fox Run Substation	PAGE 1 of 1
Project Number: 221-290		Boring No.: **B-05**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger

Total Depth: 30.5 ft
Ground Elevation: 7468.2 ft
Coordinates: N: 1455782.3 E: 3203913.8
Location: Substation

Weather Notes: Sunny/65°F
Inclination from Horiz.: Vertical
Night Work: ☐

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Logged By: B. Lykins
Final By: J. McCall

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

Elevation (feet)	Depth (feet)	Blows per 6 in / Recovery	Penetration Resistance	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
				0.0 - 0.4 ft. Poorly graded SAND (SP) (5 in), brown, moist, loose.									
		4-3-4 100%	7	**0.4 - 19.0 ft. Silty, clayey SAND (SC-SM)**, light brown, moist, loose to medium dense.									
7465	5	5-8 70%	13										
7460		4-4-3 100%	7		7.4		3.0	51.0	46.0	23	7	A-4 (0) SC-SM	
	10	2-2-2 100%	4										
7455	15	5-6-6 100%	12										
7450	20	6-8-8 100%	16	**19.0 - 28.0 ft. Silty SAND with gravel (SM)**, light brown to brown, moist, medium dense.	2.7		12.0	73.0	15.0	NV	NP	A-1-b (0) SM	
7445	25	9-11-11 100%	22										
7440				**28.0 - 30.5 ft. Clayey SAND (SC)**, tan-white, dry, loose.									
	30	8-3-3 100%	6										

Bottom of Hole at 30.5 ft.

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	Project Name: Tri-State Fox Run Substation	PAGE 1 of 1
	Project Number: 221-290	Boring No.: **B-06**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger

Total Depth: 30.0 ft
Ground Elevation: 7463.5 ft
Coordinates: N: 1455782.3 E: 3204003.8
Location: Substation

Weather Notes: Partly Cloudy/64°F
Inclination from Horiz.: Vertical
Night Work: ☐

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Logged By: B. Lykins
Final By: J. McCall

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

Elevation (feet)	Depth (feet)	Blows per 6 in / Recovery	Penetration Resistance	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
				0.0 - 0.4 ft. Silty SAND (SM) (5 in), light brown, moist, loose.									
		2-2-2 100%	4	**0.4 - 17.0 ft. Silty SAND (SM)**, light brown to tan, moist, loose to medium dense.									
7460	5	2-4 70%	6		6.4			82.0	16.0	NV	NP	A-2-4 (0) SM	pH=7.2 S=0.006% Chl=0.0006% Re=5435ohm·cm
		7-8-9 100%	17										
7455	10	8-7-6 100%	13										
7450	15	5-6-8 100%	14										
				17.0 - 23.0 ft. Silty SAND with gravel (SM), light brown, moist, medium dense.									
7445	20	6-10-12 100%	22										
				23.0 - 30.0 ft. Poorly graded SAND with gravel (SP) (Dawson Formation), white-brown with reddish brown, moist, dense.									
7440	25	23-34-40 100%	74										
7435	30	31-50/5 100%	50/5										

Bottom of Hole at 30.0 ft.

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290 Boring No.: **B-07**

Boring Began: 8/4/2021
Boring Completed: 8/4/2021
Drilling Method(s): Solid-Stem Auger

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.5 ft
Ground Elevation: 7457.1 ft
Coordinates: N: 1455782.3 E: 3204093.8
Location: Substation

Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Sunny/71°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 / Recovery	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 Classifications	Field Notes and Other Lab Tests
	0.0						**0.0 - 0.4 ft. Silty SAND (SM) (5 in)**, brown, moist, loose.									
	0.4						**0.4 - 12.0 ft. Silty SAND (SM)**, brown to light brown, moist, loose to medium dense.									
7455				2-3-3 100%	6											
	5			2-2-3 100%	5											
7450				3-4-5 100%	9			5.3			81.0	18.0	NV	NP	A-2-4 (0) SM	
	10			6-6-7 100%	13											
7445	12.0						**12.0 - 26.0 ft. Sandy lean CLAY (CL)**, light brown, moist, medium dense.									
	15			6-7 70%	13			11.2			44.0	55.0	26	13	A-6 (4) CL	
7440																
	20			7-9 70%	16											
7435	22						- with gravel below 22 ft.									
	25			11-12-11 100%	23											
	26.0						**26.0 - 30.5 ft. Poorly graded SAND with gravel (SP) (Dawson Formation)**, white-brown with reddish brown, moist, dense.									
7430																
	30			21-32-44 100%	76											
7425							Bottom of Hole at 30.5 ft.									

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290 *Boring No.:* **B-08**

Boring Began: 8/4/2021
Boring Completed: 8/4/2021
Drilling Method(s): Solid-Stem Auger

Total Depth: 30.5 ft
Ground Elevation: 7451.1 ft
Coordinates: N: 1455782.3 E: 3204183.8
Location: Substation

Weather Notes: Overcast/57°F
Inclination from Horiz.: Vertical
Night Work: ☐

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Logged By: B. Lykins
Final By: J. McCall

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

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in / Recovery	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 Classifications	Field Notes and Other Lab Tests
							0.0 - 0.4 ft. Silty SAND (SM) (5 in), dark brown, moist, loose.									
7450				2-2 70%	4		**0.4 - 17.0 ft. Clayey SAND (SC)**, light brown, moist, loose to medium dense.									
	5			2-2-3 100%	5											
7445				4-8-9 100%	17											
	10			5-8 70%	13			9.1			49.0	49.0	21	8	A-4 (1) SC	
7440																
7435	15			8-8-9 100%	17											
							17.0 - 23.0 ft. Sandy lean CLAY (CL), light brown, moist, medium stiff.									
7430	20			9-10-10 100%	20											
							23.0 - 30.5 ft. Sandy lean CLAY (CL) (Dawson Formation), white-brown with reddish brown, moist, stiff.									
7425	25			25-27-29 100%	56			14.3		1.0	35.0	64.0	40	26	A-6 (14) CL	
7420	30			9-15-32 100%	47											

Bottom of Hole at 30.5 ft.

Pressuremeter test performed at 9 ft, 24 ft BGS within 5 ft radius of B-8

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290 Boring No.: **B-09**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger
Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.5 ft
Ground Elevation: 7469.1 ft
Coordinates: N: 1455707.3 E: 3203913.8
Location: Substation
Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Sunny/65°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 / Recovery	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 Classifications	Field Notes and Other Lab Tests
							0.0 - 0.4 ft. Silty SAND (SM) (5 in), light brown, moist, loose.									
				2-2-2 100%	4		**0.4 - 19.0 ft. Silty, clayey SAND (SC-SM)**, light brown to tan, moist, loose to medium dense.									
7465	5			5-8 70%	13											
				8-5-2 100%	7											
7460	10			7-7-8 100%	15			4.5		5.0	65.0	30.0	18	4	A-2-4 (0) SC-SM	
7455	15			5-7-11 100%	18											
7450	20			14-19 70%	33		**19.0 - 30.5 ft. Silty SAND (SM)**, tan to white, moist, medium dense.									
7445	25			9-11-11 100%	22			3.1		4.0	76.0	20.0	NV	NP	A-1-b (0) SM	
7440	30			6-7-7 100%	14											

Bottom of Hole at 30.5 ft.

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290 *Boring No.:* **B-10**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger

Total Depth: 30.0 ft
Ground Elevation: 7464.0 ft
Coordinates: N: 1455707.3 E: 3204003.8
Location: Substation

Weather Notes: Overcast/62°F
Inclination from Horiz.: Vertical
Night Work: ☐

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Logged By: B. Lykins
Final By: J. McCall

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

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in / Recovery	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 Classifications	Field Notes and Other Lab Tests
							0.0 - 0.4 ft. Silty SAND (SM) (5 in), brown, moist, loose.									
				2-2-3 100%	5		**0.4 - 18.0 ft. Silty SAND (SM)**, light brown, moist, loose to medium dense.									
7460	5			2-3-2 100%	5			5.2			79.0	21.0	NV	NP	A-2-4 (0) SM	
				5-5 70%	10											
7455	10			4-2-3 100%	5											
7450	15			5-7-9 100%	16											
							18.0 - 30.0 ft. Poorly graded SAND with gravel (SP) (Dawson Formation), white-brown with reddish brown, moist, loose to medium dense.									
7445	20			13-19-27 100%	46											
7440	25			13-21-24 100%	45		- clayey at 24 ft.									
7435	30			29-50/5 100%	50/5											
							Bottom of Hole at 30.0 ft.									

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290

Boring No.: **B-11**

Boring Began: 8/5/2021
Boring Completed: 8/5/2021
Drilling Method(s): Solid-Stem Auger

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.5 ft
Ground Elevation: 7457.7 ft
Coordinates: N: 1455707.3 E: 3204093.8
Location: Substation

Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Sunny/68°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 / Recovery	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 Classifications	Field Notes and Other Lab Tests
	0.0		Solid-Stem Auger				**0.0 - 0.4 ft. Silty SAND (SM) (5 in)**, light brown, moist, loose.									
	0.4						**0.4 - 13.0 ft. Silty SAND (SM)**, light brown to tan, moist, loose to medium dense.									
				2-2-2 100%	4											
7455																
	5			1-2-2 100%	4			6.2			82.0	17.0	NV	NP	A-2-4 (0) SM	pH=7.1 S=<0.001% Chl=0.0004% Re=9223ohm·cm
7450				6-8-8 100%	16											
	10			8-8-9 100%	17											
7445	13.0						**13.0 - 23.0 ft. Sandy silty CLAY (CL-ML)**, tan-brown, moist, medium stiff.									
	15			4-4-4 100%	8			11.0			47.0	53.0	24	7	A-4 (1) CL-ML	
7440																
	20			6-10 70%	16											
7435	23.0						**23.0 - 30.5 ft. Poorly graded SAND with silt and gravel (SP-SM) (Dawson Formation)**, white-brown with reddish brown, moist, dense.									
	25			12-12-12 100%	24											
7430																
	30			18-25-36 100%	61											
7425							Bottom of Hole at 30.5 ft.									

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	Project Name: Tri-State Fox Run Substation	PAGE 1 of 1
	Project Number: 221-290	Boring No.: **B-12**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger
Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.0 ft
Ground Elevation: 7451.8 ft
Coordinates: N: 1455707.3 E: 3204183.8
Location: Substation
Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Overcast/58°F
Inclination from Horiz.: Vertical
Night Work: ☐

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

Elevation (feet)	Depth (feet)	Blows per 6 in / Recovery	Penetration Resistance	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
7451.8	0.0			**0.0 - 0.4 ft. Silty SAND (SM) (5 in)**, dark brown, moist, loose.									
				0.4 - 18.0 ft. Silty SAND (SM), light brown to tan, moist, loose to medium dense.									
7450		3-4-3 100%	7										
	5	2-2 70%	4		5.5			81.0	18.0	NV	NP	A-2-4 (0) SM	
7445		2-1-2 100%	3										
	10	2-2-2 100%	4										
7440													
	15	2-4-10 100%	14										
7435				**18.0 - 30.0 ft. Poorly graded SAND with gravel (SP) (Dawson Formation)**, white-brown with reddish brown, moist, dense.									
	20	16-22-24 100%	46										
7430													
	25	21-30-33 100%	63										
7425													
	30	22-50/6 100%	50/6	Bottom of Hole at 30.0 ft.									
7420													

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Tri-State Fox Run Substation	*PAGE 1 of 1*
	Project Number: 221-290	*Boring No.:* **B-13**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger

Total Depth: 30.5 ft
Ground Elevation: 7469.1 ft
Coordinates: N: 1455632.3 E: 3203913.8
Location: Substation

Weather Notes: Sunny/66°F
Inclination from Horiz.: Vertical
Night Work: ☐

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Logged By: B. Lykins
Final By: J. McCall

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

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in / Recovery	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 Classifications	Field Notes and Other Lab Tests
							0.0 - 0.4 ft. Silty SAND (SM) (5 in), brown, moist, loose.									
							0.4 - 8.0 ft. Silty SAND (SM), light brown, moist, loose.									
					2-3-5 100%	8										
7465	5			6-5 70%	11											
				4-5-5 100%	10											
							8.0 - 13.0 ft. Sandy SILT (ML), light brown, moist, medium dense.									
7460	10			3-5-8 100%	13			11.7		1.0	40.0	59.0	NV	NP	A-4 (0) ML	
							13.0 - 29.5 ft. Clayey SAND (SC), light brown, moist, medium dense.									
7455	15			8-8-10 100%	18											
7450	20			8-10-12 100%	22		- with gravel below 20 ft.	4.9		3.0	77.0	20.0	32	21	A-2-6 (1) SC	
7445	25			5-6-7 100%	13											
7440	30			4-3-4 100%	7		**29.5 - 30.5 ft. Lean CLAY (CL)**, gray, moist, soft.									

Bottom of Hole at 30.5 ft.

Pressuremeter test performed at 13 ft BGS within 5 ft radius of B-13

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290

Boring No.: **B-14**

Boring Began: 8/3/2021
Boring Completed: 8/3/2021
Drilling Method(s): Solid-Stem Auger

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.0 ft
Ground Elevation: 7463.9 ft
Coordinates: N: 1455632.3 E: 3204003.8
Location: Substation

Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Overcast/62°F
Inclination from Horiz.: Vertical
Night Work: ☐

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

Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Blows per 6 in / Recovery	Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
							0.0 - 0.4 ft. Silty SAND (SM) (5 in), brown, moist, loose.									
				2-1-2 100%	3		**0.4 - 7.0 ft. Silty SAND (SM)**, light brown, moist, loose to medium dense.									
7460	5			1-2-3 100%	5			6.5			79.0	18.0	NV	NP	A-2-4 (0) SM	
				4-6 70%	10		**7.0 - 24.0 ft. Sandy silty CLAY (CL-ML)**, light brown to red-brown, moist, medium stiff.									
7455	10			3-5-6 100%	11											
7450	15			2-4-5 100%	9			10.4			46.0	52.0	23	4	A-4 (0) CL-ML	
7445	20			5-6-9 100%	15											
7440	25			10-24 70%	34		**24.0 - 30.0 ft. Poorly graded SAND with gravel (SP) (Dawson Formation)**, white-brown with reddish brown, moist, dense.									
7435	30			24-50/6 100%	50/6											
							Bottom of Hole at 30.0 ft.									

Yeh and Associates, Inc. Geotechnical • Geological • Construction Services	*Project Name:* Tri-State Fox Run Substation	*PAGE 1 of 1*
	Project Number: 221-290	*Boring No.:* **B-15**

Boring Began: 8/5/2021
Boring Completed: 8/5/2021
Drilling Method(s): Solid-Stem Auger
Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.5 ft
Ground Elevation: 7458.0 ft
Coordinates: N: 1455632.3 E: 3204093.8
Location: Substation
Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Sunny/71°F
Inclination from Horiz.: Vertical
Night Work: ☐

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

Elevation (feet)	Depth (feet)	Blows per 6 in / Recovery	Penetration Resistance	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit	Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
				0.0 - 0.4 ft. Silty SAND (SM) (5 in), brown, moist, loose.									
		5-4-3 100%	7	**0.4 - 12.0 ft. Silty SAND (SM)**, light brown to tan, moist, loose to medium dense.									
7455	5	1-1-1 100%	2										
7450		2-2-2 100%	4										
	10	3-6-5 100%	11										
7445				**12.0 - 26.0 ft. Clayey SAND (SC)**, light brown to brown, moist, medium dense.									
	15	6-6 70%	12										
7440	20	4-6-9 100%	15										
7435	25	5-8-9 100%	17										
7430				**26.0 - 30.5 ft. Poorly graded SAND with silt and gravel (SP-SM) (Dawson Formation)**, white-brown with reddish brown, moist, dense.									
	30	20-29-35 100%	64		5.9		17.0	68.0	15.0	NV	NP	A-1-b (0) SM	

Bottom of Hole at 30.5 ft.

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290 Boring No.: **B-16**

Boring Began: 8/4/2021
Boring Completed: 8/4/2021
Drilling Method(s): Solid-Stem Auger

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 30.0 ft
Ground Elevation: 7451.2 ft
Coordinates: N: 1455632.3 E: 3204183.8
Location: Substation

Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Overcast/57°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 / Recovery	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 Classifications	Field Notes and Other Lab Tests
							0.0 - 0.4 ft. Silty SAND (SM) (5 in), brown, moist, loose.									
7450				2-3-3 100%	6		**0.4 - 18.0 ft. Poorly graded SAND with silt (SP-SM)**, light brown, moist, loose to medium dense.									
	5			3-5-7 100%	12			7.5		1.0	87.0	12.0	NV	NP	A-2-4 (0) SP-SM	
7445				4-4-4 100%	8											
	10			4-6 70%	10											
7440																
	15			3-3-7 100%	10											
7435							**18.0 - 30.0 ft. Silty SAND with gravel (SM) (Dawson Formation)**, white-brown with reddish brown, moist, dense.									
	20			17-24-27 100%	51			4.5		11.0	75.0	14.0	NV	NP	A-1-b (0) SM	
7430																
	25			24-50/6 100%	50/6											
7425																
	30			21-50/5 100%	50/5		Bottom of Hole at 30.0 ft.									
7420							Pressuremeter test performed at 14 ft BGS within 5 ft radius of B-16									

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

Project Name: Tri-State Fox Run Substation

Project Number: 221-290 Boring No.: **TP-1**

Boring Began: 8/5/2021
Boring Completed: 8/5/2021
Drilling Method(s): Hollow-Stem Auger

Driller: Drilling Engineers, Inc.
Drill Rig: CME 75 Truck
Hammer: Automatic (hydraulic), ER: 80%

Total Depth: 10.0 ft
Ground Elevation: 7460.6 ft
Coordinates: N: 1455707.3 E: 3204048.8
Location: Substation

Logged By: B. Lykins
Final By: J. McCall

Weather Notes: Sunny/64°F
Inclination from Horiz.: Vertical

Night Work: ☐

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

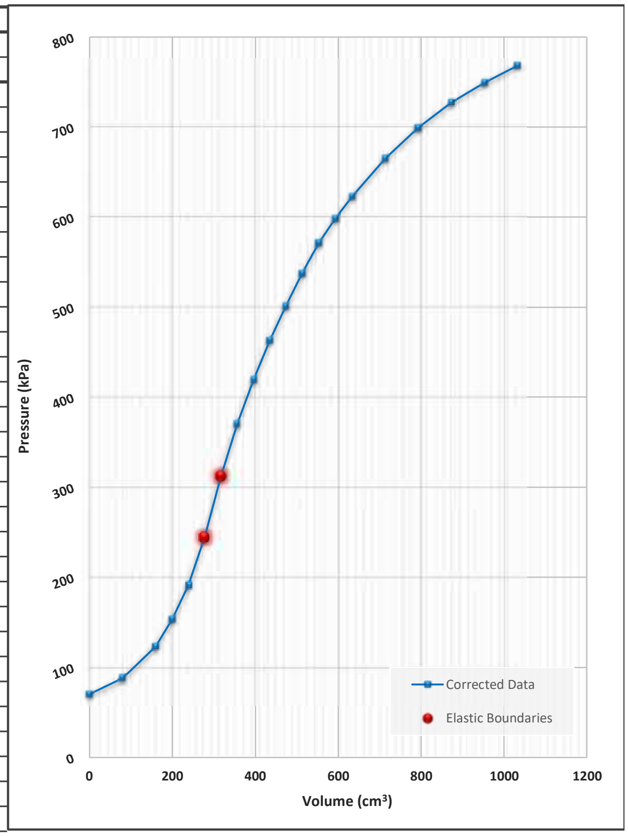
Elevation (feet)	Depth (feet)	Sample Type/Depth	Drilling Method	Soil Samples: Blows per 6 in / Recovery	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
7460							**0.0 - 0.4 ft. Silty SAND (SM) (5 in)**, brown, moist, loose.									
							0.4 - 10.0 ft. Silty SAND (SM), light brown to brown, moist.									
				100%				*7.8*			69.0	31.0	*NV*	*NP*	*A-2-4 (0) SM*	
	5															
7455																
				100%				*4.7*			67.0	32.0	*NV*	*NP*	*A-2-4 (0) SM*	
	10						Bottom of Hole at 10.0 ft.									
7450							Pressuremeter test performed at 6 ft BGS within 5 ft radius of TP-1									
7445																

PRESSUREMETER TEST

Project:	Fox Run Substation	Boring ID:	BH-1	Test Depth (ft):	25.0
City, State:	Monument, CO	Mapes In-Situ No:	P2021024	Client:	Yeh & Associates, Inc.

Test date:	8/4/21	Calibration date:	8/4/21	Pressure Calibration ID:	PMT CAP - 17(1)
Pressuremeter SN:	001A17002	Probe body SN:	001 17017	Volume Calibration ID:	PMT CAV - 17(1)
Pressuremeter model:	TEXAM[e]	Probe size (mm):	70	Calibration coefficient, a (cm^3/kPa):	0.011733
Test zone drilling method:	Mud/Wash Rotary	Calibration tube I.D. (mm):	76.2	Calibration coefficient, b (cm^3/kPa):	6.91E-05
Poisson's Ratio of soil/rock:	0.33	Calibration tube O.D. (mm):	101.6	Calibration coefficient, c (cm^3/kPa):	0.011664
Method for estimating P_L:	1/V vs. P	Tubing length (m):	50	Initial volume of probe, V_0 (cm^3):	1703

Raw Test Data		Pressure Calibration		Volume Calibration		Corrected Data		
Volume	Pressure	Volume	Pressure	Volume	Pressure	Volume	$\Delta R/R_o$	Pressure
cm^3	kPa	cm^3	kPa	cm^3	kPa	cm^3	%	kPa
0.0	-4	0.0	-3	0.0	8	0.0	0.00	70
80.7	23	81.2	6	369.1	505	80.5	2.34	88
160.3	64	161.1	12	390.6	1017	159.5	4.58	123
200.7	97	240.8	17	402.6	1516	199.5	5.70	154
240.2	137	320.8	19	411.7	1962	238.6	6.78	191
279.7	191	400.6	23	422.0	2512	277.5	7.84	244
319.7	260	480.3	25	430.2	3000	316.6	8.90	312
359.9	320	560.2	26	437.7	3498	356.2	9.96	370
400.1	371	642.0	27	444.6	3999	395.7	11.01	419
439.6	416	722.4	29	450.9	4557	434.7	12.04	463
479.3	455	802.5	30	456.1	5006	474.0	13.07	501
519.1	492	882.6	31	460.8	5505	513.3	14.08	538
559.3	526	963.0	32	465.4	6000	553.1	15.10	571
600.0	554	1043.6	33			593.5	16.13	599
640.6	579	1122.6	34			633.8	17.14	623
721.0	623	1205.3	34			713.8	19.13	665
801.0	658	1282.3	35			793.4	21.08	699
881.7	687	1362.6	36			873.6	23.01	727
961.9	710	1442.7	37			953.6	24.90	749
1041.6	730					1033.1	26.76	768



Interpreted Test Results

Deformation Modulus, E_P	9,234	kPa	1,339	psi
Reload Modulus, E_R	n.a.	kPa	n.a.	psi
Yield Pressure, P_F	312	kPa	45	psi
Ultimate Pressure, P_L [1]	872	kPa	127	psi
E_P / P_L	10.6			
P_L / P_F	2.8			

Test Remarks

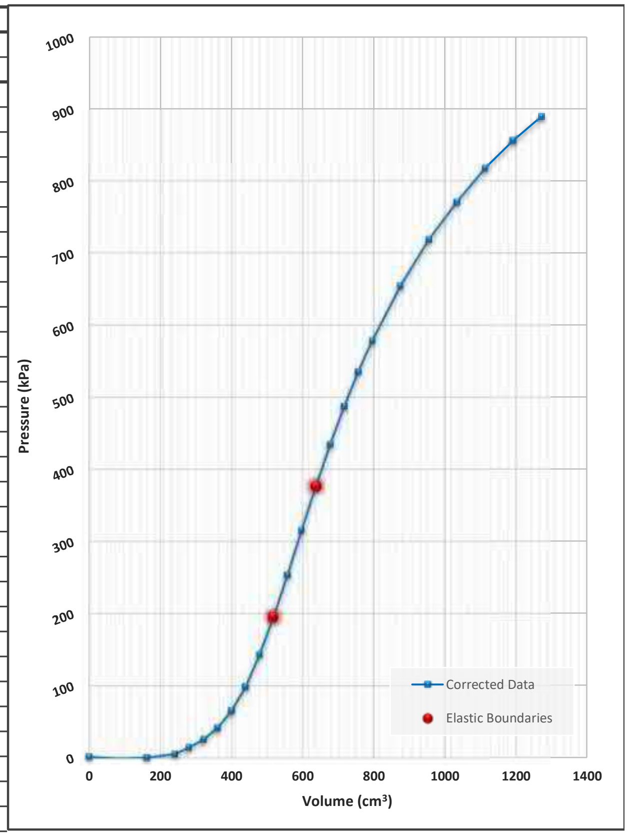
[1] Ultimate Pressure, P_L, is interpreted by extrapolating the data points in the plastic phase of the curve to 2 times the initial volume of the test zone, and reading the corresponding pressure. Accordingly, caution must be used in regards to the use of Ultimate Pressure values, particularly when a small quantity of data points are collected in the plastic phase, or when deformation is minimal due to the stiffness of the material.

PRESSUREMETER TEST

Project:	Fox Run Substation	Boring ID:	BH-8	Test Depth (ft):	9.0
City, State:	Monument, CO	Mapes In-Situ No:	P2021024	Client:	Yeh & Associates, Inc.

Test date:	8/4/21	Calibration date:	8/4/21	Pressure Calibration ID:	PMT CAP - 17(1)
Pressuremeter SN:	001A17002	Probe body SN:	001 17017	Volume Calibration ID:	PMT CAV - 17(1)
Pressuremeter model:	TEXAM[e]	Probe size (mm):	70	Calibration coefficient, a (cm^3/kPa):	0.011733
Test zone drilling method:	Shelby Tube Sampling	Calibration tube I.D. (mm):	76.2	Calibration coefficient, b (cm^3/kPa):	6.91E-05
Poisson's Ratio of soil/rock:	0.33	Calibration tube O.D. (mm):	101.6	Calibration coefficient, c (cm^3/kPa):	0.011664
Method for estimating P_L:	1/V vs. P	Tubing length (m):	50	Initial volume of probe, V_0 (cm^3):	1703

Raw Test Data		Pressure Calibration		Volume Calibration		Corrected Data		
Volume	Pressure	Volume	Pressure	Volume	Pressure	Volume	$\Delta R/R_o$	Pressure
cm^3	kPa	cm^3	kPa	cm^3	kPa	cm^3	%	kPa
0.0	-25	0.0	-3	0.0	8	0.0	0.00	1
83.5	-18	81.2	6	369.1	505	83.7	2.43	-1
161.5	-11	161.1	12	390.6	1017	161.6	4.64	0
240.9	-1	240.8	17	402.6	1516	240.9	6.84	5
280.5	9	320.8	19	411.7	1962	280.4	7.92	14
320.7	21	400.6	23	422.0	2512	320.5	9.01	25
360.6	39	480.3	25	430.2	3000	360.1	10.07	41
400.6	65	560.2	26	437.7	3498	399.9	11.12	65
440.5	99	642.0	27	444.6	3999	439.3	12.16	98
480.6	145	722.4	29	450.9	4557	478.9	13.19	143
520.0	197	802.5	30	456.1	5006	517.7	14.19	195
559.9	256	882.6	31	460.8	5505	556.9	15.20	253
600.9	319	963.0	32	465.4	6000	597.2	16.22	316
641.2	380	1043.6	33			636.7	17.21	376
681.9	439	1122.6	34			676.7	18.21	434
721.9	493	1205.3	34			716.2	19.19	487
761.8	541	1282.3	35			755.5	20.15	535
802.0	585	1362.6	36			795.1	21.12	578
882.4	662	1442.7	37			874.6	23.03	654
962.6	727					954.1	24.91	718
1042.1	780					1033.0	26.75	770
1122.2	828					1112.5	28.58	817
1202.7	867					1192.6	30.40	856
1282.1	901					1271.6	32.17	889



Interpreted Test Results

Deformation Modulus, E_P	9,245	kPa	1,341	psi
Reload Modulus, E_R	n.a.	kPa	n.a.	psi
Yield Pressure, P_F	376	kPa	55	psi
Ultimate Pressure, P_L [1]	1,112	kPa	161	psi
E_P / P_L	8.3			
P_L / P_F	3.0			

Test Remarks

Test performed in a dry borehole.

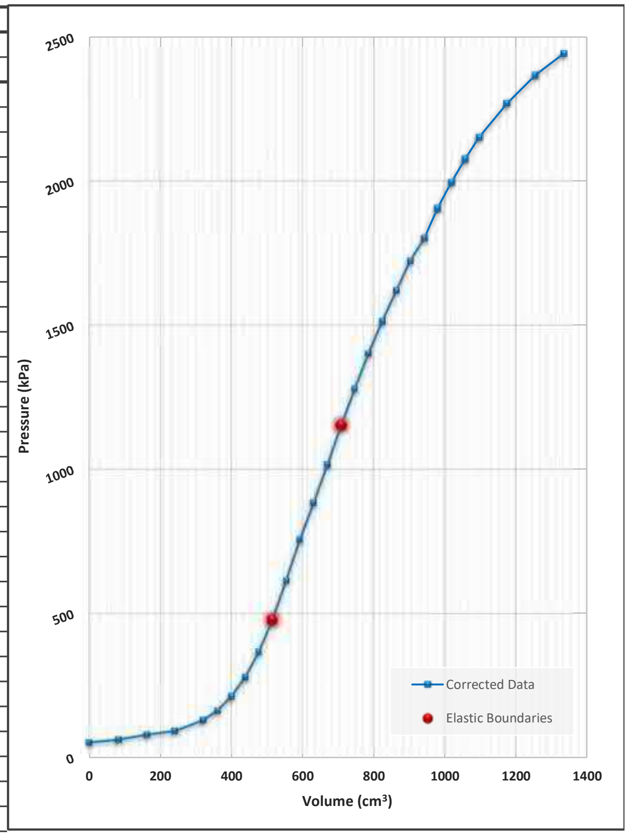
[1] Ultimate Pressure, P_L, is interpreted by extrapolating the data points in the plastic phase of the curve to 2 times the initial volume of the test zone, and reading the corresponding pressure. Accordingly, caution must be used in regards to the use of Ultimate Pressure values, particularly when a small quantity of data points are collected in the plastic phase, or when deformation is minimal due to the stiffness of the material.

PRESSUREMETER TEST

Project:	Fox Run Substation	Boring ID:	BH-8	Test Depth (ft):	24.0
City, State:	Monument, CO	Mapes In-Situ No:	P2021024	Client:	Yeh & Associates, Inc.

Test date:	8/4/21	Calibration date:	8/4/21	Pressure Calibration ID:	PMT CAP - 17(1)
Pressuremeter SN:	001A17002	Probe body SN:	001 17017	Volume Calibration ID:	PMT CAV - 17(1)
Pressuremeter model:	TEXAM[e]	Probe size (mm):	70	Calibration coefficient, a (cm^3/kPa):	0.011733
Test zone drilling method:	Mud/Wash Rotary	Calibration tube I.D. (mm):	76.2	Calibration coefficient, b (cm^3/kPa):	6.91E-05
Poisson's Ratio of soil/rock:	0.33	Calibration tube O.D. (mm):	101.6	Calibration coefficient, c (cm^3/kPa):	0.011664
Method for estimating P_L:	1/V vs. P	Tubing length (m):	50	Initial volume of probe, V_0 (cm^3):	1703

Raw Test Data		Pressure Calibration		Volume Calibration		Corrected Data		
Volume	Pressure	Volume	Pressure	Volume	Pressure	Volume	$\Delta R/R_o$	Pressure
cm^3	kPa	cm^3	kPa	cm^3	kPa	cm^3	%	kPa
0.0	-18	0.0	-3	0.0	8	0.0	0.00	53
81.6	1	81.2	6	369.1	505	81.5	2.37	63
161.2	24	161.1	12	390.6	1017	160.9	4.62	80
241.0	42	240.8	17	402.6	1516	240.5	6.83	93
320.7	81	320.8	19	411.7	1962	319.7	8.98	130
360.8	116	400.6	23	422.0	2512	359.4	10.05	163
400.6	167	480.3	25	430.2	3000	398.7	11.09	212
441.1	235	560.2	26	437.7	3498	438.3	12.14	279
480.3	324	642.0	27	444.6	3999	476.5	13.13	367
519.9	434	722.4	29	450.9	4557	514.8	14.12	477
559.8	572	802.5	30	456.1	5006	553.1	15.10	614
600.5	715	882.6	31	460.8	5505	592.2	16.09	757
641.0	843	963.0	32	465.4	6000	631.1	17.07	884
681.4	976	1043.6	33			670.0	18.04	1016
721.5	1113	1122.6	34			708.5	19.00	1152
761.2	1241	1205.3	34			746.7	19.94	1280
801.1	1364	1282.3	35			785.1	20.88	1402
841.0	1475	1362.6	36			823.7	21.81	1513
881.5	1583	1442.7	37			863.1	22.75	1620
921.9	1686					902.2	23.69	1723
962.6	1765					942.0	24.63	1801
1001.3	1869					979.5	25.51	1905
1041.1	1960					1018.2	26.41	1995
1081.1	2041					1057.3	27.32	2076
1120.9	2117					1096.2	28.21	2151
1201.4	2235					1175.4	30.01	2269
1282.0	2334					1254.8	31.79	2367
1362.4	2409					1334.3	33.55	2441



Interpreted Test Results

Deformation Modulus, E_P	21,469	kPa	3,114	psi
Reload Modulus, E_R	n.a.	kPa	n.a.	psi
Yield Pressure, P_F	1,152	kPa	167	psi
Ultimate Pressure, P_L [1]	2,974	kPa	431	psi
E_P / P_L	7.2			
P_L / P_F	2.6			

Test Remarks

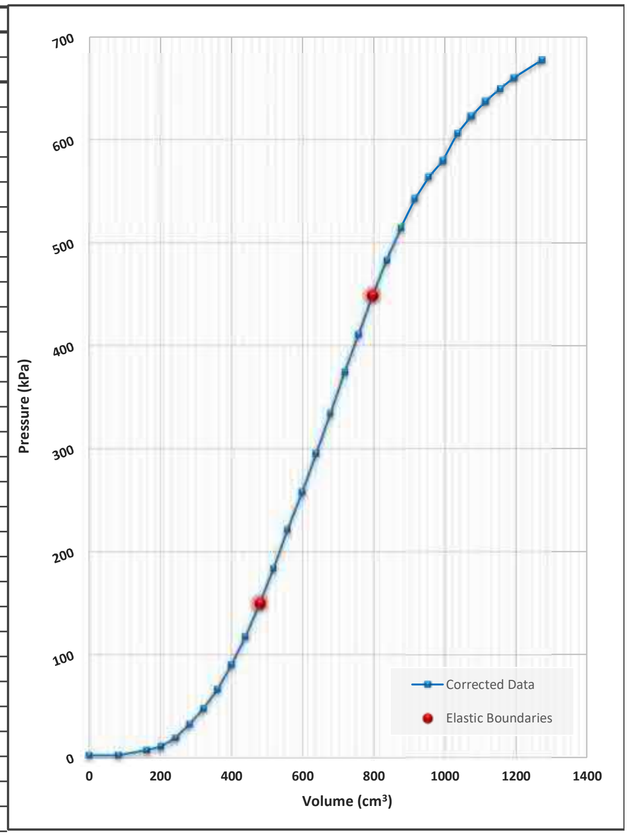
[1] Ultimate Pressure, P_L, is interpreted by extrapolating the data points in the plastic phase of the curve to 2 times the initial volume of the test zone, and reading the corresponding pressure. Accordingly, caution must be used in regards to the use of Ultimate Pressure values, particularly when a small quantity of data points are collected in the plastic phase, or when deformation is minimal due to the stiffness of the material.

PRESSUREMETER TEST

Project:	Fox Run Substation	Boring ID:	BH-13	Test Depth (ft):	9.0
City, State:	Monument, CO	Mapes In-Situ No:	P2021024	Client:	Yeh & Associates, Inc.

Test date:	8/4/21	Calibration date:	8/4/21	Pressure Calibration ID:	PMT CAP - 17(1)
Pressuremeter SN:	001A17002	Probe body SN:	001 17017	Volume Calibration ID:	PMT CAV - 17(1)
Pressuremeter model:	TEXAM[e]	Probe size (mm):	70	Calibration coefficient, a (cm^3/kPa):	0.011733
Test zone drilling method:	Shelby Tube Sampling	Calibration tube I.D. (mm):	76.2	Calibration coefficient, b (cm^3/kPa):	6.91E-05
Poisson's Ratio of soil/rock:	0.33	Calibration tube O.D. (mm):	101.6	Calibration coefficient, c (cm^3/kPa):	0.011664
Method for estimating P_L:	1/V vs. P	Tubing length (m):	50	Initial volume of probe, V_0 (cm^3):	1703

Raw Test Data		Pressure Calibration		Volume Calibration		Corrected Data		
Volume	Pressure	Volume	Pressure	Volume	Pressure	Volume	$\Delta R/R_o$	Pressure
cm^3	kPa	cm^3	kPa	cm^3	kPa	cm^3	%	kPa
0.0	-24	0.0	-3	0.0	8	0.0	0.00	2
81.5	-15	81.2	6	369.1	505	81.7	2.37	2
161.6	-4	161.1	12	390.6	1017	161.6	4.64	7
201.5	2	240.8	17	402.6	1516	201.5	5.75	11
242.2	13	320.8	19	411.7	1962	242.0	6.87	19
281.2	27	400.6	23	422.0	2512	280.8	7.93	32
320.9	43	480.3	25	430.2	3000	320.3	9.00	47
361.4	64	560.2	26	437.7	3498	360.6	10.08	66
401.0	90	642.0	27	444.6	3999	399.9	11.12	90
440.8	118	722.4	29	450.9	4557	439.5	12.16	117
480.6	151	802.5	30	456.1	5006	**478.8**	**13.19**	**149**
520.5	186	882.6	31	460.8	5505	518.3	14.21	184
560.2	224	963.0	32	465.4	6000	557.6	15.22	221
601.7	261	1043.6	33			598.7	16.26	258
641.5	299	1122.6	34			638.0	17.25	295
682.1	339	1205.3	34			678.1	18.25	334
722.2	380	1282.3	35			717.8	19.23	374
761.8	417	1362.6	36			756.9	20.19	411
801.7	455	1442.7	37			**796.4**	**21.15**	**448**
841.8	490					836.1	22.11	483
882.5	522					876.4	23.07	514
922.4	551					916.0	24.01	543
962.5	573					955.8	24.95	564
1002.1	589					995.2	25.88	580
1042.0	616					1034.8	26.80	606
1082.3	633					1074.9	27.72	623
1122.0	648					1114.4	28.63	637
1162.5	660					1154.8	29.54	649
1202.8	671					1195.0	30.45	660
1281.3	689					1273.3	32.20	677



Interpreted Test Results

Deformation Modulus, E_P	5,862	kPa	850	psi
Reload Modulus, E_R	n.a.	kPa	n.a.	psi
Yield Pressure, P_F	448	kPa	65	psi
Ultimate Pressure, P_L [1]	792	kPa	115	psi
E_P / P_L	7.4			
P_L / P_F	1.8			

Test Remarks

Test performed in a dry borehole.

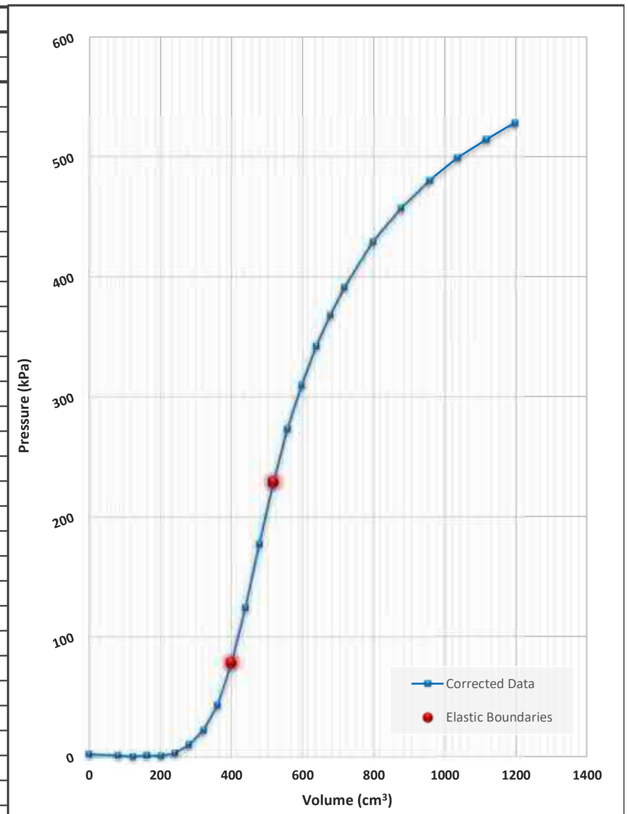
[1] Ultimate Pressure, P_L, is interpreted by extrapolating the data points in the plastic phase of the curve to 2 times the initial volume of the test zone, and reading the corresponding pressure. Accordingly, caution must be used in regards to the use of Ultimate Pressure values, particularly when a small quantity of data points are collected in the plastic phase, or when deformation is minimal due to the stiffness of the material.

PRESSUREMETER TEST

Project:	Fox Run Substation	Boring ID:	BH-16	Test Depth (ft):	14.0
City, State:	Monument, CO	Mapes In-Situ No:	P2021024	Client:	Yeh & Associates, Inc.

Test date:	8/4/21	Calibration date:	8/4/21	Pressure Calibration ID:	PMT CAP - 17(1)
Pressuremeter SN:	001A17002	Probe body SN:	001 17017	Volume Calibration ID:	PMT CAV - 17(1)
Pressuremeter model:	TEXAM[e]	Probe size (mm):	70	Calibration coefficient, a (cm^3/kPa):	0.011733
Test zone drilling method:	Shelby Tube Sampling	Calibration tube I.D. (mm):	76.2	Calibration coefficient, b (cm^3/kPa):	6.91E-05
Poisson's Ratio of soil/rock:	0.33	Calibration tube O.D. (mm):	101.6	Calibration coefficient, c (cm^3/kPa):	0.011664
Method for estimating P_L:	1/V vs. P	Tubing length (m):	50	Initial volume of probe, V_0 (cm^3):	1703

Raw Test Data		Pressure Calibration		Volume Calibration		Corrected Data		
Volume	Pressure	Volume	Pressure	Volume	Pressure	Volume	$\Delta R/R_o$	Pressure
cm^3	kPa	cm^3	kPa	cm^3	kPa	cm^3	%	kPa
0.0	-40	0.0	-3	0.0	8	0.0	0.00	2
80.6	-32	81.2	6	369.1	505	81.0	2.35	1
121.4	-30	161.1	12	390.6	1017	121.7	3.51	0
161.0	-26	240.8	17	402.6	1516	161.3	4.63	1
201.0	-24	320.8	19	411.7	1962	201.2	5.74	1
240.9	-19	400.6	23	422.0	2512	241.1	6.85	3
280.5	-11	480.3	25	430.2	3000	280.6	7.93	10
320.5	2	560.2	26	437.7	3498	320.4	9.00	22
360.8	25	642.0	27	444.6	3999	360.5	10.08	43
400.7	62	722.4	29	450.9	4557	400.0	11.13	78
440.2	109	802.5	30	456.1	5006	439.0	12.15	124
479.8	163	882.6	31	460.8	5505	477.9	13.17	177
520.0	215	963.0	32	465.4	6000	517.5	14.19	229
559.7	260	1043.6	33			556.7	15.19	273
600.6	297	1122.6	34			597.2	16.22	310
641.3	330	1205.3	34			637.5	17.23	342
681.6	357	1282.3	35			677.5	18.23	368
721.7	381	1362.6	36			717.3	19.22	391
801.5	420	1442.7	37			796.6	21.15	429
882.2	449					877.0	23.09	457
962.3	473					956.8	24.98	480
1042.1	493					1036.3	26.83	499
1122.0	509					1116.0	28.66	514
1202.7	523					1196.6	30.49	528



Interpreted Test Results

Deformation Modulus, E_P	7,363	kPa	1,068	psi
Reload Modulus, E_R	n.a.	kPa	n.a.	psi
Yield Pressure, P_F	229	kPa	33	psi
Ultimate Pressure, P_L [1]	619	kPa	90	psi
E_P / P_L	11.9			
P_L / P_F	2.7			

Test Remarks

Test performed in dry borehole.

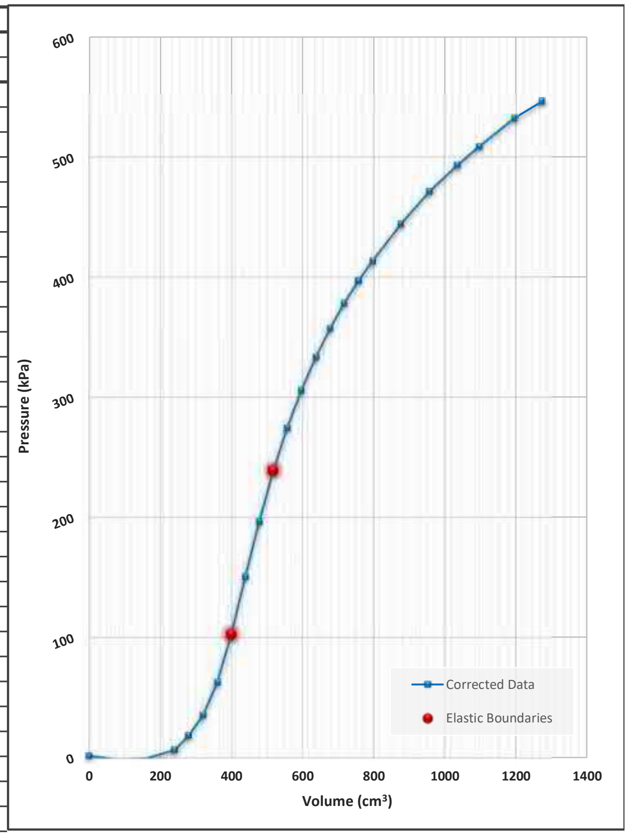
[1] Ultimate Pressure, P_L, is interpreted by extrapolating the data points in the plastic phase of the curve to 2 times the initial volume of the test zone, and reading the corresponding pressure. Accordingly, caution must be used in regards to the use of Ultimate Pressure values, particularly when a small quantity of data points are collected in the plastic phase, or when deformation is minimal due to the stiffness of the material.

PRESSUREMETER TEST

Project:	Fox Run Substation	Boring ID:	TP-1	Test Depth (ft):	6.0
City, State:	Monument, CO	Mapes In-Situ No:	P2021024	Client:	Yeh & Associates, Inc.

Test date:	8/4/21	Calibration date:	8/4/21	Pressure Calibration ID:	PMT CAP - 17(1)
Pressuremeter SN:	001A17002	Probe body SN:	001 17017	Volume Calibration ID:	PMT CAV - 17(1)
Pressuremeter model:	TEXAM[e]	Probe size (mm):	70	Calibration coefficient, a (cm^3/kPa):	0.011733
Test zone drilling method:	Shelby Tube Sampling	Calibration tube I.D. (mm):	76.2	Calibration coefficient, b (cm^3/kPa):	6.91E-05
Poisson's Ratio of soil/rock:	0.33	Calibration tube O.D. (mm):	101.6	Calibration coefficient, c (cm^3/kPa):	0.011664
Method for estimating P_L:	1/V vs. P	Tubing length (m):	50	Initial volume of probe, V_0 (cm^3):	1703

Raw Test Data		Pressure Calibration		Volume Calibration		Corrected Data		
Volume	Pressure	Volume	Pressure	Volume	Pressure	Volume	$\Delta R/R_\circ$	Pressure
cm^3	kPa	cm^3	kPa	cm^3	kPa	cm^3	%	kPa
0.0	-21	0.0	-3	0.0	8	0.0	0.00	1
80.9	-15	81.2	6	369.1	505	81.1	2.35	-2
161.1	-8	161.1	12	390.6	1017	161.2	4.63	-1
240.5	4	240.8	17	402.6	1516	240.4	6.83	6
280.2	17	320.8	19	411.7	1962	280.0	7.91	18
320.3	35	400.6	23	422.0	2512	319.9	8.99	35
360.3	64	480.3	25	430.2	3000	359.6	10.05	62
400.3	106	560.2	26	437.7	3498	399.1	11.10	102
440.0	155	642.0	27	444.6	3999	438.2	12.13	150
479.9	202	722.4	29	450.9	4557	477.5	13.16	196
520.3	245	802.5	30	456.1	5006	517.4	14.19	239
559.4	281	882.6	31	460.8	5505	556.1	15.18	274
600.4	313	963.0	32	465.4	6000	596.7	16.21	306
640.8	341	1043.6	33			636.8	17.22	333
681.6	366	1122.6	34			677.3	18.23	357
721.6	388	1205.3	34			717.0	19.21	378
761.5	407	1282.3	35			756.7	20.18	397
801.5	424	1362.6	36			796.5	21.15	413
882.0	456	1442.7	37			876.7	23.08	444
962.3	484					956.7	24.97	471
1042.0	507					1036.0	26.82	493
1102.2	523					1096.1	28.21	509
1202.4	547					1196.0	30.48	532
1281.7	562					1275.2	32.24	546



Interpreted Test Results

Deformation Modulus, E_P	6,632 kPa		962	psi
Reload Modulus, E_R	n.a.	kPa	n.a.	psi
Yield Pressure, P_F	239	kPa	35	psi
Ultimate Pressure, P_L [1]	625	kPa	91	psi
E_P / P_L	10.6			
P_L / P_F	2.6			

Test Remarks

Test performed in dry borehole.

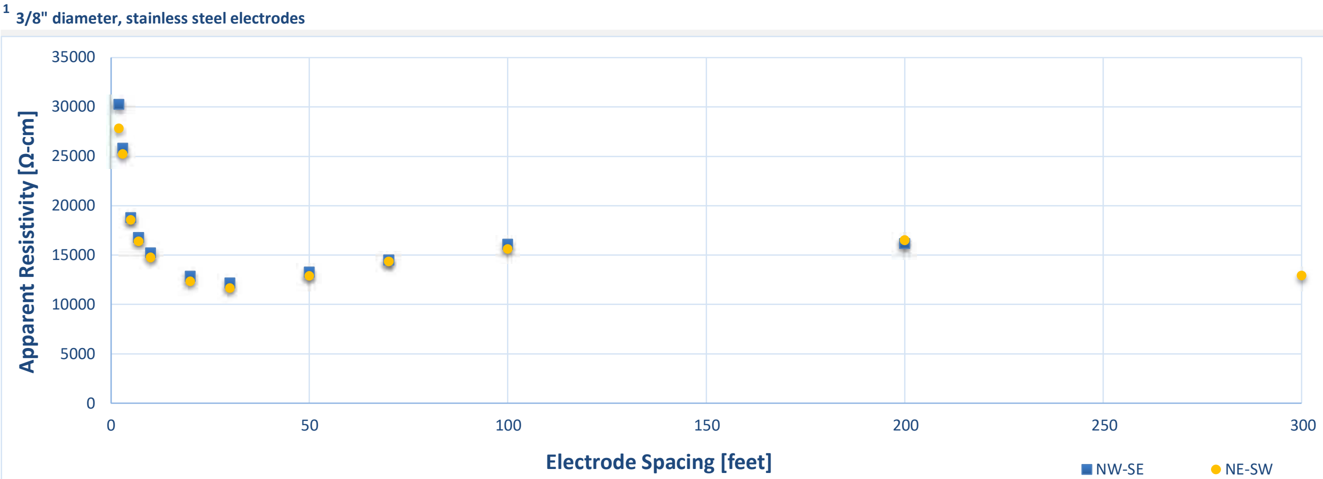
[1] Ultimate Pressure, P_L, is interpreted by extrapolating the data points in the plastic phase of the curve to 2 times the initial volume of the test zone, and reading the corresponding pressure. Accordingly, caution must be used in regards to the use of Ultimate Pressure values, particularly when a small quantity of data points are collected in the plastic phase, or when deformation is minimal due to the stiffness of the material.

Project	Fox Run Substation	**Instrument**	ABEM Terrameter SAS 1000
Date	8/4/2021	**Serial No.**	2000542
Weather / Temp	Sunny / warm, 75°F	**100 Ω Resistor Check**	100.2
Recent Weather	Rain		
Terrain	Rolling hills generally sloping down toward the east and south.		
Soil Conditions	Surface soil was moist. Very good electrode contact.		

Electrode Spacing (A) [feet]	NW-SE				
	Electrode Depth (in) [1]	Current Injected (I) (mA)	Measured Resistance (Ω)	Std. Deviation (%)	Apparent Resistivity (Ω-cm)
2	2	50	78.996	0.037	30,255
3	3	50	44.925	0.019	25,809
5	6	50	19.634	0.029	18,800
7	8	100	12.529	0.011	16,795
10	12	100	7.950	0.009	15,223
20	12	100	3.354	0.004	12,844
30	12	100	2.119	0.013	12,173
50	12	200	1.387	0.010	13,277
70	12	100	1.082	0.025	14,503
100	12	200	0.840	0.000	16,093
200	12	200	0.422	0.092	16,161
300	* Obstructed by property fence and Shahara Rd near the SE corner of the site.				
500	* Obstructed by property fence and Shahara Rd near the SE corner of the site.				

Electrode Spacing (A) [feet]	NE-SW				
	Electrode Depth (in) [1]	Current Injected (I) (mA)	Measured Resistance (Ω)	Std. Deviation (%)	Apparent Resistivity (Ω-cm)
2	2	50	72.614	0.016	27,811
3	3	100	43.917	0.045	25,230
5	6	50	19.396	0.039	18,572
7	8	100	12.230	0.003	16,394
10	12	100	7.709	0.018	14,764
20	12	100	3.220	0.002	12,333
30	12	200	2.029	0.007	11,654
50	12	100	1.347	0.063	12,896
70	12	100	1.071	0.000	14,354
100	12	200	0.815	0.052	15,616
200	12	100	0.431	0.018	16,508
300	12	200	0.225	0.005	12,950
500	* Obstructed by property fence near the NE corner of the site.				

[1] 3/8" diameter, stainless steel electrodes



Appendix C

LABORATORY TEST RESULTS

Summary of Laboratory Test Results

Project No: 221-290 Project Name: Tri-State Fox Run Substation Date: 09-03-2021

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate (%)	Water Soluble Chloride (%)	Resistivity (ohm-cm)	Swell (+) / Collapse (-) (% at Load in psf)	Unconf. Comp. Strength ()	Standard Proctor T99 (A)	Classification	
Boring No.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI								AASHTO	USCS
B-01	9.0	MC	1.8			72.0	28.0	NV	NP	NP								A-2-4 (0)	SM
B-01	24.0	SPT	7.9			72.0	28.0	NV	NP	NP								A-2-4 (0)	SM
B-02	7.0	MC	7.7			43.0	57.0	23	16	7								A-4 (1)	CL-ML
B-02	24.0	SPT	4.1		6.0	74.0	20.0	33	18	15								A-2-6 (0)	SC
B-03	4.0	SPT	8.9		0.0	80.0	20.0	NV	NP	NP	7.0	<0.001	0.0002	9308				A-2-4 (0)	SM
B-04	7.0	MC	6.4			84.0	16.0	NV	NP	NP								A-2-4 (0)	SM
B-04	24.0	SPT	3.6		7.0	79.0	14.0	NV	NP	NP								A-1-b (0)	SM
B-05	7.0	SPT	7.4			54.0	46.0	23	16	7								A-4 (0)	SC-SM
B-05	19.0	SPT	2.7		11.0	74.0	15.0	NV	NP	NP								A-1-b (0)	SM
B-06	4.0	MC	6.4			84.0	16.0	NV	NP	NP	7.2	0.006	0.0006	5435				A-2-4 (0)	SM
B-07	7.0	SPT	5.3			82.0	18.0	NV	NP	NP								A-2-4 (0)	SM
B-07	14.0	MC	11.2			45.0	55.0	26	13	13								A-6 (4)	CL
B-08	9.0	MC	9.1			51.0	49.0	21	13	8								A-4 (1)	SC
B-08	24.0	SPT	14.3			36.0	64.0	40	14	26								A-6 (14)	CL
B-09	9.0	SPT	4.5			70.0	30.0	18	14	4								A-2-4 (0)	SC-SM
B-09	24.0	SPT	3.1			80.0	20.0	NV	NP	NP								A-1-b (0)	SM
B-10	4.0	SPT	5.2		0.0	79.0	21.0	NV	NP	NP								A-2-4 (0)	SM
B-11	4.0	SPT	6.2			83.0	17.0	NV	NP	NP	7.1	<0.001	0.0004	9223				A-2-4 (0)	SM
B-11	14.0	SPT	11		0.0	47.0	53.0	24	17	7								A-4 (1)	CL-ML
B-12	4.0	MC	5.5			82.0	18.0	NV	NP	NP								A-2-4 (0)	SM

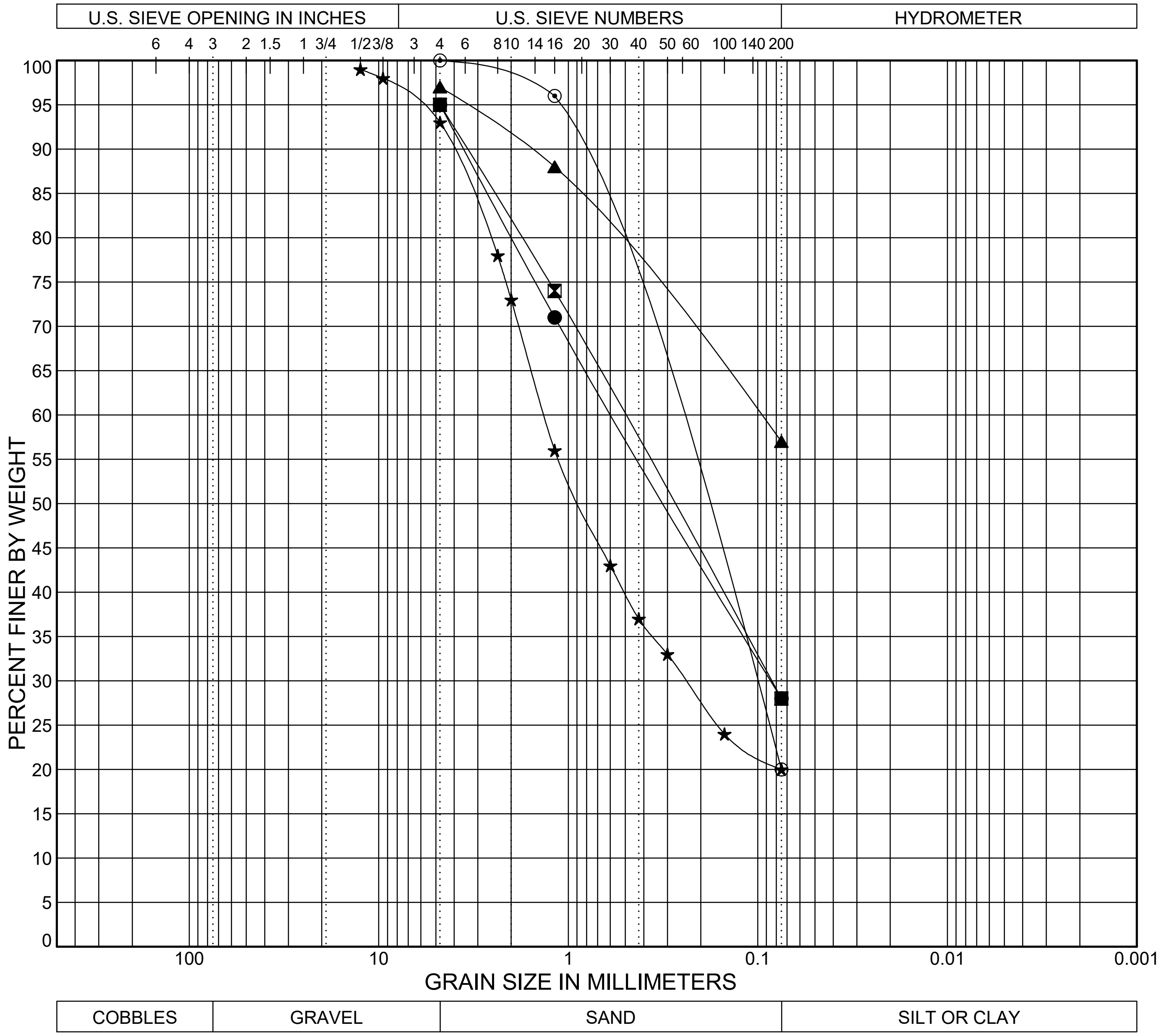
Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

Colorado Springs Lab

Summary of Laboratory Test Results

Project No: 221-290 Project Name: Tri-State Fox Run Substation Date: 09-03-2021

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate (%)	Water Soluble Chloride (%)	Resistivity (ohm-cm)	Swell (+) / Collapse (-) (% at Load in psf)	Unconf. Comp. Strength ()	Standard Proctor T99 (A)	Classification	
Boring No.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI								AASHTO	USCS
B-13	9.0	SPT	11.7			41.0	59.0	NV	NP	NP								A-4 (0)	ML
B-13	19.0	SPT	4.9			80.0	20.0	32	11	21								A-2-6 (1)	SC
B-14	4.0	SPT	6.5			82.0	18.0	NV	NP	NP								A-2-4 (0)	SM
B-14	14.0	SPT	10.4			48.0	52.0	23	19	4								A-4 (0)	CL-ML
B-15	29.0	SPT	5.9		13.0	72.0	15.0	NV	NP	NP								A-1-b (0)	SM
B-16	4.0	SPT	7.5			88.0	12.0	NV	NP	NP								A-2-4 (0)	SP-SM
B-16	19.0	SPT	4.5		8.0	78.0	14.0	NV	NP	NP								A-1-b (0)	SM
TP-1	2.5	BULK	7.8		0.0	69.0	31.0	NV	NP	NP								A-2-4 (0)	SM
TP-1	7.5	BULK	4.7			68.0	32.0	NV	NP	NP								A-2-4 (0)	SM



	BOREHOLE	DEPTH (ft)	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines %Silt	%Fines %Clay
●	**B-01**	**9.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**67.0**	**28.0**	
⧗	**B-01**	**24.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**67.0**	**28.0**	
▲	**B-02**	**7.0**	**A-4 (1)**	**CL-ML**	**23**	**16**	**7**		**40.0**	**57.0**	
★	**B-02**	**24.0**	**A-2-6 (0)**	**SC**	**33**	**18**	**15**	**6.0**	**73.0**	**20.0**	
⊙	**B-03**	**4.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**	**0.0**	**80.0**	**20.0**	

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

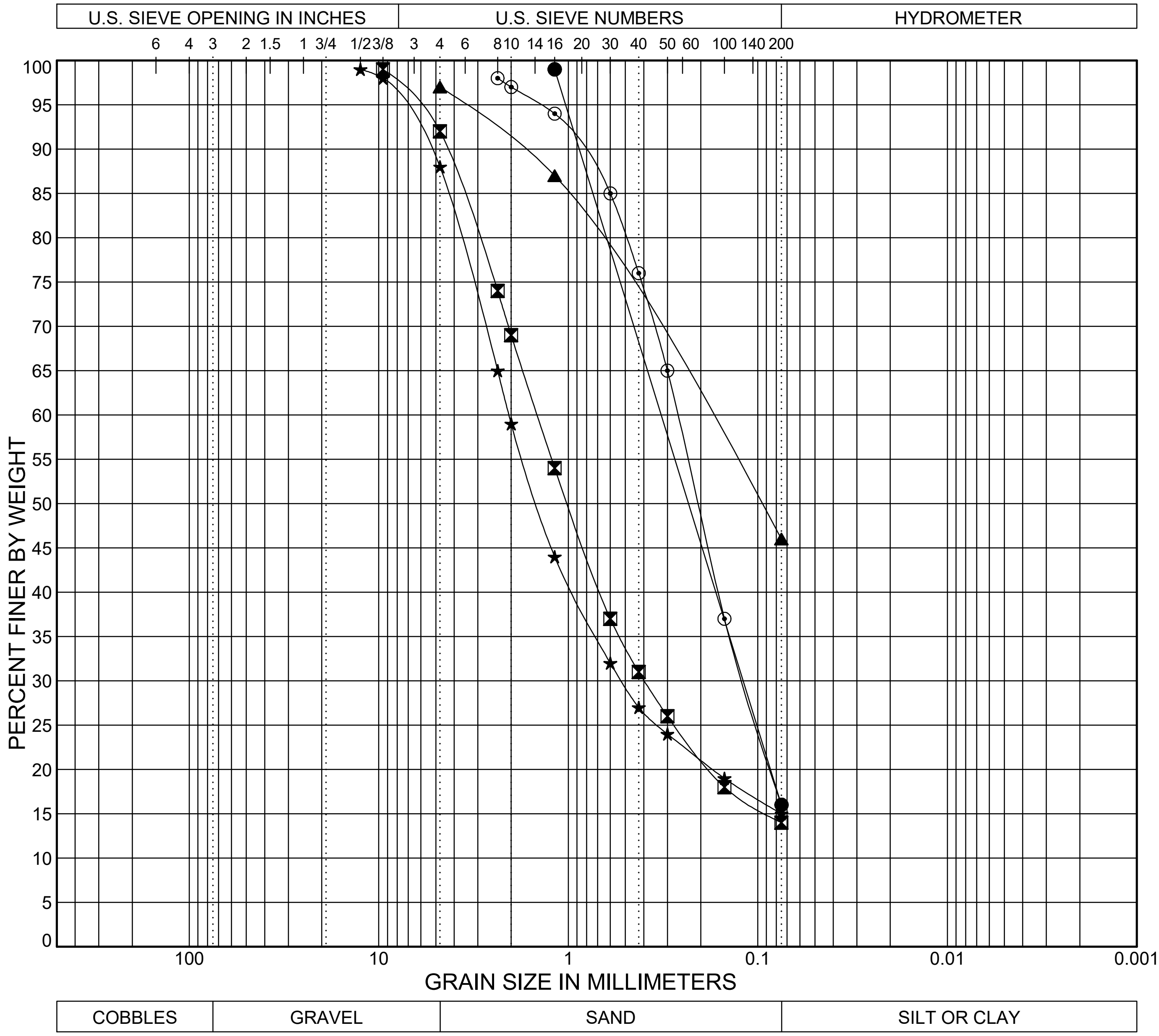
SIEVE ANALYSIS

FIGURE

C- 1

Project No. 221-290 Date: 09-02-2021
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Tri-State Fox Run Substation
Monument, Colorado



BOREHOLE		DEPTH (ft)	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines %Silt	%Fines %Clay
●	**B-04**	**7.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**83.0**	**16.0**	
⧗	**B-04**	**24.0**	**A-1-b (0)**	**SM**	**NV**	**NP**	**NP**	**7.0**	**78.0**	**14.0**	
▲	**B-05**	**7.0**	**A-4 (0)**	**SC-SM**	**23**	**16**	**7**		**51.0**	**46.0**	
★	**B-05**	**19.0**	**A-1-b (0)**	**SM**	**NV**	**NP**	**NP**	**11.0**	**73.0**	**15.0**	
⊙	**B-06**	**4.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**82.0**	**16.0**	

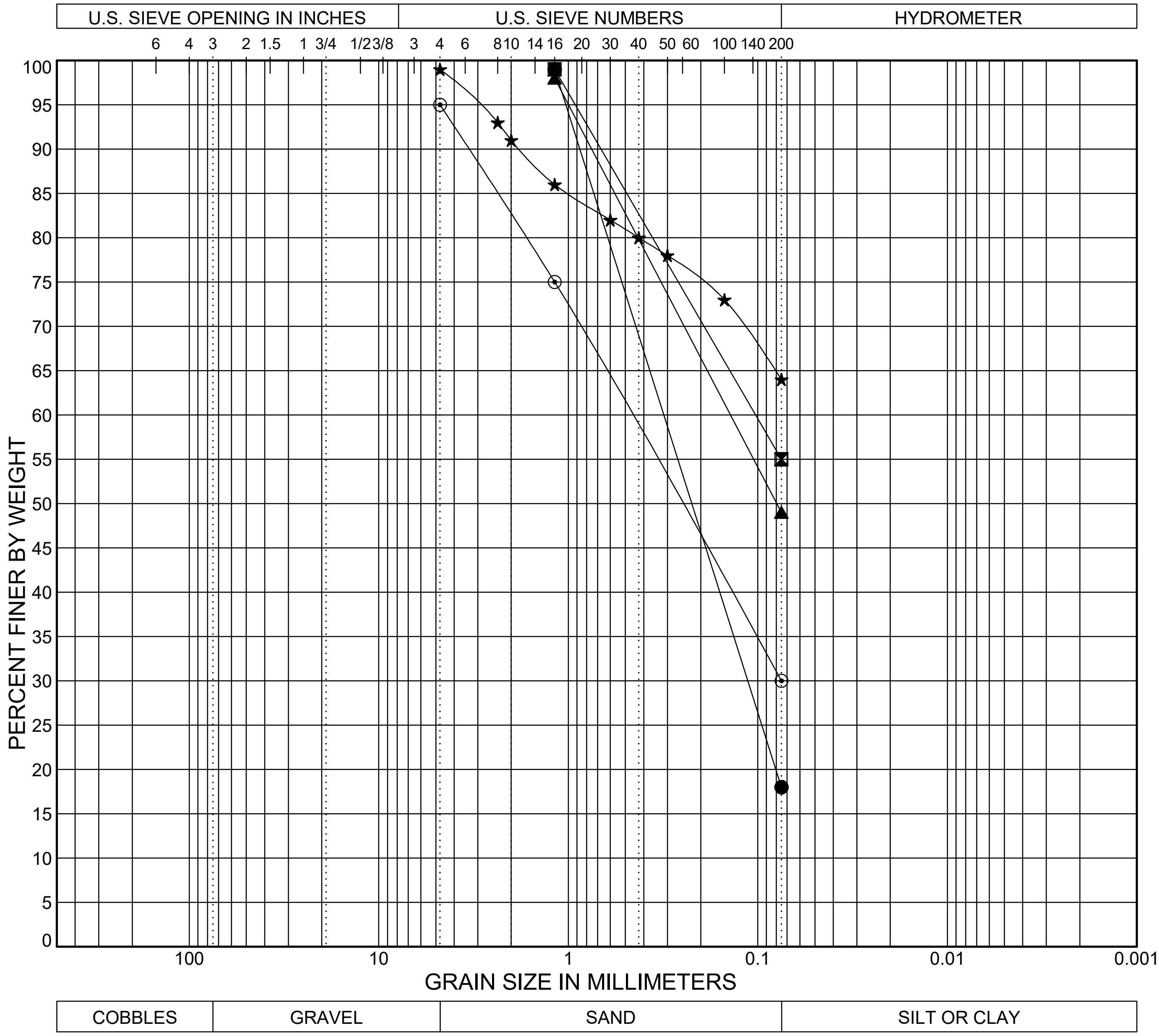
Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

SIEVE ANALYSIS

FIGURE C- 2

Project No. 221-290 Date: 09-02-2021
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Tri-State Fox Run Substation
Monument, Colorado



	BOREHOLE	DEPTH (ft)	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines	
										%Silt	%Clay
●	**B-07**	**7.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**81.0**	**18.0**	
⧗	**B-07**	**14.0**	**A-6 (4)**	**CL**	**26**	**13**	**13**		**44.0**	**55.0**	
▲	**B-08**	**9.0**	**A-4 (1)**	**SC**	**21**	**13**	**8**		**49.0**	**49.0**	
★	**B-08**	**24.0**	**A-6 (14)**	**CL**	**40**	**14**	**26**		**35.0**	**64.0**	
⊙	**B-09**	**9.0**	**A-2-4 (0)**	**SC-SM**	**18**	**14**	**4**		**65.0**	**30.0**	

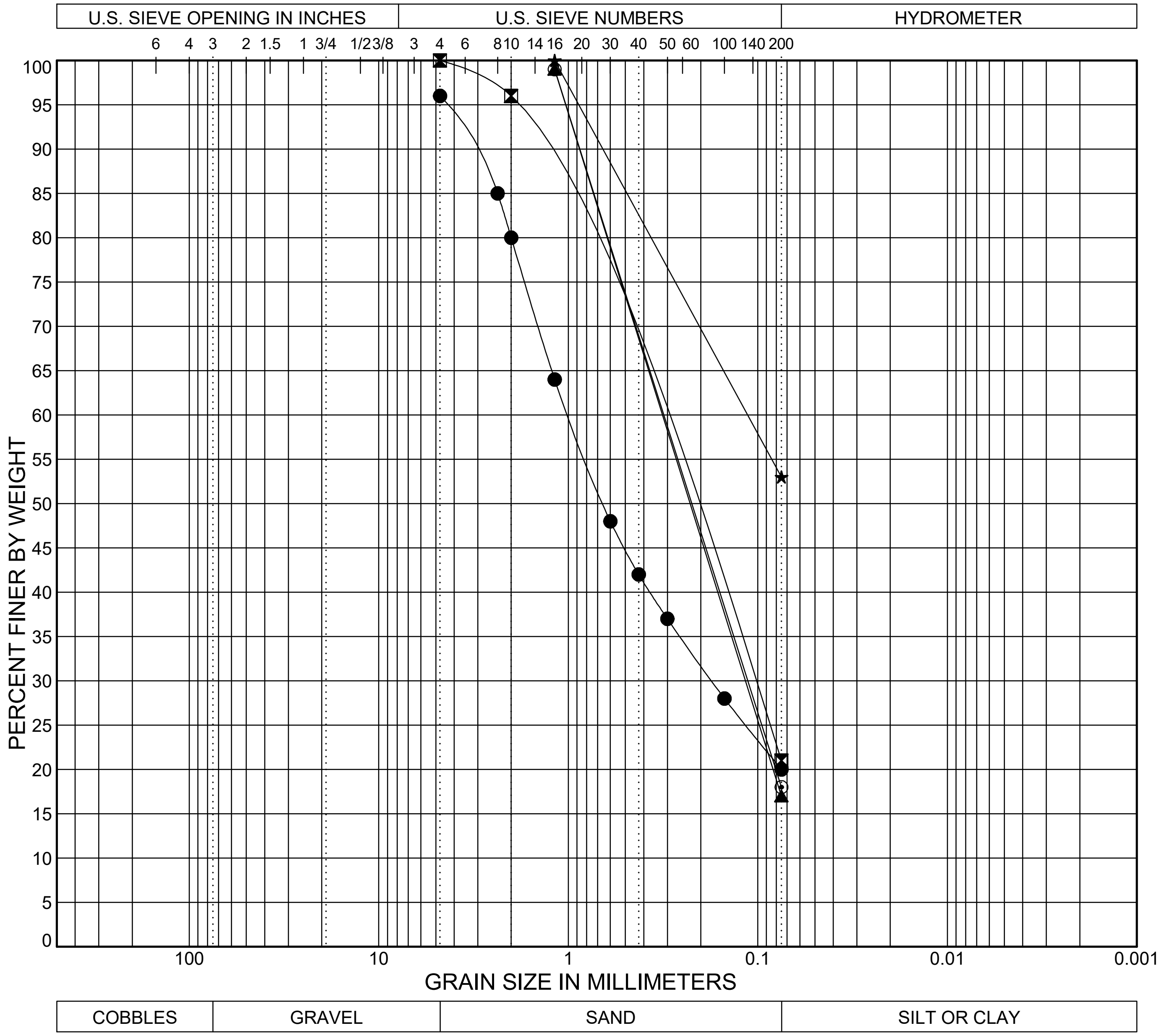
Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

SIEVE ANALYSIS

FIGURE C- 3

Project No. 221-290 Date: 09-02-2021
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Tri-State Fox Run Substation
Monument, Colorado



	BOREHOLE	DEPTH (ft)	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines: %Silt	%Fines: %Clay
●	**B-09**	**24.0**	**A-1-b (0)**	**SM**	**NV**	**NP**	**NP**		**76.0**	**20.0**	
⧗	**B-10**	**4.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**	**0.0**	**79.0**	**21.0**	
▲	**B-11**	**4.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**82.0**	**17.0**	
★	**B-11**	**14.0**	**A-4 (1)**	**CL-ML**	**24**	**17**	**7**	**0.0**	**47.0**	**53.0**	
⊙	**B-12**	**4.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**81.0**	**18.0**	

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

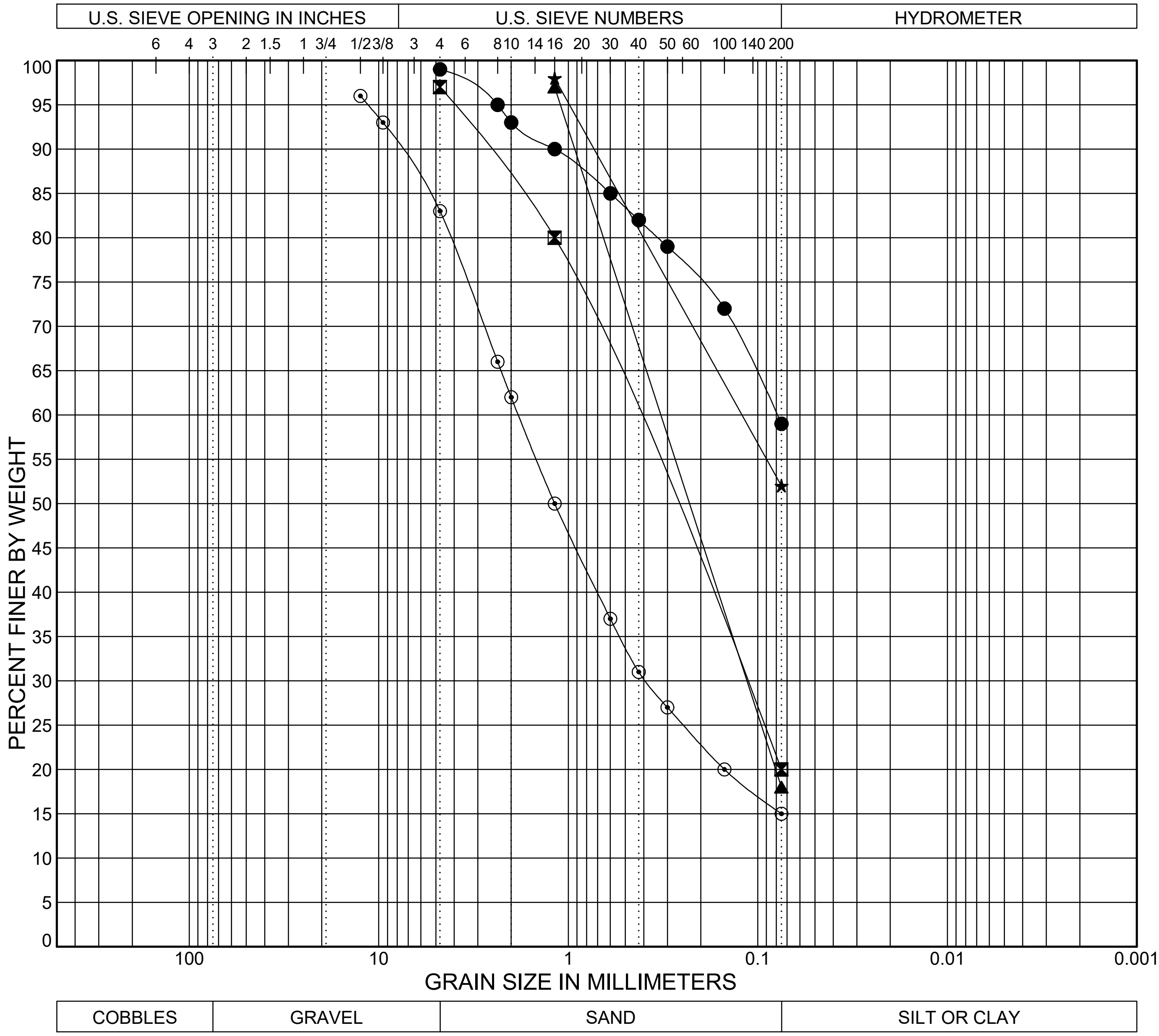
SIEVE ANALYSIS

Project No. 221-290 Date: 09-02-2021
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Tri-State Fox Run Substation
Monument, Colorado

FIGURE C- 4

03 GRAIN SIZE YEH FOX RUN SUBSTATION_GINT LOGS_DRAFT.GPJ 2021 YEH COLORADO TEMPLATE.GDT 2021 YEH COLORADO LIBRARY.GLB 9/2/21



	BOREHOLE	DEPTH (ft)	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines	
										%Silt	%Clay
●	**B-13**	**9.0**	**A-4 (0)**	**ML**	**NV**	**NP**	**NP**		**40.0**	**59.0**	
⧗	**B-13**	**19.0**	**A-2-6 (1)**	**SC**	**32**	**11**	**21**		**77.0**	**20.0**	
▲	**B-14**	**4.0**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**79.0**	**18.0**	
★	**B-14**	**14.0**	**A-4 (0)**	**CL-ML**	**23**	**19**	**4**		**46.0**	**52.0**	
⊙	**B-15**	**29.0**	**A-1-b (0)**	**SM**	**NV**	**NP**	**NP**	**13.0**	**68.0**	**15.0**	

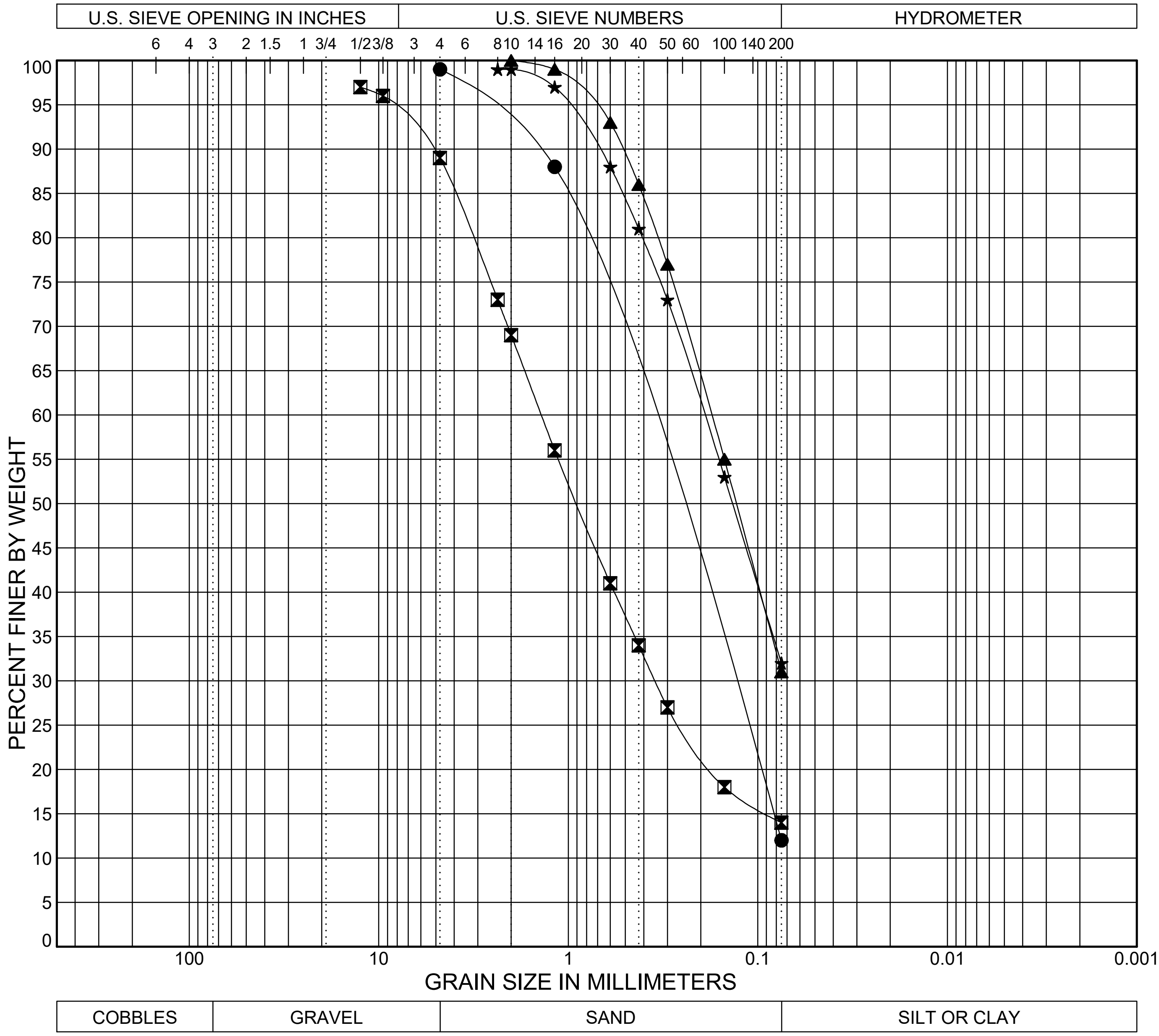
Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

SIEVE ANALYSIS

FIGURE C- 5

Project No. 221-290 Date: 09-02-2021
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Tri-State Fox Run Substation
Monument, Colorado



	BOREHOLE	DEPTH (ft)	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines: %Silt	%Fines: %Clay
●	**B-16**	**4.0**	**A-2-4 (0)**	**SP-SM**	**NV**	**NP**	**NP**		**87.0**	**12.0**	
⌧	**B-16**	**19.0**	**A-1-b (0)**	**SM**	**NV**	**NP**	**NP**	**8.0**	**75.0**	**14.0**	
▲	**TP-1**	**2.5**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**	**0.0**	**69.0**	**31.0**	
★	**TP-1**	**7.5**	**A-2-4 (0)**	**SM**	**NV**	**NP**	**NP**		**67.0**	**32.0**	

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

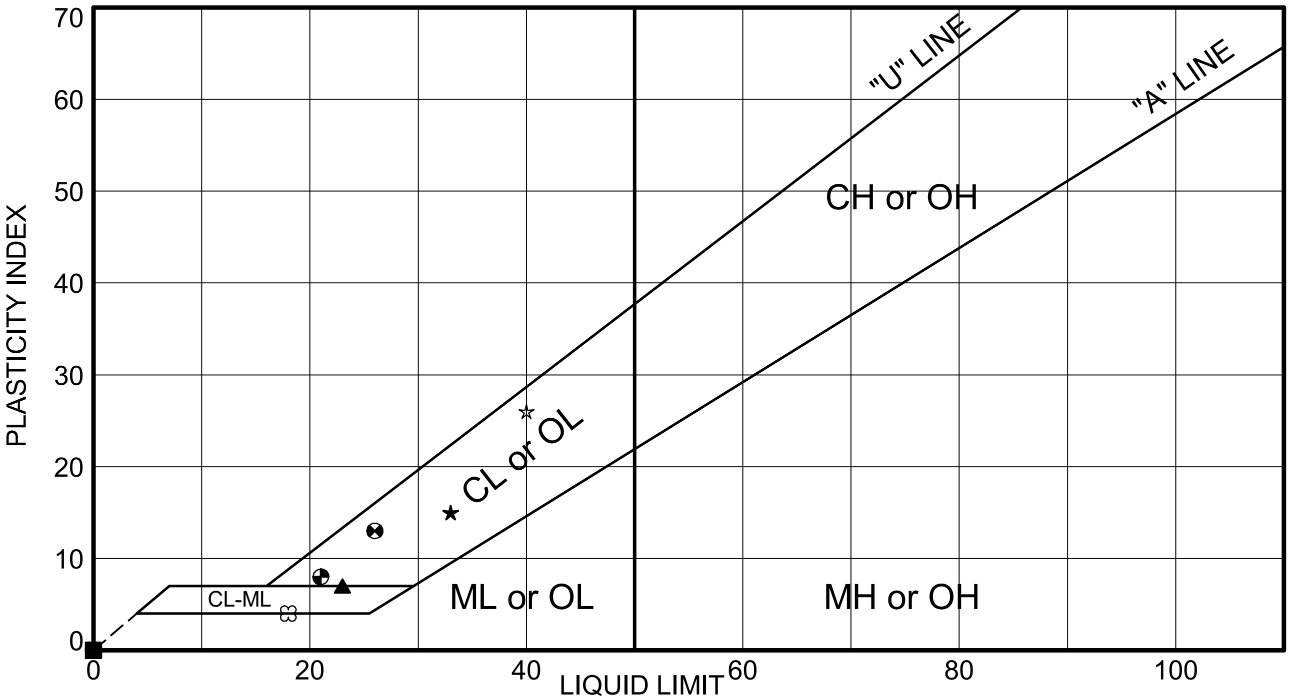
SIEVE ANALYSIS

FIGURE C- 6

Project No. 221-290 Date: 09-02-2021
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Tri-State Fox Run Substation
Monument, Colorado

03 GRAIN SIZE YEH FOX RUN SUBSTATION_GINT LOGS_DRAFT.GPJ 2021 YEH COLORADO TEMPLATE.GDT 2021 YEH COLORADO LIBRARY.GLB 9/2/21



	BOREHOLE	DEPTH (ft)	LL	PL	PI	Passing #200	USCS Sample Description and Symbol	AASHTO Class.
●	B-01	9.0	NV	NP	NP	28.0	SILTY SAND (SM)	A-2-4 (0)
⧗	B-01	24.0	NV	NP	NP	28.0	SILTY SAND (SM)	A-2-4 (0)
▲	B-02	7.0	23	16	7	57.0	SANDY SILTY CLAY (CL-ML)	A-4 (1)
★	B-02	24.0	33	18	15	20.0	CLAYEY SAND (SC)	A-2-6 (0)
⊙	B-03	4.0	NV	NP	NP	20.0	SILTY SAND (SM)	A-2-4 (0)
✿	B-04	7.0	NV	NP	NP	16.0	SILTY SAND (SM)	A-2-4 (0)
○	B-04	24.0	NV	NP	NP	14.0	SILTY SAND (SM)	A-1-b (0)
△	B-05	7.0	23	16	7	46.0	SILTY, CLAYEY SAND (SC-SM)	A-4 (0)
⊗	B-05	19.0	NV	NP	NP	15.0	SILTY SAND (SM)	A-1-b (0)
⊕	B-06	4.0	NV	NP	NP	16.0	SILTY SAND (SM)	A-2-4 (0)
□	B-07	7.0	NV	NP	NP	18.0	SILTY SAND (SM)	A-2-4 (0)
⊗	B-07	14.0	26	13	13	55.0	SANDY LEAN CLAY (CL)	A-6 (4)
◕	B-08	9.0	21	13	8	49.0	CLAYEY SAND (SC)	A-4 (1)
☆	B-08	24.0	40	14	26	64.0	SANDY LEAN CLAY (CL)	A-6 (14)
⌘	B-09	9.0	18	14	4	30.0	SILTY, CLAYEY SAND (SC-SM)	A-2-4 (0)
■	B-09	24.0	NV	NP	NP	20.0	SILTY SAND (SM)	A-1-b (0)
◆	B-10	4.0	NV	NP	NP	21.0	SILTY SAND (SM)	A-2-4 (0)
◇	B-11	4.0	NV	NP	NP	17.0	SILTY SAND (SM)	A-2-4 (0)

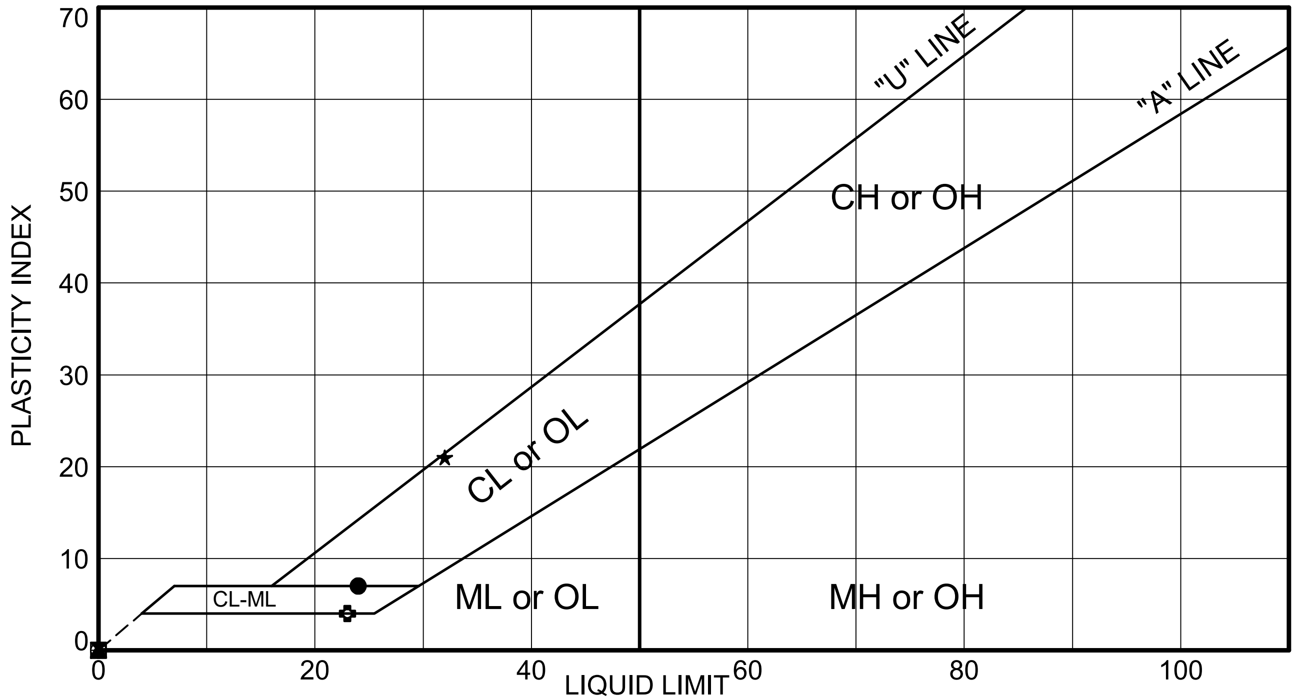
Yeh and Associates, Inc.
Geotechnical • Geological • Construction Services

ATTERBERG LIMITS

FIGURE C - 7

Project No. 221-290 Date: 09-02-2021
Report By: D. Gruenwald Yeh Lab: Colorado Springs
Checked By: J. McCall

Tri-State Fox Run Substation
Monument, Colorado



	BOREHOLE	DEPTH (ft)	LL	PL	PI	Passing #200	USCS Sample Description and Symbol	AASHTO Class.
●	**B-11**	**14.0**	**24**	**17**	**7**	**53.0**	**SANDY SILTY CLAY (CL-ML)**	**A-4 (1)**
⧗	**B-12**	**4.0**	**NV**	**NP**	**NP**	**18.0**	**SILTY SAND (SM)**	**A-2-4 (0)**
▲	**B-13**	**9.0**	**NV**	**NP**	**NP**	**59.0**	**SANDY SILT (ML)**	**A-4 (0)**
★	**B-13**	**19.0**	**32**	**11**	**21**	**20.0**	**CLAYEY SAND (SC)**	**A-2-6 (1)**
⊙	**B-14**	**4.0**	**NV**	**NP**	**NP**	**18.0**	**SILTY SAND (SM)**	**A-2-4 (0)**
✿	**B-14**	**14.0**	**23**	**19**	**4**	**52.0**	**SANDY SILTY CLAY (CL-ML)**	**A-4 (0)**
○	**B-15**	**29.0**	**NV**	**NP**	**NP**	**15.0**	**SILTY SAND with GRAVEL (SM)**	**A-1-b (0)**
△	**B-16**	**4.0**	**NV**	**NP**	**NP**	**12.0**	**POORLY GRADED SAND with SILT (SP-SM)**	**A-2-4 (0)**
⊗	**B-16**	**19.0**	**NV**	**NP**	**NP**	**14.0**	**SILTY SAND (SM)**	**A-1-b (0)**
⊕	**TP-1**	**2.5**	**NV**	**NP**	**NP**	**31.0**	**SILTY SAND (SM)**	**A-2-4 (0)**
□	**TP-1**	**7.5**	**NV**	**NP**	**NP**	**32.0**	**SILTY SAND (SM)**	**A-2-4 (0)**

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

ATTERBERG LIMITS

Tri-State Fox Run Substation
Monument, Colorado

FIGURE C - 8

Project No.	221-290	Date:	09-02-2021
Report By:	D. Gruenwald	Yeh Lab:	Colorado Springs
Checked By:	J. McCall		

Appendix C
Site Specific Physical Design Properties

Replace with rational method.

Fox Run Substation Drainage Design

Existing Conditions

Area Name	Total Area (sf)	(acres)	Flow Length	Width (A/L)	Slope (%)
Existing	626336.77	14.38	150	4175.57844	7

Land Cover Type (Soil Group B)	Curve Number	Mannings N	D-Store Pervious
Pasture or Range Land, Fair Condition	69	0.15	0.15
Open Graded Aggregate Topping Over Compacted Base	85	0.024	0.1
Compacted Base Material	85	0.024	0.05
Pavement/Concrete	98	0.015	0.05

Roughness Coefficient and Curve Number Analysis

Existing

Description	Total Area (ac)	Manning's 'n'	A*n	CN	A*CN
Native	14.38	0.15	2.1568	69	992.1312
		sum	2.1568		992.1312
Total Area (ac)	**14.38**	Weighted	0.15		69
Weighted Manning's 'n'	**0.150**				
Weighted Curve Number	**69**				
Dstore Pervious (in)	**0.15**				

Fox Run Substation Drainage Design

Proposed Conditions

	Total Area				
Area Name	**(sf)**	**(acres)**	**Flow Length**	**Width (A/L)**	**Slope (%)**
Yard	228010.3171	5.23	150	1520.1	1.0
North	292051.9481	6.70	100	2920.5	6.0
South	106271.1511	2.44	50	2125.4	7.0

Land Cover Type	**Curve Number**	**Mannings N**	**D-Store Pervious**
Pasture or Range Land, Good Condition	69	0.15	0.15
Open Graded Aggregate Topping Over Compacted Base	85	0.024	0.1
Compacted Base Material	85	0.024	0.05
Pavement/Concrete	98	0.015	0.05

Roughness Coefficient and Curve Number Analysis

Yard

Description	Total Area (ac)	Manning's 'n'	A*n	CN	A*CN
Substation Yard/Driveway	3.83	0.024	0.0919	85	325.5500
Native	0.75	0.15	0.1122	69	51.6095
Pond Area	0.66	0.15	0.0985	100	65.6433
		sum	0.3026		442.8028
Total Area (ac)	**5.23**	Weighted	0.057805993		84.59481311
Weighted Manning's 'n'	**0.058**				
Weighted Curve Number	**84.59**				
Dstore Pervious (in)	**0.15**				

North

Description	Total Area (ac)	Manning's 'n'	A*n	CN	A*CN
Driveway/County Road	0.00	0.024	0.0000	85	0.0000
Native	6.70	0.15	1.0057	69	462.6167
		sum	1.0057		462.6167
Total Area (ac)	**6.70**	Weighted	0.15		69
Weighted Manning's 'n'	**0.150**				
Weighted Curve Number	**69**				
Dstore Pervious (in)	**0.15**				

South

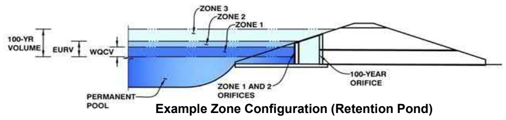
Description	Total Area (ac)	Manning's 'n'	A*n	CN	A*CN
Driveway/County Road	0.08	0.024	0.0019	85	6.8000
Native	2.36	0.15	0.3539	69	162.8158
		sum	0.3559		169.6158
Total Area (ac)	**2.44**	Weighted	0.14586826		69.52466544
Weighted Manning's 'n'	**0.146**				
Weighted Curve Number	**69.52**				
Dstore Pervious (in)	**0.15**				

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

Project: Fox Run Substation

Basin ID: Detention Pond



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	4.95	acres
Watershed Length =	500	ft
Watershed Length to Centroid =	50	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	40.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.074	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.208	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.92 in.) =	0.122	acre-feet	0.92	inches
5-yr Runoff Volume (P1 = 1.21 in.) =	0.185	acre-feet	1.21	inches
10-yr Runoff Volume (P1 = 1.47 in.) =	0.262	acre-feet	1.47	inches
25-yr Runoff Volume (P1 = 1.86 in.) =	0.427	acre-feet	1.86	inches
50-yr Runoff Volume (P1 = 2.18 in.) =	0.543	acre-feet	2.18	inches
100-yr Runoff Volume (P1 = 2.53 in.) =	0.693	acre-feet	2.53	inches
500-yr Runoff Volume (P1 = 3.43 in.) =	1.040	acre-feet	3.43	inches
Approximate 2-yr Detention Volume =	0.119	acre-feet		
Approximate 5-yr Detention Volume =	0.173	acre-feet		
Approximate 10-yr Detention Volume =	0.247	acre-feet		
Approximate 25-yr Detention Volume =	0.306	acre-feet		
Approximate 50-yr Detention Volume =	0.335	acre-feet		
Approximate 100-yr Detention Volume =	0.398	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.074	acre-feet
Zone 2 Volume (100-year - Zone 1) =	0.323	acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.398	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	0	0.000		
			--	--	--	7,253	0.166	1,813	0.042
			--	--	--	16,055	0.369	7,640	0.175
			--	--	--	17,299	0.397	15,978	0.367
			--	--	--	18,389	0.422	24,900	0.572
			--	--	--	19,509	0.448	34,375	0.789
			--	--	--	20,656	0.474	44,416	1.020
			--	--	--	21,833	0.501	55,038	1.264
			--	--	--	23,038	0.529	66,256	1.521

Provide the calculation for the composite imperviousness

Revise per DCM

Table 6-2. Rainfall Depths for Colorado Springs

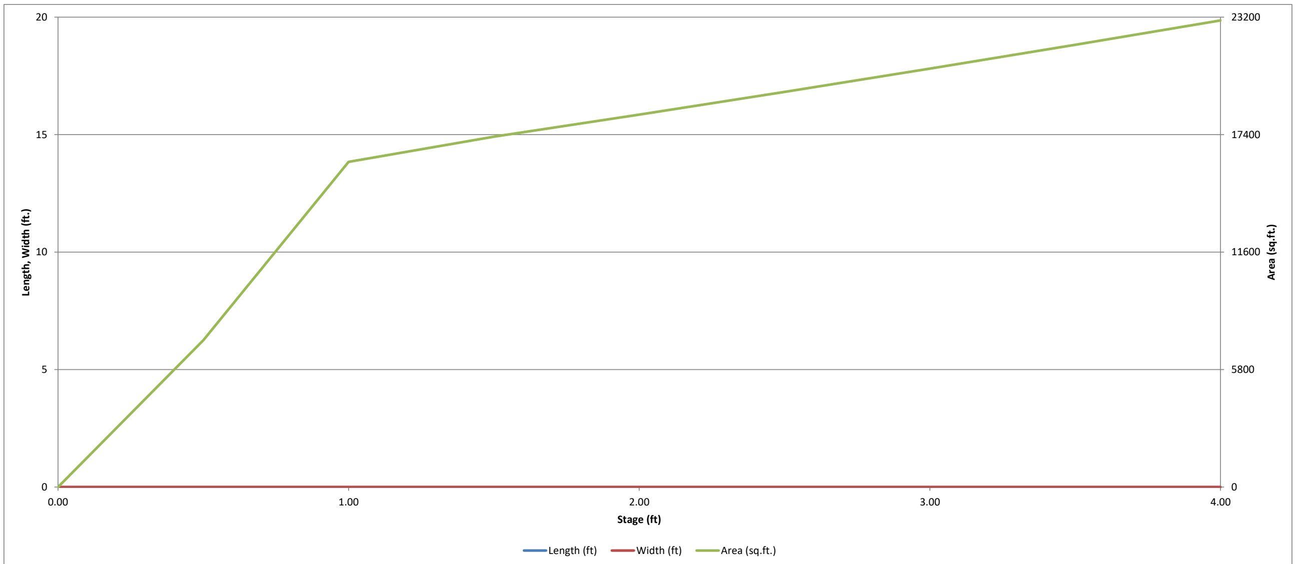
Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

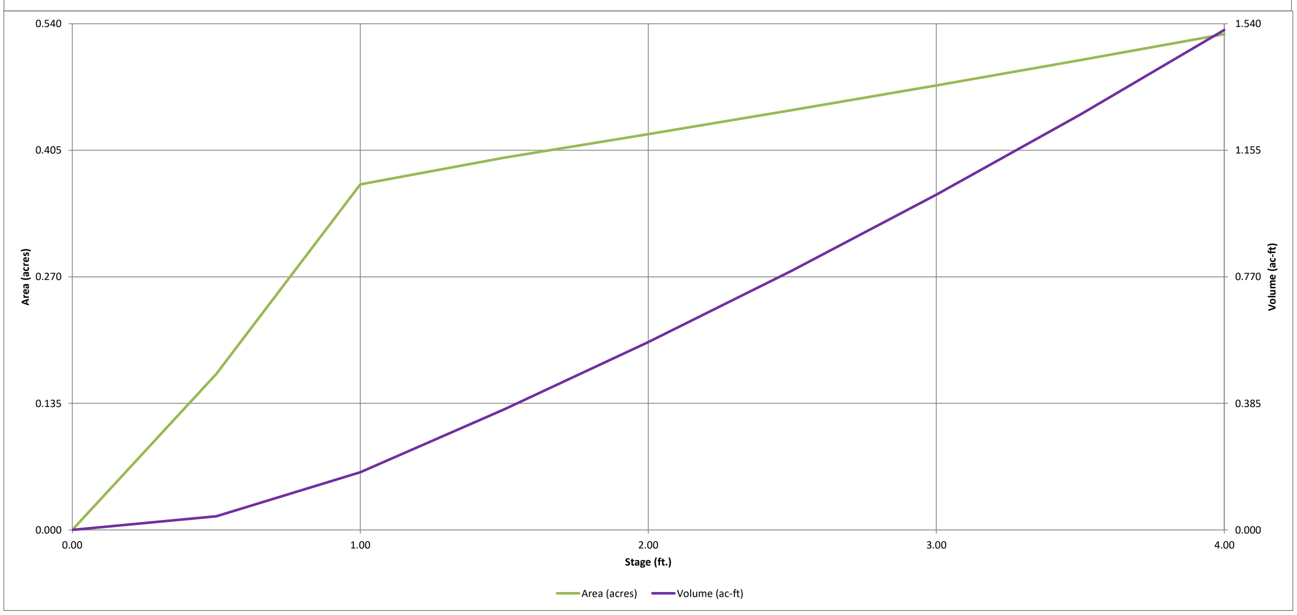
Where Z= 6,840 ft/100

Revise Zone 2 to EURV and Zone 3 to 100yr - (Zone 1 & Zone 2)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)



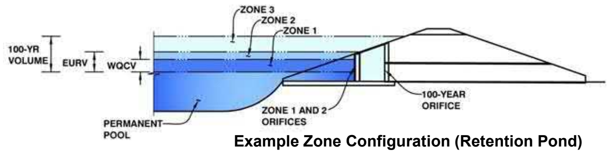


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: Fox Run Substation

Basin ID: Detention Pond



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.67	0.074	Orifice Plate
Zone 2 (100-year)	1.58	0.323	Weir&Pipe (Circular)
Zone 3			
Total (all zones)		0.398	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.00	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	6.00	inches
Orifice Plate: Orifice Area per Row =	1.76	sq. inches (diameter = 1-1/2 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.222E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.50	1.00	1.50				
Orifice Area (sq. inches)	1.76	1.76	1.76	1.76				

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =			ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
Vertical Orifice Centroid =			feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir (and No Outlet Pipe)

	Zone 2 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	0.55		ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =			feet
Overflow Weir Grate Slope =			H:V
Horiz. Length of Weir Sides =			feet
Overflow Grate Type =			
Debris Clogging % =			%

Calculated Parameters for Overflow Weir

	Zone 2 Weir	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 2 Circular	Not Selected	
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =			inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 2 Circular	Not Selected	
Outlet Orifice Area =			ft^2
Outlet Orifice Centroid =			feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

Input with spillway design.

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		ft (relative to basin bo[illegible]
Spillway Crest Length =		feet
Spillway End Slopes =		H:V
Freeboard above Max Water Surface =		feet

Calculated Parameters for Spillway

[illegible]llway Design Flow Depth=		feet
[illegible]age at Top of Freeboard =		feet
Basin Area at Top of Freeboard =		acres
Basin Volume at Top of Freeboard =		acre-ft

Routed Hydrograph Results

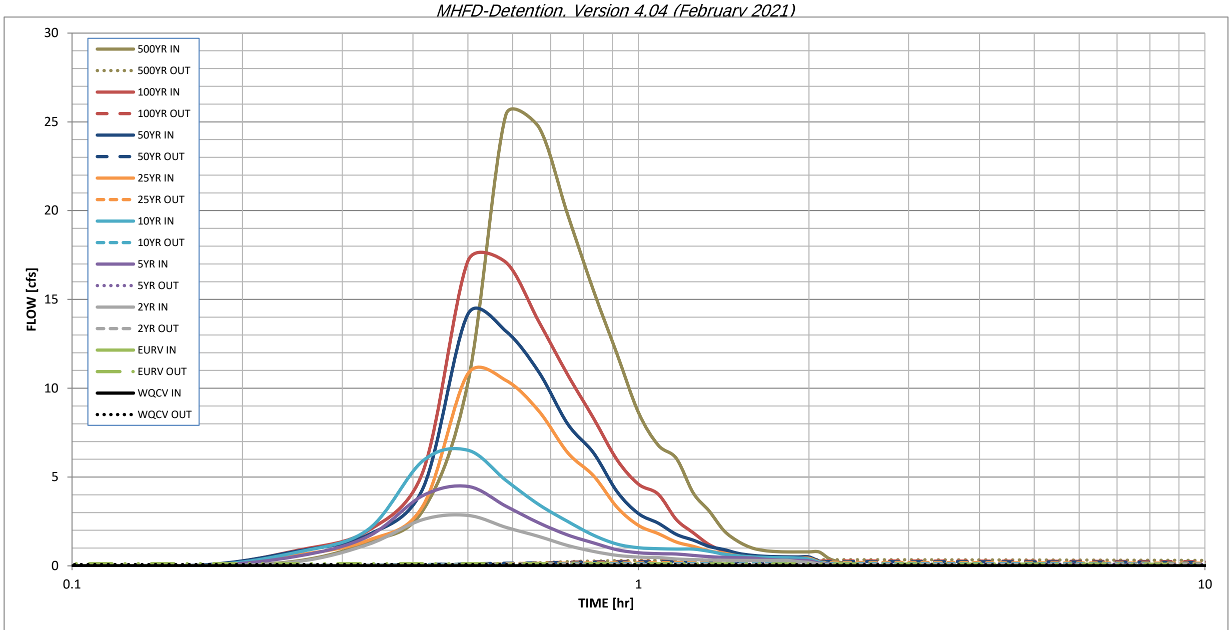
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

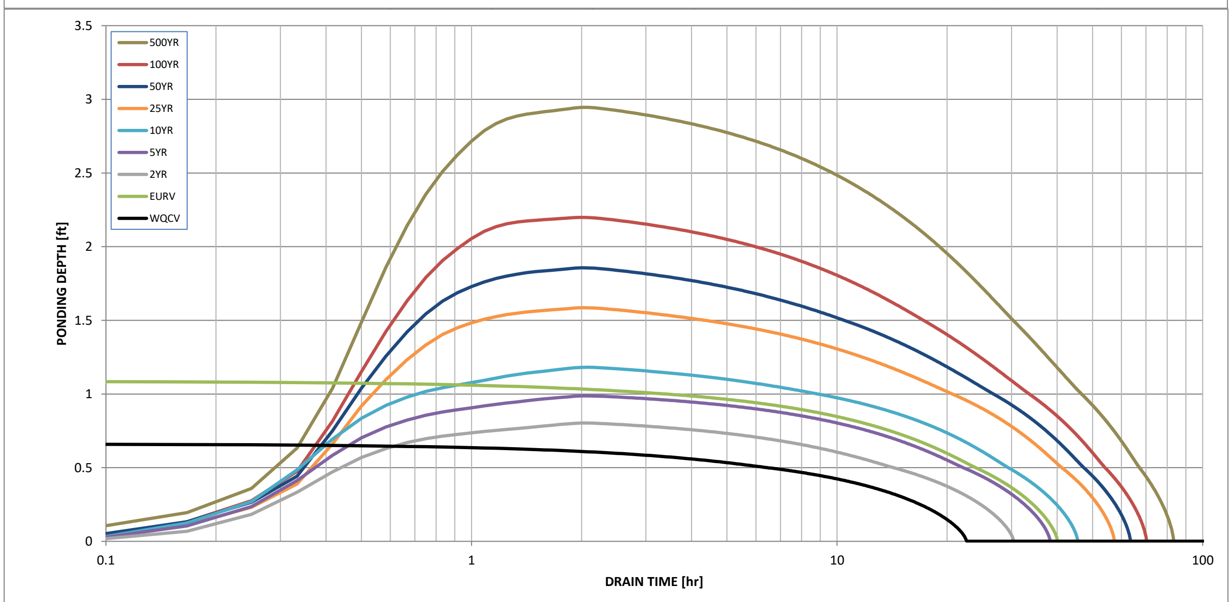
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	0.92	1.21	1.47	1.86	2.18	2.53	3.43
CUHP Runoff Volume (acre-ft) =	0.074	0.208	0.122	0.185	0.262	0.427	0.543	0.693	1.040
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.122	0.185	0.262	0.427	0.543	0.693	1.040
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.9	2.5	6.1	8.5	11.6	18.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.18	0.51	1.24	1.73	2.34	3.65
Peak Inflow Q (cfs) =	N/A	N/A	2.8	4.5	6.5	10.8	14.2	17.2	25.4
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.0	0.0	0.0	0.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	21	36	28	35	41	51	56	61	70
Time to Drain 99% of Inflow Volume (hours) =	22	38	29	37	44	55	60	66	78
Maximum Ponding Depth (ft) =	0.67	1.09	0.80	0.99	1.18	1.59	1.86	2.20	2.95
Area at Maximum Ponding Depth (acres) =	0.24	0.37	0.29	0.36	0.38	0.40	0.41	0.43	0.47
Maximum Volume Stored (acre-ft) =	0.076	0.209	0.110	0.168	0.243	0.399	0.509	0.653	0.991

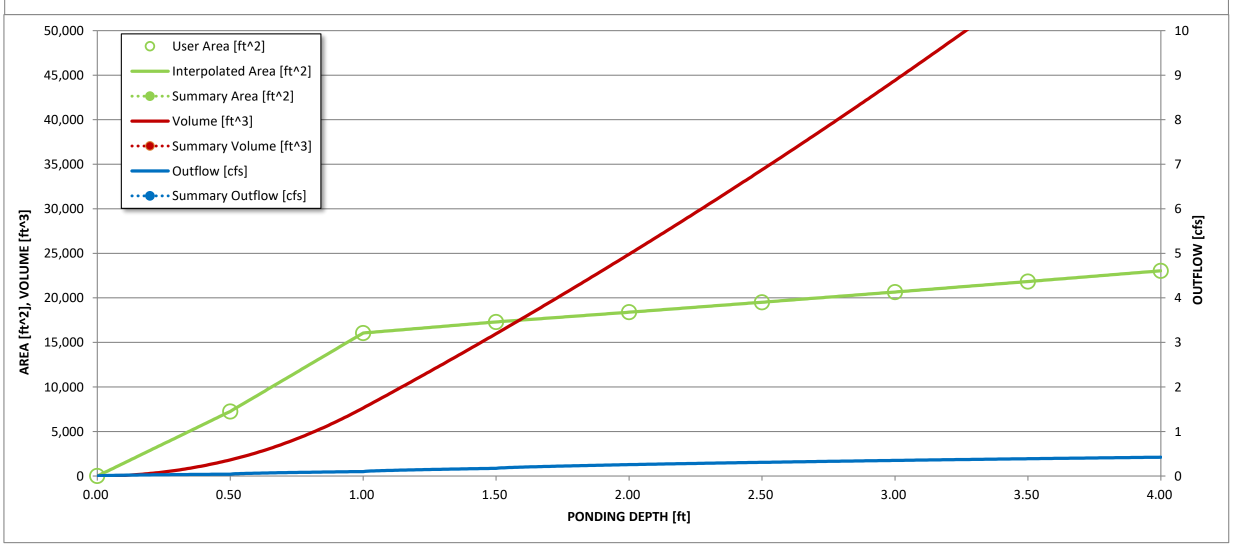
Revise to drain time of ~40hrs to ensure WQ

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)







S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.28
	0:15:00	0.00	0.00	0.24	0.54	0.77	0.61	0.83	0.87	1.33
	0:20:00	0.00	0.00	1.21	1.66	2.05	1.44	1.75	1.98	3.13
	0:25:00	0.00	0.00	2.61	3.96	5.92	3.39	4.38	5.32	10.31
	0:30:00	0.00	0.00	2.84	4.47	6.51	10.82	14.17	17.16	25.38
	0:35:00	0.00	0.00	2.17	3.36	4.82	10.44	13.22	17.09	24.71
	0:40:00	0.00	0.00	1.66	2.42	3.46	8.73	10.92	13.77	19.78
	0:45:00	0.00	0.00	1.15	1.74	2.50	6.37	7.99	10.76	15.49
	0:50:00	0.00	0.00	0.81	1.29	1.72	5.07	6.36	8.31	11.93
	0:55:00	0.00	0.00	0.59	0.91	1.22	3.30	4.18	5.97	8.64
	1:00:00	0.00	0.00	0.50	0.74	1.02	2.28	2.95	4.60	6.80
	1:05:00	0.00	0.00	0.47	0.69	0.97	1.82	2.41	4.04	6.05
	1:10:00	0.00	0.00	0.39	0.67	0.95	1.34	1.77	2.61	4.10
	1:15:00	0.00	0.00	0.35	0.59	0.94	1.10	1.45	1.86	3.09
	1:20:00	0.00	0.00	0.33	0.52	0.82	0.84	1.09	1.19	1.97
	1:25:00	0.00	0.00	0.32	0.48	0.66	0.71	0.92	0.84	1.37
	1:30:00	0.00	0.00	0.31	0.46	0.56	0.57	0.70	0.62	1.02
	1:35:00	0.00	0.00	0.30	0.44	0.51	0.49	0.60	0.53	0.86
	1:40:00	0.00	0.00	0.30	0.38	0.48	0.46	0.54	0.51	0.80
	1:45:00	0.00	0.00	0.30	0.34	0.46	0.44	0.52	0.50	0.78
	1:50:00	0.00	0.00	0.30	0.32	0.46	0.43	0.50	0.50	0.78
	1:55:00	0.00	0.00	0.24	0.31	0.44	0.43	0.50	0.50	0.78
	2:00:00	0.00	0.00	0.20	0.28	0.38	0.43	0.50	0.50	0.78
	2:05:00	0.00	0.00	0.11	0.15	0.21	0.23	0.27	0.27	0.43
	2:10:00	0.00	0.00	0.06	0.09	0.11	0.13	0.15	0.15	0.23
	2:15:00	0.00	0.00	0.03	0.04	0.06	0.06	0.08	0.07	0.12
	2:20:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.05
	2:25:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

Appendix D
SWMM Modeling Results

Replace with Rational Method

Project Description

File Name .... 21036-Fox Run Drainage.SPF

Project Options

Flow Units .... CFS
Elevation Type .... Elevation
Hydrology Method .... EPA SWMM
EPA SWMM Infiltration Method .... SCS Curve Number
Link Routing Method .... Kinematic Wave
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins...	4
Nodes..	6
Junctions	2
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links..	9
Channels	0
Pipes	2
Pumps	0
Orifices	5
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	10yr-24hr	Cumulative	inches	Colorado	El Paso	10.00	3.01	SCS Type II 24-hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Impervious Area (%)	Weighted Curve Number	Average Slope (%)	Equivalent Width (ft)	Impervious Area Manning's Roughness	Pervious Area Manning's Roughness	Total Rainfall (in)	Total Infiltration (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Existing	14.38	10.00	69.00	7.0000	4175.58	0.0150	0.1500	3.01	1.7700	1.19	17.13	20.08	0 00:29:07
2	Proposed-North	6.70	10.00	69.00	6.0000	2920.50	0.0150	0.1500	3.01	1.7680	1.19	8.00	10.03	0 00:23:54
3	Proposed-South	2.44	25.00	69.52	7.0000	2125.40	0.0150	0.1500	3.01	1.4560	1.51	3.67	5.58	0 00:13:30
4	Yard	5.23	40.00	84.59	1.0000	1520.10	0.0150	0.1500	3.01	0.7800	2.18	11.40	14.07	0 00:40:55

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Pipe-Out	Junction	7443.22	7445.19	0.00	7446.00	0.00	0.30	7443.44	0.00	1.75	0 00:00	0.00	0.00
2	Pond-Out	Junction	7443.42	7447.00	0.00	7447.00	0.00	0.30	7443.64	0.00	3.78	0 00:00	0.00	0.00
3	Existing-Out	Outfall	7435.00					20.08	7435.00					
4	Out-North	Outfall	7435.00					10.23	7435.00					
5	Out-South	Outfall	7435.00					5.58	7435.00					
6	Pond	Storage Node	7444.00	7448.00	0.00		0.00	14.07	7445.89				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Out-Pipe	Pipe	Pond-Out	Pipe-Out	40.00	7443.42	7443.22	0.5000	12.000	0.0120	0.30	2.73	0.11	2.28	0.22	0.22	0.00	Calculated
2	Out-Swale	Pipe	Pipe-Out	Out-North	326.18	0.00	0.00	0.0000	0.000	0.0150	0.30	0.00	0.11	0.00	0.22	0.22	0.00	Calculated
3	Orifice-01	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.08							
4	Orifice-02	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.08							
5	Orifice-03	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.06							
6	Orifice-04	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.05							
7	Orifice-05	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.02							
8	Spillway	Weir	Pond	Pond-Out		7444.00	7443.42				0.00							
9	Weir	Weir	Pond	Pond-Out		7444.00	7443.42				0.00							

Subbasin Hydrology

Subbasin : Existing

Input Data

Area (ac) 14.38
Impervious Area (%) 10
Weighted Curve Number 69
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 7
Equivalent Width (ft) 4175.58
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

Composite Curve Number

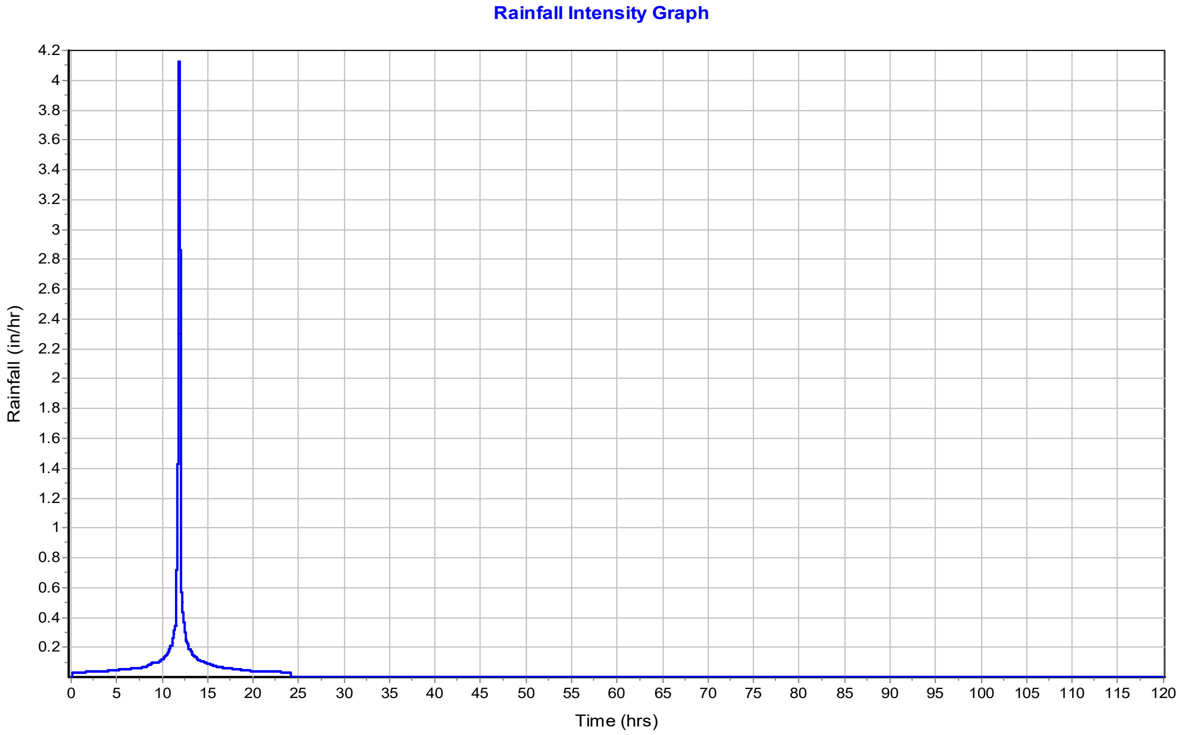
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	14.38	B	69
Composite Area & Weighted CN	14.38		69

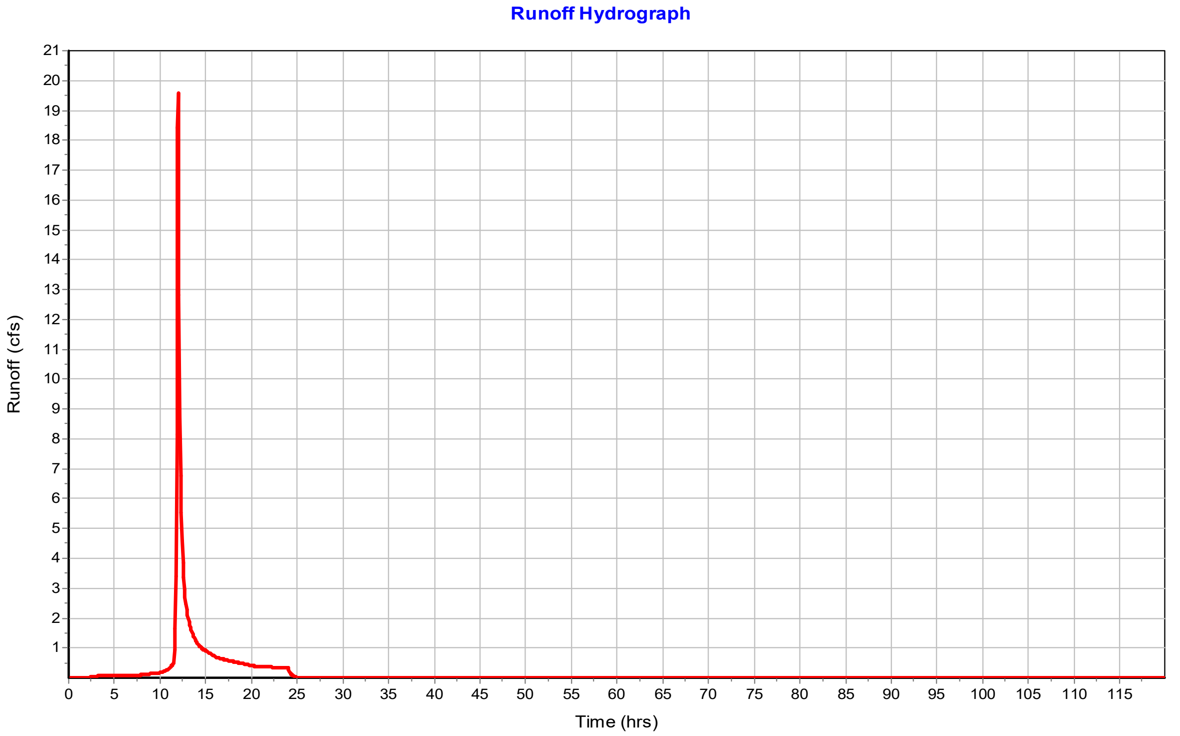
Subbasin Runoff Results

Total Rainfall (in) 3.01
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 1.77
Total Runoff (in) 1.19
Peak Runoff (cfs) 20.08
Weighted Curve Number 69
Time of Concentration (days hh:mm:ss) 0 00:29:07

Fox Run Substation
10Yr-24Hr

Subbasin : Existing





Subbasin : Proposed-North

Input Data

Area (ac) 6.7
Impervious Area (%) 10
Weighted Curve Number 69
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 6
Equivalent Width (ft) 2920.5
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

Composite Curve Number

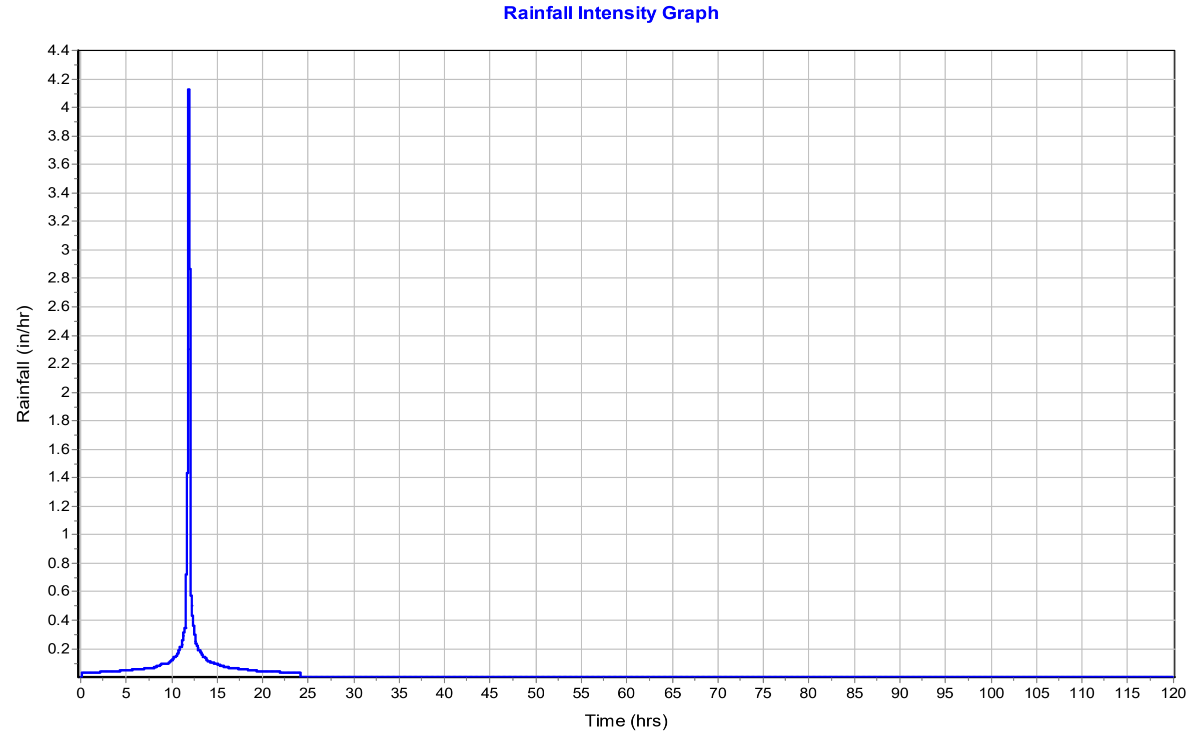
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	6.7	-	69
Composite Area & Weighted CN	6.7		69

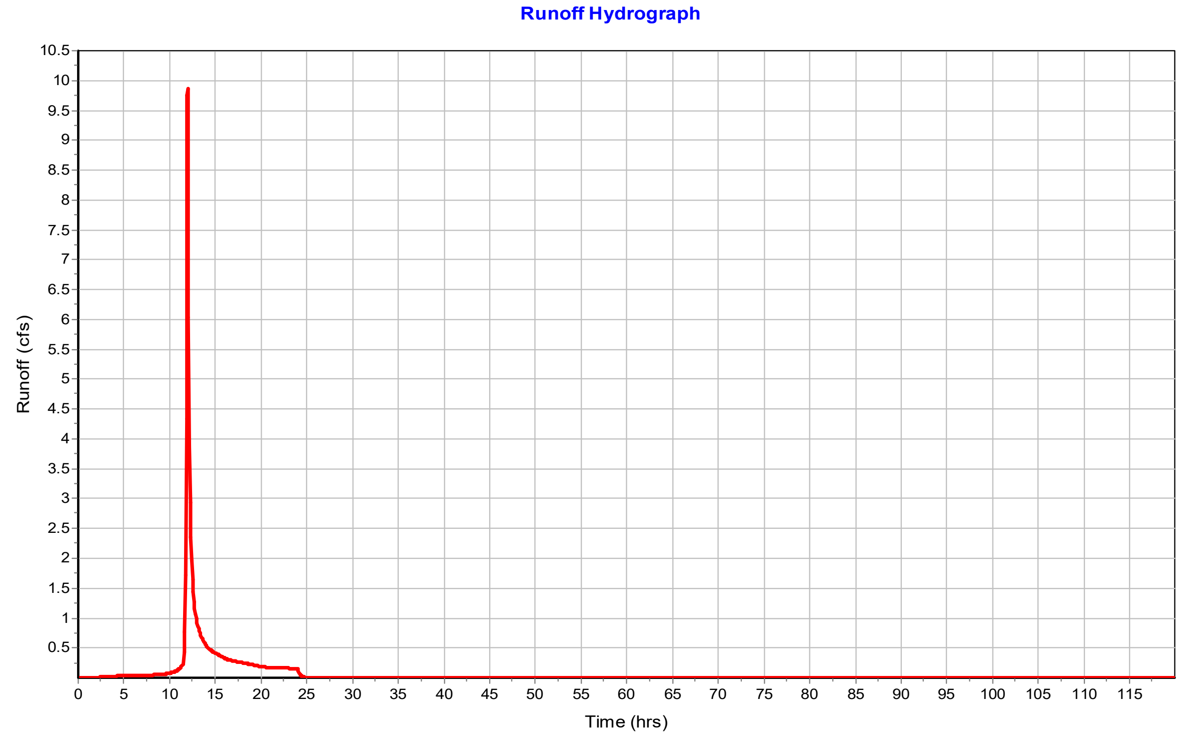
Subbasin Runoff Results

Total Rainfall (in) 3.01
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 1.768
Total Runoff (in) 1.19
Peak Runoff (cfs) 10.03
Weighted Curve Number 69
Time of Concentration (days hh:mm:ss) 0 00:23:54

Fox Run Substation
10Yr-24Hr

Subbasin : Proposed-North





Subbasin : Proposed-South

Input Data

Area (ac) 2.44
Impervious Area (%) 25
Weighted Curve Number 69.52
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 7
Equivalent Width (ft) 2125.4
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

Composite Curve Number

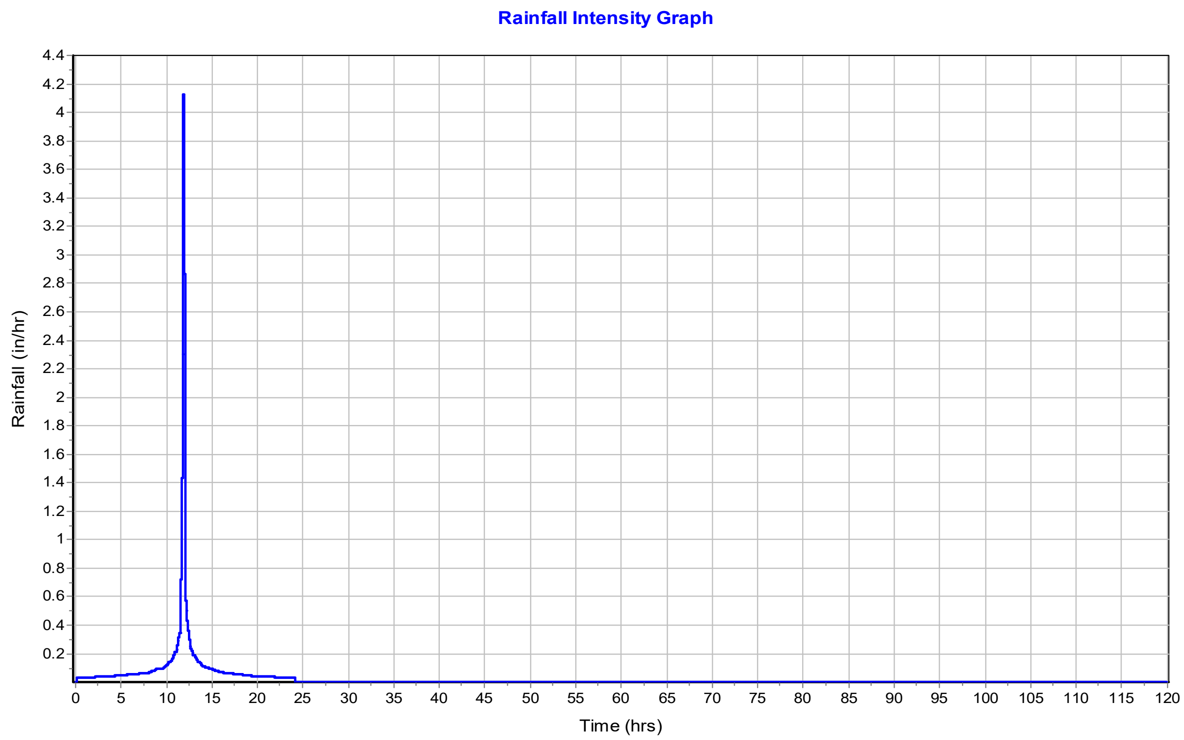
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	2.44	-	69.52
Composite Area & Weighted CN	2.44		69.52

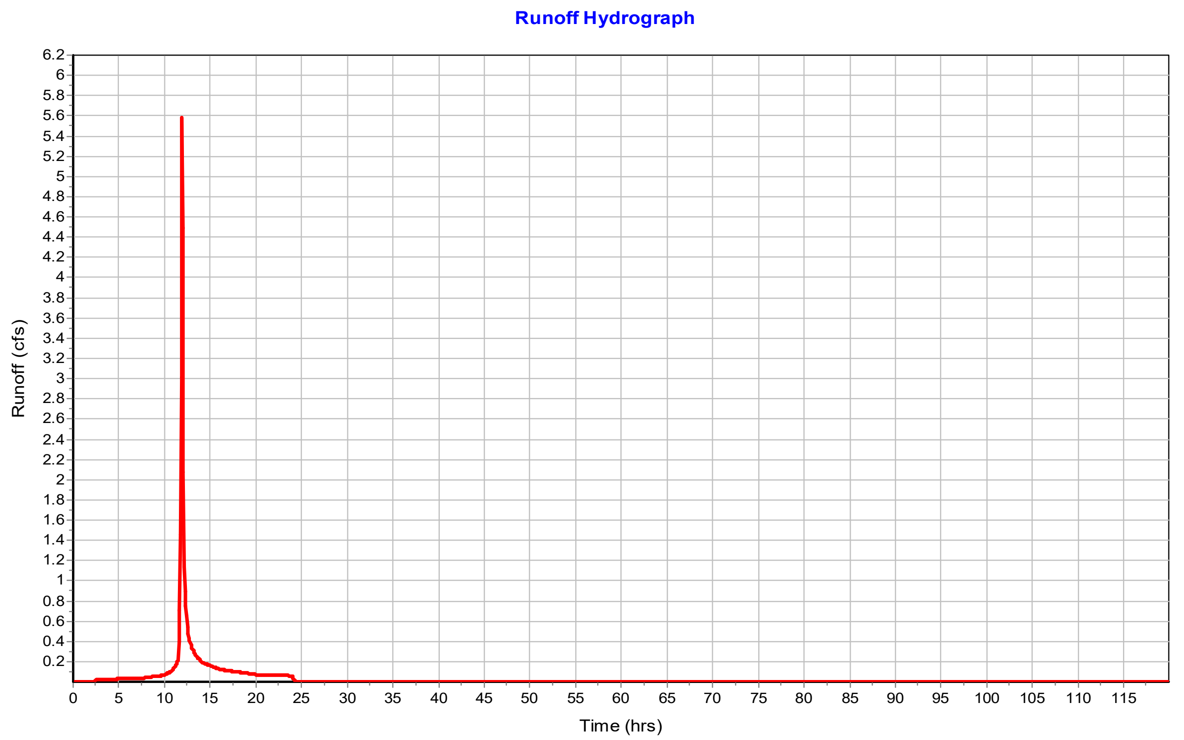
Subbasin Runoff Results

Total Rainfall (in) 3.01
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 1.456
Total Runoff (in) 1.51
Peak Runoff (cfs) 5.58
Weighted Curve Number 69.52
Time of Concentration (days hh:mm:ss) 0 00:13:30

Fox Run Substation
10Yr-24Hr

Subbasin : Proposed-South





Subbasin : Yard

Input Data

Area (ac) 5.23
Impervious Area (%) 40
Weighted Curve Number 84.59
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 1
Equivalent Width (ft) 1520.1
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

Composite Curve Number

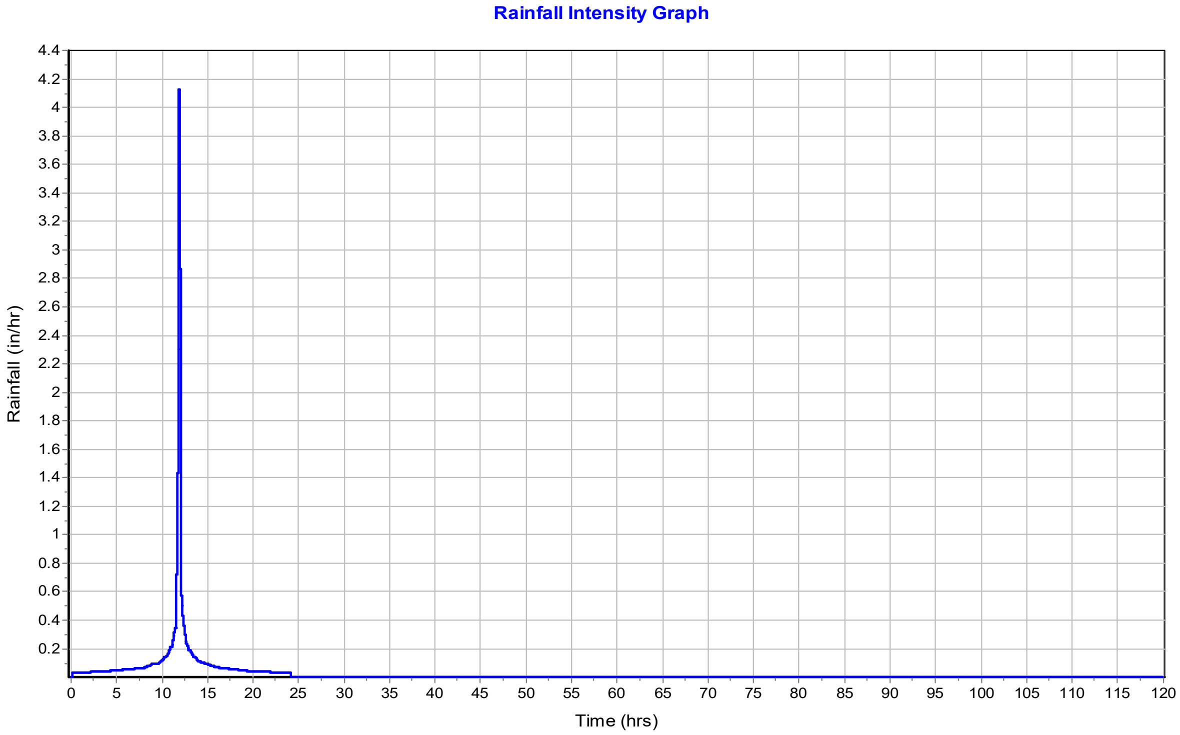
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	5.23	B	84.59
Composite Area & Weighted CN	5.23		84.59

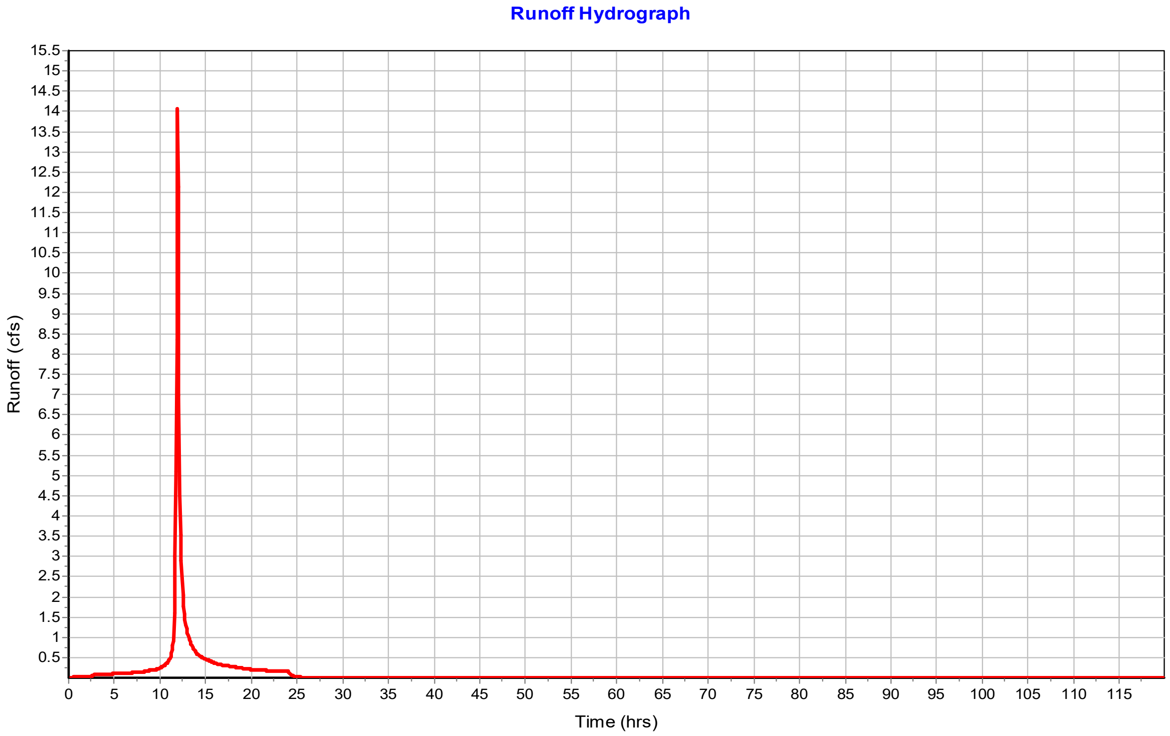
Subbasin Runoff Results

Total Rainfall (in) 3.01
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 0.78
Total Runoff (in) 2.18
Peak Runoff (cfs) 14.07
Weighted Curve Number 84.59
Time of Concentration (days hh:mm:ss) 0 00:40:55

Fox Run Substation
10Yr-24Hr

Subbasin : Yard





Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	Pipe-Out	7443.22	7445.19	1.97	0.00	-7443.22	7446.00	0.81	0.00	0.00
2	Pond-Out	7443.42	7447.00	3.58	0.00	-7443.42	7447.00	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Pipe-Out	0.30	0.00	7443.44	0.22	0.00	1.75	7443.32	0.10	0 17:26	0 00:00	0.00	0.00
2	Pond-Out	0.30	0.00	7443.64	0.22	0.00	3.78	7443.52	0.10	0 17:25	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Out-Pipe	40.00	7443.42	0.00	7443.22	0.00	0.20	0.5000	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Out-Swale	326.18	0.00	-7443.22	0.00	-7435.00	0.00	0.0000	Dummy	0.000	0.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Fox Run Substation
10Yr-24Hr

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Out-Pipe	0.30	0 17:26	2.73	0.11	2.28	0.29	0.22	0.22	0.00		Calculated
2	Out-Swale	0.30	0 17:26	0.00	0.11	0.00		0.22	0.22	0.00		Calculated

Storage Nodes

Storage Node : Pond

Input Data

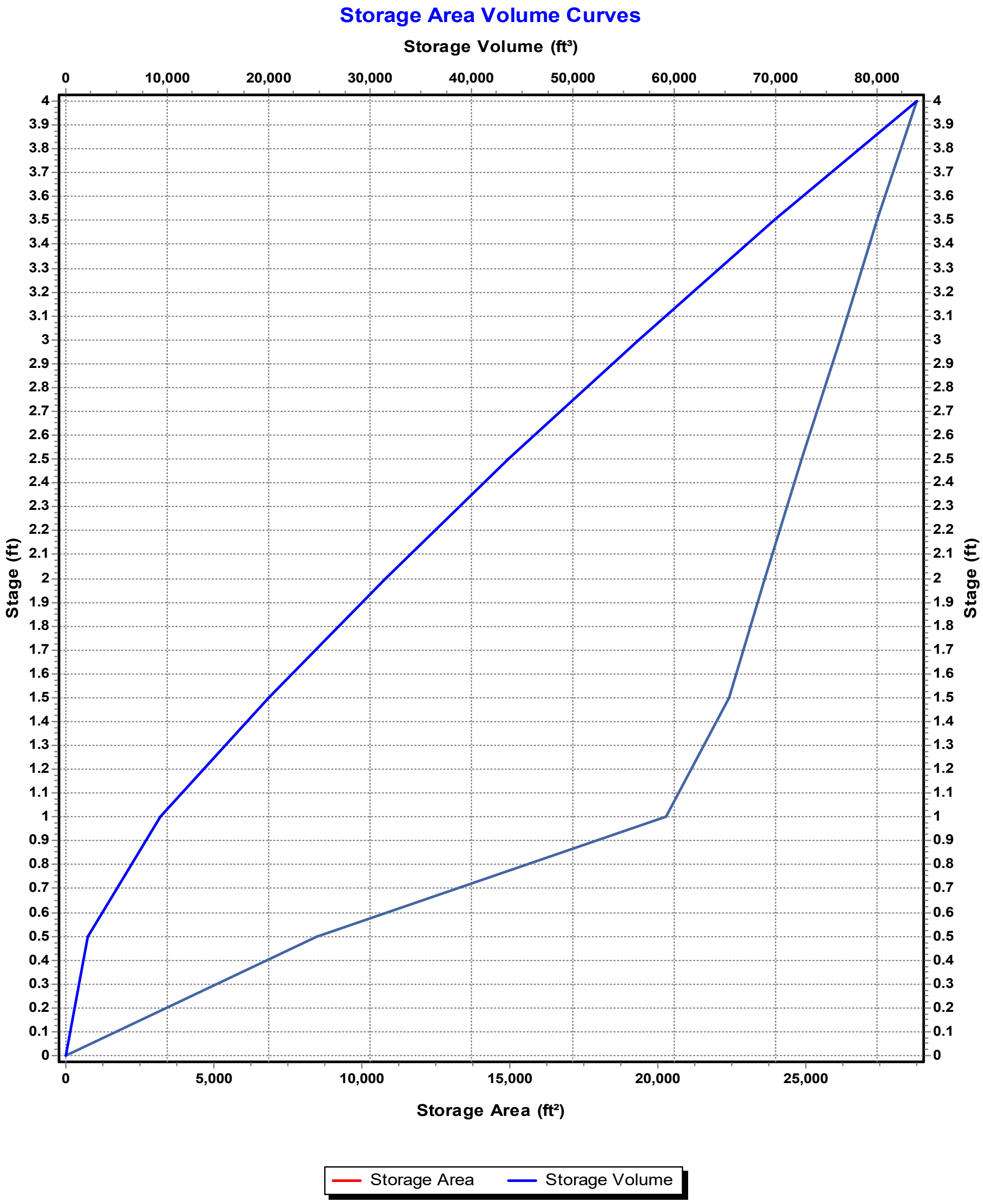
Invert Elevation (ft) 7444
Max (Rim) Elevation (ft) 7448
Max (Rim) Offset (ft) 4
Initial Water Elevation (ft) 0
Initial Water Depth (ft) .... -7444
Ponded Area (ft²) 0
Evaporation Loss 0

Storage Area Volume Curves

Storage Curve : Detention-Pond

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
0.5	8482	2120.5
1	20284	9312
1.5	22437	19992.25
2	23645	31512.75
2.5	24883	43644.75
3	26149	56402.75
3.5	27443	69800.75
4	28766	83853

Fox Run Substation
10Yr-24Hr



Storage Node : Pond (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Spillway	Trapezoidal	No	7447.00	3.00	10.00	1.00	3.37
2	Weir	Rectangular	No	7446.50	2.50	4.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-01	Side	CIRCULAR	No	1.50			7443.67	0.61
2	Orifice-02	Side	CIRCULAR	No	1.50			7444.17	0.61
3	Orifice-03	Side	CIRCULAR	No	1.50			7444.67	0.61
4	Orifice-04	Side	CIRCULAR	No	1.50			7445.17	0.61
5	Orifice-05	Side	CIRCULAR	No	1.50			7445.67	0.61

Output Summary Results

Peak Inflow (cfs) 14.07
Peak Lateral Inflow (cfs) 14.07
Peak Outflow (cfs) 0.3
Peak Exfiltration Flow Rate (cfm) 0
Max HGL Elevation Attained (ft) 7445.89
Max HGL Depth Attained (ft) 1.89
Average HGL Elevation Attained (ft) 7444.65
Average HGL Depth Attained (ft) 0.65
Time of Max HGL Occurrence (days hh:mm) 0 17:25
Total Exfiltration Volume (1000-ft³) 0
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0

Project Description

File Name .... 21036-Fox Run Drainage.SPF

Project Options

Flow Units .... CFS
Elevation Type .... Elevation
Hydrology Method .... EPA SWMM
EPA SWMM Infiltration Method .... SCS Curve Number
Link Routing Method .... Kinematic Wave
Enable Overflow Ponding at Nodes .... YES
Skip Steady State Analysis Time Periods .... NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	1
Subbasins..	4
Nodes..	6
Junctions	2
Outfalls	3
Flow Diversions	0
Inlets	0
Storage Nodes	1
Links..	9
Channels	0
Pipes	2
Pumps	0
Orifices	5
Weirs	2
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

SN	Rain Gage ID	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period (years)	Rainfall Depth (inches)	Rainfall Distribution
1	Rain Gage-01	Time Series	100yr-24hr	Cumulative	inches					User Defined

Fox Run Substation
100Yr-24Hr

Subbasin Summary

SN	Subbasin ID	Area (ac)	Impervious Area (%)	Weighted Curve Number	Average Slope (%)	Equivalent Width (ft)	Impervious Area Manning's Roughness	Pervious Area Manning's Roughness	Total Rainfall (in)	Total Infiltration (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Existing	14.38	10.00	69.00	7.0000	4175.58	0.0150	0.1500	5.15	2.3100	2.79	40.16	53.82	0 00:23:29
2	Proposed-North	6.70	10.00	69.00	6.0000	2920.50	0.0150	0.1500	5.15	2.3080	2.80	18.74	26.75	0 00:19:17
3	Proposed-South	2.44	25.00	69.52	7.0000	2125.40	0.0150	0.1500	5.15	1.8950	3.21	7.83	12.04	0 00:10:53
4	Yard	5.23	40.00	84.59	1.0000	1520.10	0.0150	0.1500	5.15	0.9070	4.20	21.95	28.42	0 00:33:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Pipe-Out	Junction	7443.22	7445.19	0.00	7446.00	0.00	1.84	7443.82	0.00	1.37	0 00:00	0.00	0.00
2	Pond-Out	Junction	7443.42	7447.00	0.00	7447.00	0.00	1.84	7444.02	0.00	3.40	0 00:00	0.00	0.00
3	Existing-Out	Outfall	7435.00					53.82	7435.00					
4	Out-North	Outfall	7435.00					27.02	7435.00					
5	Out-South	Outfall	7435.00					12.04	7435.00					
6	Pond	Storage Node	7444.00	7448.00	0.00		0.00	28.42	7446.73				0.00	0.00

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Average Slope (%)	Diameter or Height (in)	Manning's Roughness	Peak Flow (cfs)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Reported Condition
1	Out-Pipe	Pipe	Pond-Out	Pipe-Out	40.00	7443.42	7443.22	0.5000	12.000	0.0120	1.84	2.73	0.67	3.73	0.60	0.60	0.00	Calculated
2	Out-Swale	Pipe	Pipe-Out	Out-North	326.18	0.00	0.00	0.0000	0.000	0.0150	1.84	0.00	0.67	0.00	0.60	0.60	0.00	Calculated
3	Orifice-01	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.10							
4	Orifice-02	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.10							
5	Orifice-03	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.09							
6	Orifice-04	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.07							
7	Orifice-05	Orifice	Pond	Pond-Out		7444.00	7443.42		1.500		0.06							
8	Spillway	Weir	Pond	Pond-Out		7444.00	7443.42				0.00							
9	Weir	Weir	Pond	Pond-Out		7444.00	7443.42				1.43							

Subbasin Hydrology

Subbasin : Existing

Input Data

Area (ac) 14.38
Impervious Area (%) 10
Weighted Curve Number 69
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 7
Equivalent Width (ft) 4175.58
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

Composite Curve Number

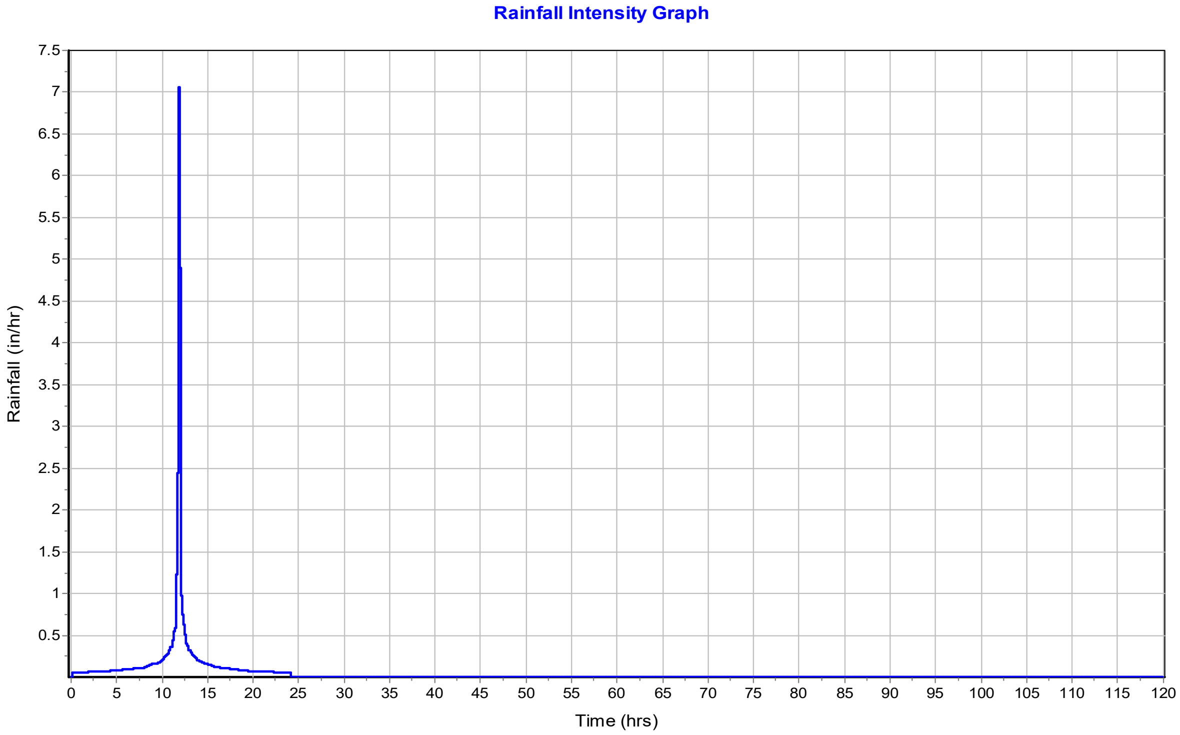
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	14.38	B	69
Composite Area & Weighted CN	14.38		69

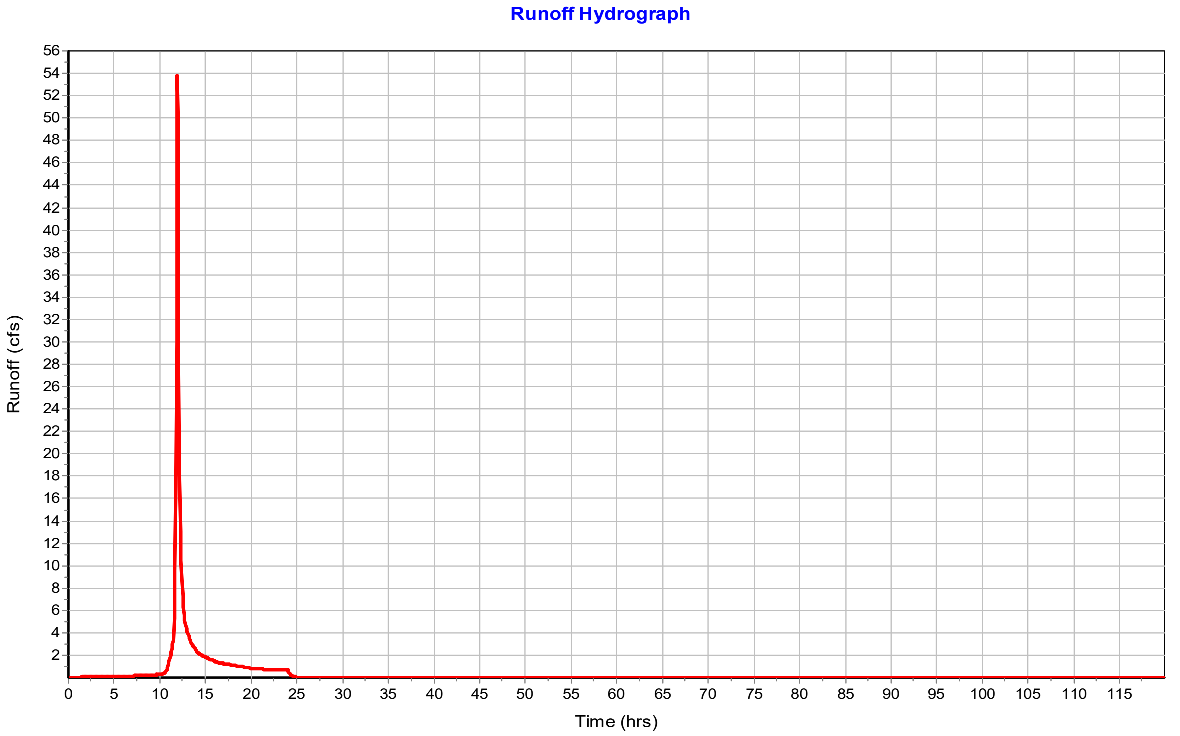
Subbasin Runoff Results

Total Rainfall (in) 5.15
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 2.31
Total Runoff (in) 2.79
Peak Runoff (cfs) 53.82
Weighted Curve Number 69
Time of Concentration (days hh:mm:ss) 0 00:23:29

Fox Run Substation
100Yr-24Hr

Subbasin : Existing





Subbasin : Proposed-North

Input Data

Area (ac) 6.7
Impervious Area (%) 10
Weighted Curve Number 69
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 6
Equivalent Width (ft) 2920.5
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

Composite Curve Number

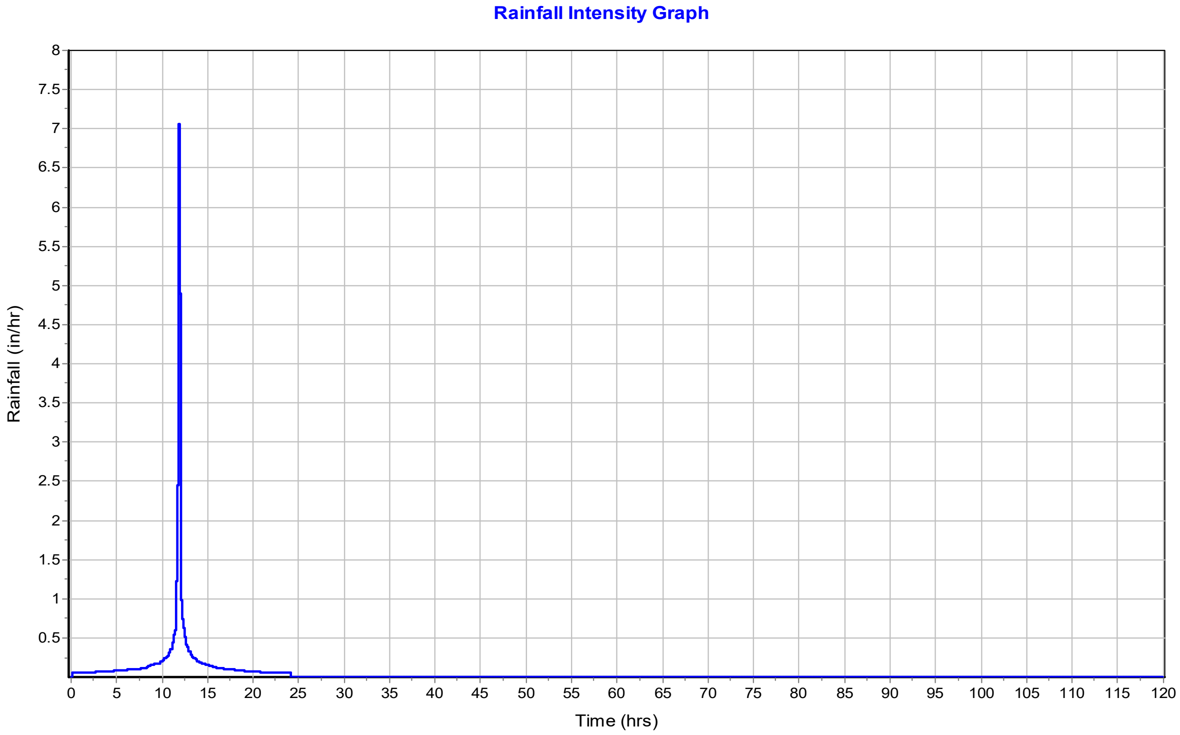
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	6.7	-	69
Composite Area & Weighted CN	6.7		69

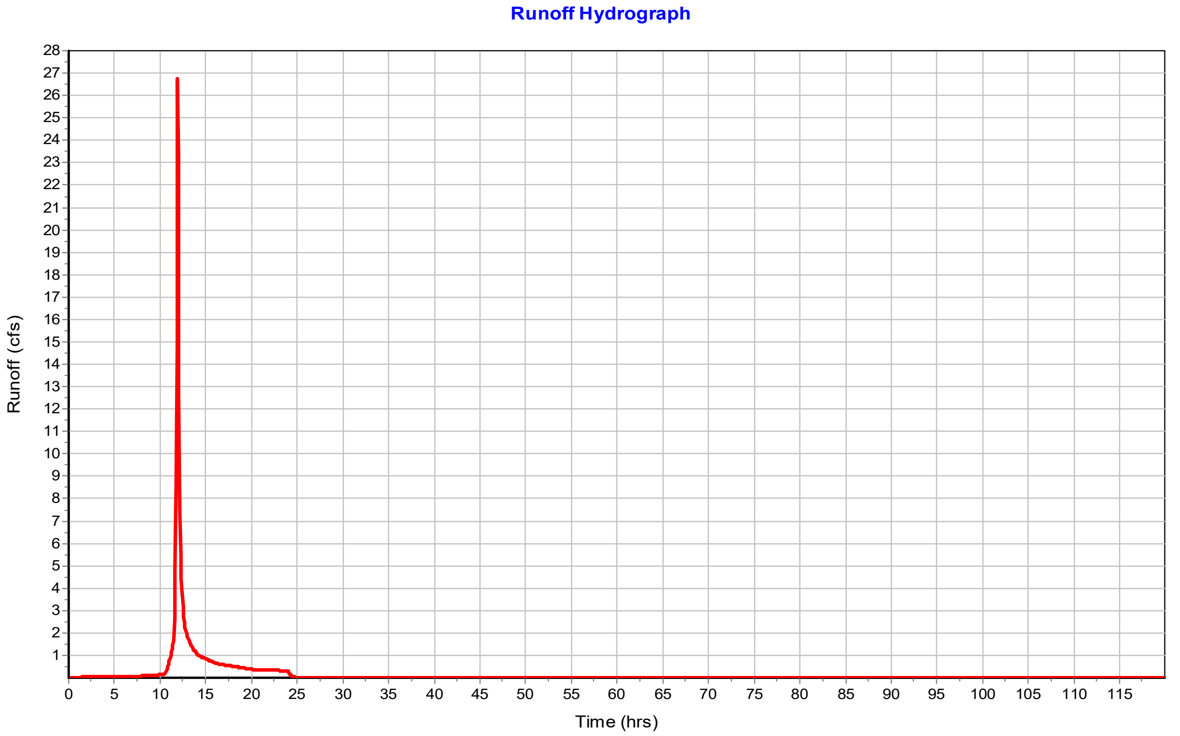
Subbasin Runoff Results

Total Rainfall (in) 5.15
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 2.308
Total Runoff (in) 2.8
Peak Runoff (cfs) 26.75
Weighted Curve Number 69
Time of Concentration (days hh:mm:ss) 0 00:19:17

Fox Run Substation
100Yr-24Hr

Subbasin : Proposed-North





Subbasin : Proposed-South

Input Data

Area (ac) 2.44
Impervious Area (%) 25
Weighted Curve Number 69.52
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 7
Equivalent Width (ft) 2125.4
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

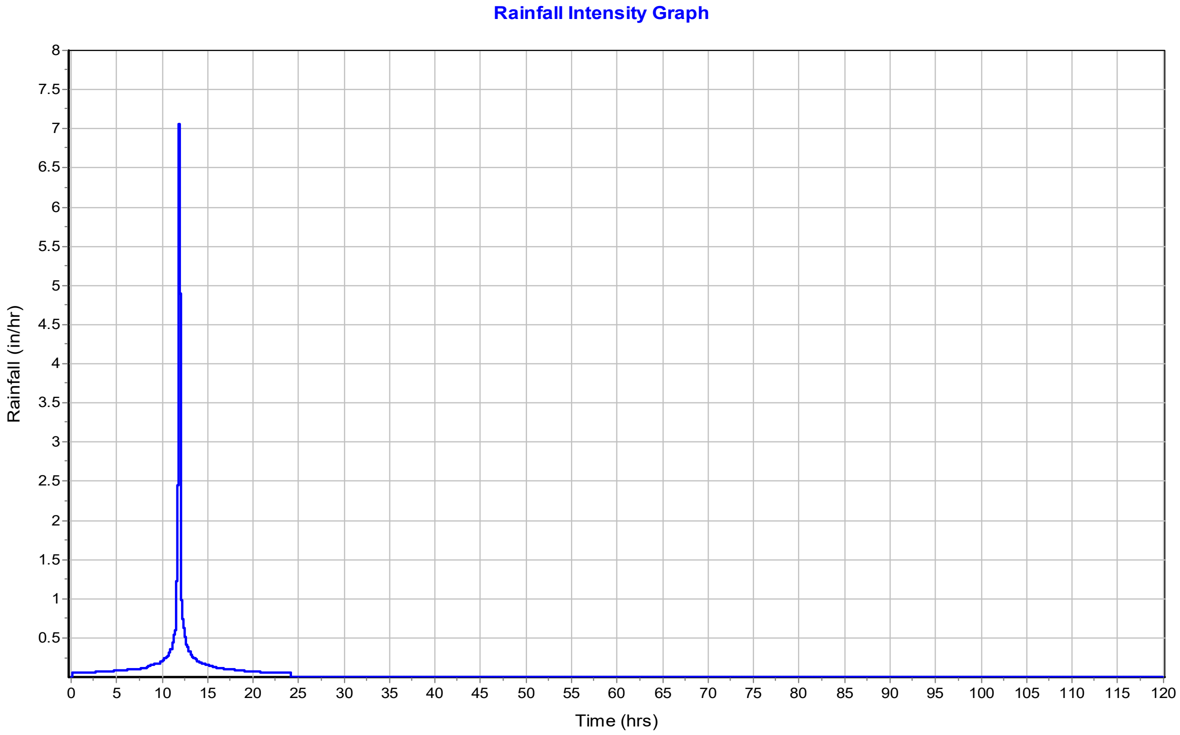
Composite Curve Number

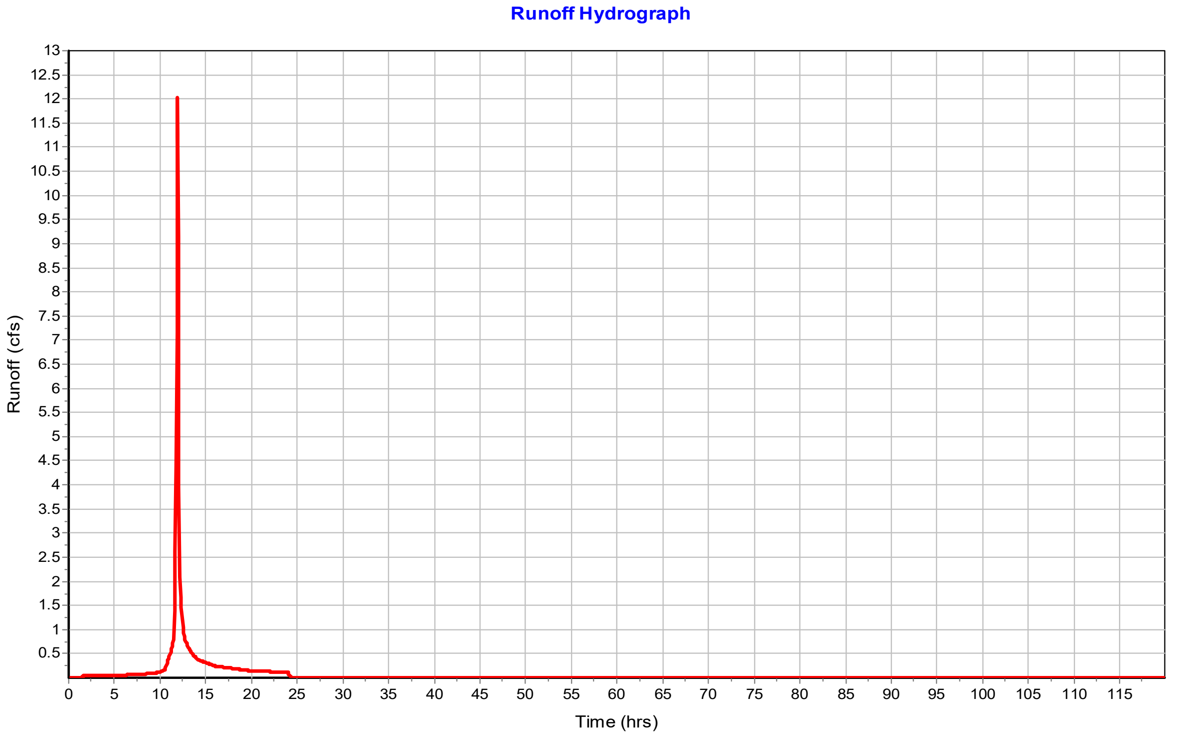
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
-	2.44	-	69.52
Composite Area & Weighted CN	2.44		69.52

Subbasin Runoff Results

Total Rainfall (in) 5.15
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 1.895
Total Runoff (in) 3.21
Peak Runoff (cfs) 12.04
Weighted Curve Number 69.52
Time of Concentration (days hh:mm:ss) 0 00:10:53

Subbasin : Proposed-South





Subbasin : Yard

Input Data

Area (ac) 5.23
Impervious Area (%) 40
Weighted Curve Number 84.59
Conductivity (in/hr) 0.15
Drying Time (days) 7
Average Slope (%) 1
Equivalent Width (ft) 1520.1
Impervious Area
Manning's Roughness 0.015
Pervious Area
Manning's Roughness 0.15
Curb & Gutter Length (ft) 0
Rain Gage ID .... Rain Gage-01

Composite Curve Number

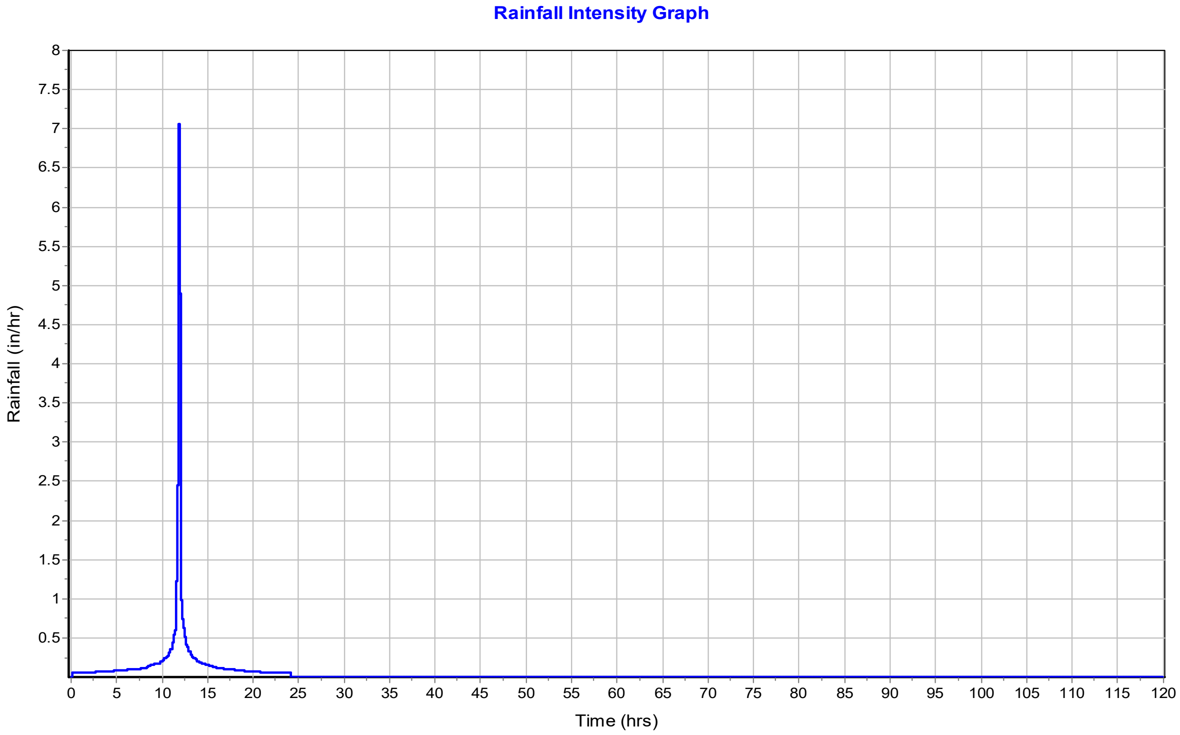
32 Soil/Surface Description	Area (acres)	Soil Group	Curve Number
50 - 75% grass cover, Fair	5.23	B	84.59
Composite Area & Weighted CN	5.23		84.59

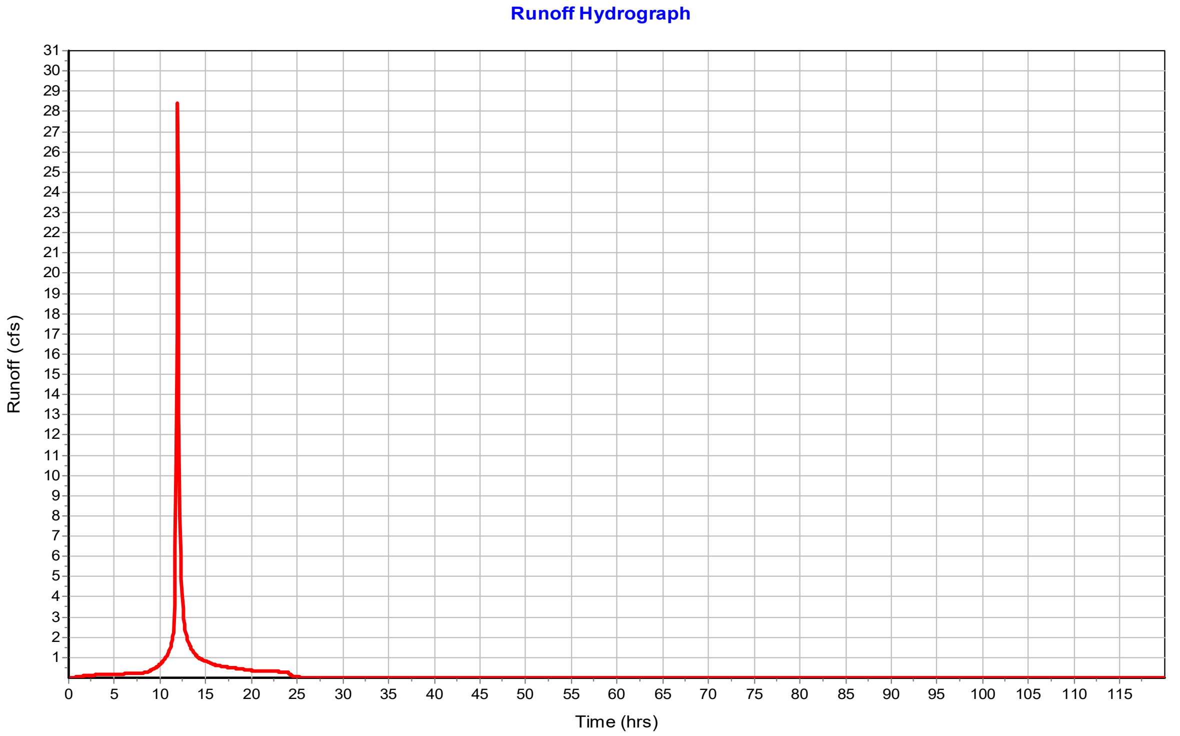
Subbasin Runoff Results

Total Rainfall (in) 5.15
Total Runon (in) 0
Total Evaporation (in) 0
Total Infiltration (in) 0.907
Total Runoff (in) 4.2
Peak Runoff (cfs) 28.42
Weighted Curve Number 84.59
Time of Concentration (days hh:mm:ss) 0 00:33:00

Fox Run Substation
100Yr-24Hr

Subbasin : Yard





Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft²)	Minimum Pipe Cover (in)
1	Pipe-Out	7443.22	7445.19	1.97	0.00	-7443.22	7446.00	0.81	0.00	0.00
2	Pond-Out	7443.42	7447.00	3.58	0.00	-7443.42	7447.00	0.00	0.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	Pipe-Out	1.84	0.00	7443.82	0.60	0.00	1.37	7443.36	0.14	0 13:08	0 00:00	0.00	0.00
2	Pond-Out	1.84	0.00	7444.02	0.60	0.00	3.40	7443.56	0.14	0 13:08	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Out-Pipe	40.00	7443.42	0.00	7443.22	0.00	0.20	0.5000	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Out-Swale	326.18	0.00	-7443.22	0.00	-7435.00	0.00	0.0000	Dummy	0.000	0.000	0.0150	0.5000	0.5000	0.0000	0.00	No	1

Fox Run Substation
100Yr-24Hr

Pipe Results

SN	Element ID	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Design Flow Capacity (cfs)	Peak Flow/ Design Flow Ratio	Peak Flow Velocity (ft/sec)	Travel Time (min)	Peak Flow Depth (ft)	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged (min)	Froude Number	Reported Condition
1	Out-Pipe	1.84	0 13:08	2.73	0.67	3.73	0.18	0.60	0.60	0.00		Calculated
2	Out-Swale	1.84	0 13:08	0.00	0.67	0.00		0.60	0.60	0.00		Calculated

Storage Nodes

Storage Node : Pond

Input Data

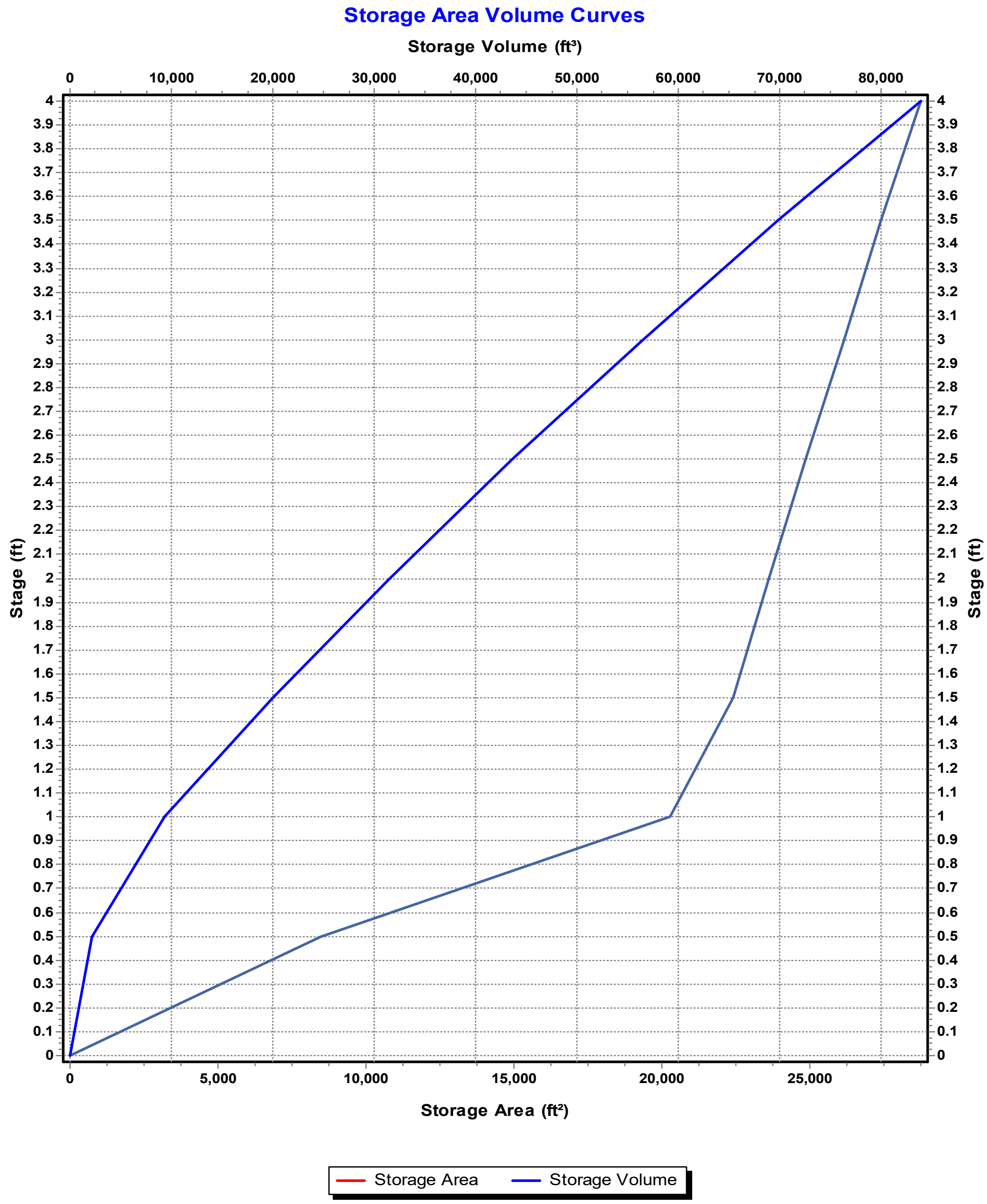
Invert Elevation (ft) 7444
Max (Rim) Elevation (ft) 7448
Max (Rim) Offset (ft) 4
Initial Water Elevation (ft) 0
Initial Water Depth (ft) .... -7444
Ponded Area (ft²) 0
Evaporation Loss 0

Storage Area Volume Curves

Storage Curve : Detention-Pond

Stage (ft)	Storage Area (ft²)	Storage Volume (ft³)
0	0	0
0.5	8482	2120.5
1	20284	9312
1.5	22437	19992.25
2	23645	31512.75
2.5	24883	43644.75
3	26149	56402.75
3.5	27443	69800.75
4	28766	83853

Fox Run Substation
100Yr-24Hr



Storage Node : Pond (continued)

Outflow Weirs

SN	Element ID	Weir Type	Flap Gate	Crest Elevation (ft)	Crest Offset (ft)	Length (ft)	Weir Total Height (ft)	Discharge Coefficient
1	Spillway	Trapezoidal	No	7447.00	3.00	10.00	1.00	3.37
2	Weir	Rectangular	No	7446.50	2.50	4.00	1.00	3.33

Outflow Orifices

SN	Element ID	Orifice Type	Orifice Shape	Flap Gate	Circular Orifice Diameter (in)	Rectangular Orifice Height (in)	Rectangular Orifice Width (in)	Orifice Invert Elevation (ft)	Orifice Coefficient
1	Orifice-01	Side	CIRCULAR	No	1.50			7443.67	0.61
2	Orifice-02	Side	CIRCULAR	No	1.50			7444.17	0.61
3	Orifice-03	Side	CIRCULAR	No	1.50			7444.67	0.61
4	Orifice-04	Side	CIRCULAR	No	1.50			7445.17	0.61
5	Orifice-05	Side	CIRCULAR	No	1.50			7445.67	0.61

Output Summary Results

Peak Inflow (cfs) 28.42
Peak Lateral Inflow (cfs) 28.42
Peak Outflow (cfs) 1.84
Peak Exfiltration Flow Rate (cfm) 0
Max HGL Elevation Attained (ft) 7446.73
Max HGL Depth Attained (ft) 2.73
Average HGL Elevation Attained (ft) 7444.99
Average HGL Depth Attained (ft) 0.99
Time of Max HGL Occurrence (days hh:mm) 0 13:08
Total Exfiltration Volume (1000-ft³) 0
Total Flooded Volume (ac-in) 0
Total Time Flooded (min) 0
Total Retention Time (sec) 0