Transcontinental Gas Pipeline Company, LLC

Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan

Revision No. *1*

Southeast Supply Enhancement – Eden Loop VA
Pittsylvania County, Virginia
Docket No. CP 25-10

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LIST OF ACRONYMS AND ABBREVIATIONS

CI	Chief Inspector
CM	Construction Manager
Commission	Federal Energy Regulatory Commission
Contractor	HDD Contractor
Dth/d	Dekatherms per day
ECM	Environmental Compliance Manager
EI	Environmental Inspector
FERC	Federal Energy Regulatory Commission
HDD	Horizontal Directional Drill
IR	Inadvertent Return
NSF/ANSI	NSF American National Standards Institute
OGRE	Oil and Gas Reporting Electronic
Plan	Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan
PM	Project Manager
Project	Southeast Energy Connector
Protocol	Drilling Fluids Management Protocol
ROW	Right-of-Way
RQD	Rock Quality Designation
SDS	Safety Data Sheets
Transco	Transcontinental Gas Pipeline Company, LLC
Transco Plan	Project-specific Upland Erosion Control, Revegetation, and Maintenance Plan
Transco Procedures	Project-specific Wetland and Waterbody Construction and Mitigation Procedures
UAV	Unmanned Aerial Vehicle
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VADEQ	Virginia Department of Environmental Quality
VMRC	Virginia Marine Resources Commission
Williams	The Williams Companies, Inc.

1. INTRODUCTION

1.1 PROJECT BACKGROUND

Transcontinental Gas Pipeline Company, LLC (Transco), an indirect, wholly owned subsidiary of The Williams Companies, Inc. (Williams), is seeking authorization from the Federal Energy Regulatory Commission (FERC or Commission), under Section 7(c) of the Natural Gas Act and Part 157 of Commission's regulations, to construct, own, operate, and maintain the proposed Southeast Supply Enhancement Eden Loop (Virginia) (Project) facilities.

The Project is an expansion of Transco's existing natural gas transmission system that will enable Transco to provide 1,596,900 dekatherms per day (Dth/d) of incremental firm transportation capacity to remove pipeline capacity constraints in zones 4 and 5 and meet growing natural gas-fired power generation, commercial, residential, and industrial in the southeast United States.

Transco is proposing to use horizontal directional drill (HDD) construction as the primary crossing method at four crossing locations along the proposed 30.8-mile-long 42-inch-diameter pipeline loop (Eden Loop). The proposed Eden Loop begins in Rockingham County, North Carolina and crosses the North Carolina-Virginia state line into Pittsylvania County, Virginia. This plan is specific to the two proposed crossings within the state of Virginia which are herein referred to as the proposed Sandy River and Banister River HDDs (Eden Loop VA HDDs). The Sandy River and Banister River sites are in Pittsylvania County, Virginia. Please refer to the Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan Eden Loop NC for the Eden Loop North Carolina HDDs. As part of FERC's *Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plans* (FERC Guidance; FERC 2019), an HDD is defined as any type of trenchless construction method, including HDD and proprietary technologies, that utilizes drilling fluids under pressure.

Transco has conducted geotechnical studies for the proposed HDD crossings to evaluate the risks inherent to using the HDD crossing method and determine the feasibility of the proposed HDD crossings. Transco has developed this Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan (Plan) to establish procedures for handling these inherent risks and to address potential impacts associated with inadvertent releases of drilling fluid returns during the HDD process. This Plan identifies operational procedures and responsibilities for abandoning HDD drill holes and the prevention, containment, and clean-up of drilling fluids that have pooled on the ground surface or within a wetland or waterbody in response

to an inadvertent release of drilling fluid during HDD operations. The specific objectives of this Plan apply to each HDD crossing and include:

- Defining the HDD process and how to identify when the HDD has failed and should be abandoned;
- Identifying the procedures that will be followed when an HDD drill hole must be abandoned;
- Minimizing the potential for an inadvertent release of drilling fluids;
- Timely detection of an inadvertent release of drilling fluids;
- Providing for environmental protection of wetlands and waterbodies and associated habitats in the event an inadvertent release occurs;
- Establishing response procedures to address containment and clean-up of an inadvertent release of fluids; and
- Identification of the appropriate parties and regulatory agencies to be notified in the event of an inadvertent release of fluids.

Supporting information provided as appendices to this Plan include a Project Organizational Chart (Appendix A); Drilling Fluids List and Safety Data Sheets (SDS) (Appendix B); HDD Design and Geotechnical Reports (Appendix C); and a Disposal Tracking Log (Appendix D). As noted throughout this Plan, these appendices will be supplemented and further developed in future revisions of the Plan prior to the start of Project construction.

Transco will ensure that the HDD Contractor(s) (Contractor) comply with the methods outlined herein during construction, restoration, and operation of the Project. Contractor personnel will be trained on the requirements of this Plan during mandatory pre-construction environmental training. Compliance with these requirements will be documented in the field by Environmental Inspectors (EIs) and submitted to FERC as applicable. This Plan is subject to revision based on new data or on agency recommendations.

Preparing for a successful HDD installation, one that minimizes impacts to sensitive resources and the surrounding communities, includes:

- Identifying the appropriate personnel to oversee the installation and provided clear direction on roles and responsibilities;

- Training its personnel on how to properly monitor conditions of the drill so that they may recognize both normal and abnormal operating conditions;
- Training its employees on how to respond to abnormal operating conditions and to take corrective or mitigating actions before a warning sign escalates into something more concerning; and
- Training its employees on how to respond to an inadvertent return (IR) so they may understand direct actions that need to be taken in the field to mitigate the impact and so they may know how to report such an incident.

1.2 HDD CROSSING INFORMATION

The following tables summarize basic information for the HDD locations associated with the Project.

- **Table 1:** Provides information pertaining to the proposed HDD crossing locations, including the crossing name, pipeline diameter, location (HDD entry and exit milepost), total length; and subsurface material.
- **Table 2:** Provides information pertaining to the proposed wetland crossings and includes a unique feature identification, wetland classification, delineated area, HDD entry and exit stationing, elevation difference, depth of cover, and horizontal setback from the HDD entry and exit locations.
- **Table 3:** Provides information pertaining to the proposed waterbody crossings, including unique feature identification, stream flow rate, HDD entry and exit stationing, elevation difference, depth of cover, and horizontal setback from the HDD entry and exit locations.
- **Tables 4a and 4b:** As recommended by the FERC Guidance, these tables contain an abbreviated list of potential unique conditions or features that may increase the risk of drill failure or potential resource impacts for each of the Eden Loop VA HDDs. Additional details are included in the HDD Design and Geotechnical Reports (Appendix C).
- **Table 5:** Provides information pertaining to identified wells within 150 feet of the proposed HDD crossings, including HDD stationing and offset from the HDD alignment.

Table 1
Proposed HDD Locations

Crossing Name	Pipeline Diameter (inches)	Approx. HDD Begin Milepost	Approx. HDD End Milepost	Approx. Horizontal Crossing Length (feet)	Approx. Tied in Length (feet)	Subsurface Material
Eden Loop VA						
Sandy River	42	1394.99	1395.57	3,100	3,135	Silt, Clay, Sand, Decomposed Bedrock, Conglomerate, Mudstone, Siltstone, Sandstone
Banister River	42	***1408.56***	***1409.02***	***2,390***	***2,411***	***Silt, Sand, Decomposed Bedrock, Gneiss***

Key:
Approx. = Approximate

Table 2
HDD Wetland Crossings

Wetland ID	Wetland Type	Delineated Acres	Wetland Entry (Milepost[a])	Wetland Exit (Milepost[a])	Entry/Exit Elevation Difference (feet)	Depth of Cover[b] (feet)	Horizontal Setback Distance (Entry/Exit, feet)[c]
Sandy River HDD							
E1-W046-VA	PEM	<0.01	1395.04	1395.05	~32/-4	~49	~299.48/2,778.43
E1-W045-VA	PEM	<0.01	1395.05	1395.05	~32/-4	~49	~329.13/2,810.38
Banister River HDD							
E1-W190-VA	***PFO***	***0.16***	***1408.80***	***1408.81***	***~69/66***	***~68***	***~1273/1106***

[a] Milepost as shown on FERC Alignment Sheet Drawings. E&S Stationing has not yet been developed.
[b] Vertical separation between the wetland and the drill profile.
[c] Distance from the closest edge of the sensitive resource being crossed to the HDD entry and exit locations.

Key:
E&S = Erosion and Sediment
FERC = Federal Energy Regulatory Commission
HDD = Horizontal Directional Drill
PEM = Palustrine Emergent
PFO = Palustrine Forested

Table 3
HDD Waterbody Crossings

Waterbody ID (Name)	Estimated Range of Stream Flow During Crossing (cfs)	Waterbody Entry (Milepost[a])	Waterbody Exit (Milepost[a])	Entry/Exit Elevation Difference (feet)	Depth of Cover[b] (feet)	Horizontal Setback Distance (Entry/Exit, feet)[c]
Sandy River HDD						
E1-L019-VA (Perennial)	No Gauge[d]	1395.05	1395.05	~32/-4	~49	~321.04/2,770.76
E1-L019-VA (Perennial)	18.5-4,980[e]	1395.27	1395.29	~106/70	~113	~1,519.86/1,499.49
Banister River HDD						
E2-L103-VA (Perennial)	***No Gauge[d]***	***1408.78***	***1408.80***	***~69/67***	***~64***	***~1340.44/977.64***

[a] Milepost as shown on FERC Alignment Sheet Drawings. E&S Stationing has not yet been developed.

[b] Vertical separation between the bed of the waterbody and the drill profile.

[c] Distance from the closest edge of the sensitive resource being crossed to the HDD entry and exit locations

[d] Stream flow/gauge data not available

[e] Values reported reflect minimum and maximum flow recorded by the USGS at the Sandy River Near Danville, Virginia (monitoring location 02074500) for the period of August 29, 2023 – August 29, 2024 (USGS 2024).

Key:
cfs = Cubic Feet Per Second
E&S = Erosion and Sediment
FERC = Federal Energy Regulatory Commission
HDD = Horizontal Directional Drill
N/A = Not Applicable
TBD = To Be Determined
USGS = U.S. Geological Survey

Table 4a
Unique Conditions or Features within Proximity to HDD

Unique Condition or Feature	Description and Mitigation
Eden Loop VA – Sandy River HDD	
Single-family Housing	The proposed HDD entry workspace area is situated within the existing Transco pipeline corridor. Single-family housing has been constructed proximate to the existing pipeline corridor. During the noise study completed at the site, unmitigated sound level attributable to drilling operations at the HDD entry workspace was found to likely exceed the maximum allowable sound level criterion of 55 dBA Ldn (A-weighted decibels, day-night sound level) at the closest noise sensitive area. As a result, noise mitigation measures at the entry workspace will be implemented throughout HDD construction.
Hard/Abrasive Bedrock	Very hard and abrasive sedimentary bedrock consisting primarily of conglomerate with interbedded layers of siltstone, sandstone, and mudstone was encountered in all six borings completed at the crossing location. This very hard/abrasive bedrock formation could lead to downhole drill bit and downhole tool wear and could lead to downhole tool failures during construction. Transco will work with the selected Contractor to develop a detailed plan with means and methods put in place to adequately mitigate the risks associated with this formation.
Elevation Differential	There is approximately 40 feet of elevation differential between the elevation of the designed HDD entry and exit points. This elevation differential will cause a portion of the hole to be “dry” (unsupported by drilling fluid) because the drilling fluid within the hole will equalize at the lower of the two points. Transco will work with the selected Contractor to develop a detailed plan with means and methods put in place to adequately mitigate the risks associated with the dry hole condition.
Key: HDD = Horizontal Directional Drill	

Table 4b
Unique Conditions or Features within Proximity to HDD

Unique Condition or Feature	Description and Mitigation
Eden Loop VA – Banister River HDD	
Hard/Abrasive Bedrock	Hard and abrasive metamorphic bedrock consisting primarily of gneiss was encountered in all four of the borings completed at the crossing location to date. This hard/abrasive bedrock formation could lead to downhole drill bit and downhole tool wear and could lead to downhole tool failures during construction. Transco will work with the selected Contractor to develop a detailed plan with means and methods put in place to adequately mitigate the risks associated with this formation.
Key: HDD = Horizontal Directional Drill	

Table 5
Identified Wells Within 150 Feet of HDD Crossings

Well (Type)	Well Location (Milepost[a])	Depth of HDD Profile[b] (feet)	Horizontal Offset Distance (feet)[c]
Sandy River HDD			
None	N/A	N/A	N/A
Banister River HDD			
None	N/A	N/A	N/A

[a] Milepost as shown on FERC Alignment Sheet Drawings. Stationing has not yet been developed.
[b] Vertical separation between the ground surface and the drill profile at the well location.
[c] Distance from the well to the HDD alignment measured perpendicular to the HDD alignment.

Key:
E&S = Erosion and Sediment
FERC = Federal Energy Regulatory Commission
HDD = Horizontal Directional Drill
N/A = Not Applicable

1.3 SITE-SPECIFIC CROSSING PLANS

Site-specific crossing plans have been developed for the proposed Sandy River and Banister River HDDs. These crossing plans, along with the following are included in Appendix C: results of the site-specific geotechnical studies for the proposed HDD crossings; plan and profile drawings; engineering analyses (including quantitative and qualitative hydraulic fracture and IR analyses); and construction risks.

2. PERSONNEL AND RESPONSIBILITIES

2.1 GENERAL / SHARED RESPONSIBILITIES

Prior to the start of HDD operations at each site, Transco and the Contractor will employ qualified personnel that have responsibilities in their field. The Project team has overall responsibility for implementing this Plan and ensuring compliance. Additionally, compliance with this Plan and all Project permits, as noted in Resource Report 1, is the responsibility of all personnel on this Project, including the Contractor.

Shared responsibilities include:

- Verify that all workers are properly trained and familiar with the implementation of the Plan, prior to and during drilling operations.
- Maintain constant communication with the Project team and Contractor personnel in the event that an IR is suspected.
- Verify that all drilling equipment is in working order, including annular pressure monitoring equipment.
- Monitor the HDD alignment for IRs and other signs of environmental impact.
- In the event of an IR, coordinate corrective actions and cleanup response and notify regulatory agencies timely. Verify all waste materials are properly containerized, labelled, removed from the site, and transported to an approved facility.
- Confirm that drilling mud/spoils/cuttings associated with the crossings will be managed and disposed of at an approved facility if contaminated soil is encountered.
- Be familiar with all aspects of the drilling activity, the contents of this Plan, and the conditions of approval under which the activity is permitted to take place.
- Have the authority to stop work and commit the resources (personnel and equipment) necessary to implement this Plan.
- Verify that a copy of this Plan is available on site and is accessible to all construction personnel.

2.2 SPECIFIC OVERALL ROLES AND RESPONSIBILITIES

The Contractor will be responsible for conducting all HDD operations in accordance with all federal, state, and local laws and regulations, permits, and associated engineering / geotechnical design and contingency plans, best management practices, and industry standards. Transco's Project team will monitor and record HDD operations and ensure compliance with all applicable permit conditions. Specific overall roles and responsibilities for personnel are listed below:

- **Project Manager (PM)** – The PM is the leader of the Project team who has the accountability for all aspects of the Project.
- **Project / HDD Engineer** – Transco will designate a Professional Engineer responsible for the trenchless design and engineering review of the HDDs throughout the entire Project life cycle.
- **Construction Manager (CM)** – The CM has direct oversight over the inspection workforce, contractor, and all construction activities associated with the Project.
- **Chief Inspector (CI)** – Transco will designate a CI for the Project who will have overall authority for construction activities for the Project, including the HDDs.
- **Trenchless Inspector** – The Trenchless Inspector's primary responsibility is to observe and document all HDD site activities occurring during each shift. The Trenchless Inspector will be familiar with this Plan, the Contractor's drill plan, the Project specifications, and all permit conditions. The Trenchless Inspector shall ensure the Contractor follows all items as described in this Plan. Should the Trenchless Inspector observe a deviation or out of compliance condition, the CI, CM, and/or EI shall be notified immediately.
- **Environmental Inspector (EI)** – One EI will be assigned during active construction or restoration. The EI will have peer status with all other activity inspectors and will report directly to the Transco CI who has overall authority on the Construction Right-of-Way (ROW). The EI will have the authority to stop activities that violate the environmental conditions of the FERC Certificate (as applicable), other federal and state permits, or landowner requirements, and to order corrective action.
- **Environmental Compliance Manager (ECM*)*** – The ECM works closely with the EIs to provide guidance and ensure consistency from the EIs. The ECM also coordinates with the EIs on the documentation of field conditions or concerns and pushes that

information to the Environmental Project Lead. The ECM is the lead for permitting and environmental compliance efforts during construction of the Project. The ECM is typically the point of contact between Transco and regulatory agencies and is the responsible individual for ensuring notification to agencies in a timely manner in the event of an IR.

- **General Contractor Superintendent** – The General Contractor Superintendent will be the senior field representative of the Contractor. This Superintendent has responsibility for the entire Eden Loop VA, including the HDD installations.
- **HDD Superintendent** – The HDD Superintendent will be the senior on-site representative of the Contractor and will have the overall responsibility for implementing this Plan on behalf of the Contractor. The HDD Superintendent will be familiar with all aspects of the drilling activities, the contents of the Plan, and the conditions of approval under which the activity is permitted to take place. The HDD Superintendent will make a copy of this Plan available at the drill site and will distribute it to the appropriate construction personnel. The HDD Superintendent will ensure that workers are properly trained and familiar with the necessary procedures for response to an IR.
- **HDD Operator** – The HDD Operator will be responsible for operating the drilling equipment and mud pumps, monitoring circulation back to the HDD entry and exit locations, and monitoring annular pressures during pilot hole drilling. In the event of loss of circulation or abnormal annular pressure readings, the HDD Operator must communicate the event to the HDD Superintendent and Contractor field crews, as well as the onsite Trenchless Inspector and EI. The HDD Operator is responsible for stoppage or changes to the drilling program in the event of an observed or anticipated IR.
- **HDD Contractor Personnel** – During HDD installation, HDD Contractor Personnel will be responsible for monitoring the HDD alignment along with the Transco field representatives. HDD Contractor Personnel, in coordination with the EI, will be responsible for timely notifications and responses to observed releases in accordance with this Plan. The EI ultimately must sign off on the action plan for mitigating the release and will convey any information regarding an observed release to the ECM.

- **Drilling Fluid Engineer/Technician** – The Drilling Fluid Engineer/Technician will be responsible for monitoring the drilling fluid properties like drilling fluid weight, viscosity, sand content, pH, etc. The Drilling Fluid Engineer/Technician will be consulted if any changes to the fluid properties are required in order to prevent an IR from occurring or to maintain hole stability for a successful completion of the crossing.

3. PRE-CONSTRUCTION ACTIVITIES

3.1 TRAINING

Prior to set-up at each HDD site, and consistent with the FERC Guidelines, site-specific implementation, environmental, and safety training will be conducted for all Transco and Contractor personnel. This training will address all applicable environmental impact avoidance and minimization measures that will be implemented during drilling. Each person involved in HDD operations will be familiar with the locations of IR containment equipment and materials and the specific procedures for handling IRs. Training will be conducted for new personnel added to the Project after HDD activities have commenced. Additional training may be added at other times throughout the Project to ensure compliance. Documentation records of training will be maintained as described in Section 4. The site-specific training will include, but not be limited to:

- Safety and environmental training specific to the HDD installations;
- Site-specific geotechnical and design conditions;
- The locations of sensitive environmental resources;
- The location, operation, inventory, and condition of IR response equipment and materials;
- Provisions of this Plan and site-specific permit and monitoring requirements;
- Pre-construction landowner and agency notification requirements;
- Site-specific IR monitoring requirements;
- Drilling procedures for IR prevention;
- Protocols for detecting, communicating, and reporting IRs or related conditions; and
- IR response procedures for mitigating impacts and recovery operations.

3.2 SITE INSPECTION

Transco will inspect the proposed HDD alignment at each of the Eden Loop VA HDD sites prior to the start of HDD activities. If any site-specific conditions impede the ability to conduct a visual inspection along the HDD alignment, modifications to the proposed inspection routine will be developed and communicated to the Contractor, Project team, and EI. If previously unidentified conditions or features are discovered that necessitate a modification to the approved Plan, Transco will coordinate with FERC to obtain the necessary variances prior to implementation.

4. DOCUMENTATION

A copy of this Plan will be available and accessible to all construction personnel. Documentation detailed in Table 6 below will be maintained by parties noted in the right-most column. If requested, this information will be provided to FERC and other federal and state agencies with applicable regulatory jurisdiction.

Table 6
Documentation to be Maintained

Procedure	Documentation	Personnel Responsible for Maintaining Documentation
Employee Training	• All personnel on this Project will be trained for environmental compliance, including IR management. • Record of employee training detailing when training was conducted, material covered, and employees in attendance.	• ECM • CM
HDD Visual and Pedestrian Monitoring	• Environmental Inspector, Trenchless Inspector, and HDD Contractor's personnel will document within daily reports IR monitoring and the finding of these inspections. • An IR Tracking Log will be maintained.	• HDD Contractor • EI • Trenchless Inspector
HDD Instrument Logs	• Pilot hole progression. • Drill string axial and torsional loads. • Drilling fluid discharge rate and pressure. • Down-hole annular pressure monitoring during drilling of the pilot hole (or alternative monitoring methods and/or best drilling practices to ensure that the drilled and bored holes do not become plugged with drill cuttings leading to IR).	• HDD Contractor
Drilling Fluid Composition	• Use of LCM and other drilling fluid additives, including the quantity, timing, and location of use. • Monitoring logs of drilling fluid physical properties throughout drilling activities (mud weight, viscosity, sand content, and pH). • Laboratory results of sampled drilling fluid/source water for any inorganic and organic environmental contaminants.	• HDD Contractor • Drilling Fluid Engineer / Technician
Public and Agency Inquiries/Comments	• A record of communication with the public and agencies that has occurred during HDD activities. • This record will include inquiries and comments, as well as response actions.	• ECM • Land Representatives • CM (support as necessary)

Table 6
Documentation to be Maintained

Procedure	Documentation	Personnel Responsible for Maintaining Documentation
Key: CM = Construction Manager ECM = Environmental Compliance Manager EI = Environmental Inspector HDD = Horizontal Directional Drill IR = Inadvertent Return LCM = Lost Circulation Material		

A summary of HDD-specific information will be included in the applicable construction status reports provided to FERC. This information may include overall status, a summary of visual and pedestrian monitoring activities, issues encountered (including any IRs) and response actions, and complaints and how they were addressed.

4.1 PROJECT ORGANIZATIONAL CHARTS

A Project organizational chart is provided in Appendix A. Prior to the start of construction, Appendix A will be supplemented with a Project-specific organization chart that includes contact information for the Project Team.

5. DRILLING FLUID MANAGEMENT

The HDD process utilizes drilling fluids to facilitate the associated operations. Drilling fluid can be categorized as a slurry composed of water and bentonite clay. Bentonite clay is an absorbent aluminum phyllosilicate clay consisting mostly of sodium montmorillonite. It is a naturally occurring clay, extremely hydrophilic, and expands when wet, absorbing several times its dry mass in water. Exact mixtures of fluids and additives will be included within the Drilling Fluids Management Plan, which will be developed by the Contractor and their Drilling Fluid Engineer and evaluated by Transco. This section describes how the drilling fluid will be managed throughout the duration of the installation process including proper disposal techniques of excess drilling fluids and associated materials.

Table 7 below provides an estimate on the volume of drilling fluid make-up water that Transco plans to withdraw for the Eden Loop VA HDDs. A water withdrawal rate of approximately 800 gallons per minute has been assumed for each water source noted in Table 7. Transco will acquire the necessary authorizations from the applicable state or federal agency.

Table 7
Drilling Fluid Make-up Water Source Locations and Estimated Withdrawal Volumes

Crossing Name	Pipeline Diameter (inches)	Approx. HDD Begin Milepost	Approx. HDD End Milepost	Approx. Horizontal Crossing Length (feet)	Estimated Withdrawal Volume (gallons)	Water Source
Eden Loop VA						
Sandy River	42	1394.99	1395.57	3,100	946,000	Sandy River
Banister River	42	***1408.56***	***1409.02***	***2,390***	***728,000***	Banister River
Key: Approx. = Approximate						

If the Contractor proposes to source drilling fluid make-up water from an off-site location, the source must be submitted to Transco for approval. If the water supply is a non-municipal source, the drilling fluid/water source should be tested for environmental contaminants prior to use, and documentation of consultation with local and state agencies regarding the results of such tests be provided.

A Drilling Fluids Management Protocol (Protocol) will be developed by the Contractor prior to HDD activities. The Protocol will include the items outlined in Sections 5.1 through 5.5, below:

5.1 COMPOSITION

The composition of drilling fluids and their engineering properties will be formulated to be suitable for the given subsurface conditions encountered. The drilling fluids will be formulated to:

- Stabilize the borehole against collapse, failures, or formations;
- Prevent fluid loss;
- Drive downhole drill motor for rock drilling;
- Lubricate, cool, and clean the tooling cutters and guidance electronics;
- Transport cuttings by suspension to allow surface collection at entry/exit points for recycling or disposal;
- Provide lubrication for drill string and downhole assembly while drilling;
- Reduce soil friction against the pipe and reduce the pull load; and
- Produce hydrostatic fluid pressure in the bore hole to offset ground formation and groundwater pressure.

5.2 ADDITIVES

A list of proposed drilling fluid additives, including SDS, will be provided in Appendix B by the Contractor, once selected. Only pre-approved, non-petrochemical-based, non-hazardous additives that comply with permit requirements and environmental regulations will be utilized. Additionally, proposed additives will conform with NSF/American National Standards Institute (ANSI) Standard 60 (Drinking Water Treatment Chemicals – Health Effects). Transco will work with FERC and the applicable state agencies should additional drilling fluid products be proposed.

5.3 DRILLING FLUID PHYSICAL PROPERTIES

The Contractor will monitor the drilling fluid properties (e.g., fluid weight, viscosity, sand content, additives, and pH) in accordance with Transco's project requirements. The drilling fluid properties will be tested during drilling operations while drilling fluid is being circulated downhole. The frequency of testing will ultimately be determined by the contractor but shall be no less than four times per 12-hour shift. A Drilling Fluid Engineer/Technician will be consulted if any changes to the fluid properties are required in order to prevent an IR from occurring or to maintain hole stability for successful completion of the crossing. Documentation for drilling fluid composition shall be maintained in accordance with Table 6.

5.4 DISPOSAL

Drilling fluid and cuttings handling and disposal will comply with federal and state regulations as well as the stipulations outlined below:

- The Contractor will provide a process and description for how the materials will be collected and stored (e.g., will it be placed into portable tanks or roll-off containers). This will vary significantly based on volume, location, environmental conditions, space, etc.
- Transco and the Contractor will assess and determine the appropriate facilities where the materials will be sent for disposal.
- The Contractor will provide a sampling plan for conducting any analytical or waste characterization required by the disposal facility. The plan will address if the materials need to be treated or solidified prior to disposal and the means and methods to do so, if required.
- All documentation relating to disposal will be kept on site, tallied for accuracy, and later stored within the Plan, specifically Appendix D, for the Project record.
- Disposal will comply with Transco's Project-specific Upland Erosion Control, Revegetation and Maintenance Plan (Transco Plan) and all application permit requirements.

5.5 TRACKING LOGS

Instrument logs will be monitored throughout the day to ensure function and progression with HDD progress at each of the Eden Loop VA HDDs, drilling fluid discharge rate and pressure, and downhole annular pressure monitoring. Construction Inspectors will document the condition of the worksite on a daily basis, which will include a visual check of all equipment that is a part of the drilling fluid management effort. This will be recorded on daily reports.

6. HDD OPERATIONAL CONDITIONS AND RESPONSE ACTIONS

A qualitative evaluation was completed to estimate the risk of IR utilizing Rock Quality Designation (RQD). Details regarding the qualitative evaluation are included in the HDD Design and Geotechnical Report prepared for each of the Eden Loop VA HDDs (Appendix C). To minimize the potential environmental impact associated with a loss or release of HDD drilling fluids, Transco and its Contractor will employ best efforts to maintain full annular circulation of drilling fluids and recycle the drilling fluid to the extent practical. Transco and its Contractor will utilize real-time annular pressure monitoring with the use of a down-hole annular pressure tool throughout pilot hole drilling operations to help prevent hydraulic fracture and IR. The annular pressure readings will be recorded and evaluated relative to calculated and expected annular drilling fluid pressure ranges, if applicable. The Contractor will also monitor drilling fluid circulation rates and pressures and will closely monitor the HDD entry and exit points to ensure that drilling fluids are circulating to the drilling fluid return pits.

Monitoring of the HDD alignment for an IR is an integral component of this Plan and the success of any HDD. Monitoring frequency will vary depending on a multitude of factors and characterized by the operating conditions listed below. For the purposes of this Plan and HDD operations, there are three operating conditions:

- Normal drilling (full drilling fluid circulation);
- Loss of drilling fluid circulation; and
- Inadvertent returns.

The following sections describe drilling and monitoring procedures for each operational condition.

6.1 NORMAL DRILLING (FULL DRILLING FLUID CIRCULATION)

When HDD operations are in progress and full drilling fluid circulation is being maintained at one or both of the HDD endpoints, the following monitoring protocol shall be implemented:

- The presence of drilling fluid returns at the HDD entry/exit points will be periodically monitored and documented.
- Land-based areas along the drilled alignment will be periodically walked and visually inspected for signs of inadvertent drilling fluid returns as well as surface heaving and settlement.

- Along overwater areas (Sandy River and Banister River) where walking and visually inspecting the alignment is not an option because of accessibility and/or safety concerns, inspections may include the use of a boat (overwater) or unmanned aerial vehicle (UAV) to evaluate the drill alignment.
- Drilling fluid products present at the jobsite shall be documented.
- Drilling fluid properties will be tested, monitored, and recorded during drilling operations.
- Drilling fluid pump rates and pump durations will be recorded.
- During pilot hole operations, downhole annular pressures will be recorded and evaluated relative to calculated and anticipated annular drilling fluid pressure range.
- If the downhole annular pressure begins to deviate outside of the calculated and anticipated annular drilling fluid pressure range, the Contractor will evaluate drilling conditions and take necessary and reasonable steps to bring the annular drilling fluid pressure back within the expected range.

6.2 LOSS OF DRILLING FLUID CIRCULATION

When HDD operations are in progress, some minor losses of drilling fluid can be expected as part of the process during normal drilling operations. When drilling fluid circulation to the HDD entry/exit points is lost or significantly diminished (“loss of circulation”), all protocols identified in Section 6.1 above will be followed and, additionally, the following monitoring protocol will be implemented:

- The EI will be notified by the Trenchless Inspector of lost or significantly diminished drilling fluid returns. The EI will immediately notify the ECM of the status of the drill. The HDD will continue while the EI, Trenchless Inspector, and Contractor immediately perform a walkthrough inspection along the drill alignment looking for inadvertent returns. Visual inspection frequency will be increased along the alignment as well as other areas of high risk for IRs. Inspections will include attention to sensitive environmental resources. Inspections may include the use of a boat or UAV to evaluate the drill alignment.
- Drilling fluid pump rates and pump durations will be recorded to estimate the lost circulation volumes.

- The Contractor will take reasonable steps to restore circulation, and the Trenchless Inspector will document these steps. Potential steps include (or be any combination of) the following:
    - Extract the downhole drill pipe string and tooling until drilling fluid returns are restored;
    - Decrease pump pressure;
    - Decrease penetration rate;
    - Temporarily cease drilling operations and shut down mud pump;
    - Restart pump and swab the hole to restore circulation;
    - Install small-diameter casing over the downhole drill pipe string through overburden soils;
    - Introduce additional flow along the borehole using “weeper” subs; and
    - Modify the drilling fluid properties in consultation with the drilling fluid engineer/technician with a change in viscosity, rheology, and/or lost circulation additives.
- If circulation is regained, the EI, Trenchless Inspector, and Contractor will resume the monitoring protocol described in Section 6.1 above.
- If circulation is not re-established, the EI will increase the frequency of visual inspection along the drilled path alignment as appropriate. Drilling fluid pump rates and pump durations will be recorded to estimate the lost circulation volumes, site-specific parameters will be evaluated, and additional reasonable steps to restore circulation will be taken.

6.3 INADVERTENT RETURNS

During HDD activities, it is typical for drilling fluid to surface near the upland entry and exit points for an HDD, where there is less overburden to counteract the annular drilling fluid pressures. Such returns are both normal and anticipated and are therefore not considered “inadvertent returns.” The HDDs have been designed for this risk, and the workspaces are designed accordingly. At these locations, containment measures will be in place to prevent fluid migration outside of the workspace and protect adjacent resources.

As outlined in Section 6.2 above, Transco will conduct increased monitoring in the event of lost or significantly diminished drilling fluid volumes. If during that continued monitoring an IR of drilling fluids is detected outside of certificated workspaces, the following monitoring and operational protocol will be implemented:

- Immediately upon discovery, drilling operations will be suspended, and containment measures will be implemented by the Contractor. Documentation of any containment measures employed will be conducted by the EI.
- The EI and Trenchless Inspector will document the location, approximate area impacted, approximate volume, and potential for aquatic or sensitive resources to be impacted by the return and notify the ECM.
- The EI will periodically monitor and document both the IR and the effectiveness of the containment measures (further discussed in Section 7.0). Drilling fluid pump rates and pump durations will be recorded to estimate the inadvertent return volume. Drilling operations will resume when the return is contained and successfully remediated, mitigation measures have been put in place, and approval is given to resume operations.
- The ECM will coordinate and make the required notifications outlined in Section 8.2.2 and 8.2.3.

7. RESPONDING TO INADVERTENT RETURNS

7.1 MATERIALS AND EQUIPMENT

From the day-to-day operation and maintenance routine, the HDD personnel will be aware of which materials are critical during a response to IRs and have these items on hand. Since IRs can be easily controlled on land where they have the greatest potential of occurring, containment items will be stored within the entry and exit point workspaces. The Contractor will also have heavy equipment, such as tracked excavators, a rubber-tired excavator, or a skid steer, that may be utilized to control and clean up IRs.

The following materials and equipment will be maintained at the HDD site in sufficient quantities to ensure containment of any inadvertent releases of drilling fluid:

- Straw or hay bales;
- Wood stakes, t-post, or rebar to secure bales;
- Buckets, wheel barrows, and/or 55-gallon drums;
- Plastic sheeting or geotextile fabric;
- Silt fence (to meet minimum specifications for the Project);
- Sand bags;
- Sledge hammers;
- Shovels and push brooms;
- Storage tanks; and
- Leak-free hose(s) and portable pump(s).

The following materials and equipment will be maintained at a nearby location in sufficient quantities to ensure containment of any inadvertent releases of drilling fluid:

- Vacuum truck(s);
- Light tower(s) with appropriate secondary containment(s), as applicable;
- Rubber-tired/tracked excavator or skid steer;
- A boat with appropriate personal safety equipment; and
- Floating turbidity curtain for use in large waterbodies.

7.2 CLEAN-UP RESPONSE PROTOCOL

The actions taken to respond to an IR will be dependent on, but not limited to, the location, site-specific geologic conditions, and volume. Transco will coordinate with affected landowners for access if an IR occurs outside of the certificated workspace, as well as coordinate with FERC staff. Transco will also obtain the necessary environmental and cultural resource clearances and FERC variances for access and restoration of affected resources, as applicable.

As previously described, the limits of disturbance at the HDD entry and exit locations have been designed to account for anticipated returns. If an inadvertent return of drilling fluid is identified, the following measures will be employed:

- Work stoppage will be determined by the Project team and EI through evaluation of the IR. Items to consider include whether there are any direct or potential impacts to public health and safety or to sensitive resource areas.
- Containment and cleanup will be executed by the Contractor who will work to ensure appropriate actions are taken to reduce, eliminate, or control the return. This work will be overseen by the Trenchless Inspector and the EI.
- Agency and landowner notifications will occur as applicable (Section 8).
- Drilling fluid may be recovered, recycled, and reused to the best extent practicable. All drilling fluid that cannot be reused will be disposed of in accordance with Section 5.4 Disposal.

7.3 SENSITIVE RESOURCE AREAS (WETLANDS, WATERBODIES, CULTURAL AREAS)

If an IR is identified within a resource feature such as a wetland, stream, or cultural area the following measures will be employed:

- Drilling operations will be shut down to allow the EI to appropriately quantify the return, assess potential impacts, and develop a management plan with the Contractor.
- Notification shall be made to the applicable agencies identifying the release and its status (see Section 8.2).
- The Contractor will take appropriate actions to reduce, eliminate or control the IR. Approved activities would only be implemented under the close, full-time supervision of the Trenchless Inspector and EI.

- The IR area will continue to be monitored during the daily inspection performed by the Trenchless Inspector or EI.
- Upon completion of the drilling operations, Transco will consult with applicable agencies to determine if any final remediation or cleanup will be necessary.
- Documentation pertaining to the release will be executed in accordance with Section 4. Additional information including status updates will be provided to the Project team, as necessary.

7.4 POTABLE WATER SUPPLY

Transco has not identified any private or public water supplies within 150 feet of the Eden Loop VA HDDs as shown in Table 5.

Transco will offer to have a qualified, independent testing service conduct pre-construction testing, where landowners are agreeable, and post-construction groundwater testing for comparison, for wells located within 150 feet of the alignment. Water quantity testing will include yield measurements using the existing pump and discharge line when possible and a portable submersible pump when necessary. Well modification for the purposes of testing will be completed with the permission of the landowner, as applicable. Water samples collected for water quality analysis will be tested for specific conductivity, temperature, pH, turbidity, nitrate, volatile organic compounds, and total petroleum hydrocarbon. In the unlikely event that the HDD installations temporarily affect the water quality or yield of a private or public well, Transco will provide alternative water sources or other compensation to the well owner(s). In the unlikely event that a well is permanently affected due to construction activities, Transco will repair, replace, or provide alternative sources of potable water.

8. NOTIFICATIONS

8.1 PRE-CONSTRUCTION LANDOWNER NOTIFICATION

Transco has developed communication procedures to ensure proper coordination with affected landowners and abutters. The Land Department will work with the Project team to ensure accurate, up-to-date information is available for distribution to the appropriate recipients. The specific landowner notification procedures include, but are not limited to the following:

- Transco will notify affected landowners in writing prior to the start of HDD activities. This notice will include:
  - A description of the proposed work, including any nighttime work proposed;
  - The name and phone number of Transco representatives that the landowner can contact if there are any questions or concerns regarding the proposed work;
  - A toll-free phone number to contact Transco that can be used as an alternative to contacting the ROW Agents; and
  - A toll-free phone number to contact FERC if the landowner believes that Transco has not resolved their concerns.
- In the event of nighttime work, Transco will contact the owners of the properties at the nearby noise sensitive areas at least 48 hours ahead of planned nighttime construction activities, advising them that noise-generating equipment may be operated during nighttime hours.
- In the event of IR during the HDD activities, Transco will reach out to each subject landowner to further discuss each IR event and any necessary follow up to remediate such events on their property.
- Transco will provide appropriate updates to landowners throughout the HDD activities and will provide notifications upon HDD completion.

8.2 AGENCY NOTIFICATION

8.2.1 Pre-Construction Notification

Transco will notify FERC and the appropriate federal and state agencies, which may include but is not limited to, the U.S. Army Corps of Engineers (USACE), U.S. Fish and Wildlife Service (USFW), Virginia Department of Environmental Quality (VADEQ), and Virginia Marine Resources Commission (VMRC) of the proposed construction date prior to commencing HDD operations.

8.2.2 Inadvertent Returns

If an IR is detected, as described in Section 6.3, the ECM will immediately contact FERC via e-mail, phone, or electronically delivered letter. If an IR is detected within a Sensitive Resource Area, the ECM will also make immediate notifications to the appropriate federal and state agencies, including but not limited to USACE and VADEQ and will initiate consultation with relevant agencies stipulated in the *Unanticipated Discovery Plan for Cultural Resources and Human Remains*. Additional notifications to the U.S. Fish and Wildlife Service (USFWS) and the appropriate state protected species field offices will be made if an IR is identified within an area where federally listed threatened or endangered species or state protected species are known to occur.

8.2.3 Impact to Water Supply

Transco has not identified any private or public water supplies within 150 feet of the Eden Loop VA HDDs as shown in Table 5. In the unlikely event of an impact to a public or private water supply, Transco will immediately provide a verbal notification to the owner of the potable water supply to determine the best path forward for management during the remainder of drilling operations.

9. RESTORATION

All areas affected by an IR will be restored to pre-existing conditions and contours, to the extent practicable, in accordance with Transco's Project-specific Plan and Wetland and Waterbody Construction and Mitigation Procedures (Procedures) and applicable permits. Upland areas will be restored through typical ROW restoration procedures, such as grading, seeding, and temporary and permanent erosion control devices, as necessary. Similarly, wetlands and waterbodies will be restored to pre-existing conditions and contours to the extent practicable.

Transco will continue to monitor for post-construction restoration issues, track the issues identified, and correct these issues during this post-construction phase of the Project.

10. CONTINGENCY PLANNING

10.1 HDD PROCESS AND POTENTIAL CAUSES OF FAILURE

There are three basic steps to install a pipeline crossing using the HDD method:

1. Pilot hole drilling;
2. Hole reaming; and
3. Pipe pullback.

This section briefly describes the HDD process and describes some potential causes of failure associated with each installation step.

10.1.1 Pilot Hole Process

Completing the pilot hole is the first step in the HDD process. It consists of directionally drilling the initial hole beneath the proposed crossing along a predetermined alignment and profile. The pilot hole is drilled using either a downhole displacement mud motor connected to a tri-cone rotary bit or a jetting assembly. Drilling fluid is pumped through the drill pipe aiding the mud motor or jetting assembly in cutting the soil or rock strata. The drilling fluid flows back to the surface through the annulus of the hole. The drilling fluid also helps lubricate the drill stem, suspend and carry the drilled cuttings to the surface, and form a wall cake to keep the hole open. Control of the drill bit is achieved by using a non-rotating drill string with an asymmetrical leading edge. This asymmetry creates a steering bias that allows the drill bit to be directed along the planned alignment and profile.

A pilot hole can also be completed using the intersect method where pilot holes are advanced simultaneously from both sides of the crossing and intersected at some point along the profile. Pilot hole intersects are often used to complete very long crossings because as the length of the pilot hole increases, the HDD contractor's ability to steer the drill bit diminishes. Completing a pilot hole in this manner also helps to reduce the annular drilling fluid pressures required to complete the pilot hole, thus reducing the risk of inadvertent drilling fluid returns.

A successful pilot hole provides pertinent data to aid in determining the possible success of the crossing. Data obtained from the pilot hole includes the rate of penetration to be expected during reaming operations and confirmation of the geotechnical strata. The Contractor can then better determine a plan for enlarging the hole to the required diameter. The diameter required to install the pipeline will vary depending on the geotechnical strata and the Contractor's judgment.

The failure mode that can occur during the drilling of the pilot hole is the hole collapsing on the drill pipe string. This is typically caused by either not being able to maintain a good bentonite wall cake to keep the hole stable or an unfavorable drilling stratum containing highly fractured rock, non-cohesive alluvial material, or gravel and cobbles. If the hole collapses on the drill pipe and creates high friction on the drill pipe surface, the torque required to rotate the drill pipe can exceed the maximum torque the drill pipe can handle and can cause the pipe to break in the hole. Multiple changes in strata and long drill lengths contribute to the probability of this type of failure. Typically, the HDD installation method will be considered a failure if there are two unsuccessful attempts at completing the pilot hole.

10.1.2 Hole Opening (Reaming) Process

The second step of the HDD process consists of one or more reaming passes. There are two types of tools that enlarge the pilot hole:

- Flycutters, used for most soil formations; and
- Rock hole opening tools, used for very dense soil or rock formations.

Typically, the hole opening tool (reamer) is attached to the drill pipe string that drills the pilot hole and is then rotated and pulled back toward the drill rig from the exit point.

The number of reaming passes varies depending on the subsurface conditions and carrier pipe size. Typically, the Contractor conducts a swab pass once the hole is enlarged to the appropriate diameter. During the swab pass, a reaming tool several inches smaller than the outside diameter of the final hole opening tool is pulled through the hole immediately prior to pullback. The purpose of the swab pass is to ensure the establishment of a good drilling fluid wall cake, a clean hole, and a hole full of drilling fluid with the proper density.

Drilling through rock formations typically requires multiple passes, with each pass increasing the diameter of the hole until the desired hole diameter is achieved.

Drill pipe is typically added behind the reaming tool at exit to keep a continuous string of drill pipe in the hole along the entire length of the crossing.

The hole opening process may require a significant length of time to enlarge the hole to the required diameter. As the length of time to complete this process increases, the probability of failure also increases. This is especially true when drilling in soil stratum that is loose or unstable (gravel and cobbles). At times, the loose material can be drilled very quickly, but maintaining an open hole through the unstable soil strata over an extended period of time can be very difficult.

If the hole reaming process is unsuccessful, the main reason for failure is often due to material collapsing into the hole caused by unstable zones along the hole, a loss of tooling downhole that cannot be recovered, or the tooling becoming stuck downhole. Additionally, if drilling fluid returns are not maintained or the drilling fluid is no longer able to carry the drilled cuttings out of the hole, an excess quantity of cuttings would remain in the hole. The cuttings would slowly build up in the bottom of the hole, increasing the friction on the drill pipe and creating additional wear and stress on the drill pipe. The increased friction can cause the drill pipe to slow or stop rotation to a point where the drill rig cannot supply enough torque to continue drilling without causing drill pipe failure.

In rock formations, excessive tooling wear and stress can also lead to failure. Excessive wear and stress can occur on the arms and bearings holding the roller cones on the reamer and at the tool joint connections between the drill string and the reaming tools. If the wear is excessive, the roller cones can separate from the tool, leaving the tool unable to cut or rotate or the tool joint connections to break. If the lost tooling can still be removed from the hole, the hole opening pass can resume. The HDD installation method would be considered a failure if there is an unsuccessful attempt at retrieving tools downhole and it has been determined that the reaming operations cannot be completed.

10.1.3 Pullback Process

The last step to complete a successful installation is the pullback of the prefabricated pipeline into the enlarged hole. A reinforced pullhead is attached to the leading end of the carrier pipe. A swivel is then connected between the pullhead and a reamer that is made up to the downhole drill pipe string. The swivel is placed between the reamer and the carrier pipe to allow rotation of the reamer during pullback while minimizing the transfer of rotation and torsion to the carrier pipe.

The pipeline will be buoyant in the drilling fluid during the pullback process which will require the pipe to be partially filled with water to reduce positive buoyancy and pull forces. The following issues could occur if positive buoyancy of the pipe is not reduced during the pullback process:

- Skin friction of the pipeline will increase, which will then increase the load that the drill rig must pull. The pipeline could be damaged if an excessive amount of pull force is applied to the pipe during the pullback process;

- The leading edge of the pullhead could dislodge a cobble or rock fragment from the top of the hole, binding the pipeline and making it impossible to move in either direction; and
- The external coating could be damaged by sharp and/or protruding material and highly abrasive material (coarse sands and rock).

During pullback, the aboveground portion of the pull section is supported with a combination of roller stands, pipe handling equipment, and/or a floatation ditch to further minimize excessive tension on the pipe and prevent the carrier pipe and coatings from being damaged during the pullback process. The carrier pipe will be coated with an abrasion resistant overlay to prevent pipeline damage during installation.

Failure of the pullback process occurs when the pipe becomes lodged in the hole and is unable to be moved in either direction. If this occurs, Transco and the Contractor will assess the situation and determine the appropriate course of action. Transco will, based on site-specific conditions, conduct agency consultation if needed.

10.1.4 Mechanical Failures

Mechanical failure occurs if there is a major mechanical breakdown of one or more pieces of equipment involved in the HDD operation. If the drill pipe and downhole tooling remain idle for an extended time, the material in the drilled hole annulus can seize the drill pipe string in place and prevent further movement such that the drill pipe may not continue to rotate or move in either direction. If this occurs during pilot hole drilling, the contractor will be required to modify the alignment and/or profile of the crossing to avoid the abandoned hole and start the drilling process from the beginning.

HDD installations may also be considered a failure if after either repairing or replacing the broken drill rig or vital piece of ancillary equipment, the drill pipe, hole opening tools, or pipeline cannot be rotated or pulled. If failure occurs, Transco will follow its standard process of selecting and permitting, as necessary, another appropriate installation method.

10.2 ALTERNATE CROSSING MEASURES

During the design phase of the Project, Transco conducted geotechnical studies at the proposed HDD crossings to minimize the risks inherent with HDD installations. Should the HDD technology fail during construction, as discussed in Section 10.1, Transco will consider shifting the alignment and/or profile within the proposed workspace and attempt to re-drill the crossing. If alignment shifts do not yield a successful drill, an evaluation of the failed attempt(s) will be performed to

determine the appropriate contingency methods to complete the crossing(s). This may include open-cut techniques or an alternative trenchless construction method. Transco will consult with appropriate regulatory agencies in determining the most appropriate contingency method to complete the crossing(s).

10.3 ABANDONMENT

If for any reason an HDD hole must be abandoned, Transco will coordinate abandonment procedures with the appropriate permitting and regulatory agencies and will obtain all necessary permits and approvals prior to their implementation. The Contractor will fill the upper 30 feet of the abandoned hole with a cement grout to completely seal it off. The top 5 feet of the abandoned hole will be filled with compacted soil to allow vegetation to reestablish. If deemed necessary by Transco, the Contractor may be required to complete grouting up to and including the entire abandoned hole to reduce the risk of ground subsidence, inadvertent drilling fluid returns from adjacent HDD alignments, or to comply with applicable regulatory requirements or other Project conditions.

The grout mixture used to abandon a borehole will consist of either a cement grout or cement/bentonite grout mixture that can be pumped downhole through the drill pipe used to drill/ream the hole. The grout mix (e.g., water/cement/bentonite ratios) will be designed generally for each HDD location based on the geologic formation(s) along the abandoned portion of the hole. Additional modifiers, such as those used in structural concrete, may be used to modify the flowability and/or set time of the grout. To grout the abandoned hole, the Contractor will extract all cutting tools (i.e., reamer and cutting heads) from the hole, advance the drill pipe into the hole to the required grout depth, and begin pumping the grout mixture while the drill pipe is extracted from the hole. The rate at which the drill pipe is extracted during grouting operations will be regulated to match the rate of grout placement.

11. REFERENCES

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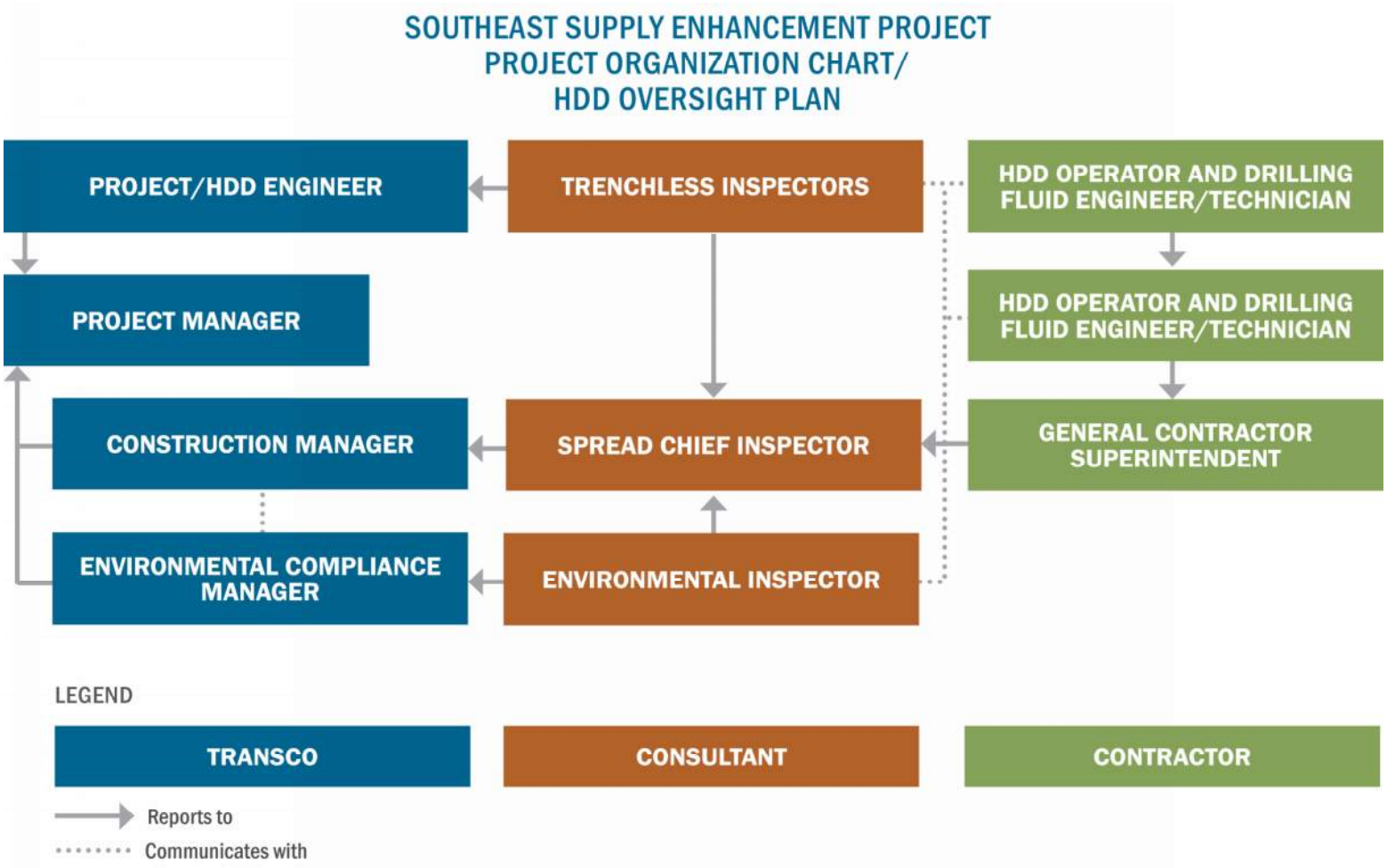
Transcontinental Gas Pipeline Company, LLC

Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan

Appendix A – Project Organizational Charts

Southeast Supply Enhancement – Eden Loop VA
Pittsylvania County, Virginia

January 2025


SOUTHEAST SUPPLY ENHANCEMENT PROJECT
PROJECT ORGANIZATION CHART/
HDD OVERSIGHT PLAN
PROJECT/HDD ENGINEER
TRENCHLESS INSPECTORS
HDD OPERATOR AND DRILLING FLUID ENGINEER/TECHNICIAN
PROJECT MANAGER
HDD OPERATOR AND DRILLING FLUID ENGINEER/TECHNICIAN
CONSTRUCTION MANAGER
SPREAD CHIEF INSPECTOR
GENERAL CONTRACTOR SUPERINTENDENT
ENVIRONMENTAL COMPLIANCE MANAGER
ENVIRONMENTAL INSPECTOR
LEGEND
TRANSCO
CONSULTANT
CONTRACTOR
Reports to
Communicates with

Transcontinental Gas Pipeline Company, LLC

Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan

Appendix B – Drilling Fluids List and Safety Data Sheets

Southeast Supply Enhancement – Eden Loop VA
Pittsylvania County, Virginia

January 2025

The Drilling Fluids List and Safety Data Sheets ***(to be included in future revisions to the Plan following contractor selection)***

Transcontinental Gas Pipeline Company, LLC

Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan

Appendix C – HDD Design and Geotechnical Reports

Southeast Supply Enhancement – Eden Loop VA
Pittsylvania County, Virginia

January 2025

HDD Design Services

Southeast Supply Enhancement -
Sandy River HDD
Pittsylvania County, Virginia

for
Transcontinental Gas Pipeline Company, LLC

September 10, 2024

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GeoEngineers

HDD Design Services

Southeast Supply Enhancement -
Sandy River HDD
Pittsylvania County, Virginia

File No. 08169-235-00
September 10, 2024

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Appendix E. HDD Best Practices
Appendix F. Report Limitations and Guidelines for Use

Executive Summary

This report provides GeoEngineers, Inc.'s (GeoEngineers') horizontal directional drill (HDD) design and construction recommendations for the proposed 42-inch-diameter Sandy River HDD as part of the Southeast Supply Enhancement (SSE) Eden Loop (Project) located in Pittsylvania County, Virginia.

We understand that Transco is planning to install a new section of 42-inch steel pipe under a perennial stream and the Sandy River utilizing the HDD method of construction. The designed horizontal length of the Sandy River HDD is 3,100 feet. The proposed HDD alignment follows the existing Transco pipeline right-of-way (ROW) and is orientated southwest to northeast (entry to exit), as shown on the HDD Design Drawing in Appendix A.

We explored the subsurface conditions along the Sandy River HDD alignment by completing a total of six (6) geotechnical borings, the results of which are summarized in our Geotechnical Data Report which is included in Appendix B.

Based on the information available at this time, the results of the geotechnical borings completed at the site, our geotechnical engineering evaluation, and detailed HDD design analyses, it is our opinion that the proposed Sandy River HDD has a high probability of a successful installation. Our assessment of the construction risks is based upon the contractor adhering to the recommendations contained herein and implementing plans and procedures that are in accordance with Project requirements. The HDD contractor should address the items in Sections 6.0 and 7.2 of this report in the preconstruction and construction phases of the project to facilitate a successful HDD installation and to mitigate possible difficulties from arising during construction. We anticipate contractor selection will be critically important to the ultimate success of this HDD installation, and we recommend the Project team consider engaging an HDD contractor experienced in projects of similar length and diameter in similar subsurface conditions well in advance of construction to provide feedback on the project plans and specifications.

The Executive Summary should be used only in context of the full report for which it is intended.

1.0 Introduction

1.1 GENERAL

This report provides GeoEngineers, Inc.'s (GeoEngineers') horizontal directional drill (HDD) design and construction recommendations for the proposed 42-inch-diameter Sandy River HDD located in Pittsylvania County, Virginia. The project site is shown in the Vicinity Map, Figure 1.

1.2 PROJECT DESCRIPTION

We understand that Transcontinental Gas Pipeline Company, LLC (Transco) is proposing to construct a new approximately 30.8-mile-long 42-inch-diameter steel pipeline as part of the Southeast Supply Enhancement (SSE) Eden Loop (Project). The Project route, located in Rockingham County, North Carolina and Pittsylvania County, Virginia generally follows Transco's existing pipeline corridor, including the Sandy River crossing for which this report has been prepared. The designed horizontal length of the Sandy River HDD is 3,100 feet. The proposed HDD alignment follows the existing Transco pipeline right-of-way (ROW) and is oriented southwest to northeast (entry to exit), as shown on the HDD Design Drawing in Appendix A. The HDD design is based on the design parameters presented below in Table 1.

TABLE 1. PIPELINE DESIGN PARAMETERS

CARRIER PIPE DATA	DESIGN PARAMETER
Carrier Pipe Specifications	42 inches O.D x 0.888 inches w.t.[A] API-5L X70
Maximum Allowable Operating Pressure (MAOP)	1,480 psig[B]
Assumed Operating Temperature	70 degrees F
Assumed Tie-In Temperature	50 degrees F
Design Factor[C]	0.5

Notes:
[A] w.t. – wall thickness
[B] psig – pounds per square inch gauge
[C] As defined in CFR Title 49, Parts 192.5 and 192.111

2.0 Scope of Services

The work described in this section was undertaken by GeoEngineers to design the HDD, perform the HDD engineering, and prepare this HDD design report for the proposed Sandy River HDD. The following provides an abbreviated list of our scope of services for the design phase of the project. Refer to our proposal, dated January 17, 2024, for our original scope of services for the entire project.

1. Completed a conceptual design for the Sandy River HDD.
2. Explored the subsurface conditions at the crossing site by completing six geotechnical borings to depths up to approximately 201 feet below ground surface (bgs) and summarized the results of the geotechnical explorations and subsequent laboratory testing program in our geotechnical data report

titled, "Southeast Supply Enhancement – Sandy River Crossing Geotechnical Data Report," dated September 5, 2024.

3. Performed an HDD feasibility evaluation considering the subsurface conditions encountered during the exploration program.
4. Completed an HDD design and performed engineering and design analyses. Our design and calculations were performed in accordance with Sections 833.3 and 833.4 of American Society of Mechanical Engineers (ASME) B31.8 for steel pipe, PRCI Catalog No. PR-277-144507-E01, FERC HDD Plan Guidance (October 2019), Transco's specifications, and generally accepted practices within the pipeline industry.
5. Completed quantitative and qualitative hydraulic fracture and drilling fluid surface release analyses for portions of the HDD profile within the overburden soils and bedrock, respectively. Our qualitative evaluation includes considerations from the Federal Energy Regulatory Commission (FERC) 2019 "Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan".
6. Prepared and submitted Issued for Review (IFR) HDD design drawings for review and comment by the project team.
7. Prepared a draft HDD engineering and design report for the crossing for review by the project team.
8. Prepared and submitted this Final HDD design report, including Issued for Permit (IFP) drawings and engineering calculations, sealed by a licensed professional engineer in the state of Virginia.

3.0 Site Conditions

The proposed Sandy River HDD is located roughly 8.8 miles northwest of Danville, Virginia. As part of our scope of work for the project, we performed a site reconnaissance with Transco personnel and conducted a site-specific geotechnical exploration program. Please see our geotechnical data report titled, "Southeast Supply Enhancement – Sandy River Crossing Geotechnical Data Report," dated September 5, 2024, in Appendix B for further details of the regional and local geologic setting at the site and a description of the mapped surficial materials and bedrock geology at the site.

3.1 SURFACE CONDITIONS

We evaluated the surface conditions at the Sandy River site during our initial site reconnaissance with Transco personnel on February 29, 2024, and during our subsurface exploration program conducted from May 13 through 22, 2024 and again from June 3 through 12, 2024. We also reviewed aerial photographs viewed on Google Earth® software. The proposed HDD alignment is shown relative to an aerial photograph base map in the HDD Design Drawing included in Appendix A. Photographs of the site conditions in the vicinity of the proposed entry, exit, and pipe stringing and fabrication workspace areas are included in Figures 2 through 4 and a photograph in the vicinity of the Sandy River as crossed by the HDD alignment is included in Figure 5.

The proposed HDD alignment is roughly oriented southwest to northeast within Transco's existing pipeline corridor. Generally, the ground surface at the Sandy River site features undulating topography on either side of the Sandy River with the river valley at the lowest elevation along the proposed HDD alignment at

an elevation of approximately 528 feet North American Vertical Datum (NAVD) 88. Elevations on either side of the river range from roughly 540 feet NAVD 88 near the northeast bank of the river to approximately 638 feet NAVD 88 at the proposed HDD entry point; the proposed HDD exit point is at an elevation of approximately 599 feet NAVD 88.

The project area is generally undeveloped and forested except for the existing Transco pipeline right-of-way. The alignment crosses the Sandy River at an oblique angle over a distance of roughly 80 feet.

Refer to Section 4.2 of this report for a more detailed discussion regarding the conditions and layout of the entry, exit, and pipe stringing workspaces.

3.2 SUBSURFACE CONDITIONS

3.2.1 General

The subsurface conditions at the site were explored from May 13 through 22, 2024 and again from June 3 through 12, 2024 by drilling six geotechnical borings (SR-B-1 through SR-B-6) to depths of up to approximately 201 feet bgs using a rubber-tired drill rig.

To characterize the subsurface conditions for the crossing design, the borings were drilled as close as practical to the alignment of the proposed crossing, but generally no closer than 25 feet, except for boring SR-B-6 which was completed closer than 25 feet to the alignment as a result of limited space available on the east side of the ROW to safely complete the boring. A description of the geologic conditions at the site, field exploration and laboratory testing procedures, laboratory test results, as well as logs of the borings are presented in our geotechnical data report included in Appendix B.

3.2.2 Subsurface Description

Our geotechnical exploration program encountered predominantly residual soil consisting of stiff to very stiff lean clay and silt and medium dense silty sand overlying decomposed bedrock (dense to very dense sand with variable silt content) grading to competent conglomerate and siltstone bedrock. Our core samples indicate the bedrock quality along the HDD profile is generally fair to excellent with some isolated portions where the bedrock quality is very poor to poor, specifically in boring SR-B-2 where very poor to poor quality, predominately decomposed bedrock was observed within the upper 70 feet of bedrock. Table 2 below provides a range of the unconfined compressive strength, Mohs hardness, and Cerchar Abrasivity Index (CAI) test results completed for selected samples. Table 7 further in this report provides a detailed summary of the boring identification and sample depth for each sample tested.

TABLE 2. SUMMARY OF ROCK CORE TEST RESULTS

TEST TYPE	RANGE
Unconfined Compressive Strength (UCS)	2,280 – 31,143 psi[A]
Mohs Hardness	4½ – 7½
Cerchar Abrasivity Index (CAI)	3.08 – 4.54

Notes:
[A] psi – pounds per square inch

3.2.3 Groundwater Conditions

Groundwater was not observed at the time of drilling borings SR-B-1 through SR-B-6 because of the drilling method. The absence of groundwater at the time of drilling may not be representative of present or future levels within the subsurface. The groundwater level likely fluctuates because of seasonal variation and precipitation, recharge and other factors, and may be present at different elevations during construction.

4.0 HDD Design Elements

4.1 BASIS OF DESIGN

The following sections discuss the design elements of the proposed Sandy River HDD as depicted in Appendix A.

Because of the length of the HDD alignment and the hardness and abrasivity of the bedrock, we anticipate that the selected HDD contractor may wish to complete the pilot hole using the intersect method. Additionally, using a drill rig on both sides of the crossing during reaming operations would allow for increased flexibility of operations and other advantages, including the following:

- Reduction in overall project schedule, particularly during the pilot hole;
- Increasing the contractor's ability to complete the pilot hole within the specified tolerance should they encounter steering difficulties;
- Being able to more easily ream the hole in either direction; and,
- Increasing the likelihood of recovering tooling in the event of a downhole tooling failure.

Because the HDD contractor may elect to use a drill rig on both sides of the crossing, the HDD geometry and workspaces were laid out to accommodate this possibility.

4.1.1 HDD Geometry

The design geometry is primarily based on the following factors:

- Entering and exiting the bedrock within the steepest portions (the entry and exit tangents) of the profile.
- Utilizing entry and exit tangents of suitable length for large HDD drill rigs.
- Designing the profile to target the better-quality bedrock observed in SR-B-2 to reduce the risk of formational fluid loss and hole instabilities. As a result of targeting the generally good quality bedrock at depth beneath the Sandy River, the horizontal length of the proposed HDD was increased by approximately 600 feet on the entry side of the crossing.
- Using larger than standard (100D) design radii for the vertical curves to provide a reasonable variance between the design radii and the minimum allowable radius.

The proposed Sandy River HDD alignment is 3,100 feet long as measured along the HDD centerline, with a pipe length of approximately 3,135 feet. The entry and exit angles are 14 and 10 degrees, respectively, and the design radius of curvature for the entry and exit curves is 4,800 feet.

4.2 HDD WORKSPACE AREAS

The proposed temporary workspaces at entry and exit and the pipe stringing and fabrication workspace are situated within the project's limits of disturbance composed of the permanent easement, temporary workspace, and additional temporary workspace. The following sections provide relevant details regarding the proposed workspace areas.

4.2.1 Entry Workspace

The proposed entry workspace is located on the southwest side of the crossing and occupies both maintained pipeline ROW and private property. The maintained ROW area is grass covered, and the private property is occupied by mature trees. The ground surface within the workspace is generally moderately sloped (less than 2H:1V) except for the northwestern portion which is steeply sloped (steeper than 2H:1V). The ground surface generally slopes from the back (southwest) of the workspace to the front (northeast). There is an ephemeral stream approximately 26 feet northwest of the proposed HDD entry point, and the entry point is positioned 153 feet southwest of the northeast perimeter of the entry workspace. Photographs of the proposed entry workspace are provided in Figure 2.

4.2.2 Exit and Pipe Stringing and Fabrication Workspaces

The proposed exit workspace is located on the northeast side of the crossing and occupies both maintained pipeline ROW and private property. The maintained area and private property are both used for agricultural purposes. The ground surface within the workspace slopes gently upward from the front (southwest) of the workspace to the back (northeast). The HDD exit point is situated 200 feet northeast of the southwestern edge of the additional temporary workspace to include the portion of the HDD alignment where we anticipate the risk of inadvertent drilling fluid returns (IR) is high. Photographs of the proposed exit workspace are provided in Figure 3.

The proposed pipe stringing and fabrication workspace extends 2,495 feet northeast of the exit point. The workspace is within grass-covered maintained ROW along relatively flat to gently sloping terrain. There is an existing perennial stream and wetland crossed by the stringing workspace and distribution powerline crossing perpendicular to the stringing workspace. The wetland is approximately 1,970 feet northeast of the proposed HDD exit point. Along this area there is also a delineated stream beyond the project LOD. The proposed LOD in this area was reduced to reduce impacts on environmental features. The workspace is not long enough to accommodate a single string of carrier pipe, and therefore, a minimum of two sections will need to be fabricated before pullback and require at least one mid-weld during pullback. A photograph of the proposed pipe stringing, and fabrication workspace is provided in Figure 4.

5.0 Engineering and Analysis

5.1 HYDRAULIC FRACTURE AND INADVERTENT RETURNS EVALUATION

5.1.1 General

Drilling fluid surface releases, commonly referred to as "inadvertent returns" (IRs) or "Frac Outs," occur when drilling fluid emerges at the ground surface or in any other undesired location such as waterbodies, or other environmentally sensitive features or utilities. Hydraulic fracture is a term typically used to describe the condition in which the annular drilling fluid pressure exceeds the capacity of the surrounding formation

to resist that pressure (formation limit pressure). Once the formation limit pressure (FLP) is exceeded, drilling fluid is lost either through crack propagation (fracture) or by uncontrolled cavity expansion (blowout).

Hydraulic fracture typically occurs when the drill path passes through relatively weak cohesive soils or loose granular soils with low shear strength. Very loose to loose sands and silty sands, and soft to medium stiff silts and clays typically have a higher hydraulic fracture potential. Medium dense to very dense sands and very stiff to hard silts and clays have a low to moderate hydraulic fracture potential. However, the HDD contractor's construction procedures are an important factor influencing the risk of hydraulic fracture and inadvertent drilling fluid returns. If the contractor operates with insufficient drilling fluid flow rates, inadequate drilling fluid properties or excessive rates of penetration, the annulus may become blocked through an accumulation of drill cuttings falling out of suspension. This can occur within formations that typically have a low potential for hydraulic fracture. If the accumulation of cuttings creates a blockage downhole, the annulus may become over-pressurized, leading to hydraulic fracturing and potentially, drilling fluid surface releases. The hydraulic fracture analysis does not account for this over-pressurized condition.

The FLP of a given soil strata can be estimated based on cavity expansion theory (Vesic, 1972). Our analysis computes the factors of safety against hydraulic fracture in soil. The factor of safety against hydraulic fracture is the ratio of the soil formation limit pressure to the estimated drilling fluid pressure along the profile. The formation limit pressure varies depending on the soil properties anticipated along the HDD profile as described in Section 5.1.2. The estimated drilling fluid pressure also varies along the HDD profile and is a function of the drilling fluid properties as described in Section 5.1.2. A more detailed explanation of our hydraulic fracture analysis methodology is presented in Appendix C.

Bedrock, because of its high shear strength, has a relatively low potential for hydraulic fracture. Hydraulic fracture of soil is defined by and can be quantitatively analyzed by cavity expansion theory. However, cavity expansion theory cannot be applied to bedrock conditions. The annular drilling fluid pressures associated with the HDD construction method are typically not capable of hydraulically fracturing competent bedrock.

However, inadvertent returns of drilling fluid to the ground surface can occur during HDD operations in bedrock by following existing fractures and planes of weakness within the formation. Currently, there are no widely accepted methods for calculating the safety factor against inadvertent returns occurring from within bedrock during HDD operations. However, the risk can be qualitatively characterized based on the type and quality of the bedrock as discussed further in Section 5.1.4.

5.1.2 Model Input Parameters

The HDD geometry used for our analyses of the Sandy River HDD is shown on the HDD Design Drawing in Appendix A. The soil units along the HDD profile are characterized by borings SR-B-5 and SR-B-6. We developed the following soil properties based on laboratory-testing data and published correlations with standard penetration testing (SPT) for use in our hydraulic fracture analysis. Please see Appendix C for a more detailed discussion of the hydraulic fracture analysis methodology.

TABLE 3. ESTIMATED SOIL PROPERTIES

SOIL DESCRIPTIONS	USCS[B] CLASSIFICATION	WET UNIT WEIGHT (PCF)[C]	FRICTION ANGLE/ PHI (DEGREES)	K_0 VALUE	COHESION (PSF)[D]
Stiff Sandy Silt/Silt w/ Sand	ML	110	0	1	1.500
Medium Dense Silty Sand	SM	115	30	0.50	0
Very Dense Silty Sand	SM	125	34	0.44	0
Conglomerate/Siltstone Bedrock[A]	N/A	N/A	N/A	N/A	N/A

Notes:
[A] Profile segments where bedrock conditions are anticipated were qualitatively evaluated for risk of IR.
[B] USCS = Unified Soil Classification System
[C] pcf = pounds per cubic foot
[D] psf = pounds per square foot

We estimated the anticipated annular drilling fluid pressure using the Bingham Plastic model. Downhole drilling fluid pressure are influenced by the tool dimensions and rheological drilling fluid properties selected by the contractor. For the purposes of our analysis, we selected a range of rheological properties and typical tooling dimensions for the length of the crossing and subsurface conditions expected along the HDD profile, as summarized in Table 4. The range of drilling fluid properties was chosen based on our experience with crossings in similar subsurface conditions. Our model assumes that no obstructions are present within the drill hole, drilling fluid returns are maintained at all times, and the drill hole is completely cylindrical. Because these parameters are subject to change depending on HDD contractor's means and methods, the hydraulic fracture analysis can and should be refined once the HDD contractor is selected, and these parameters are known.

TABLE 4. ESTIMATED TOOL DIMENSIONS AND RHEOLOGICAL PROPERTIES

PARAMETER	VALUE
Pilot Hole Bit Diameter	12.25 inches
Drill Pipe Diameter	6.625 inches
Drilling Fluid Weight	9 – 12 ppg[A]
Plastic Viscosity	13 – 25 cP[B]
Yield Point	25 – 45 lb/100 sf[C]

Notes:
[A] ppg = pounds per gallon
[B] cP = centipoise
[C] lb/100 sf = pounds per 100 square feet

5.1.3 Results of Quantitative Hydraulic Fracture Evaluation

We evaluated hydraulic fracture and IR risk assuming the pilot hole was advanced solely from entry to exit (Figures C-1 and C-2) as well as from exit to entry (C-3 and C-4). We also evaluated hydraulic fracture and IR risk assuming the pilot hole would be simultaneously advanced from entry to exit and exit to entry (pilot hole intersect [Figures C-5 and C-6]). The estimated formation limit pressure and the calculated annular drilling fluid pressure (AP) along the HDD profile are shown as the green line and the red line, respectively,

in Figures C-1, C-3, and C-5. A range of calculated drilling fluid pressures is shown in Figures C-1, C-3 and C-5 based on the lower bound and upper bound values for the drilling fluid properties shown in Table 4. The calculated safety factor against hydraulic fracture along the HDD profile is shown in Figures C-2, C-4, and C-6. As shown in Figures C-2 and C-4, our hydraulic fracture analysis indicates the risk of hydraulic fracture and IR becomes high as the pilot hole nears the exit point and is within soil. This risk is relatively low (safety factors above 2.0) for the portions of the pilot hole anticipated to be within soil, provided the pilot hole intersect method is used to complete the pilot hole. Our analyses assumes that the HDD contractor follows the HDD Best Practices presented in Appendix E and maintains annular drilling fluid pressures below the calculated values included in this report. If the pilot hole is advanced entirely from entry to exit, our analysis indicates there is a high risk of an IR as the profile transitions from bedrock to soil near the HDD exit point. **If the HDD contractor elects to advance the pilot hole entirely from one side, we recommend the pilot hole be advanced from exit to entry.**

5.1.4 Inadvertent Returns Risk

For this crossing, we anticipate there is a high risk of IR within approximately 100 feet of the proposed HDD entry and exit points, assuming the pilot hole intersect method is used to complete the pilot hole. If the pilot hole intersect method is not used, we anticipate the risk of IR becoming high within approximately 100 and 225 feet of the proposed HDD exit and entry points, respectively. We understand that no environmentally sensitive features or settlement sensitive structures are located within these high-risk zones. **There is a delineated perennial stream approximately 330 feet northeast of the proposed HDD entry point. We anticipate that the proposed HDD profile will be within fair to good quality bedrock at this location, however, we recommend erecting erosion and sediment control along the southwestern bank of the stream, staging materials in this area, and monitoring this location for indications of an IR during construction.**

The bedrock observed in the borings ranged in quality, as previously described. It is our opinion that the risk of significant formational fluid loss along the proposed HDD is generally low to moderate, but there is a localized risk of fluid loss within the zones of poor rock quality observed in the borings. We should note that during the geotechnical explorations, drilling fluid returns were maintained during rock coring operations in borings SR-B-4 through SR-B-6. During rock coring, drilling fluid returns were lost in borings SR-B-1, SR-B-2, and SR-B-3 at depths of approximately 72, 106, and 18½ feet bgs and not regained, suggesting that some formational drilling fluid loss during HDD operations could occur. It is also our opinion that there is generally a low risk of drilling fluid surface release along the portions of the HDD profile that are within the bedrock.

5.1.5 Calculated Drilling Fluid Pressure

The calculated fluid pressures presented in Figures C-1, C-3, and C-5 are intended to provide a baseline of estimated annular drilling fluid pressures based on assumed drilling fluid properties and the HDD contractor's tooling parameters. Variations to one or both will affect the fluid pressures. Transco's Horizontal Directional Drilling – Construction specification 33 05 07P, requires the contractor to monitor annular pressures during pilot hole operations. If the annular pressures are higher than the calculated values, it could be indicative of a downhole obstruction or other problem that should be addressed by the HDD contractor to limit the risk of inadvertent returns. In addition, annular pressures higher than anticipated will result in a reduction in the calculated safety factor against hydraulic fracture.

In accordance with Transco's specification, we recommend that the HDD contractor utilize an annular pressure tool to monitor downhole annular pressures while drilling the pilot hole. We recommend that the contractor take necessary and reasonable steps to maintain the annular drilling fluid pressure within the expected range of calculated pressures presented in Figures C-1, C-3, and C-5. The calculated drilling fluid pressures are presented in tabular form on the HDD Design Drawing – Sheet 4 in Appendix A.

5.2 OPERATING CONDITIONS

For our analyses, the tie-in and operating temperatures used for the 42-inch pipeline were 50 degrees and 70 degrees Fahrenheit, respectively. We can further evaluate different installation and operating temperatures, if necessary. The design radius of curvature for the HDD is 4,800 feet. However, the operating stresses in Table 5 below are based on an allowable minimum radius of curvature of 3,200 feet at the maximum allowable operating pressure (MAOP) provided in Table 1. If the pilot hole is completed with a minimum radius of curvature less than 3,200 feet, the operating stresses will be increased. Table 5 below presents a summary of the operating stresses for the carrier pipe specifications proposed for the HDD. Detailed operating stress calculations are included in Appendix D.

TABLE 5. CALCULATED OPERATING STRESSES*

STRESS COMPONENT	STRESS (PSI)	PERCENT SMYS[A] (%)	MAXIMUM ALLOWABLE PERCENT SMYS[A] (%)
Longitudinal Bending Stress	16,200	23	-
Hoop Stress	35,000	50	50[B]
Longitudinal Tensile Stress from Hoop Stress	10,500	15	-
Longitudinal Stress from Thermal Expansion	-3,800	6	90[C]
Maximum Net Longitudinal Stress	22,800	33	90[D]
Maximum Shear Stress	22,300	32	45[E]
Maximum Combined Biaxial Stress	44,500	64	90[F]

Notes:

* Operating Stresses are based on an Allowable Minimum Radius of 3,200 feet.

A SMYS - Specified Minimum Yield Stress

B Limited by design factor from DOT regulations, CFR Title 49 Part 192.111 for gas.

C Limited by Table 403.3.1-1 of ASME B31.4 for liquids.

D Limited by Table 403.3.1-1 of ASME B31.4 for liquids and Section 833.3 of ASME B31.8 for gas.

E Limited by Section 403.12 of ASME B31.4 for liquids.

F Limited by Section 833.4 of ASME B31.8 for gas.

5.3 PULLBACK LOADS

The installation loads are estimated based on the designed geometry and the methods developed by the Pipeline Research Committee International (PRCI) of the American Gas Association (PRCI 2015). To calculate the safe pull force for a given installation, we first assume that during pullback the pipe experiences the maximum hoop stress and minimum bending radius at the deepest part of the proposed drill profile. We then utilize the equation for combined stress found in Section 5.2.4 of the PRCI Guidelines (PRCI 2015) to back-calculate the allowable tensile stress that may be applied to the pipe at that point.

With the allowable tensile stress known, we can estimate the safe pull force at that same point. It should be noted that this can be conservative because the maximum hoop stress and bending stress may not be acting on the pipe at the same location. For this installation, the calculated safe pull force exceeds the limitations of HDD drill rigs which may be used to complete the installation.

For the proposed HDD, we analyzed the anticipated pull loads based upon different drilling fluid weights in the hole during pullback with the pipe empty and full of water. Based on our analysis of the installation loads (see Table 6), the pullback force during installation of the 42-inch-diameter carrier pipe may be as high as approximately 790,500 pounds, depending on the weight of the drilling fluid in the hole at the time of pullback, the buoyancy control measures employed by the contractor, and how well the hole is prepared for pullback. Detailed installation load and stress calculations are provided in Appendix D.

The five cases analyzed are as follows:

1. The annulus contains 9.5 pounds per gallon (lb/gal) drilling fluid and the carrier pipe is empty.
2. The annulus contains 9.5 lb/gal drilling fluid and the carrier pipe is full of water.
3. The annulus contains 12 lb/gal drilling fluid and the carrier pipe is empty.
4. The annulus contains 12 lb/gal drilling fluid and the carrier pipe is full of water.
5. The annulus contains 12 lb/gal drilling fluid and the carrier pipe is filled such that neutral buoyancy is achieved.

TABLE 6. INSTALLATION LOADS[A]

DRILLING FLUID WEIGHT (LB/GAL)	BUOYANCY CONDITION	BUOYANCY CONTROL (LB/FT)	EFFECTIVE PIPE WEIGHT (LB/FT)[B]	PULLBACK FORCE[C] (LB)
9.5	Empty	0	-292.9	598,900
9.5	Full	550.7	257.8	484,400
12.0	Empty	0	-472.8	791,800
12.0	Full	550.7	77.9	302,200
12.0	Neutral	472.8	0	277,700

Notes:
[A] See Appendix D for detailed calculations.
[B] Assumes a fully open drilled hole.
[C] Assumes a fully open drilled hole.

6.0 HDD Construction Risks and Considerations

6.1 GENERAL

The HDD contractor's means and methods during construction are critical to the successful completion of the HDD. The contractor should follow HDD Best Practices during construction, including those recommended by GeoEngineers in Appendix E. The HDD Best Practices in Appendix E are not site-specific

best practices, rather they are applicable to HDD construction in general. The following sections summarize site-specific conditions to be considered during construction.

6.2 TEMPORARY WORKSPACE AREAS

The entry and exit workspaces are located within the Project limits of disturbance of the permanent easement, temporary workspace, and additional temporary workspace and will be accessed via approved access roads. The entry and exit workspace areas will require relatively level areas for staging equipment such as the drill rig, drilling fluid recycling system, and high pressure drilling fluid pump. Depending on the ground conditions at the time of construction, timber matting or similar might be needed to provide a stable platform within the workspaces. The existing high pressure natural gas pipelines within the workspaces will require matting for protection. **The contractor should evaluate the existing ground conditions and provide a site-specific plan to stabilize and prepare the ground for construction in the entry and exit workspaces.**

All temporary site improvements should be removed upon completion of the carrier pipe installation and the areas should be restored in accordance with the project site restoration plan and in Transco's construction specification. Temporary workspaces for the trenchless operations are shown on the design drawings in Appendix A.

6.2.1 Workspace Preparation

The entry workspace is situated on moderately to steeply sloping terrain which will require grading to create level workspace areas for HDD equipment. Grading for the portions of the workspaces within the existing pipeline ROW may require special consideration because of the presence of the adjacent pipelines. Additionally, there is a delineated stream within the entry workspace that will require protection during construction. Grading within the exit workspace should be marginal.

To reduce ground disturbance to the extent possible, we recommend temporary construction entrances, access roads and work pad areas (as appropriate) be improved by placing temporary board or timber mats. Temporary entrances and access roads should be constructed with culverts and other improvements necessary to allow surface water runoff to drain without ponding or changing off-site drainage patterns.

6.2.2 Noise Mitigation

We understand that Transco has engaged an acoustic engineering consultant to evaluate the current ambient noise levels and develop mitigation measures. The noise modeling for the Sandy River HDD assumed HDD equipment operating in both the entry and exit workspaces simultaneously, 24 hours per day. The acoustical assessment completed for the Sandy River HDD indicates that the unmitigated sound level attributable to drilling operations at the HDD entry workspace is likely to exceed the maximum allowable sound level criterion of 55 A-weighted decibels (day-night sound level) at the closest noise sensitive areas. As a result, implementing noise mitigation measures at the HDD entry workspace during construction will be necessary.

Often noise mitigation measures may include outfitting diesel power units and other stationary equipment with noise-reducing mufflers. In addition, the workspaces can be muffled by placing baffles around the equipment to further reduce noise emissions when needed. The provisions of the noise reduction measures are generally implemented by the selected contractor, when necessary. Please refer to the project noise study report for details related to specific mitigation recommendations.

6.3 UTILITIES

The locations of all currently known underground utilities are shown on the design drawing. The selected contractor should complete one-calls and implement appropriate measures to positively identify public and private utilities along the access routes and HDD alignment prior to mobilizing equipment and beginning drilling operations. Additionally, the contractor should implement all reasonable measures to protect these utilities during mobilization, construction, and demobilization.

We understand that Transco operates three existing natural gas pipelines within the maintained pipeline ROW and that these pipelines were installed by conventional lay pipeline construction. Based on the project civil survey, the proposed HDD entry and exit points are located 28 feet and 27 feet, respectively, from existing Transco pipelines, which should be positively located prior to construction, particularly prior to installing the drill rig's anchors, and excavating the entry and exit pits.

The contractor should ensure that equipment can be safely operated at the required distance beneath and adjacent to existing utilities. GeoEngineers should be notified if a potential conflict between the HDD profile and existing utilities is identified.

6.4 HARD AND ABRASIVE BEDROCK

Our Geotechnical Data Report completed for the crossing reports unconfined compressive strength test results up to approximately 31,143 psi, indicating that very hard rock is present at the site. While rock with compressive strength values of greater than 31,000 psi may not be extensive at the site, **the HDD contractor should be prepared to encounter hard rock with compressive strength values greater than 30,000 psi along the designed HDD profile.** Furthermore, as noted in the Geotechnical Data Report, the results of CAI testing ranged from 3.08 to 4.54, indicating highly to extremely abrasive bedrock at the site. Mohs hardness values ranged from 4.5 to 7.5 on samples selected for unconfined compressive strength testing. As such, accelerated downhole tooling wear is considered likely.

The compressive strength of the rock samples tested suggests the rock has low to high compressive strength with a relatively large range in strength between samples of similar composition, state of weathering, and hardness. The HDD contractor should consider these factor's effects on penetration rates and their implications on an estimated construction schedule, necessary drill bit and hole opener specifications, and the number of drill bits and hole openers in their estimate.

In accordance with Transco's specification for pipe coating thickness, because of the abrasivity of the bedrock at the site the HDD pipe will be coated with 12 mils of base fusion bonded epoxy (FBE), 30 mils of FBE-abrasion resistant overlay (ARO), and 50 mils of liquid ARO.

6.5 OPERATIONAL CONSIDERATIONS

Ultimately, the means and methods of daily HDD operations will vary based on the selected HDD contractor and their typical approach for completing projects of similar length and diameter. However, site and project-specific factors should also be considered by the HDD contractor to inform their decisions during pre-construction planning regarding tooling and equipment selection, workspace configuration, and scheduling, among other items.

6.5.1 Downhole Tooling

Based on the subsurface conditions observed in the geotechnical explorations completed at the site and results from the subsequent laboratory testing program, we recommend that the following be considered by prospective HDD contractors:

- Drill pipe and crossover sub wear may be excessive. Because of the projected long duration of the project, a monitoring and inspection program during construction should be considered for all drill pipe and subs used downhole. **We recommend that the drill pipe and crossover subs used during drilling be inspected and results turned into Transco prior to the start of drilling and that reinspection be completed after a pre-determined time frame to reduce the risk of downhole drill pipe failures.**
- A positive displacement mud motor will be required to complete the pilot hole. Because of the strength and abrasivity of the bedrock, multiple mud motors may be required.
- The HDD contractor should closely monitor the hours and/or cone revolutions on all tooling to reduce the risk of bearing failure and tool loss downhole.
- The cutting structure design of roller cone drill bits and reamers should be appropriately selected based on the bedrock strength and abrasivity. The profile of the tungsten carbide inserts in the cones on the drill bits and reamers may have a large influence on the rate of penetration (ROP).
- For pipe diameters greater than 24 inches the final hole diameter is generally 12 inches larger than the carrier pipe diameter, or in this case with a 42-inch-diameter carrier pipe, roughly 54 inches. Multiple hole openers of various sizes will be required to enlarge the hole to a minimum final hole diameter of 54 inches which may present challenges for procuring hole openers on short notice.

6.5.2 Pilot Hole - Survey

According to Transco's Horizontal Directional Drilling – Construction specification 33 05 07P, "the position of the drill string must be monitored by contractor with precise downhole survey instruments and verified with secondary survey location equipment (i.e., TruTracker, ParaTrack or equal). A walkover type survey system is not considered equivalent and will require company approval."

The contractor should use a pilot hole survey system capable of calculating the location of the bottom hole assembly (BHA) based on the inclination and azimuth of the steering probe as well as through a secondary means. In addition, Transco's specifications require that the pilot hole survey system be capable of real-time annular pressure readings. The pilot hole survey system should be either a magnetic based system (TruTracker, ParaTrack, or equivalent) where the tool azimuth is determined using the earth's magnetic field or a gyroscopic based system (Brownline's GST, Vector Magnetics' PGM, or Sharewell's Opti-Trac) where both the inclination and azimuth of the survey tool are determined using gyroscopes. Both magnetic and gyroscopic systems available today provide for a secondary means of locating the BHA and annular pressure monitoring.

The proposed HDD alignment is located within an existing pipeline easement and generally crosses areas where the HDD contractor could use a secondary survey coil wire. We recommend the HDD contractor review the project plans, permitting requirements, and workspace limitations to determine the most appropriate pilot hole survey system for this site.

The HDD contractor should complete the pilot hole as closely as possible to the designed HDD alignment and profile while still maintaining three-joint vertical and horizontal radii equal to or greater than the minimum allowable radius specified on the HDD Design Drawing. **We recommend that the three-joint radius be calculated for each three-joint section (for Range 2 Drill Pipe, approximately 90 feet) completed during pilot hole operations. We recommend that the contractor drill the pilot hole within the specified horizontal and vertical tolerances provided on the HDD Design Drawing. We also recommend that, upon completion of the pilot hole, GeoEngineers have the opportunity to review the pilot hole survey data prior to the start of reaming operations.**

6.5.3 Reaming

We recommend that the HDD Contractor consider the use of HDD drill rigs on both sides of the crossing to increase the flexibility of drilling operations and aid in recovering tooling in the event of a downhole tooling failure. The HDD Contractor will need to be prepared for tooling wear mentioned above and consider the abrasivity of the bedrock anticipated along the HDD profile to estimate the amount of spare tooling that may be required to complete the installation.

6.5.4 Pullback

Based on our analysis of the installation loads (see Table 6), the pullback force during installation of the 42-inch-diameter carrier pipe may be as high as approximately 790,500 pounds, depending on the weight of the drilling fluid in the hole at the time of pullback, the buoyancy control measures employed by the contractor, and how well the hole is prepared for pullback. Because of the relatively large diameter of this installation, we anticipate that the HDD contractor will elect to use buoyancy control during pullback operations to reduce installation forces and reduce the likelihood of coating damage during installation. Because actual pull loads vary, sometimes greatly, from those estimated because of irregularities in the hole geometry, **we recommend that the selected HDD contractor drill the pilot hole within the specified tolerance using gradual steering corrections so that the pipe can more easily conform to the shape of the hole during installation.**

In our experience, the communication between the general and HDD contractor preceding and during installation of the carrier pipe can contribute, oftentimes significantly, to limiting downtime during pullback. Sheet 2 of the design drawings provides a plan and profile view of the stringing workspace with a typical HDD pullback alignment and additional pull section (s) for reference only. We recommend that the general and HDD contractor discuss the most effective layout of the fabricated pull section(s) and consider the following:

- Ability to install and repair fill lines for buoyancy control water and location of mobile storage tanks relative to the ends of the pull sections;
- Length of carrier pipe installed before temporarily suspending pullback to complete a mid-weld and associated risk;
- Type, size, spacing, and lift capabilities of pullback support equipment;
- Travel lanes for equipment and personnel during pullback operations; and
- Ground surface contours and any grading that may be required to safely support the carrier pipe without overstressing.

Transco's specifications require a pullback plan be submitted as part of the HDD contractor's drill plan. We recommend that the pullback plan address the items listed above at a minimum.

6.6 HYDRAULIC FRACTURE, INADVERTENT RETURNS AND FORMATIONAL FLUID LOSS

As is typical with all HDD installations, we anticipate that there is an elevated risk of hydraulic fracture and inadvertent returns near the entry and exit points. For this crossing, we anticipate there is a high risk of hydraulic fracture and IR within approximately 100 feet of the proposed HDD entry and exit points, assuming the pilot hole is completed using the pilot hole intersect method. As discussed in Section 5.1.4, we anticipate the risk of IR becoming high within approximately 100 and 225 feet of the proposed HDD exit and entry points, assuming the pilot hole is advanced solely from entry to exit or exit to entry, respectively, because of the combination of the shallow depth of cover, anticipated loose sandy soils, and the higher drilling fluid pressures required to transport cuttings as the profile reaches the exit point. We considered the higher risk of IRs near the HDD entry and exit points and proposed additional temporary workspace to include the portions of the HDD alignment where we anticipate the risk of IRs is high. We understand that no environmentally sensitive features or settlement sensitive structures are located within these high-risk zones. If this risk is unacceptable, temporary steel casing could be installed at the HDD entry point to help reduce the risk, however, it is possible that an IR may occur during installation of the temporary steel casing.

Beyond the areas near the entry and exit points, much of the HDD profile will be situated within conglomerate and siltstone bedrock. As mentioned above, it is our opinion that the risk of significant formational fluid loss along the proposed HDD is generally low to moderate except within the localized zones of poor rock quality observed in the borings.

As a general comment and consideration, proper management of the drilling fluid properties will assist with supporting the hole, properly removing soil and rock cuttings, and contribute to reducing the risk of hydraulic fracture and IR.

The HDD contractor should be aware that a project-specific Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan was developed as a FERC requirement and that they will be required to adhere to the protocols described within the plan. Furthermore, the HDD contractor should be aware that Transco's Horizontal Directional Drilling – Construction specification 33 05 07P requires the HDD contractor to:

- Employ a qualified third-party drilling fluid engineer/technician to develop a drilling fluid program and assist with maintaining appropriate drilling fluid properties during HDD operations.
- Monitor downhole annular pressures while drilling the pilot hole.
- Prepare a crossing-specific Inadvertent Drilling Fluid Return Contingency Plan to respond to IRs, if they should occur, along the HDD alignment.
- Monitor facilities and other sensitive areas within a minimum of 500 feet (pending permit and landowner constraints) of the drill path for drilling fluid migration and release.

These procedures should be addressed within the appropriate plans described within Transco's Horizontal Directional Drilling – Construction specification 33 05 07P and be reviewed and approved by Transco prior to construction.

6.7 CUTTINGS REMOVAL

Most of the proposed HDD profile appears to be located within fair to excellent quality sedimentary bedrock. Provided appropriate drilling fluid properties and flow rates are maintained, cuttings removal should not be problematic due to low penetration rates and higher drilling fluid rates. However, if poor drilling fluid properties are maintained, then the hole may become plugged causing drilling fluid circulation to cease and downhole annular pressures to increase, sometimes significantly. This temporary spike in downhole annular pressure can greatly increase the risk of hydraulic fracture and IRs. If drilling fluid returns begin to diminish or are lost, the HDD contractor should trip out the downhole tooling until drilling fluid returns are reestablished before proceeding forward or make other adjustments necessary to restore drilling fluid returns prior to further advancing the pilot hole or reamed hole.

Additionally, if cuttings cannot be effectively removed from the hole during HDD operations, pullback forces could become excessively high during pullback of the carrier pipe, or the carrier pipe could become lodged in the hole. The failure to effectively remove cuttings from the hole could potentially result in failure of the HDD installation. Therefore, we recommend that the HDD contractor maintain drilling fluid returns at all times and use appropriate means and methods (appropriate penetration rates, drilling fluid management, and mechanical methods) to adequately remove cuttings from the hole during the HDD process. Furthermore, we recommend that a drilling fluid engineer be required to test the drilling fluid properties during HDD operations. In our opinion, understanding the drilling fluid rheology (plastic viscosity and yield point) throughout construction is critical to assessing the quality of the drilling fluid and the risk of a potential downhole blockage from accumulated cuttings. As such, and in accordance with Transco's specifications, the contractor should be required to test the drilling fluid rheology throughout construction.

6.8 DRILL HOLE STABILITY

We consider the overall hole instability risk for the proposed HDD to be generally low because the HDD profile should largely be situated within fair to excellent quality bedrock; however, there are localized zones of poorer rock quality which will have a greater risk of hole instability. As the hole diameter increases with successive reaming passes, the risk of instability may increase marginally. In the event of minor collapse within the rock portion of the hole during the reaming process, larger rock fragments should be able to be broken down into smaller fragments by the reaming tools.

The difference in elevation of approximately 40 feet between the HDD entry and exit points of the proposed HDD will cause the drilling fluid within the hole to come to equilibrium at the lower of the two points, causing a portion of the hole to be situated above the drilling fluid equilibrium elevation. This condition creates a dry section within the hole, or portion of the drilled hole, which will be unsupported by drilling fluid. Subsurface conditions along the dry hole section are anticipated to consist of medium dense silty sand residuum and very dense sand with varying silt content (decomposed bedrock). For the segment of the profile within the decomposed bedrock, we judge the risk of hole collapse to be low to moderate, and where the profile is shallow near the entry point, we judge the risk of hole collapse to be high. Large-diameter casing should be installed before beginning pilot hole operations and left in place throughout construction to mitigate the risk of hole collapse.

Near the exit point, we consider the risk of hole instability within the shallow portions of the HDD profile situated in the overlying soils to be low to moderate, with the highest risk within approximately 50 feet of the exit point because of the long construction duration expected to install the new pipeline.

Additionally, if extended zones of poor quality bedrock are encountered, or in transition zones from soil to rock and rock to soil, there is potential for localized hole stability problems. We judge the risk of hole instability along this section of the hole to be overall low. **The HDD contractor should submit a plan as part of the drill plan describing how hole instability risks will be mitigated.**

6.9 SOIL/BEDROCK INTERFACE

Based on the borings completed at the site, the subsurface conditions along the designed profile likely transition from soil to rock along the entry and exit tangents. The soil/bedrock interface along with transitions from softer to harder rock and vice versa may cause steering difficulties during pilot hole operations as the drill bit could become deflected from the designed HDD profile and follow the contour(s) of the soil/rock interface(s), potentially causing an excessive offset within the hole. If steering difficulties are experienced, the contractor can reduce the drilling penetration rate to allow the drill bit additional time to penetrate through the rock versus sliding along the soil/rock interface(s). In our opinion, the risk of steering difficulties transitioning from soil to rock along the entry and exit tangents is relatively low because of the presence of a weathering profile to the bedrock that results in a gradual transition from very soft decomposed rock to harder more competent bedrock.

During the reaming process, the soil/rock interface(s) within the hole can be a location where an excessive vertical offset (dogleg) in the hole profile can form as a result of the relatively heavy rock hole openers over-mining the bottom of the soil portions of the hole. Vertical offsets may also occur where significant variations in bedrock strength are observed. Decreasing the penetration rates of downhole tooling while passing the locations of the soil and rock interface will help allow for the downhole tooling to create a smoother profile and reduce the risk of a vertical offset from developing. If it is suspected that a severe hole offset exists at the soil/rock interface or along segments of the profile where the strength of the bedrock varied significantly, the hole can be reamed to a larger diameter than typically required to allow more annular space for the carrier pipe to conform to the hole and pass through the interface without becoming lodged in the hole. The HDD Contractor should submit an assessment of the potential for excessive hole offset at the soil/rock interface(s) and their proposed mitigation procedures to reduce this risk with their drill plan.

7.0 Conclusions and Recommendations

It is our opinion that there is a high probability for a qualified, prepared HDD contractor to successfully complete this crossing provided that the contractor adequately addresses the considerations outlined in this report and conducts their operations in general accordance with the HDD Best Practices presented in Appendix E.

7.1 GENERAL RECOMMENDATIONS

We recommend that a prequalification process of the candidate HDD contractors be initiated and then an agreement set in place with the selected HDD contractor so that detailed construction procedures can be

agreed upon through means of a written drill plan. **We recommend that GeoEngineers be given an opportunity to review the drill plan prepared by the HDD contractor to confirm that the considerations outlined in this report were adequately addressed.**

We recommend contacting GeoEngineers. immediately if subsurface conditions are claimed to be different than presented in this report. Because the subsurface conditions can vary between widely spaced borings, we recommend GeoEngineers be on site during HDD construction to document the drilling process in real time and to characterize and quantify risks that might reduce the potential for a successful installation of this HDD.

In accordance with Transco's Horizontal Directional Drilling – Construction specification 33 05 07P, a qualified drilling fluid technician or engineer will be required to evaluate the drilling fluid properties (including rheological properties [plastic viscosity and yield point]) on a continuous basis throughout the entire HDD process. Close coordination between the HDD contractor and the drilling fluid technician is vital to maintaining proper drilling fluid properties, penetration rates and drilling fluid flow rates.

7.2 HDD DRILL PLAN REQUIREMENTS

We recommend that the HDD contractor address the items below in their HDD Drill Plan to facilitate a successful carrier pipe installation and to mitigate possible difficulties that could arise during the HDD installation. The list below is intended to provide items that should be addressed based on site-specific construction considerations but does not include all items that are provided in a typical drill plan such as size and type of equipment to be used to complete the crossing, pilot hole tracking system and drilling fluid recycling system. The contractor's drill plan should include all drill plan items required in the contract specifications and include those noted below.

- Method by which the contractor will physically locate (pothole) and protect existing utilities near the proposed entry and exit points.
- A plan that addresses how the bedrock strength and abrasivity will affect penetration rates and the estimated construction schedule, necessary drill bit and hole opener specifications, and the number of drill bits and hole openers in their estimate. Consideration of the following should be discussed:
  - Use of HDD drill rigs on both sides of the crossing.
  - Monitoring plan for downhole tooling hours/revolutions.
  - Monitoring/inspection plan for drill pipe and crossover sub wear.
- Proposed pilot hole survey system(s) and a narrative describing any limitations on the selected survey system.
- A pilot hole drill plan to reduce the risks of hydraulic fracture and inadvertent returns. The plan should include the following:
  - Drill bit type and size and drill pipe sizes with the intention of providing sufficient annular space between the drilled hole and the drill pipe such that the risk of hydraulic fracture and inadvertent returns can be reduced to the extent practical.
  - Proposed method of monitoring downhole annular pressures during pilot hole operations in accordance with Transco's specifications.

- A contingency and mitigation plan to respond to downhole annular pressure spikes, loss of drilling fluid returns and inadvertent drilling fluid returns, if they should occur, along the HDD profile. This plan should include, but not be limited to, drilling fluid returns monitoring and response, surface patrols, containment structures, drilling fluid removal, and materials to be staged at the site to contain and collect inadvertent returns. This plan should emphasize means and methods the contractor will utilize to reduce the risk of inadvertent returns occurring along the HDD alignment in general. This plan should be reviewed and approved by Transco and any applicable regulatory agencies prior to the beginning of construction.
- A plan describing how hole instability risks, particularly near the HDD entry point, will be mitigated during construction.
- An assessment of the potential for excessive hole offset at the soil/rock interface(s) and proposed mitigation procedures to reduce this risk as part of the drill plan.
- Documentation for all drilling fluid constituents intended for use, including manufacturer's literature and material safety data sheets (MSDS).

8.0 Failure and Contingency Planning

As a result of Transco's commitment to undertake a robust subsurface exploration program, we anticipate the Sandy River HDD has a low risk of failure provided that the contractor prepares a drill plan that addresses the conditions described in this report. Transco has prepared and submitted a Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan addressing contingency planning for the proposed Sandy River HDD, as required for the project. In the event difficulties are encountered during construction, Transco, the HDD contractor and general contractor will implement the contingency plan as appropriate.

9.0 Limitations

We have prepared this report for use by Transco and their authorized agents and other approved members of the design team involved with this project. The report is not intended for use by others and the information contained herein is not applicable to other sites. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions. The conclusions and recommendations in this report should be applied in their entirety.

Variations in subsurface conditions are possible between the borings. Subsurface conditions may also vary with time. A contingency for unanticipated conditions should be included in the project budget and schedule for such an occurrence. We recommend that sufficient monitoring and consultation be provided by GeoEngineers during construction to confirm that the conditions encountered are consistent with those indicated by the borings, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and pipeline installation activities comply with contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct The HDD contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in developing a drill plan.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty or other conditions, express, written, or implied, should be understood.

Please refer to Appendix F, titled "Report Limitations and Guidelines for Use," for additional information pertaining to the use of this report.

10.0 References

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Tables

Table 7

Rock Core Laboratory Test Results[1]

Sandy River HDD

Pittsylvania County, Virginia

Boring	Depth (Feet)	Dry Unit Weight (pcf)	Mohs' Hardness	Cerchar Abrasivity Index	Point Load Estimated Compressive Strength (psi)	Tensile Splitting Strength (psi)	Young's Modulus (psi)	Unconfined Compressive Strength (psi)
SR-B-1	67 - 68	161	5.5					8,590
	90.5 - 91	158	7.5					12,680
	108 - 109	161	7.5					20,300
	121 - 122	163	4.5					11,300
	136 - 137	164	6.5					8,990
	145			4.42				
	153 - 154	175	4.5				7,059,000	10,664
	160			3.4				
	168 - 169	173	4.5					6,540
	181 - 182	178	5.5					2,280
SR-B-2	26 - 31				663			
	61 - 66				924			
	101 - 106	162	6.5					7,810
	116 - 121	164	6.5	4.41				8,790
	131 - 136	164	7.5	4.54			11,140,000	24,040
	146 - 151	162	4.5					7,960
SR-B-3	35 - 36	160	5.5					13,020
	58 - 59	165	4.5					8,360
	80 - 81	164	7.5					14,970
	103 - 104	163	7.5					14,110
	116 - 117	163	6.5					21,580
	131.7 - 132.5	166	6.5				11,360,000	23,105
	132			4.18				
	136 - 141	161	6.5		17,041			
	150 - 151	165	7.5					6,370
	165 - 166	163	6.5					11,130
SR-B-4	31.2 - 36.2	164	6.5					11,780
	59 - 61.2	163	4.5					25,410
	71.2 - 76.2	164	5.5					8,190

Table 7

Rock Core Laboratory Test Results[1]

Sandy River HDD

Pittsylvania County, Virginia

Boring	Depth (Feet)	Dry Unit Weight (pcf)	Mohs' Hardness	Cerchar Abrasivity Index	Point Load Estimated Compressive Strength (psi)	Tensile Splitting Strength (psi)	Young's Modulus (psi)	Unconfined Compressive Strength (psi)
	86.2 - 91.2	163	5.5					7,450
	100			4.33				
	101.2 - 106.2	164	7.5				14,060,000	23,140
	116.2 - 121.2	163	5.5					14,880
	136.2 - 138.2	161	6.5					8,550
SR-B-5	30 - 31	162	6.5					7,780
	33.2 - 34			3.08				
	41 - 46	166	7.5				14,570,000	31,343
	56 - 58	163	5.5					9,970
	76 - 81	164	6.5					11,040
	98 - 100	162	6.5					18,610
	121 - 123	167	4.5					22,280
	146 - 148	164	4.5					13,100
SR-B-6	52.4 - 57.4	163	6.5				7,768,000	18,354
	60.5 - 61.2	157	6.5	4.05				9,470
	77.4 - 78.4	163	7.5					11,870
	87 - 87.4			3.74				
	94 - 95	157	4.5					5,780
	114 - 115	159	4.5					15,850
	133 - 134	162	4.5					10,690

Notes:

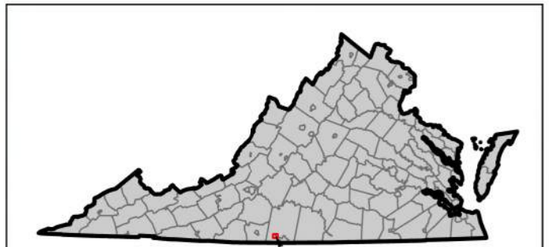
[1]Refer to Geotechnical Data Report for laboratory test results and rock core photographs.

pcf = pounds per cubic foot; psi = pounds per square inch

Figures

Legend

- Proposed Centerline Alignment
- Proposed HDD Alignment



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers USA, P.C. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI

Projection: NAD 1983 2011 StatePlane Virginia South FIPS 4502 Ft US

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FEET

Transcontinental Gas Pipeline Company, LLC
Vicinity Map

Proposed 42-inch Eden Loop
Sandy River HDD
Pittsylvania County, Virginia

GeoEngineers

FIGURE 1

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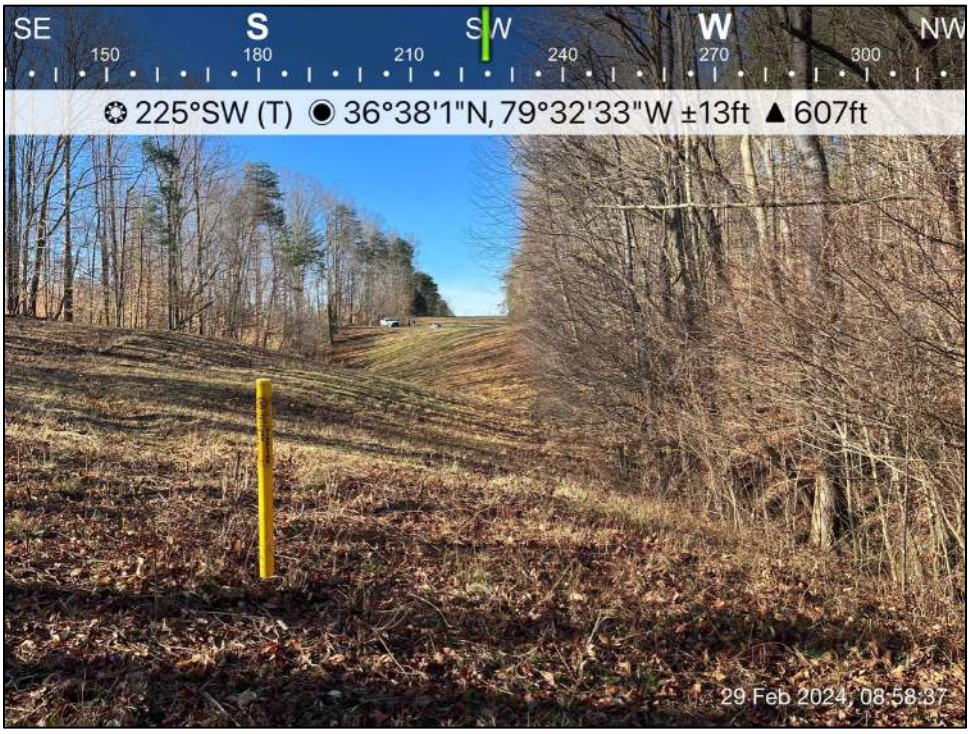
Photograph 1: Sandy River Horizontal Directional Drill (HDD) Entry (southwest side) Workspace (Facing Northeastward)



Photograph 2: Sandy River HDD Entry Workspace (Facing Southwestward)

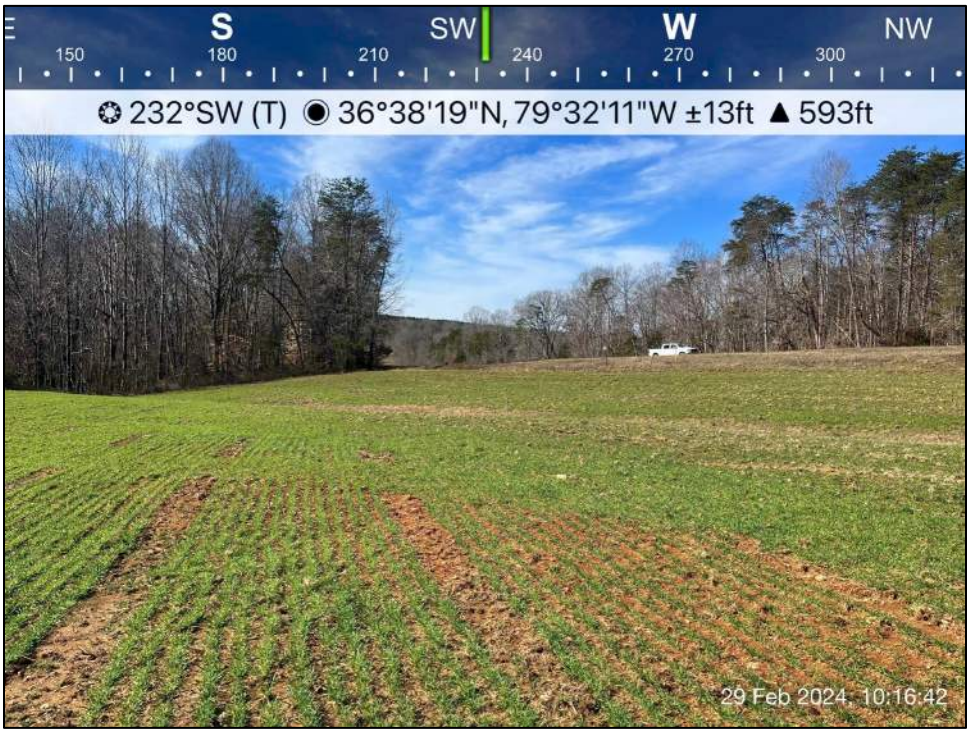
Transcontinental Gas Pipeline Company, LLC
Sandy River Site Photographs

Proposed 42-inch Eden Loop
Sandy River HDD
Pittsylvania County, Virginia

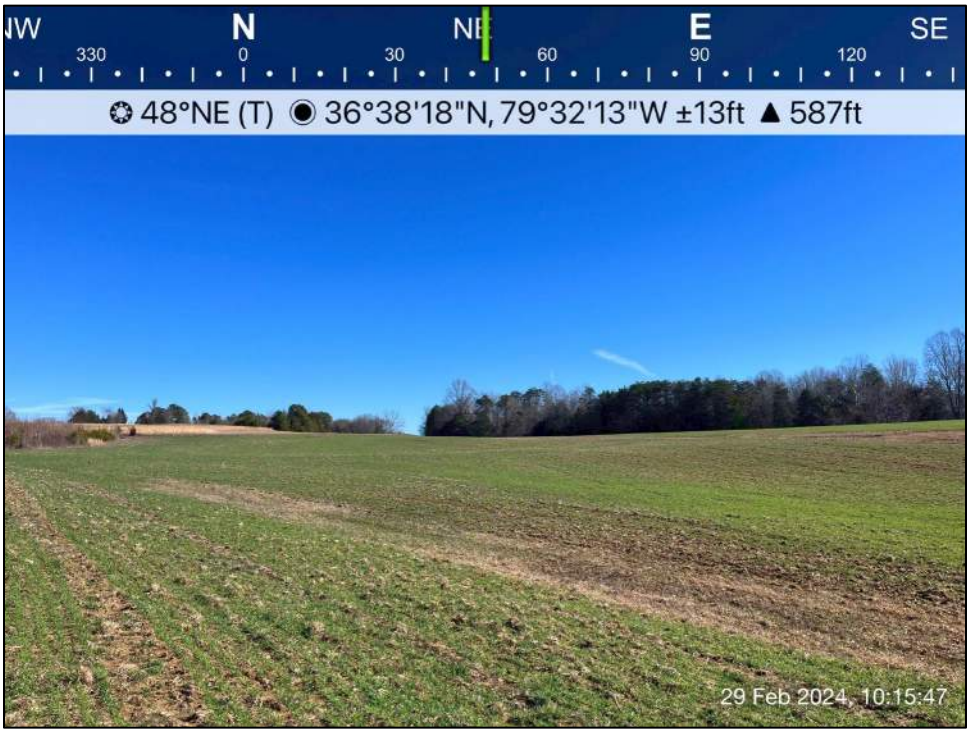
GeoEngineers

Figure 2

8169-235-00 Date Exported: 8/14/24



Photograph 3: Sandy River HDD Exit (northeast side) Workspace (Facing Southwestward)



Photograph 4: Sandy River HDD Exit Workspace (Facing Northeastward)

Transcontinental Gas Pipeline Company, LLC
Sandy River HDD Site Photographs

Proposed 42-inch Eden Loop
Sandy River HDD
Pittsylvania County, Virginia

GeoEngineers

Figure 3

8169-235-00 Date Exported: 8/14/24

Photograph 5: Sandy River HDD Pipe Stringing and Fabrication Workspace (Facing Northeastward)

Transcontinental Gas Pipeline Company, LLC
Sandy River HDD Site Photographs

Proposed 42-inch Eden Loop
Sandy River HDD
Pittsylvania County, Virginia

GeoEngineers

Figure 4

8169-235-00 Date Exported: 8/14/24

Photograph 6: Sandy River (Facing Southwestward)

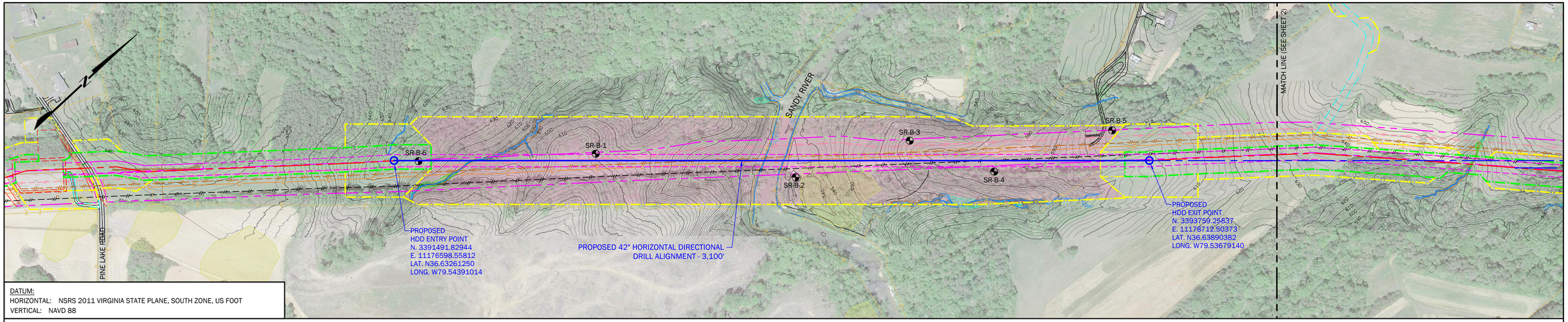
Transcontinental Gas Pipeline Company, LLC Sandy River HDD Site Photographs	
Proposed 42-inch Eden Loop Sandy River HDD Pittsylvania County, Virginia	
GeoEngineers	Figure 5

8169-235-00 Date Exported: 8/14/24

Appendices

Appendix A

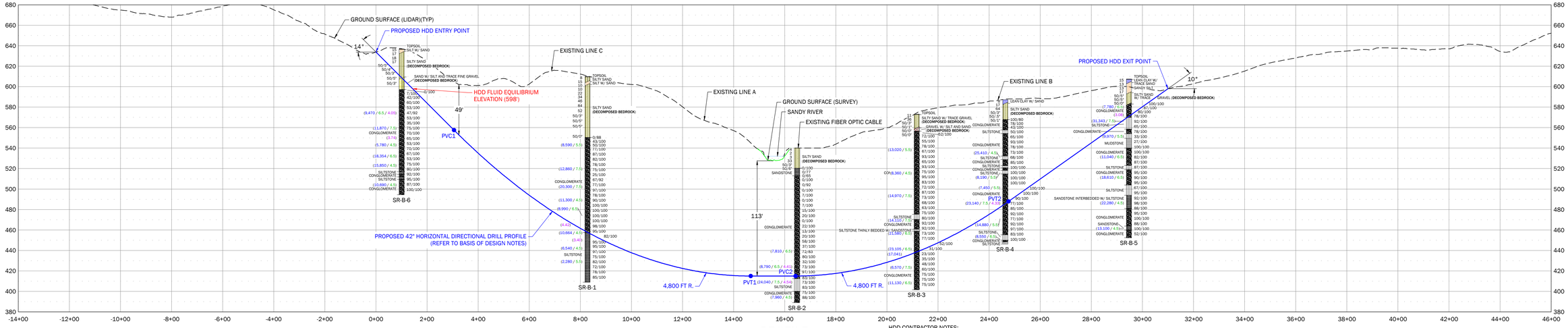
Design Drawings (Sheets 1 through 4)



DATUM:
HORIZONTAL: NSRS 2011 VIRGINIA STATE PLANE, SOUTH ZONE, US FOOT
VERTICAL: NAVD 88

PLAN

200 0 200
SCALE IN FEET



DIRECTIONAL DRILL DATA SANDY RIVER HDD		
DESCRIPTION	STATION (FT)	ELEVATION (FT)
ENTRY @ 14°	0+00.00	633.82
PVC1 (14.00° @ 4,800 FT R.)	3+05.77	557.58
PVT1	14+66.99	415.00
PVC2 (10.00° @ 4,800 FT R.)	16+42.22	415.00
PVT2	24+75.73	487.92
EXIT @ 10°	31+00.00	598.00
HORIZONTAL DISTANCE = 3,100.00 FT		
DIRECTIONAL DRILL PIPE LENGTH = 3,134.87 FT		

PILOT HOLE TOLERANCES	
ITEM	* TOLERANCE
ENTRY ANGLE	INCREASE ANGLE UP TO 1° (STEEPER), BUT NO DECREASE IN ANGLE ALLOWED.
ENTRY LOCATION	AS PER COORDINATES PROVIDED BY COMPANY WITH NO CHANGES WITHOUT COMPANY APPROVAL.
EXIT ANGLE	INCREASE ANGLE UP TO 1° (STEEPER) OR DECREASE UP TO 2° (FLATTER).
EXIT LOCATION	UP TO 20 FEET BEYOND OR 10 FEET SHORT OF THE EXIT STAKE. BETWEEN 5 FEET LEFT AND 5 FEET RIGHT OF CENTERLINE.
DEPTH	UP TO 2 FEET ABOVE THE DESIGN DRILL PROFILE ALLOWED. UP TO 10 FEET BELOW THE DESIGN DRILL PROFILE ALLOWED.
ALIGNMENT	UP TO 5 FEET LEFT OR RIGHT OF THE HDD ALIGNMENT WILL BE ALLOWED.
MINIMUM ALLOWABLE 3-JOINT RADIUS	3,200 FEET

* TOLERANCE SHALL BE MAINTAINED UNLESS OTHERWISE APPROVED BY THE COMPANY.

BORING LEGEND

SPT N — TYPE OF SOIL
UNCONFINED COMPRESSIVE STRENGTH (PSI)
Mohs HARDNESS (#)
CERCHAR ABRASIVITY INDEX (#)
RQD/REC% — TYPE OF ROCK
BORING LOCATION

PROFILE

200 0 200
HORIZONTAL SCALE IN FEET
50 0 50
VERTICAL SCALE IN FEET

Table 1: Mohs Hardness Scale

Mineral Name	Scale Number	Common Object
Diamond	10	
Corundum	9	Masonry Drill Bit (8.5)
Topaz	8	
Quartz	7	Steel Nail (6.5)
Orthoclase	6	Knife / Glass Plate (5.5)
Apatite	5	
Fluorite	4	Copper Penny (3.5)
Calcite	3	Fingernail (2.5)
Gypsum	2	
Talc	1	

Table 2: Cerchar Abrasivity Index Classification

Classification	Average CAI (hrc=55)
Very Low Abrasiveness	0.3 – 0.5
Low Abrasiveness	0.5 – 1.0
Medium Abrasiveness	1.0 – 2.0
High Abrasiveness	2.0 – 4.0
Extreme Abrasiveness	4.0 – 6.0
Quartzitic	6.0 – 7.0

BASIS OF DESIGN:

1. CARRIER PIPE WILL CONSIST OF 42" O.D. X 0.888" W.T., API-5L X-70 PIPE WITH 12 MILS BASE FUSION BONDED EPOXY (FBE), 30 MILS OF FBE-ABRASION RESISTANT OVERLAY (ARO), AND 50 MILS OF LIQUID ARO.
2. THE MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP) = 1,480 PSI.
3. DESIGN FACTOR = 0.5
4. THE ASSUMED OPERATING TEMPERATURE = 70° FAHRENHEIT
5. THE ASSUMED TIE-IN TEMPERATURE = 50° FAHRENHEIT

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
9/10/2024
PROFESSIONAL ENGINEER

ISSUED FOR PERMIT
NOT FOR CONSTRUCTION

LEGEND

- PROPOSED CENTERLINE ALIGNMENT
- PROPOSED PIPELINE EASEMENT
- EXISTING COMPANY ROW
- EXISTING LINE A
- EXISTING LINE B
- EXISTING LINE C
- PROPOSED TEMPORARY WORKSPACE
- PROPOSED ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED ACCESS ROUTE
- PROPOSED FOOT TRAFFIC WORKSPACE
- EXISTING PROPERTY LINE
- SD — EXISTING STORM DRAIN
- C — EXISTING FIBER OPTIC CABLE
- P — EXISTING OVERHEAD POWER
- X — EXISTING FENCE
- EXISTING DRAINAGE CENTERLINE
- TOP OF BANK
- EDGE OF ROAD
- ROAD CENTERLINE
- TREE LINE
- PALUSTRINE EMERGENT WETLANDS
- PALUSTRINE FORESTED WETLANDS
- ARCHAEOLOGICAL AREA
- WATERWAY LINE
- MAJOR CONTOUR - 10' INTERVAL
- MINOR CONTOUR - 2' INTERVAL

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HDD CONTRACTOR NOTES:

1. HDD CONTRACTOR SHALL ADHERE TO OWNER'S SPECIFICATIONS, CONTRACT DOCUMENTS AND SPECIAL PERMIT CONDITIONS, EXCEPT AS NOTED ON THIS DRAWING.
2. HDD CONTRACTOR SHALL FAMILIARIZE THEMSELVES WITH THE ACCOMPANYING HDD DESIGN REPORT FOR A MORE DETAILED DESCRIPTION OF THE HDD DESIGN BASIS AND ASSUMPTIONS INCLUDING SUBSURFACE CONDITIONS, SURFACE CONDITIONS, AND HDD CONSTRUCTION RISKS AND CONSIDERATIONS.
3. HDD CONTRACTOR IS RESPONSIBLE FOR CALLING VIRGINIA ONE-CALL AND PHYSICALLY LOCATING UNDERGROUND UTILITIES THAT MAY CONFLICT WITH HDD OPERATIONS PRIOR TO BEGINNING CONSTRUCTION.
4. HDD CONTRACTOR SHALL IDENTIFY AND PROTECT ANY UTILITY THAT MAY BE AFFECTED BY THE HDD OPERATIONS.
5. WATER USED FOR HDD OPERATIONS SHALL BE OBTAINED FROM A SOURCE APPROVED BY OWNER.
6. REFUELING OF ALL EQUIPMENT SHALL BE COMPLETED IN ACCORDANCE WITH THE OWNER'S CONTRACT DOCUMENTS.
7. THE HDD PILOT HOLE SHALL BE ADVANCED FROM THE EXIT POINT TO THE ENTRY POINT AS SHOWN UNLESS OTHERWISE APPROVED BY THE OWNER IN CONSULTATION WITH GEOENGINEERS.
8. THE HDD PILOT HOLE GEOMETRY SHALL BE MAINTAINED WITHIN THE TOLERANCES SHOWN ON THESE DRAWINGS.
9. DURING PILOT HOLE OPERATIONS, DOWNHOLE ANNULAR PRESSURES WILL BE RECORDED AND EVALUATED RELATIVE TO CALCULATED AND ANTICIPATED ANNULAR DRILLING FLUID PRESSURE RANGE. IF THE DOWNHOLE ANNULAR PRESSURE BEGINS TO DEVIATE OUTSIDE OF THE CALCULATED AND ANTICIPATED ANNULAR DRILLING FLUID PRESSURE RANGE, THE HDD CONTRACTOR WILL EVALUATE DRILLING CONDITIONS AND TAKE NECESSARY AND REASONABLE STEPS TO BRING THE ANNULAR DRILLING FLUID PRESSURE BACK WITHIN THE EXPECTED RANGE.
10. DRILLING FLUID PROPERTIES SHALL BE MONITORED AND TESTED BY A DRILLING FLUID ENGINEER AND BE MODIFIED AS NECESSARY TO MAINTAIN HOLE STABILITY, EFFECTIVELY REMOVE CUTTINGS, AND LIMIT ANNULAR DRILLING FLUID PRESSURES.
11. HDD CONTRACTOR SHALL TAKE NECESSARY STEPS TO MAINTAIN DRILLING FLUID RETURNS TO THE ENTRY AND/OR EXIT POINTS. IF DRILLING FLUID RETURNS DIMINISH, HDD CONTRACTOR SHALL IMPLEMENT PROCEDURES OUTLINED WITHIN HDD IR CONTINGENCY PLAN.
12. THE HDD CONTRACTOR SHALL PROVIDE PILOT HOLE SURVEY DATA TO OWNER'S REPRESENTATIVE UPON REQUEST.
13. ACCESS TO THE DRILL CAB SHALL BE PERMITTED BY APPROVED OWNER'S REPRESENTATIVE IN ORDER TO OBSERVE AND DOCUMENT GUAGE DATA AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE.
14. AFTER THE PILOT HOLE IS COMPLETE, CONTRACTOR'S AS-DRILLED PROFILE SHALL BE SUBMITTED TO OWNER FOR APPROVAL PRIOR TO PROCEEDING WITH HDD ACTIVITIES IF REQUIRED BY THE CONTRACT DOCUMENTS.
15. THE DRILL STRING SHALL BE ROTATED PRIOR TO PUMPING DRILLING FLUID DOWNHOLE TO BREAK THE FLUID GEL STRENGTH AND ALLOW THE FLUID TO BECOME MORE FLOWABLE.
16. HDD CONTRACTOR SHALL CONFIRM THAT THE HOLE IS PROPERLY PREPARED FOR CARRIER PIPE PULLBACK BY CONDUCTING AT LEAST ONE SWAB PASS, AS REQUIRED BY OWNER'S SPECIFICATIONS.
17. THE CARRIER PIPE PULL SECTION(S) SHALL BE MADE UP WITHIN THE APPROVED CONSTRUCTION PIPE STRINGING AND FABRICATION WORKSPACE AS SHOWN ON THIS DRAWING.
18. HDD CONTRACTOR SHALL DISPOSE OF EXCESS DRILLING FLUID IN ACCORDANCE WITH THE APPROVED DRILL PLAN AND OWNER'S CONTRACT DOCUMENTS.
19. HDD CONTRACTOR SHALL FOLLOW THE REQUIREMENTS IN THE CONTRACT DOCUMENTS REGARDING INADVERTENT DRILLING FLUID RETURNS PREVENTION, MONITORING, CONTAINMENT AND REPORTING.

REFERENCES:

1. GEOTECHNICAL DATA: THE GEOTECHNICAL INFORMATION PROVIDED ON THIS DRAWING IS A GENERAL SUMMARY. REFER TO THE HDD DESIGN REPORT ASSOCIATED WITH THIS DRAWING FOR MORE DETAILED INFORMATION.
2. AERIAL IMAGE TAKEN FROM GOOGLE EARTH PRO © 2024, LICENSED TO GEOENGINEERS, INC., IMAGE DATED 12/01/22.
3. GROUND SURFACE AND SURVEY DATA PROVIDED BY TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC.

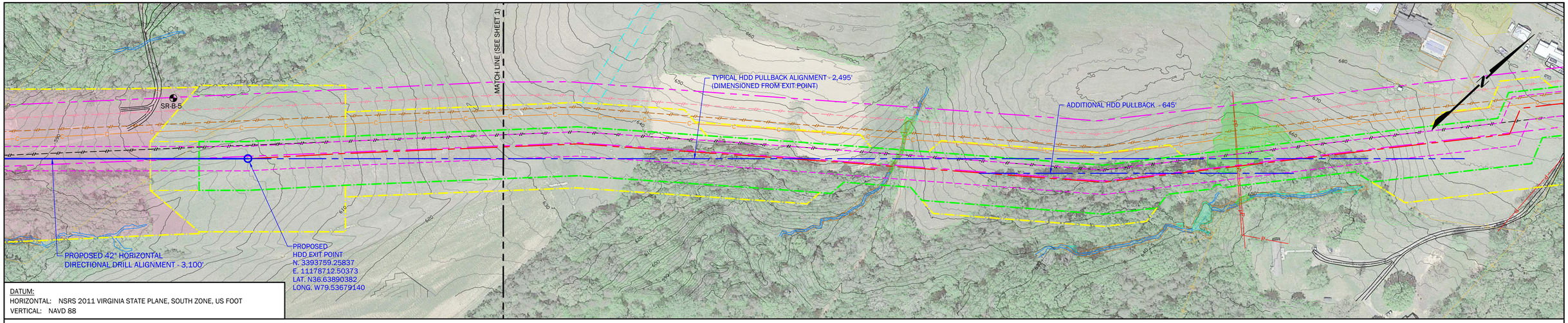
REFERENCE DRAWINGS		REVISIONS						
DRAWING NO.	TITLE	NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
MAIN-E_28_PEX	CIVIL SURVEY	A	03/01/24	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
EDEN LAND	BOUNDARY SURVEY	B	06/12/24	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
EDEN PROP	PROPOSED CENTERLINE, EASEMENTS & TWS	C	08/02/24	BTL	ISSUED FOR REVIEW: NOT FOR CONSTRUCTION		TJP	
SHAPE FILES	ARCHAEOLOGY & WETLANDS	D	08/21/24	BTL	DRAFT: NOT FOR CONSTRUCTION		TJP	
PROP MAINT	COMPANY MAINTENANCE AREA	E	09/10/24	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR

TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
PLAN AND PROFILE
SANDY RIVER HDD
MP 1394.98 TO 1395.57
PITTSYLVANIA COUNTY, VIRGINIA

Williams

DRAWN BY: BTL	DATE: 02/20/24	ISSUED FOR BID:	SCALE: 1" = 200'
CHECKED BY: TJP	DATE: 02/20/24	ISSUED FOR CONSTRUCTION:	REVISION:
APPROVED BY:	DATE:	DRAWING NUMBER: SANDY RIVER HDD_REV E	SHEET 1 OF 4
WO:	RID:	5:53:21 PM BLANE 9/10/2024	

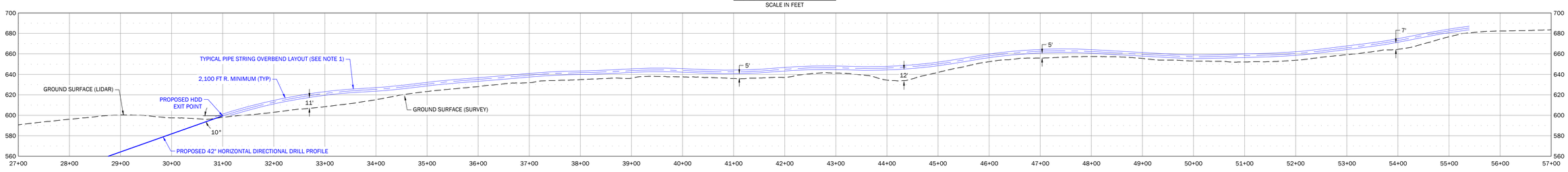
T:\P-B\1500\25\CAD\DWG\PRINT\Sandy_River\Sandy River HDD\Sandy River HDD_Rev E.dwg



DATUM:
HORIZONTAL: NSRS 2011 VIRGINIA STATE PLANE, SOUTH ZONE, US FOOT
VERTICAL: NAVD 88

PLAN

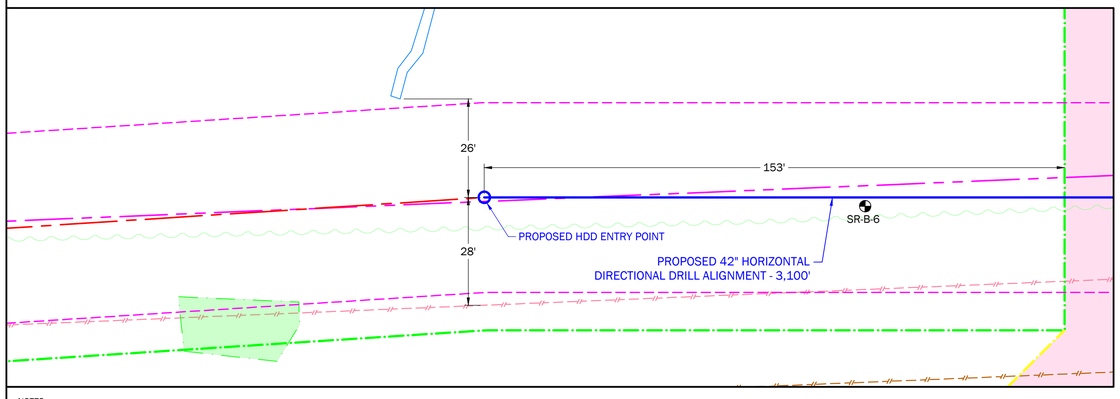
100 0 100
SCALE IN FEET



PROFILE

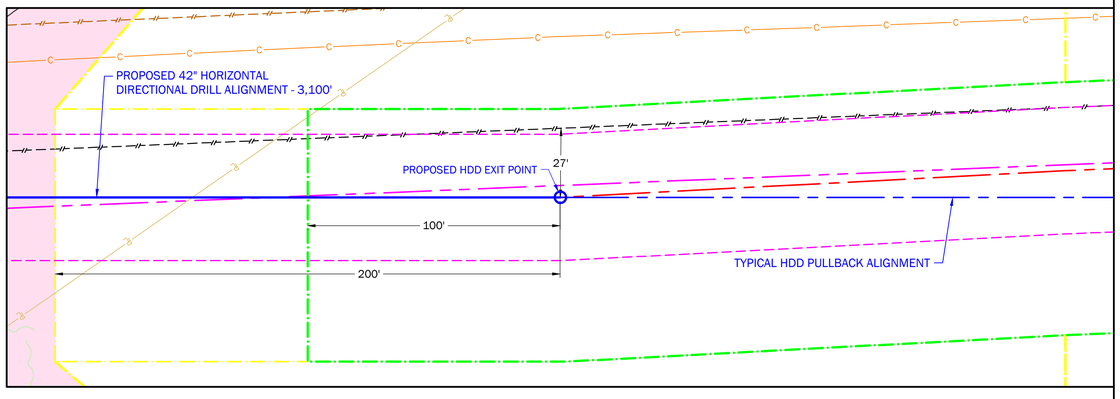
100 0 100
SCALE IN FEET

50 0 50
VERTICAL SCALE IN FEET



ENTRY DETAIL

20 0 20
SCALE IN FEET



EXIT DETAIL

30 0 30
SCALE IN FEET

NOTES:

1. TYPICAL PIPE STRING OVERBEND LAYOUT ASSUMES A RADIUS OF CURVATURE OF 2,100 FEET. DIMENSIONS RELATIVE TO GROUND SURFACE ARE FOR REFERENCE ONLY.
2. HDD CONTRACTOR SHALL SUBMIT A PULLBACK LIFT PLAN IN ACCORDANCE WITH TRANSCO'S SPECIFICATIONS AND CONTRACT DOCUMENTS.

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
9/10/24
PROFESSIONAL ENGINEER

ISSUED FOR PERMIT
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LEGEND

- BORING LOCATION
- PROPOSED CENTERLINE ALIGNMENT
- PROPOSED PIPELINE EASEMENT
- EXISTING COMPANY ROW
- EXISTING LINE A
- EXISTING LINE B
- EXISTING LINE C
- PROPOSED TEMPORARY WORKSPACE
- PROPOSED ADDITIONAL TEMPORARY WORKSPACE
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- ARCHAEOLOGICAL AREA
- WATERWAY LINE
- MAJOR CONTOUR - 10' INTERVAL
- MINOR CONTOUR - 2' INTERVAL

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REFERENCE DRAWINGS	
DRAWING NO.	TITLE
MAIN-E_28_PEX	CIVIL SURVEY
EDEN LAND	BOUNDARY SURVEY
EDEN PROP	PROPOSED CENTERLINE, EASEMENTS & TWS
SHAPE FILES	ARCHAEOLOGY & WETLANDS
PROP MAINT	COMPANY MAINTENANCE AREA

REVISIONS						
NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
A	03/01/24	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
B	06/12/24	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
C	08/02/24	BTL	ISSUED FOR REVIEW: NOT FOR CONSTRUCTION		TJP	
D	08/21/24	BTL	DRAFT: NOT FOR CONSTRUCTION		TJP	
E	09/10/24	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR

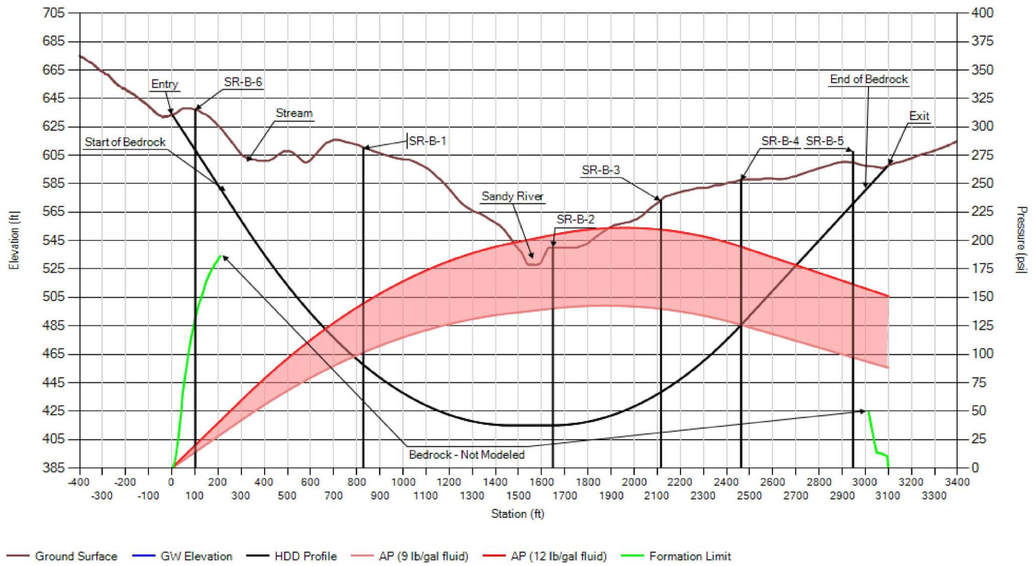
TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
STRINGING WORKSPACE / DETAILS
SANDY RIVER HDD
MP 1394.98 TO 1395.57
PITTSYLVANIA COUNTY, VIRGINIA

Williams

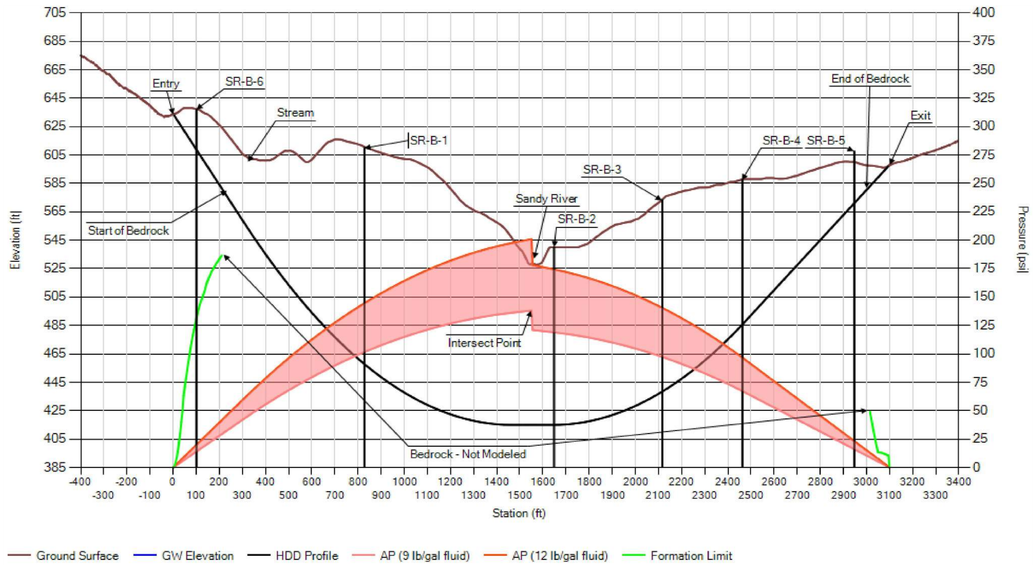
DRAWN BY: BTL	DATE: 02/20/24	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY: TJP	DATE: 02/20/24	ISSUED FOR CONSTRUCTION:	REVISION:
APPROVED BY:	DATE:	DRAWING NUMBER: SANDY RIVER HDD_REV E	SHEET 2 OF 4
WO:	RID:	5:53:49 PM BLANE 9/10/2024	

T:\PJT\2024\0237\CAD\TH\DWG\Virginia_Eden Sandy River\2024 Sandy River HDD_Rev E.dwg

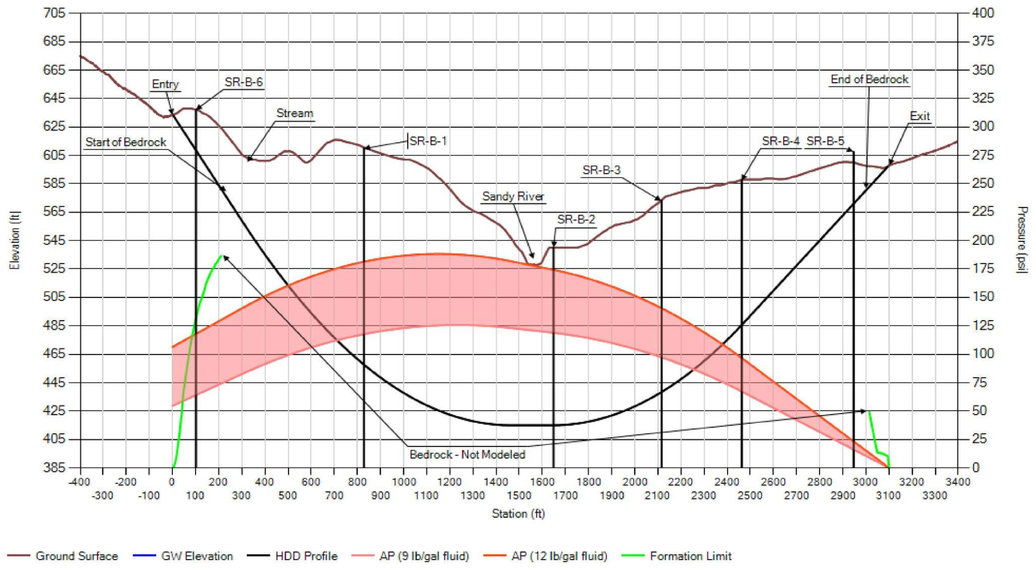
Hydraulic Fracture Analysis (HFA) (Entry To Exit)



Hydraulic Fracture Analysis (HFA) (Intersect)



Hydraulic Fracture Analysis (HFA) (Exit To Entry)



HDD Design Summary

Project: SSE Project - Eden Loop
HDD Name: Sandy River HDD
Owner: Transcontinental Gas Pipeline Company, LLC
Project No: 8169-235-00 **By:** TJP **Ck'd By:** MAM **Location:** Pittsylvania County, VA **Date:** Tuesday, September 10, 2024

Design Parameters

- Pipe Diameter = 42.000 in
- Wall Thickness = 0.888 in
- Yield Stress = 70,000 psi
- Pipe Material = Steel
- Min. Operating Temp = 50 °F
- Max. Operating Temp = 70 °F
- Design Factor = 0.5
- MAOP = 1,480 psi

Drill Data Box

Point	Station (ft)	Elevation (ft)
ENTRY @ 14°	0.00	633.82
PVC1 (14.00° @ 4,800 ft R.)	305.77	557.58
PVT1	1,466.99	415.00
PVC2 (10.00° @ 4,800 ft R.)	1,642.22	415.00
PVT2	2,475.73	487.92
EXIT @ 10°	3,100.00	598.00

Horizontal Alignment Length = 3,100.00 ft

Profile Segment Information

Segment Name	Segment Type	Segment Length (ft)
Entry Tangent	Straight	315.13
Entry Curve	Vertical Curve	1,172.86
Bottom Tangent	Straight	175.23
Exit Curve	Vertical Curve	837.76
Exit Tangent	Straight	633.90

Pipe Length = 3,134.87 ft

Installation Load Summary

Drilling Fluid Weight (lb/gal)	Buoyancy Condition	Buoyancy Control (lb/ft)	Effective Pipe Weight (lb/ft)	Total Installation Force* (lb)
9.50	Empty	0.00	-292.86	598,900
9.50	Full	550.66	257.80	484,400
12.00	Empty	0.00	-472.79	791,800
12.00	Full	550.66	77.87	302,200
12.00	Neutral	472.79	0.00	277,700

* Pull forces are rounded to the nearest 100 lb

NOTES:

1. REFER TO ACCOMPANYING HDD DESIGN REPORT FOR HYDRAULIC FRACTURE ANALYSIS MODEL METHODS, INPUT PARAMETERS, ASSUMPTIONS AND LIMITATIONS FOR USE.
2. REFER TO ACCOMPANYING HDD DESIGN REPORT FOR DETAILED OPERATING STRESS AND PULLBACK LOAD CALCULATIONS, ASSUMPTIONS AND LIMITATIONS FOR USE.

ISSUED FOR PERMIT
NOT FOR CONSTRUCTION

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
9/10/24
PROFESSIONAL ENGINEER

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REFERENCE DRAWINGS		REVISIONS						
DRAWING NO.	TITLE	NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
		A	08/21/24	BTL	DRAFT: NOT FOR CONSTRUCTION		TJP	
		B	09/10/24	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR

TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
HFA AND INSTALLATION FORCE SUMMARY
SANDY RIVER HDD
MP 1394.98 TO 1395.57
PITTSYLVANIA COUNTY, VIRGINIA

Williams

DRAWN BY:	BTL	DATE: 08/14/24	ISSUED FOR BID:	SCALE:	
CHECKED BY:	TJP	DATE: 08/14/24	ISSUED FOR CONSTRUCTION:	REVISION:	
APPROVED BY:		DATE:	DRAWING NUMBER: SANDY RIVER HDD_REV E	SHEET 3 OF 4	
WO:		RID:	5:53:50 PM BLANE 9/10/2024		

P:\8169\235\CAD\HDD\Virginia_Eden\Sandy River (Intersect)\Sandy River HDD_Rev E.dwg

Calculated Drilling Fluid Pressures

Station	Profile Elevation	Profile Measured Distance (MD) (feet)	Lower Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Upper Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Lower Bound Calculated Drilling Fluid Pressure (Exit to Entry)	Upper Bound Calculated Drilling Fluid Pressure (Exit to Entry)
0+00	633.82	0	0.00	0.00	54.66	106.41
0+10	631.32	10.31	1.40	1.98	55.59	107.54
0+20	628.83	20.61	2.80	3.95	56.52	108.67
0+30	626.34	30.92	4.20	5.93	57.45	109.80
0+40	623.84	41.22	5.60	7.91	58.38	110.93
0+50	621.35	51.53	7.00	9.89	59.31	112.06
0+60	618.86	61.84	8.40	11.86	60.24	113.19
0+70	616.36	72.14	9.80	13.84	61.17	114.33
0+80	613.87	82.45	11.20	15.82	62.10	115.46
0+90	611.38	92.76	12.60	17.80	63.03	116.59
1+00	608.88	103.06	14.00	19.77	63.96	117.72
1+10	606.39	113.37	15.40	21.75	64.90	118.85
1+20	603.9	123.67	16.80	23.73	65.83	119.98
1+30	601.4	133.98	18.20	25.71	66.76	121.11
1+40	598.91	144.29	19.60	27.68	67.69	122.24
1+50	596.42	154.59	21.01	29.66	68.62	123.37
1+60	593.92	164.9	22.41	31.64	69.55	124.50
1+70	591.43	175.2	23.81	33.62	70.48	125.63
1+80	588.94	185.51	25.21	35.59	71.41	126.77
1+90	586.45	195.82	26.61	37.57	72.34	127.90
2+00	583.95	206.12	28.01	39.55	73.27	129.03
2+10	581.46	216.43	29.41	41.52	74.20	130.16
2+20	578.97	226.73	30.81	43.50	75.14	131.29
2+30	576.47	237.04	32.21	45.48	76.07	132.42
2+40	573.98	247.35	33.61	47.46	77.00	133.55
2+50	571.49	257.65	35.01	49.43	77.93	134.68
2+60	568.99	267.96	36.41	51.41	78.86	135.81
2+70	566.5	278.27	37.81	53.39	79.79	136.94
2+80	564.01	288.57	39.21	55.37	80.72	138.07
2+90	561.51	298.88	40.61	57.34	81.65	139.21
3+00	559.02	309.18	42.01	59.32	82.58	140.34
3+10	556.53	319.49	43.41	61.30	83.51	141.47
3+20	554.04	329.79	44.81	63.27	84.44	142.59
3+30	551.59	340.09	46.19	65.22	85.35	143.70
3+40	549.16	350.39	47.56	67.16	86.25	144.79
3+50	546.76	360.68	48.91	69.08	87.14	145.86
3+60	544.38	370.96	50.26	70.98	88.02	146.93
3+70	542.02	381.24	51.60	72.88	88.89	147.97
3+80	539.68	391.51	52.92	74.75	89.75	149.01
3+90	537.37	401.78	54.24	76.62	90.59	150.03
4+00	535.08	412.04	55.54	78.47	91.43	151.04
4+10	532.81	422.3	56.84	80.30	92.26	152.03
4+20	530.56	432.55	58.12	82.12	93.08	153.01
4+30	528.34	442.8	59.40	83.93	93.88	153.97
4+40	526.14	453.04	60.66	85.72	94.68	154.92
4+50	523.96	463.28	61.91	87.50	95.46	155.86
4+60	521.8	473.51	63.15	89.27	96.24	156.79
4+70	519.67	483.74	64.38	91.02	97.00	157.70
4+80	517.56	493.96	65.60	92.75	97.76	158.59
4+90	515.47	504.18	66.81	94.48	98.50	159.48
5+00	513.4	514.4	68.01	96.18	99.24	160.35
5+10	511.35	524.61	69.20	97.88	99.96	161.20
5+20	509.33	534.81	70.38	99.56	100.67	162.04
5+30	507.33	545.01	71.55	101.23	101.38	162.87
5+40	505.35	555.21	72.70	102.88	102.07	163.69
5+50	503.39	565.4	73.85	104.52	102.75	164.49
5+60	501.46	575.59	74.99	106.14	103.43	165.28
5+70	499.54	585.78	76.11	107.75	104.09	166.05
5+80	497.65	595.96	77.23	109.35	104.74	166.81
5+90	495.78	606.13	78.34	110.93	105.38	167.56
6+00	493.93	616.3	79.43	112.50	106.01	168.29
6+10	492.11	626.47	80.52	114.06	106.64	169.01
6+20	490.31	636.64	81.59	115.60	107.25	169.72
6+30	488.52	646.8	82.66	117.13	107.85	170.41
6+40	486.76	656.95	83.71	118.64	108.44	171.09
6+50	485.03	667.11	84.75	120.14	109.02	171.76
6+60	483.31	677.25	85.79	121.63	109.59	172.41
6+70	481.61	687.4	86.81	123.10	110.15	173.05
6+80	479.94	697.54	87.82	124.56	110.71	173.68
6+90	478.29	707.68	88.83	126.01	111.25	174.29
7+00	476.66	717.81	89.82	127.44	111.78	174.89
7+10	475.05	727.94	90.80	128.86	112.30	175.48
7+20	473.47	738.07	91.77	130.26	112.81	176.05
7+30	471.9	748.19	92.74	131.65	113.31	176.61
7+40	470.36	758.32	93.69	133.03	113.80	177.16
7+50	468.84	768.43	94.63	134.39	114.28	177.69
7+60	467.34	778.55	95.56	135.74	114.75	178.21
7+70	465.86	788.66	96.48	137.08	115.21	178.72

Station	Profile Elevation	Profile Measured Distance (MD) (feet)	Lower Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Upper Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Lower Bound Calculated Drilling Fluid Pressure (Exit to Entry)	Upper Bound Calculated Drilling Fluid Pressure (Exit to Entry)
7+80	464.4	798.76	97.39	138.40	115.66	179.21
7+90	462.97	808.87	98.29	139.71	116.11	179.69
8+00	461.55	818.97	99.19	141.01	116.54	180.16
8+10	460.16	829.07	100.07	142.29	116.96	180.61
8+20	458.79	839.16	100.94	143.56	117.37	181.05
8+30	457.44	849.26	101.80	144.82	117.77	181.48
8+40	456.11	859.35	102.65	146.06	118.16	181.89
8+50	454.81	869.43	103.49	147.29	118.54	182.29
8+60	453.52	879.52	104.32	148.50	118.91	182.68
8+70	452.26	889.6	105.14	149.70	119.27	183.05
8+80	451.01	899.68	105.95	150.89	119.63	183.41
8+90	449.79	909.75	106.75	152.07	119.97	183.76
9+00	448.59	919.83	107.54	153.23	120.30	184.09
9+10	447.41	929.9	108.32	154.38	120.62	184.42
9+20	446.25	939.97	109.09	155.51	120.93	184.72
9+30	445.12	950.03	109.85	156.63	121.24	185.02
9+40	444	960.1	110.60	157.74	121.53	185.30
9+50	442.91	970.16	111.35	158.84	121.81	185.57
9+60	441.84	980.22	112.08	159.92	122.08	185.82
9+70	440.78	990.27	112.80	160.99	122.34	186.07
9+80	439.75	1000.33	113.51	162.04	122.60	186.30
9+90	438.75	1010.38	114.21	163.09	122.84	186.51
10+00	437.76	1020.43	114.90	164.11	123.07	186.72
10+10	436.79	1030.48	115.58	165.13	123.30	186.91
10+20	435.84	1040.52	116.25	166.13	123.51	187.08
10+30	434.92	1050.57	116.91	167.12	123.71	187.25
10+40	434.02	1060.61	117.56	168.10	123.91	187.40
10+50	433.13	1070.65	118.20	169.06	124.09	187.54
10+60	432.27	1080.69	118.84	170.01	124.27	187.66
10+70	431.43	1090.73	119.46	170.94	124.43	187.77
10+80	430.61	1100.76	120.07	171.87	124.58	187.87
10+90	429.81	1110.79	120.67	172.78	124.73	187.96
11+00	429.04	1120.82	121.26	173.67	124.86	188.03
11+10	428.28	1130.85	121.84	174.56	124.99	188.09
11+20	427.54	1140.88	122.42	175.43	125.10	188.14
11+30	426.83	1150.91	122.98	176.28	125.21	188.17
11+40	426.14	1160.93	123.53	177.13	125.31	188.19
11+50	425.46	1170.96	124.07	177.96	125.39	188.20
11+60	424.81	1180.98	124.61	178.77	125.47	188.19
11+70	424.18	1191	125.13	179.58	125.53	188.17
11+80	423.57	1201.02	125.64	180.37	125.59	188.14
11+90	422.99	1211.04	126.15	181.15	125.64	188.10
12+00	422.42	1221.05	126.64	181.91	125.68	188.04
12+10	421.87	1231.07	127.12	182.67	125.70	187.97
12+20	421.35	1241.08	127.60	183.40	125.72	187.89
12+30	420.84	1251.1	128.06	184.13	125.73	187.79
12+40	420.36	1261.11	128.52	184.84	125.73	187.68
12+50	419.89	1271.12	128.96	185.54	125.71	187.56
12+60	419.45	1281.13	129.39	186.23	125.69	187.42
12+70	419.03	1291.14	129.82	186.90	125.66	187.27
12+80	418.63	1301.15	130.23	187.56	125.62	187.11
12+90	418.25	1311.16	130.64	188.21	125.57	186.94
13+00	417.89	1321.16	131.04	188.85	125.51	186.75
13+10	417.55	1331.17	131.42	189.47	125.44	186.55
13+20	417.24	1341.18	131.80	190.08	125.36	186.34
13+30	416.94	1351.18	132.16	190.67	125.27	186.11
13+40	416.67	1361.19	132.52	191.25	125.17	185.87
13+50	416.41	1371.19	132.87	191.82	125.06	185.62
13+60	416.18	1381.19	133.20	192.38	124.94	185.35
13+70	415.97	1391.19	133.53	192.92	124.82	185.07
13+80	415.77	1401.2	133.85	193.45	124.68	184.78
13+90	415.6	1411.2	134.16	193.97	124.53	184.48
14+00	415.45	1421.2	134.45	194.47	124.37	184.16
14+10	415.32	1431.2	134.74	194.96	124.20	183.83
14+20	415.22	1441.2	135.02	195.44	124.03	183.49
14+30	415.13	1451.2	135.29	195.91	123.84	183.13
14+40	415.06	1461.2	135.55	196.36	123.64	182.76
14+50	415.02	1471.2	135.80	196.80	123.44	182.38
14+60	414.99	1481.2	136.04	197.23	123.22	181.99
14+70	414.99	1491.2	136.27	197.64	123.00	181.58
14+80	415	1501.2	136.49	198.04	122.76	181.16
14+90	415	1511.2	136.72	198.45	122.53	180.75
15+00	415	1521.2	136.94	198.86	122.31	180.34
15+10	415	1531.2	137.17	199.27	122.08	179.93
15+20	415	1541.2	137.40	199.68	121.85	179.52
15+30	415	1551.2	137.63	200.09	121.62	179.11
15+40	415	1561.2	137.85	200.51	121.40	178.70
15+50	415	1571.2	138.08	200.92	121.17	178.28

Station	Profile Elevation	Profile Measured Distance (MD) (feet)	Lower Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Upper Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Lower Bound Calculated Drilling Fluid Pressure (Exit to Entry)	Upper Bound Calculated Drilling Fluid Pressure (Exit to Entry)
15+60	415	1581.2	138.31	201.33	120.94	177.87
15+70	415	1591.2	138.54	201.74	120.71	177.46
15+80	415	1601.2	138.77	202.15	120.48	177.05
15+90	415	1611.2	138.99	202.56	120.26	176.64
16+00	415	1621.2	139.22	202.97	120.03	176.23
16+10	415	1631.2	139.45	203.38	119.80	175.82
16+20	415	1641.2	139.68	203.79	119.57	175.41
16+30	415	1651.2	139.90	204.20	119.35	175.00
16+40	415	1661.2	140.13	204.61	119.12	174.59
16+50	415	1671.2	140.36	205.02	118.89	174.18
16+60	415.02	1681.2	140.58	205.42	118.65	173.75
16+70	415.07	1691.2	140.78	205.80	118.40	173.31
16+80	415.14	1701.2	140.98	206.17	118.14	172.86
16+90	415.23	1711.2	141.16	206.52	117.87	172.39
17+00	415.34	1721.2	141.34	206.87	117.59	171.91
17+10	415.47	1731.2	141.51	207.19	117.30	171.42
17+20	415.62	1741.21	141.68	207.51	117.01	170.92
17+30	415.79	1751.21	141.81	207.81	116.70	170.40
17+40	415.99	1761.21	141.95	208.10	116.38	169.87
17+50	416.2	1771.21	142.08	208.38	116.05	169.32
17+60	416.43	1781.21	142.19	208.65	115.71	168.77
17+70	416.69	1791.22	142.30	208.90	115.37	168.20
17+80	416.97	1801.22	142.40	209.14	115.01	167.61
17+90	417.27	1811.22	142.49	209.36	114.64	167.02
18+00	417.58	1821.23	142.57	209.57	114.27	166.41
18+10	417.92	1831.23	142.64	209.77	113.88	165.78
18+20	418.28	1841.24	142.70	209.96	113.48	165.15
18+30	418.66	1851.25	142.75	210.13	113.08	164.50
18+40	419.07	1861.25	142.79	210.29	112.66	163.84
18+50	419.49	1871.26	142.82	210.44	112.24	163.16
18+60	419.93	1881.27	142.84	210.57	111.80	162.48
18+70	420.4	1891.28	142.85	210.70	111.35	161.78
18+80	420.88	1901.29	142.85	210.80	110.90	161.06
18+90	421.39	1911.31	142.84	210.90	110.43	160.34
19+00	421.92	1921.32	142.82	210.98	109.96	159.60
19+10	422.46	1931.33	142.79	211.05	109.48	158.84
19+20	423.03	1941.35	142.76	211.11	108.98	158.08
19+30	423.62	1951.37	142.71	211.15	108.48	157.30
19+40	424.24	1961.38	142.65	211.18	107.96	156.51
19+50	424.87	1971.4	142.58	211.20	107.44	155.70
19+60	425.52	1981.42	142.51	211.20	106.91	154.88
19+70	426.19	1991.45	142.42	211.20	106.36	154.05
19+80	426.89	2001.47	142.32	211.17	105.81	153.21
19+90	427.61	2,011.49	142.22	211.14	105.25	152.35
20+00	428.34	2,021.52	142.10	211.09	104.67	151.48
20+10	429.1	2,031.55	141.97	211.03	104.09	150.59
20+20	429.88	2,041.58	141.84	210.96	103.50	149.69
20+30	430.68	2,051.61	141.69	210.87	102.90	148.78
20+40	431.5	2,061.64	141.54	210.77	102.28	147.86
20+50	432.34	2,071.68	141.37	210.66	101.66	146.92
20+60	433.21	2,081.71	141.20	210.53	101.03	145.97
20+70	434.09	2,091.75	141.01	210.39	100.39	145.01
20+80	434.99	2,101.79	140.82	210.24	99.74	144.03
20+90	435.92	2,111.83	140.61	210.08	99.07	143.04
21+00	436.87	2,121.88	140.40	209.90	98.40	142.04
21+10	437.84	2,131.92	140.18	209.71	97.72	141.02
21+20	438.83	2,141.97	139.94	209.50	97.03	139.99
21+30	439.84	2,152.02	139.70	209.28	96.33	138.95
21+40	440.87	2,162.07	139.45	209.05	95.62	137.90
21+50	441.92	2,172.13	139.18	208.81	94.89	136.83
21+60	443	2,182.18	138.91	208.55	94.16	135.74
21+70	444.09	2,192.24	138.63	208.28	93.42	134.65
21+80	445.21	2,202.30	138.33	208.00	92.67	133.54
21+90	446.35	2,212.36	138.03	207.70	91.91	132.42
22+00	447.51	2,222.43	137.72	207.40	91.14	131.28
22+10	448.69	2,232.50	137.39	207.07	90.36	130.13
22+20	449.89	2,242.57	137.06	206.74	89.57	128.97
22+30	451.11	2,252.64	136.72	206.39	88.76	127.79
22+40	452.36	2,262.72	136.37	206.03	87.95	126.60
22+50	453.62	2,272.80	136.00	205.65	87.13	125.40
22+60	454.91	2,282.88	135.63	205.26	86.30	124.18
22+70	456.22	2,292.96	135.25	204.86	85.46	122.95
22+80	457.55	2,303.05	134.86	204.45	84.61	121.71
22+90	458.9	2,313.14	134.46	204.02	83.75	120.45
23+00	460.27	2,323.23	134.04	203.58	82.87	119.18
23+10	461.67	2,333.32	133.62	203.12	81.99	117.90
23+20	463.08	2,343.42	133.19	202.65	81.10	116.60
23+30	464.52	2,353.52	132.75	202.17	80.20	115.29

Station	Profile Elevation	Profile Measured Distance (MD) (feet)	Lower Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Upper Bound Calculated Drilling Fluid Pressure (Entry to Exit)	Lower Bound Calculated Drilling Fluid Pressure (Exit to Entry)	Upper Bound Calculated Drilling Fluid Pressure (Exit to Entry)
23+40	465.98	2,363.63	132.30	201.68	79.29	113.97
23+50	467.46	2,373.74	131.84	201.17	78.37	112.63
23+60	468.96	2,383.85	131.36	200.65	77.43	111.28
23+70	470.48	2,393.96	130.88	200.12	76.49	109.91
23+80	472.03	2,404.08	130.39	199.57	75.54	108.54
23+90	473.59	2,414.20	129.89	199.01	74.58	107.14
24+00	475.18	2,424.32	129.38	198.43	73.60	105.74
24+10	476.79	2,434.45	128.86	197.85	72.62	104.32
24+20	478.42	2,444.58	128.32	197.25	71.63	102.89
24+30	480.08	2,454.71	127.78	196.63	70.62	101.44
24+40	481.75	2,464.85	127.23	196.00	69.61	99.98
24+50	483.45	2,474.99	126.67	195.36	68.58	98.51
24+60	485.17	2,485.13	126.10	194.71	67.55	97.02
24+70	486.9	2,495.28	125.51	194.04	66.51	95.52
24+80	488.67	2,505.43	124.92	193.36	65.45	94.00
24+90	490.44	2,515.59	124.32	192.67	64.39	92.48
25+00	492.2	2,525.74	123.73	191.99	63.34	90.96
25+10	493.97	2,535.90	123.14	191.31	62.28	89.45
25+20	495.73	2,546.05	122.54	190.63	61.22	87.93
25+30	497.49	2,556.21	121.95	189.94	60.17	86.42
25+40	499.26	2,566.36	121.36	189.26	59.11	84.90
25+50	501.02	2,576.51	120.77	188.58	58.06	83.38
25+60	502.78	2,586.67	120.17	187.90	57.00	81.87
25+70	504.54	2,596.82	119.58	187.22	55.95	80.35
25+80	506.31	2,606.98	118.99	186.53	54.89	78.84
25+90	508.07	2,617.13	118.39	185.85	53.84	77.32
26+00	509.83	2,627.29	117.80	185.17	52.78	75.80
26+10	511.6	2,637.44	117.21	184.49	51.72	74.29
26+20	513.36	2,647.59	116.61	183.81	50.67	72.77
26+30	515.12	2,657.75	116.02	183.12	49.61	71.26
26+40	516.89	2,667.90	115.43	182.44	48.56	69.74
26+50	518.65	2,678.06	114.83	181.76	47.50	68.22
26+60	520.41	2,688.21	114.24	181.08	46.45	66.71
26+70	522.18	2,698.36	113.65	180.39	45.39	65.19
26+80	523.94	2,708.52	113.06	179.71	44.34	63.68
26+90	525.7	2,718.67	112.46	179.03	43.28	62.16
27+00	527.47	2,728.83	111.87	178.35	42.22	60.64
27+10	529.23	2,738.98	111.28	177.67	41.17	59.13
27+20	530.99	2,749.14	110.68	176.98	40.11	57.61
27+30	532.76	2,759.29	110.09	176.30	39.06	56.09
27+40	534.52	2,769.44	109.50	175.62	38.00	54.58
27+50	536.28	2,779.60	108.90	174.94	36.95	53.06
27+60	538.05	2,789.75	108.31	174.26	35.89	51.55
27+70	539.81	2,799.91	107.72	173.57	34.83	50.03
27+80	541.57	2,810.06	107.12	172.89	33.78	48.51
27+90	543.34	2,820.22	106.53	172.21	32.72	47.00
28+00	545.1	2,830.37	105.94	171.53	31.67	45.48
28+10	546.86	2,840.52	105.35	170.84	30.61	43.97
28+20	548.63	2,850.68	104.75	170.16	29.56	42.45
28+30	550.39	2,860.83	104.16	169.48	28.50	40.93
28+40	552.15	2,870.99	103.57	168.80	27.45	39.42
28+50	553.92	2,881.14	102.97	168.12	26.39	37.90
28+60	555.68	2,891.30	102.38	167.43	25.33	36.39
28+70	557.44	2,901.45	101.79	166.75	24.28	34.87
28+80	559.21	2,911.60	101.19	166.07	23.22	33.35
28+90	560.97	2,921.76	100.60	165.39	22.17	31.84
29+00	562.73	2,931.91	100.01	164.71	21.11	30.32
29+10	564.5	2,942.07	99.41	164.02	20.06	28.81
29+20	566.26	2,952.22	98.82	163.34	19.00	27.29
29+30	568.02	2,962.38	98.23	162.66	17.95	25.77
29+40	569.79	2,972.53	97.64	161.98	16.89	24.26
29+50	571.55	2,982.68	97.04	161.30	15.83	22.74
29+60	573.31	2,992.84	96.45	160.61	14.78	21.23
29+70	575.08	3,002.99	95.86	159.93	13.72	19.71
29+80	576.84	3,013.15	95.26	159.25	12.67	18.19
29+90	578.6	3,023.30	94.67	158.57	11.61	16.68
30+00	580.37	3,033.46	94.08	157.88	10.56	15.16
30+10	582.13	3,043.61	93.48	157.20	9.50	13.64
30+20	583.89	3,053.76	92.89	156.52	8.44	12.13
30+30	585.66	3,063.92	92.30	155.84	7.39	10.61
30+40	587.42	3,074.07	91.71	155.16	6.33	9.10
30+50	589.18	3,084.23	91.11	154.47	5.28	7.58
30+60	590.95	3,094.38	90.52	153.79	4.22	6.06
30+70	592.71	3,104.54	89.93	153.11	3.17	4.55
30+80	594.47	3,114.69	89.33	152.43	2.11	3.03
30+90	596.23	3,124.84	88.74	151.75	1.06	1.52
31+00	598	3,135.00	88.15	151.06	0.00	0.00

ISSUED FOR PERMIT
NOT FOR CONSTRUCTION

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
PROFESSIONAL ENGINEER
9/10/24

811 Know what's below. Call before you dig.

GeoEngineers

REFERENCE DRAWINGS		REVISIONS						
DRAWING NO.	TITLE	NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
		A	08/21/24	BTL	DRAFT: NOT FOR CONSTRUCTION		TJP	
		B	09/10/24	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR

TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
CALCULATED DRILLING FLUID PRESSURES
SANDY RIVER HDD
MP 1394.98 TO 1395.57
PITTSYLVANIA COUNTY, VIRGINIA

Williams

DRAWN BY: BTL	DATE: 08/14/24	ISSUED FOR BID:	SCALE:
CHECKED BY: TJP	DATE: 08/14/24	ISSUED FOR CONSTRUCTION:	REVISION:
APPROVED BY:	DATE:	DRAWING NUMBER: SANDY RIVER HDD_REV E	SHEET 4 OF 4
WO:	RID:	5:53:54 PM BLANE 9/10/2024	

G:\81302023\CAD\DOD\Virginia_Eden Looking Down\Sandy River\Sandy River HDD_Rev E.dwg

Appendix B
Geotechnical Data Report

Geotechnical Data Report

Southeast Supply Enhancement -
Sandy River Crossing
Pittsylvania County, Virginia

for
Transcontinental Gas Pipeline Company, LLC

September 5, 2024

2155A West Chesterfield Boulevard
Springfield, Missouri 65807
417.831.9700

GeoEngineers

Geotechnical Data Report

Southeast Supply Enhancement -
Sandy River Crossing
Pittsylvania County, Virginia

File No. 08169-235-00
September 5, 2024

Prepared for:

Transcontinental Gas Pipeline Company, LLC
2800 Post Oak Boulevard
Houston, Texas 77056

Attention: Robert Foran

Prepared by:

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Senior Civil Engineer

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Principal

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1.0 Introduction and Project Understanding

GeoEngineers, Inc. (GeoEngineers) is pleased to submit this geotechnical data report for the proposed Sandy River crossing as part of the Southeast Supply Enhancement (SSE) Project – Eden Loop (Project). Our work was completed at the request of Transcontinental Gas Pipeline Company, LLC (Transco), and in general accordance with Williams Request for Services (RFS) purchase order dated April 16, 2024. This report provides the results of our geotechnical exploration and laboratory testing programs and summarizes the surface and subsurface site conditions for the Sandy River crossing.

We understand that the Project includes a new approximately 30.8-mile-long 42-inch-diameter pipeline. The Project route, located in Rockingham County, North Carolina and Pittsylvania County, Virginia generally follows Transco's existing pipeline corridor, including the Sandy River crossing for which this report has been prepared, which is shown on the attached Vicinity Map, Figure 1. We understand that Transco is proposing to cross Sandy River using the horizontal directional drill (HDD) method of construction.

Our geotechnical services completed at the site included six (6) geotechnical borings at the locations shown on the Boring Location Map, Figure 2. Our specific geotechnical services are summarized in the following section. Our feasibility assessment of the proposed HDD crossing, detailed engineering design, and construction recommendations will be provided in a separate HDD design report.

2.0 Scope of Services

The purpose of our services was to investigate and describe the subsurface soil and groundwater conditions (where possible) at the site to support trenchless feasibility evaluation and to prepare this geotechnical data report summarizing the results. The following provides an abbreviated list of our scope of services for this phase of the project. Refer to our proposal dated January 17, 2024, for a complete list of our scope of services.

1. Reviewed geologic maps to evaluate geologic conditions at the site.
2. Reviewed and interpreted historical aerial photography available from Google Earth.
3. Completed a visual site reconnaissance at the site with members of the project team to perform the following tasks:
    a. Evaluate drill rig access.
    b. Identify boring locations.
    c. Assess water availability, and utility locations.
4. Explored the subsurface conditions at the crossing site by completing six (6) geotechnical borings to depths up to approximately 201 feet bgs. We utilized a rubber-tired drill rig for the borings. A GeoEngineers field representative logged the borings, recorded groundwater table depths where possible, and obtained samples of the soil and rock encountered at various depths. Upon completion, our subcontracted driller backfilled the borings with cement-bentonite grout. The locations were staked for identification by the project surveyors.

5. Performed general project management and daily communication with Williams during geotechnical explorations.
6. Completed a laboratory testing program on selected samples obtained from the borings to evaluate pertinent engineering properties. The tests included the following:
    a. Standard Classification of Soils in general accordance with ASTM D2488.
    b. Percent fines determinations in general accordance with ASTM D1140.
    c. Gradation of soils in general accordance with ASTM D6913.
    d. Moisture content determination in general accordance with ASTM D2216.
    e. Atterberg Limits determination in general accordance with ASTM D4318.
    f. Unconfined compressive strength tests (Methods C and D) on rock samples in general accordance with ASTM D7012.
    g. Representative Mohs hardness values for each unconfined compressive strength test.
    h. Point load strength index of rock samples in general accordance with ASTM D5731.
    i. Cerchar Abrasivity Index on rock specimens in general accordance with ASTM D7625.
7. Prepared logs of the borings which included the following:
    a. Standard Penetration Test (SPT) values as an indication of in-situ soil density.
    b. Rock Quality Designation (RQD), Mohs hardness and recovery values for rock core samples.
    c. Index and classification properties of soil and rock samples, as applicable.
    d. Other properties as applicable.
8. Provided this geotechnical data report summarizing the results of our geotechnical exploration and laboratory testing programs. This report includes the following:
    a. A general description of the site geology and topography.
    b. Descriptions of the surface and subsurface conditions at the time of our exploration activities.
    c. Boring location map indicating the locations of the borings.
    d. Logs of the borings including the descriptions in item 7 above.
    e. Description of in-situ and laboratory test methods and test results performed in general accordance with ASTM specifications.
    f. Other relevant information necessary for the interpretation of the soil and rock properties for the crossing design.

3.0 Site Description

3.1 GEOLOGIC HAZARDS

We understand that Transco retained Civil & Environmental Consultants, Inc. (CEC) to complete a geologic hazard study for the Project. Based on CEC's Preliminary Geohazard Assessment for the Project, the Sandy

River site is described as moderately susceptible to landslide hazards with a low incidence. Please refer to CEC's full report for further details.

3.2 GEOLOGY

3.2.1 Regional Geologic Setting

The SSE Project Eden Loop is located within the eastern Piedmont Physiographic Region in north-central North Carolina and south-central Virginia. The Piedmont is a region of gently rolling hills and low ridges underlain by Proterozoic and Paleozoic Age (2,500 million to 251 million years ago) metamorphic and intrusive igneous rocks. Rocks exposed in the Piedmont experienced a complex geologic history. Some of these rocks are exotic with respect to North America. Packages of rock with distinctly different geologic histories, separated from one another by fault zones, are called geologic terranes. The oldest rocks in the Piedmont are around 1,070 million years old and occur in the enigmatic Goochland terrane west of Richmond, Virginia. Other terranes include Ordovician to Silurian igneous rocks that are the remains of ancient volcanic arcs (much like the present-day Aleutian Islands) that collided with and accreted onto the eastern edge of North America during Appalachian Mountain building. Granitic rocks of late Paleozoic age are common and form large plutons in many areas of the Piedmont. Many terranes have experienced multiple episodes of metamorphism and deformation, resulting in a complex geologic puzzle (McReynolds, 2008), (William & Mary University, 2024).

The region also includes Early Mesozoic (225 to 190 million years ago) sedimentary rocks, diabase dikes, and basalt flows that formed during the early stages of rifting associated with the opening of the Atlantic Ocean. These rocks are exposed in a number of structural basins known as half-grabens and grabens. Some Mesozoic basins preserve dinosaur, fish, and insect fossils. Coal was also deposited in swampy lowlands in some of these basins (William & Mary University, 2024).

Piedmont soils derived from Carolina Slate Belt rocks are generally quartz-, feldspar-, and mica-rich clays and loams although sandy soils can be found in some upland areas. Diagnostic heavy minerals include amphiboles (especially hornblende), epidote, and pyroxenes. Feldspars weather into kaolin group minerals, which are consequently the dominant clay minerals in the Carolina Slate Belt. Illite, chlorite, vermiculite, and hydroxy-interlayered vermiculite are also locally present, but smectite is generally absent except in the vicinity of metagabbro intrusions in the Albemarle-Asheboro region (ibid).

3.2.2 Bedrock Geology

Geologic mapping indicates the Triassic Age (251 to 200 million years ago) Dry Fork Formation is the predominant bedrock unit shown at the Sandy River crossing site, as shown in the Bedrock Geology Map, Figure 3. The Dry Fork Formation primarily consists of very well-indurated, dominantly massive, crudely stratified, gray and greenish gray, poorly sorted, coarse-grained, arkose and lithic arkose sandstone, interbedded with subordinate mudrock and conglomerate with interbeds of grayish red and dark reddish-brown siltstones and silty mudstones. The interbeds are typically massive to medium and thick bedded and in places have burrow mottles, carbonate concretions and thick laminations (Price, et al, 1980).

3.2.3 Surficial Material

Surficial geologic mapping indicates Quaternary and Tertiary Age (65.5 million years ago to present) red silty sand to silty clay decomposition residuum is the predominant surficial soil present at the Sandy River site. The red silty sand to silty clay decomposition residuum typically consists of red, reddish gray, reddish

brown, or purplish red silty sandy loam and silty clay loam. The residuum may locally include rounded pebbles and cobbles, primarily consisting of quartz. The lower part of the residuum typically contains chips and larger fragments of sandstone and grades down to sandstone bedrock. The residuum may contain crumbly clasts of diorite along lineaments aligned over underlying diorite dikes. The thickness of the silty sand to silty clay decomposition residuum is typically 1 to 10 feet, overlying the bedrock described above (Howard, et al, 1991).

Geologic mapping indicates Quaternary Age (2.6 million years ago to present) alluvium is also likely present at the Sandy River site, within the stream valley and floodplain of Sandy River. The alluvium typically consists of unconsolidated floodplain deposits containing interlayers and lenses of light brown and gray organic clays and light brown sands and gravels. Some of the gravel may be present within a clay matrix. Cut and fill structures and cross bedding are common within the alluvium. The thickness of the alluvium is variable, overlying the silty sand to silty clay decomposition residuum and/or the bedrock as described above (Price, et al, 1980).

Geologic mapping indicates Quaternary Age terrace deposits may also be present at the Sandy River site, particularly near the northeast end of the site. The terrace deposits typically consist of unconsolidated stream deposits composed of rounded pebbles, cobbles and boulders in a matrix ranging from clay to sand, occurring as valley fill or terrace deposits along hill slopes and on interfluves. Valley fill and low terrace material may be composed of white clay with thin and interlayered white sand beds, generally with a white cobble layer at the base. The terrace deposits are variable in thickness, overlying the silty sand to silty clay decomposition residuum and/or the bedrock as described above (ibid).

According to the United States Department of Agriculture (USDA) soil survey the site soil consists of fine sandy loam on 2 to 25 percent slopes.

3.3 SURFACE CONDITIONS

3.3.1 General

We evaluated the surface conditions at the Sandy River site during our initial site reconnaissance with Transco personnel on February 28, 2024, and again during our subsurface exploration program conducted from May 13 through 22, 2024 and again from June 3 through 12, 2024.

3.3.2 Surface Description

The proposed pipeline alignment is roughly oriented southwest to northeast within Transco's existing pipeline corridor. Generally, the ground surface at the Sandy River site features undulating topography on either side of the Sandy River with the river valley at the lowest elevation along the proposed pipeline alignment at an elevation of approximately 528 feet North American Vertical Datum (NAVD) 88. Elevations on either side of the river range from roughly 540 feet NAVD 88 to approximately 640 feet NAVD 88.

The project area is generally undeveloped and forested except for the existing Transco pipeline right-of-way. The alignment crosses the Sandy River at an oblique angle over a distance of roughly 80 feet.

3.4 SUBSURFACE CONDITIONS

GeoEngineers and our subcontracted driller (S&ME, Inc. [S&ME]) explored the subsurface conditions at the site from May 13 through 22, 2024 and again from June 3 through 12, 2024, by drilling six geotechnical

borings (SR-B-1 through SR-B-6). The borings were drilled to depths of up to approximately 201 feet bgs. The surveyed boring locations are shown on the attached Boring Location Map, Figure 2.

Samples collected from the borings were preserved and transported to a laboratory for testing. Testing was performed on representative samples, including index and strength testing to confirm field classifications and to determine pertinent engineering parameters. Laboratory testing on soil samples included moisture content, Atterberg limits, particle-size distribution (gradation), and percent fines content. Laboratory testing on rock specimens included unit weight determinations, unconfined compressive strength testing (UCT), Point Load strength index tests, Cerchar Abrasivity Index (CAI) and Mohs hardness. A detailed description of the geotechnical exploration and laboratory testing procedures, logs of the borings, photographs of the rock cores, and laboratory test results are presented in Appendix A.

3.4.1 Subsurface Description

In general, the subsurface conditions encountered in the borings were consistent with published geology and are described within the boring descriptions below.

3.4.1.1 BORING SR-B-1

Drilling operations were conducted at boring SR-B-1 from June 6 through 8, 2024, utilizing a rubber-tired drill rig. During drilling at boring SR-B-1, we observed 19½ feet of loose to medium dense silty sand and stiff silt with sand overlying decomposed bedrock described as dense to very dense silty sand to a depth of about 59½ feet bgs, where competent bedrock was encountered to the termination depth of 201 feet bgs. Bedrock generally consisted of moderately weathered to fresh, fair to excellent quality (except for the upper 1½ feet of very poor quality and a 5-foot run from 96 to 101 feet bgs of poor quality) conglomerate and slightly weathered to fresh, fair to excellent quality siltstone. Unconfined compressive strengths ranging from 2,280 psi to 20,300 psi and Mohs hardness values ranging from 4½ to 7½ were reported on selected samples. The Cerchar abrasivity of selected samples from the boring ranges from 3.40 (high abrasivity) to 4.42 (extreme abrasivity). Drilling fluid returns were maintained during coring operations to a depth of approximately 71½ feet bgs before being briefly restored and then lost to the formation through the termination depth of the boring.

3.4.1.2 BORING SR-B-2

Drilling operations were conducted at boring SR-B-2 on May 21 and 22, 2024, utilizing a rubber-tired drill rig. During drilling at boring SR-B-2, we observed 13½ feet of very loose to dense silty sand overlying decomposed bedrock described as very dense silty sand to a depth of about 19½ feet bgs, where competent bedrock was encountered to the termination depth of approximately 151 feet bgs. Bedrock generally consisted of moderately weathered very poor quality sandstone and predominately decomposed to decomposed, very poor quality conglomerate to a depth of 96 feet bgs. Below 96 feet bgs, moderately weathered to fresh, generally fair to excellent quality conglomerate and fresh, fair to good quality, siltstone was observed. Unconfined compressive strengths ranging from 7,810 psi to 24,040 psi and Mohs hardness values ranging from 4½ to 7½ were reported on selected samples. The Cerchar abrasivity of selected samples from the boring ranges from 4.41 to 4.54 (extreme abrasivity). Drilling fluid returns were maintained during coring operations to a depth of approximately 98 feet bgs before being briefly restored and then lost to the formation at a depth of 106 feet bgs through the termination depth of the boring. A potential void was noted from approximately 98 to 99 feet bgs.

3.4.1.3 BORING SR-B-3

Drilling operations were conducted at boring SR-B-3 from June 3 through 5, 2024, utilizing a rubber-tired drill rig. During drilling at boring SR-B-3, we observed 8½ feet of medium dense to very dense silty sand overlying decomposed bedrock described as very dense silty sand and very dense gravel with silt to a depth of about 16.7 feet bgs, where competent bedrock was encountered to the termination depth of 171½ feet bgs. Bedrock generally consisted of slightly weathered to fresh, fair to good quality (except for intermittent runs of very poor, poor, and excellent quality) conglomerate and fresh, good to excellent quality siltstone. Unconfined compressive strengths ranging from 6,570 psi to 23,105 psi and Mohs hardness values ranging from 4½ to 7½ were reported on selected samples. The estimated unconfined compressive strength from a point load test on a selected sample was 17,041 psi. The Cerchar abrasivity of a selected sample from the boring was 4.18 (extreme abrasivity). Drilling fluid returns were maintained during coring operations. A potential void was noted above the soil-bedrock interface at a depth of approximately 12.7 feet bgs.

3.4.1.4 BORING SR-B-4

Drilling operations were conducted at boring SR-B-4 on May 20 and 21, 2024, utilizing a rubber-tired drill rig. During drilling at boring SR-B-4, we observed about 8½ feet of medium stiff lean clay with sand and medium dense to very dense silty sand overlying decomposed bedrock described as very dense silty sand to a depth of about 19½ feet bgs, where competent bedrock was encountered to the termination depth of 141 feet bgs. Bedrock generally consisted of slightly weathered to fresh, fair to excellent quality conglomerate (except for a 5-foot run from approximately 26 to 31 feet bgs of poor quality) conglomerate and fresh, good to excellent quality siltstone. Unconfined compressive strengths ranging from 7,450 psi to 25,410 psi and Mohs hardness values ranging from 4½ to 7½ were reported on selected samples. The Cerchar abrasivity of a selected sample from the boring was 4.33 (extreme abrasivity). Drilling fluid returns were maintained during coring operations.

3.4.1.5 BORING SR-B-5

Drilling operations were conducted at boring SR-B-5 from May 13 through 16, 2024, utilizing a rubber-tired drill rig. During drilling at boring SR-B-5, we observed about 13½ feet of stiff lean clay with trace sand and stiff to very stiff sandy silt overlying approximately 5 feet of very dense silty sand with trace gravel followed by decomposed bedrock described as very dense silty sand with trace gravel to a depth of about 24½ feet bgs, where competent bedrock was encountered to the termination depth of 155 feet bgs. Bedrock generally consisted of slightly weathered to fresh, fair to excellent quality conglomerate, fresh, excellent quality sandstone, fresh, fair to excellent quality siltstone, and fresh, poor quality mudstone. Unconfined compressive strengths ranging from 7,780 psi to 31,143 psi and Mohs hardness values ranging from 4½ to 7½ were reported on selected samples. The Cerchar abrasivity of a selected sample from the boring was 3.08 (high abrasivity). Drilling fluid returns were maintained during coring operations.

3.4.1.6 BORING SR-B-6

Drilling operations were conducted at boring SR-B-6 from June 9 through 12, 2024, utilizing a rubber-tired drill rig. During drilling at boring SR-B-6, we observed 13½ feet of stiff silt with sand and medium dense silty sand overlying decomposed bedrock described as very dense silty sand and sand with silt to a depth of about 39.7 feet bgs, where competent bedrock was encountered to the termination depth of 142½ feet bgs. Bedrock generally consisted of moderately weathered to predominately decomposed, very poor to fair quality, conglomerate to a depth of approximately 67 feet bgs overlying slightly weathered to fresh, fair to

excellent quality (except for a 5-foot run from 72½ to 77½ feet bgs of poor quality) conglomerate and slightly weathered, excellent quality siltstone. Unconfined compressive strengths ranging from 5,780 psi to 18,354 psi and Mohs hardness values ranging from 4½ to 7½ were reported on selected samples. The Cerchar abrasivity of selected samples from the boring ranges from 3.74 (high abrasivity) to 4.05 (extreme abrasivity). Drilling fluid returns were maintained during coring operations. During drilling, drill chatter was observed at depths of approximately 12, 15½, 25½, 30, and 34½ feet bgs; the drill chatter likely indicates the presence of gravel, cobble, and/or boulder sized material.

3.4.1.7 GROUNDWATER CONDITIONS

Groundwater was not observed at the time of drilling borings SR-B-1 through SR-B-6 because of the drilling method. The absence of groundwater at the time of drilling may not be representative of present or future levels within the subsurface. The groundwater level likely fluctuates because of seasonal variation and precipitation, recharge and other factors, and may be present at different elevations during construction.

4.0 Abrasive Bedrock Conditions

To evaluate the abrasivity of the bedrock at the site, CAI tests were requested on rock samples obtained from the borings. The criteria for the CAI from ASTM D7625 is described by the data presented in Table 1 below. The testing results are presented in Table 2 below at their respective sample depths.

TABLE 1. CRITERIA FOR THE CERCHAR ABRASIVENESS INDEX

CLASSIFICATION	AVERAGE CAI (HRC=55)
Very Low Abrasiveness	0.3 – 0.5
Low Abrasiveness	0.5 – 1.0
Medium Abrasiveness	1.0 – 2.0
High Abrasiveness	2.0 – 4.0
Extreme Abrasiveness	4.0 – 6.0
Quartzitic	6.0 – 7.0

TABLE 2. CERCHAR ABRASIVITY INDEX TEST RESULTS

BORING NUMBER	SAMPLE DEPTH (FT)	CAI
SR-B-1	145	4.42
SR-B-1	160	3.40
SR-B-2	120	4.41
SR-B-2	135	4.54
SR-B-3	132	4.18
SR-B-4	100	4.33
SR-B-5	33.2 – 34	3.08
SR-B-6	60.5 – 61	4.05
SR-B-6	87 – 87.4	3.74

As shown in Table 2 above, the CAI values for the selected samples range between 3.08 and 4.54, which indicates high to extreme abrasiveness.

5.0 Limitations

We have prepared this geotechnical data report for use by Transco and other approved members of the project team involved with this project. This report is not intended for use by others, and the information contained herein is not applicable to other sites. The data and report should be provided to prospective contractors, but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations. Subsurface conditions may also vary with time. A contingency for unanticipated conditions should be included in the project budget and schedule for such an occurrence. We recommend that sufficient monitoring, testing and consultation be provided by GeoEngineers during construction to evaluate that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and pipeline installation activities comply with contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express, written or implied, should be understood.

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Please refer to Appendix B, titled “Report Limitations and Guidelines for Use,” for additional information pertaining to use of this report.

6.0 References

ASTM International (2010). Annual Book of ASTM Standards, Volume 04.08, “Soil and Rock,” American Society for Testing and Materials, West Conshohocken, PA.

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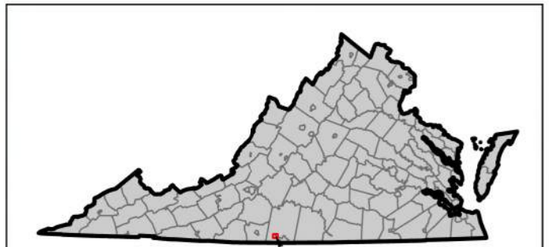
Figures

Legend

- Proposed Centerline Alignment
- Proposed HDD Alignment



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers USA, P.C. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI

Projection: NAD 1983 2011 StatePlane Virginia South FIPS 4502 Ft US

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FEET

Transcontinental Gas Pipeline Company, LLC
Vicinity Map

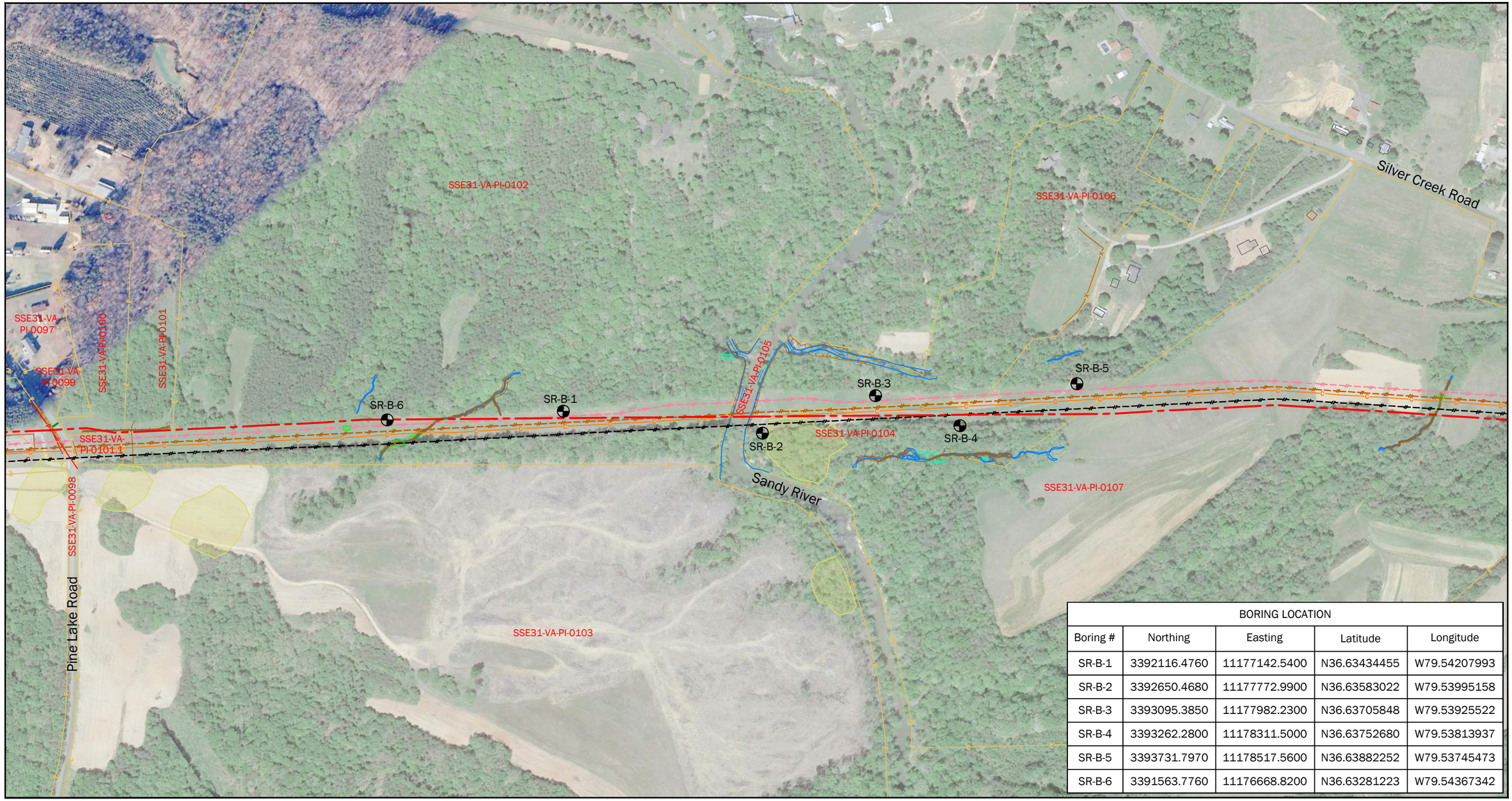
Proposed 42-inch Eden Loop
Sandy River HDD
Pittsylvania County, Virginia

GeoEngineers

FIGURE 1

P:\S\8169235\GIS\8169235_Project\8169235_Project.aprx\8169235_Project Date Exported: 08/09/24 by ccabrera

TJP : BTL
C:\Users\blane\appdata\local\temp\AcPublish_21304\Figure 2_Sandy River BLM.dwg\TAB:FIGURE 2 modified on Sep 05, 2024 - 7:27am BLANE



BORING LOCATION				
Boring #	Northing	Easting	Latitude	Longitude
SR-B-1	3392116.4760	11177142.5400	N36.63434455	W79.54207993
SR-B-2	3392650.4680	11177772.9900	N36.63583022	W79.53995158
SR-B-3	3393095.3850	11177982.2300	N36.63705848	W79.53925522
SR-B-4	3393262.2800	11178311.5000	N36.63752680	W79.53813937
SR-B-5	3393731.7970	11178517.5600	N36.63882252	W79.53745473
SR-B-6	3391563.7760	11176668.8200	N36.63281223	W79.54367342

Note(s):
1. GeoEngineers, Inc. has not verified the field location of the existing utilities.

Source(s):
- Aerial from Google Earth Pro, dated 11/17/23.
- Survey provided from Williams by email on 02/05/24.

Coordinate System: NSRS2011 Virginia State Plane, South Zone, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers, Inc. The locations of features shown may be approximate. GeoEngineers, Inc. makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers, Inc. and is the official document of record.

Legend

- Boring Location
- Proposed Centerline Alignment
- Existing Line A
- Existing Line B
- Existing Line C
- Existing Company Row
- Existing Property Lines
- Existing Storm Drain
- Existing Fiber Optic Cable
- Existing Overhead Power
- Existing Fence
- Top Of Bank
- Palustrine Emergent Wetlands
- Palustrine Forested Wetlands
- Archaeological Area
- Waterway Line

N

0 400
Feet

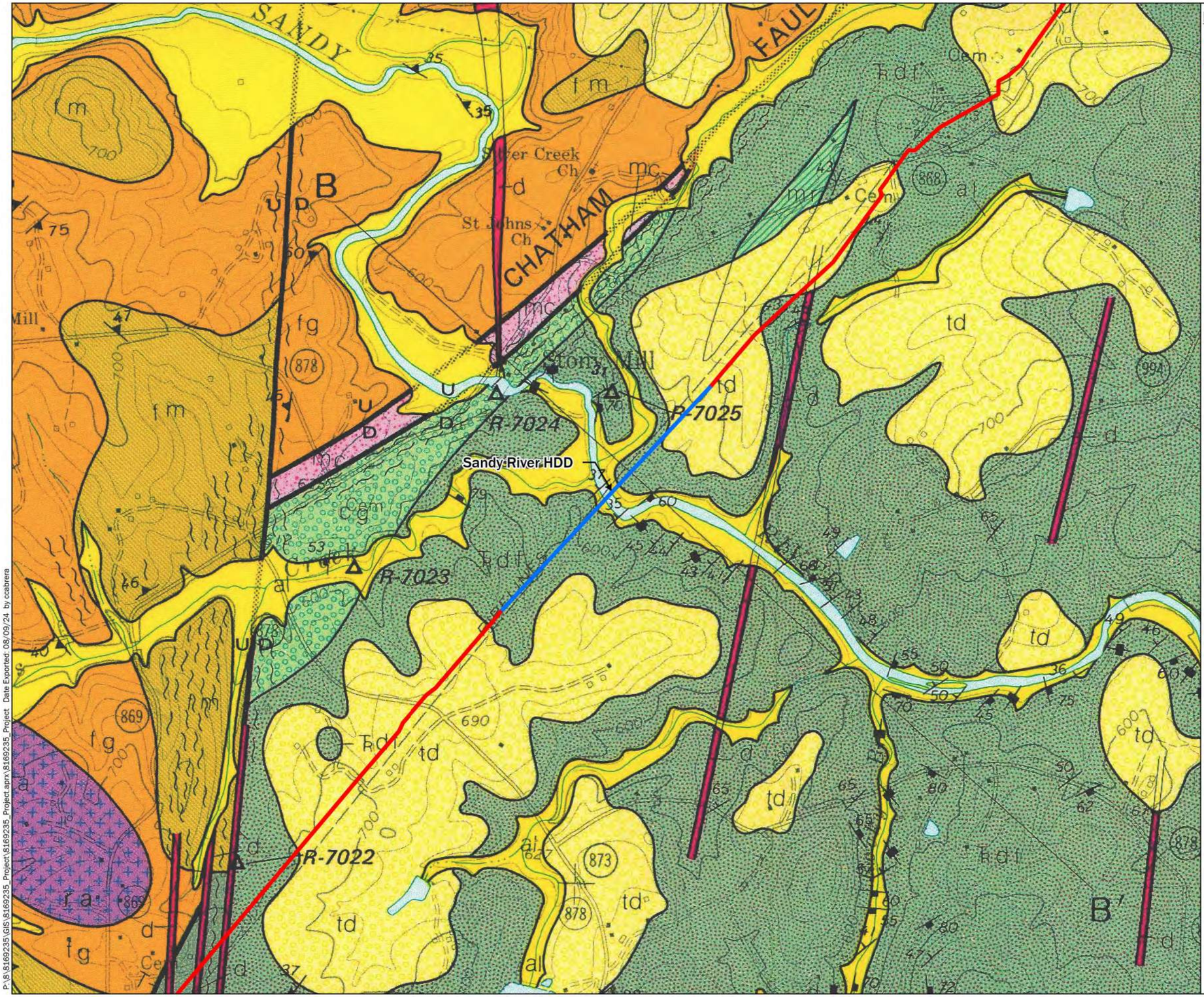
NOT FOR CONSTRUCTION

Transcontinental Gas Pipeline Company, LLC
Boring Location Map

Proposed 42-inch Eden Loop
Sandy River
Pittsylvania County, Virginia

GeoEngineers

Figure 2



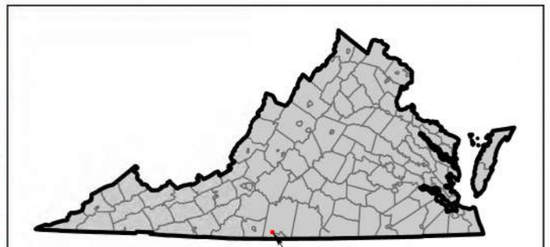
LEGEND

- Proposed HDD Alignment
- Proposed Centerline Alignment

al — Alluvium: *Unconsolidated floodplain deposits containing interlayers and lenses of light-brown and gray organic clays and light-brown sands and gravels; some gravels in clay matrix; cut-and-fill structures and cross-bedding common.*

td — Terrace deposits: *Unconsolidated stream deposits composed of rounded pebbles, cobbles and boulders in a matrix ranging from clay to sand occur as valley fill or terrace deposits along hill slopes and on interfluves; valley fill and low terrace material composed of white clay with thin, interlayered white sand beds, generally with white cobble layer at the base.*

Tcdf (Dry Fork Formation, sandstone facies), *very well-indurated, dominantly massive, crudely stratified, gray and greenish-gray, poorly sorted, coarse-grained, arkose and lithic arkose interbedded with subordinate mudrock and conglomerate; grayish-red and dark-reddish-brown interbeds are chiefly siltstones and silty mudstones, massive to medium- and thick-bedded and in places with burrow mottles, carbonate concretions and thick laminations.* **mr** (mudrock facies), *dominantly uniformly and thinly bedded, medium- to dark-gray, silty, laminated mudrock containing carbonaceous films and pyrite and silt-shale. Sandstone subordinate, poorly sorted, arkosic and subarkosic with minor amounts of granule and pebble lithic arkosic conglomerate. Minor sedimentary structures include ripple marks, small-scale, tabular cross-stratification, burrow casts, and primary current lineations. There are some carbonized wood chips.*



Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers USA, P.C. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Carpenter, P.A. III. 1982. Geologic map of Region G (Alamance, Caswell, Davidson, Guilford, Randolph, and Rockingham counties), North Carolina. Regional Geology Series 2. North Carolina

Projection: NAD 1983 2011 StatePlane Virginia South FIPS 4502 Ft US

N

0 1,000
Feet

Transcontinental Gas Pipeline Company, LLC
Bedrock Geology Map

Proposed 42-inch Eden Loop
Sandy River HDD
Pittsylvania County, Virginia

GeoEngineers

Figure 3

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Appendices

Appendix A
Geotechnical Explorations and Laboratory Testing

Appendix A
Geotechnical Explorations and Laboratory Testing

GEOTECHNICAL EXPLORATIONS

We explored the subsurface conditions at the site from May 13 through 22, 2024 and again from June 3 through 12, 2024, by completing six (6) geotechnical borings (SR-B-1 through SR-B-6) to depths of up to approximately 201 feet below ground surface (bgs). Drilling operations were completed by our drilling subcontractor, S&ME, Inc. (S&ME), operating a rubber-tired drill rig. The locations of the borings are shown on the attached Boring Location Map, Figure 2. The Virginia State "One-Call" utility locating agency was contacted to locate utilities in the project area prior to the start of the exploratory borings.

A GeoEngineers representative observed field activities, classified the soil encountered, obtained representative samples, and prepared a log of each exploration. The soils encountered were classified visually in general accordance with American Society for Testing and Materials (ASTM) D2488, which is described in Figure A-1. The rock encountered was classified visually in general accordance with the American Society of Civil Engineers (ASCE) Manual of Engineering Practice No. 56, which is described in Figure A-2.

In general, soil samples were obtained from the borings at 2½-foot depth intervals in the upper 10 feet and 5-foot-depth intervals thereafter using 1.5-inch I.D. split-spoon samplers. The split-spoon samplers were driven 18 inches during Standard Penetration Tests (SPT), using a 140-pound hammer with a 30-inch drop. The number of hammer blows required to drive the sampler the final 12-inches was recorded on field logs. Bedrock was continuously cored using NQ2 rock coring techniques. Each boring was backfilled upon completion with cement-bentonite grout.

The apparent consistency or relative density of the SPT samples recovered at each depth interval was evaluated based on correlations with lab and field observations in general accordance with the values outlined in Table A-1 below.

TABLE A-1. CORRELATION FOR BLOW COUNTS AND APPARENT CONSISTENCY OR RELATIVE DENSITY [1]

APPARENT CONSISTENCY OF COHESIVE SOIL (SILT AND CLAY) [2]						
Parameter	Very Soft	Soft	Medium Stiff	Stiff	Very Stiff	Hard
Blows (N)	0 - 1	2 – 4	5 – 8	9 – 15	16 – 30	> 30
RELATIVE DENSITY OF GRANULAR SOIL (SAND AND GRAVEL) [3]						
Parameter	Very Loose	Loose	Medium Dense	Dense	Very Dense	
Blows (N)	0 – 4	5 – 10	11 – 30	31 – 50	> 50	

Notes:

[1] After Peck R.B., Hansen W.E., and Thornburn, T.H., "Foundation Engineering," Second Edition, John Wiley & Sons, 1974.

[2] Classification also applies to cohesive soils containing additional constituents; that is, organic soil, sand, gravel, etc.

[3] Classification also applies to granular soils containing additional constituents; that is, organic soil, silt, clay, etc.

The Rock quality designation (RQD) of the rock core samples recovered from each core run was evaluated and is presented on the exploration logs, where applicable, in Figures A-3 through A-8. The rock quality descriptions are correlated to RQD (%) as outlined in Table A-2, below.

TABLE A-2. ROCK QUALITY DESIGNATION

RQD (%)	ROCK QUALITY DESCRIPTION
0-25	Very Poor
26-50	Poor
51-75	Fair
76-90	Good
91-100	Excellent

The boring logs are presented in Figures A-3 through A-8. The logs are based on our interpretation of the field data obtained from the subsurface explorations and indicate the various types of soils and rock encountered, while indicating the approximate depths at which the subsurface conditions change. Unless noted on the boring logs, the lines designating changes in classification between soil and rock types represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. Additionally, the boring logs represent conditions observed at the time of drilling and have been edited to incorporate results of the laboratory tests performed as appropriate.

LABORATORY TESTING

General

Samples collected from the borings were transported to our Cary, North Carolina office. Representative soil and rock core samples were selected for laboratory testing. Laboratory testing on samples included moisture content determinations, Atterberg limit determinations, sieve analyses, percent fines, unconfined compressive strength testing, Mohs hardness, and Cerchar Abrasivity Index testing. The laboratory testing procedures are discussed in more detail below. Laboratory test results prepared by Geo Testing Express and Geotechnics are presented at the end of Appendix A.

Moisture Content

Moisture Content tests were performed on selected soil samples obtained from the borings. The tests were completed in general accordance with ASTM D2216. The results of these tests are presented on the boring logs in Figures A-3 through A-8 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

Percent Fines

Percent Fines tests were performed on selected soil samples obtained from the borings. The tests were completed in general accordance with ASTM D1140. The results of these tests are presented on the boring logs in Figures A-3 through A-8 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

Gradation of Soils

Gradation of Soils (SA) tests were performed on selected soil samples obtained from the borings. The tests were completed in general accordance with ASTM D6913. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS) and are shown in the laboratory test results. The percentage passing the U.S. No. 200 sieve is shown on the boring logs at the respective sample depths.

Atterberg Limits

Atterberg Limits were performed on selected fine-grained soil samples in general accordance with ASTM D4318. The tests were used to classify the soils as well as to evaluate their index properties. The results of the Atterberg Limits testing are shown on the boring logs at the depth at which the samples were obtained and in the attached Laboratory Test Results.

Mohs Hardness Testing

Mohs Hardness (MOH) tests were performed on selected rock specimens obtained from the borings. The results of these tests are presented on the boring logs in Figures A-3 through A-7 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

Unconfined Compression Testing

Unconfined compression (UC) tests were performed on selected rock specimens obtained from the borings. The tests were used to evaluate compressive strength characteristics and were completed in general accordance with ASTM D7012. The results of testing are presented on the boring logs at their respective sample depths and are shown in the laboratory test results. Rock core sample photographs are presented in Figures A-9 through A-89.

Point Load Strength Index Testing

Point load strength index tests were performed on selected rock samples obtained from the borings to provide an estimated compressive strength of the samples. The tests were completed in general accordance with ASTM D5731. The results of testing are presented on the boring logs at their respective sample depths and are shown in the laboratory test results.

Cerchar Abrasivity Index Testing

Cerchar Abrasivity Index (CAI) tests were performed on selected rock specimens obtained from the borings to provide a relative estimate of the samples abrasiveness. The tests were completed in general accordance with ASTM D7625. The results of these tests are presented on the boring logs in Figures A-3 through A-8 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

Sampler Symbol Descriptions

- Modified California Sampler (6-inch sleeve) or Dames & Moore
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab
- Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

- Measured groundwater level in exploration, well, or piezometer
- Measured free product in well or piezometer

Graphic Log Contact

- Distinct contact between soil strata
- Approximate contact between soil strata

Material Description Contact

- Contact between geologic units
- Contact between soil of the same geologic unit

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

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Figure A-1

Scale of Relative Rock Weathering[1]

Designation	Field Identification
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric. Decomposition extends up to 1 inch into rock.
Moderately Weathered	Rock mass is decomposed 50% or less. Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Predominantly Decomposed	Rock mass is more than 50% decomposed. Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to soil with hand pressure.

Scale of Relative Rock Hardness[1]

Term	Hardness Designation	Field Identification	Approximate Unconfined Compressive Strength
Extremely Soft	R0	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.	< 100 psi
Very Soft	R1	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocketknife. Scratched with fingernail.	100-1000 psi
Soft	R2	Can be peeled by a pocketknife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.	1000-4000 psi
Medium Hard	R3	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.	4000-8000 psi
Hard	R4	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.	8000-16000 psi
Very Hard	R5	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.	> 16000 psi

Discontinuity Spacing[1]

Description for Bedding, Foliation, or Flow Banding	Spacing	Description of Joints, Faults, or Other Fractures
Very Thick	>10 ft	Very Widely Spaced
Thick	3 ft – 10 ft	Widely Spaced
Medium	1 ft – 3 ft	Moderately Spaced
Thin	2 in – 1 ft	Closely Spaced
Very Thin	<2 in	Very Closely Spaced

Rock Quality Designation (RQD)[1, 2]

RQD (Percent)	Description of Rock Quality
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

NOTES: 1. Based on ASCE Manual on Engineering Practice No. 56,1976. 2. RQD is a modified core recovery measurement which expresses the number of hard and sound rock pieces of 4" or more in size as a percentage of the total length of core run.

Explanation of Bedrock Terms

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Figure A-2

Drilled Start 6/6/2024 End 6/8/2024	Total Depth (ft) 201	Logged By GLH Checked By TJP	Driller S&ME, Inc.	Drilling Method Mud Rotary and NQ Wireline Rock Coring	
Surface Elevation (ft) 610.1 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment CME 550X Rubber Tire Drill Rig	
Latitude 36.6344 Longitude -79.542		System Datum North Carolina State Plane North NSRS 2011		Groundwater not observed at time of exploration	

Notes: Borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0	18	8	S1			TS	Brown silty fine to medium sand (topsoil)			
							SM	Brown silty fine to coarse sand with trace fine gravel (loose, moist)			
		0	15	S2				No recovery			
605	5						ML	Brown silt with fine to coarse sand (stiff, moist)			Classification based on cuttings
		0	10	S3				No recovery			
		9	10	S4 %F			SM	Brown silty fine to coarse sand (medium dense, moist)	30	45	
600	10							Becomes fine to medium			
		14	22	S5							
595	15										
		12	34	S6				Becomes with trace fine gravel and dense (decomposed bedrock)			
590	20										
		14	46	S7 SA				Becomes fine to coarse		31	Gravel content (%) = 3
585	25										
		13	84	S8				Becomes fine to medium, without gravel and very dense			
580	30										
		12	52	S9				Becomes with trace fine gravel			
	35										

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Survey). Vertical approximated based on GPS (Survey).

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Log of Boring SR-B-1

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35										
		3	50/2"	S10							
570	40										
		4	50/5"	S11				Becomes without gravel			
565	45										
		5	50/5"	S12							
560	50										Drill chatter observed at 52 feet
		5	50/5"	S13							
555	55										
		0	50/0"	S14				No recovery			
550	60	88		R1	0		Conglomerate	Brown and gray, moderately weathered, medium hard to hard, conglomerate			Run 1 - 3 minute run Very poor rock quality
		100		R2	43			Becomes gray and slightly weathered			Run 2 - 15 minute run Poor rock quality
545	65										
		100		R3 UCS UDW MOH	50						Run 3 - 12 minute run Fair rock quality UCS = 8,590 psi; UDW = 161 pcf; Mohs Hardness = 5.5
540	70										
		100		R4	77			Becomes slightly weathered to fresh			Run 4 - 11 minute run Good rock quality Loss of drilling fluid returns at 71.5 feet bgs Full drilling fluid returns at 72 feet bgs Loss of drilling fluid returns at 73 feet bgs
535	75										
		100		R5	87						

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Log of Boring SR-B-1 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-3
Sheet 2 of 5

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
530	80										Run 5 - 13 minute run Good rock quality
		100		R6	82						Run 6 - 10 minute run Good rock quality
525	85										
		100		R7 UCS UDW MOH	78						Run 7 - 9 minute run Good rock quality
520	90										
		100			75						UCS = 12,680 psi; UDW = 158 pcf; Mohs Hardness = 7.5 Run 8 - 11 minute run Good rock quality
515	95										
		100		R9	25						Run 9 - 9 minute run Poor rock quality
510	100										
		92		R10	67						Run 10 - 9 minute run Fair rock quality
505	105										
		100		R11 UCS UDW MOH	77						Potential void at 105.6 feet bgs Run 11 - 11 minute run Good rock quality
											UCS = 20,300 psi; UDW = 161 pcf; Mohs Hardness = 7.5
500	110							Becomes hard to very hard (R4-R5)			
		100		R12	97						Run 12 - 11 minute run Excellent rock quality
								Becomes fresh			
495	115										
		100		R13 UCS UDW MOH	78						Run 13 - 14 minute run Good rock quality

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Log of Boring SR-B-1 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-3

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
490	120										
		100		R14	90						Run 14 - 10 minute run Excellent rock quality UCS=11,300 psi; UDW = 163 pcf; Mohs Hardness = 4.5
485	125										
		100		R15	100						Run 15 - 14 minute run Excellent rock quality
480	130										
		100		R16	100						Run 16 - 15 minute run Excellent rock quality
475	135										
		100		R17 UCS UDW MOH	100						Run 17 - 15 minute run Excellent rock quality UCS = 8,990 psi; UDW = 164 pcf; Mohs Hardness = 6.5
470	140										
		100		R18	100						Run 18 - 19 minute run Excellent rock quality
465	145										
				CAI							CAI = 4.42
		100		R19	98						Run 19 - 21 minute run Excellent rock quality
460	150										
		100		R20 UCS UDW MOH YM (E)	95		Siltstone	Gray, fresh, hard to very hard, siltstone			Run 20 - 21 minute run Excellent rock quality UCS = 10,664 psi; UDW = 175 pcf; Mohs Hardness = 4.5; E = 7,059,000
455	155										
		100		R21	82						Run 21 - 17 minute run Good rock quality
450	160										

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Log of Boring SR-B-1 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
				CAI							CAI = 3.40
		100		R22	95						Run 22 - 13 minute run Excellent rock quality
445	165										
		100		R23 UCS UDW MOH	95						Run 23 - 10 minute run Excellent rock quality UCS = 6,540 psi; UDW = 173 pcf; Mohs Hardness = 4.5
440	170										
		100		R24	97			Becomes slightly weathered			Run 24 - 11 minute run Excellent rock quality
435	175										
		100		R25	75			Becomes fresh			Run 25 - 12 minute run Good rock quality
430	180										
		100		R26 UCS UDW MOH	82						Run 26 - 12 minute run Good rock quality UCS = 2,280 psi; UDW = 178 pcf; Mohs Hardness = 5.5
425	185										
		100		R27	72						Run 27 - 10 minute run Fair rock quality
420	190							Becomes medium hard to hard (R3-R4)			
		100		R28	78						Run 28 - 11 minute run Good rock quality
415	195										
		100		R29	85						Run 29 - 9 minute run Good rock quality
410	200										

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Log of Boring SR-B-1 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Drilled Start 5/21/2024 End 5/22/2024	Total Depth (ft) 151	Logged By GLH Checked By TJP	Driller S&ME, Inc.	Drilling Method Mud Rotary and NQ Wireline Rock Coring	
Surface Elevation (ft) 539.6 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment CME 550X Rubber Tire Drill Rig	
Latitude 36.6358 Longitude -79.5399		System Datum North Carolina State Plane North NSRS 2011		Groundwater not observed at time of exploration	

Notes: Borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0	16	4	S1			SM	Brown fine to medium silty sand (very loose, moist)			
535	5	16	2	S2				Becomes fine to coarse			
		10	3	S3							
530	10	12	33	S4 SA HM				Becomes gray and dense with wood fragments and trace gravel (USDA - loamy sand)		16	Gravel content (%) = 2
525	15	9	50/3"	S5				Becomes brown and very dense decomposed bedrock			
		0	50/0"	S6				No recovery			Moderate drill chatter observed
520	20	100		R1	0		Sandstone	Brown, highly to moderately weathered, very soft to soft, sandstone, fine to coarse grained			Run 1 - 4 minute core run Very poor rock quality
		77		R2	0						Run 2 - 10 minute core run Very poor rock quality
515	25	65		R3 PLS	0						Run 3 - 9 minute core run Very poor rock quality Point Load Index = 29 psi; Estimated UCS = 663 psi
							Conglomerate	Brown, completely to highly weathered, extremely soft to soft, conglomerate			
510	30	100		R4	0						Run 4 - 7 minute core run Very poor rock quality
505	35										

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Survey). Vertical approximated based on GPS (Survey).

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Log of Boring SR-B-2

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-4
Sheet 1 of 4

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35	92		R5	0						Run 5 - 7 minute core run Very poor rock quality
500	40	100		R6	0						Run 6 - 11 minute core run Very poor rock quality
495	45	100		R7	7						Run 7 - 10 minute core run Very poor rock quality
490	50	100		R8	0						Run 8 - 10 minute core run Very poor rock quality
485	55	100		R9	7						Run 9 - 8 minute core run Very poor rock quality
480	60	100		R10 PLS	15						Run 10 - 9 minute core run Very poor rock quality Point Load Index = 41 psi; Estimated UCS = 924 psi
475	65	100		R11	20						Run 11 - 8 minute core run Very poor rock quality
470	70	100		R12	0						Run 12 - 10 minute core run Very poor rock quality
465	75	100		R13	22						

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Log of Boring SR-B-2 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
											Run 13 - 10 minute core run Very poor rock quality
460	80										
		100		R14	13						Run 14 - 10 minute core run Very poor rock quality
455	85										
		100		R15	20						Run 15 - 9 minute core run Very poor rock quality
450	90							Becomes highly weathered			
		100		R16	58			Becomes moderately weathered and soft to hard			Run 16 - 9 minute core run Fair rock quality
445	95										
		100		R17	37			Becomes brown to gray, moderately weathered to fresh, and medium hard to hard			Run 17 - 8 minute core run Poor rock quality Drilling fluid loss at 98 feet bgs Potential void from 98 to 99 feet bgs
440	100										
		83		R18 UCS UDW MOH	72			Becomes gray, fresh to slightly weathered and hard to very hard			Run 18 - 11 minute core run Fair rock quality UCS = 7,810 psi; UDW = 162 pcf Mohs Hardness = 6.5
435	105										Drilling fluid returns at 105 feet bgs
		100		R19	80						Run 19 - 11 minute core run Good rock quality Drilling fluid loss at 106 feet bgs
430	110										
		100		R20	32			Becomes gray and brown and medium hard to hard			Run 20 - 11 minute core run Poor rock quality
425	115										
		100		R21 UCS UDW MOH CAI	73			Becomes gray and hard to very hard			Run 21 - 10 minute core run Fair rock quality UCS = 8,790 psi; UDW = 164 pcf Mohs Hardness = 6.5; CAI = 4.41

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Log of Boring SR-B-2 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
420	120										
		100		R22	97						Run 22 - 12 minute core run Excellent rock quality
415	125										
		100		R23	83						Run 23 - 12 minute core run Good rock quality
							Siltstone	Gray, fresh, hard to very hard, siltstone			
410	130										
		100		R24 UCS UDW MOH YM(E) CAI	73						Run 24 - 10 minute core run Fair rock quality UCS = 24,040 psi; UDW = 164 pcf Mohs Hardness = 7.5; E = 11,140,000 psi; CAI = 4.54
405	135										
		100		R25	83						Run 25 - 12 minute core run Good rock quality
400	140						Conglomerate	Gray, fresh, medium hard to hard, conglomerate			
		100		R26	75						Run 26 - 12 minute core run Fair rock quality
395	145										
		100		R27 UCS UDW MOH	88			Becomes hard to very hard			Run 27 - 15 minute core run Good rock quality UCS = 7,960 psi; UDW = 162 pcf Mohs Hardness = 4.5
390	150										

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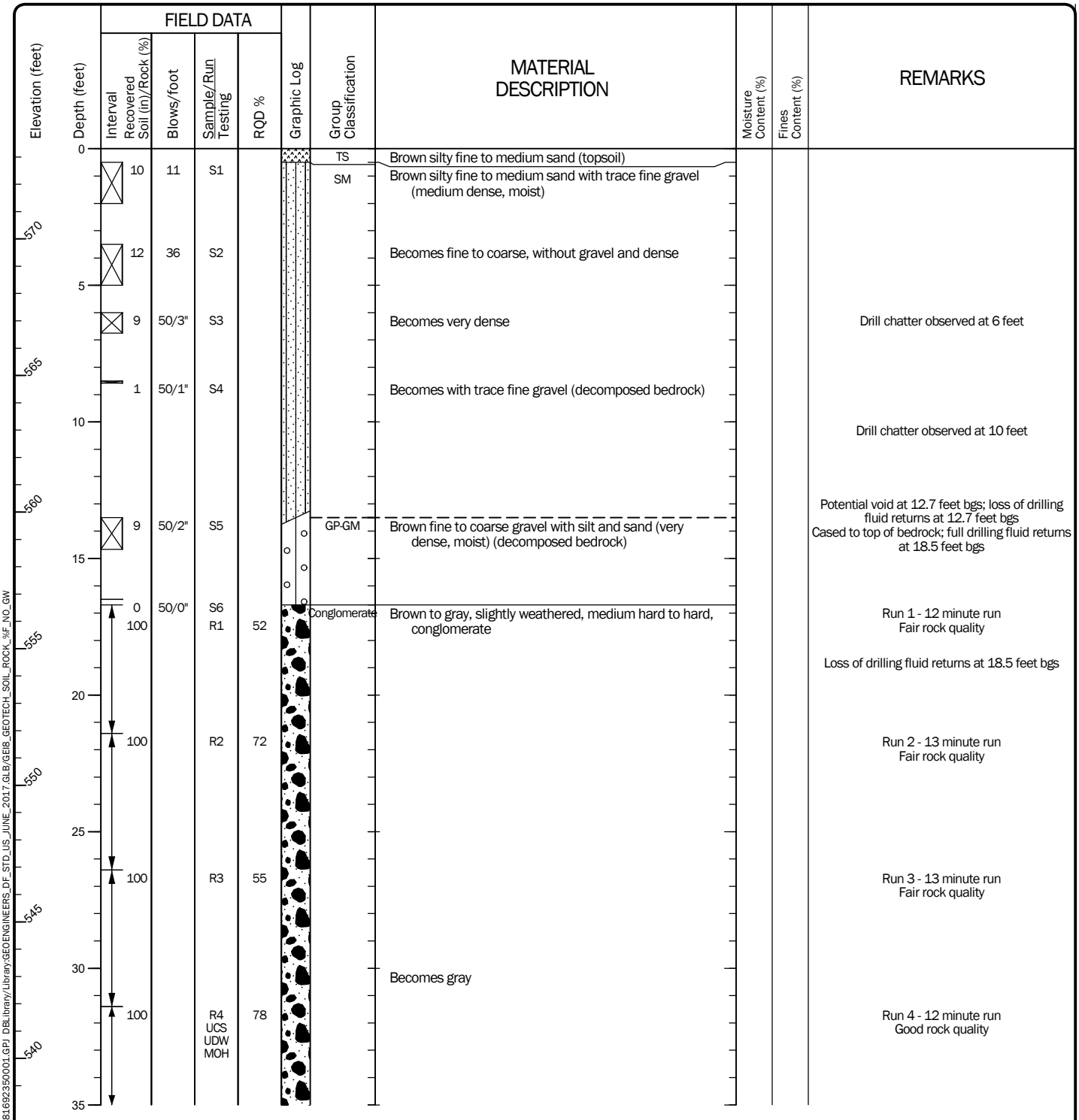
Log of Boring SR-B-2 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Drilled: Start 6/3/2024 End 6/5/2024	Total Depth (ft) 171.5	Logged By GLH Checked By TJP	Driller S&ME, Inc.	Drilling Method Mud Rotary and NQ Wireline Rock Coring	
Surface Elevation (ft) 573.3 Vertical Datum NAVD88	Hammer Data Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment CME 550X Rubber Tire Drill Rig			
Latitude 36.6371 Longitude -79.5392	System Datum North Carolina State Plane North NSRS 2011	Groundwater not observed at time of exploration			

Notes: Borehole backfilled with cement-bentonite grout.



Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Survey). Vertical approximated based on GPS (Survey).

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Log of Boring SR-B-3

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-5
Sheet 1 of 5

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35										UCS = 13,020 psi; UDW = 160 pcf; Mohs Hardness = 5.5
535		100		R5	67			Becomes slightly weathered to fresh			Run 5 - 13 minute run Fair rock quality
	40										
		100		R6	93			Becomes hard to very hard			Run 6 - 16 minute run Excellent rock quality
530	45										
		100		R7	65						Run 7 - 14 minute run Fair rock quality
525	50							Becomes medium hard to hard			
		100		R8	93			Becomes fresh and hard to very hard			Run 8 - 13 minute run Excellent rock quality
520	55										
		100		R9 UCS UDW MOH	75						Run 9 - 13 minute run Good rock quality UCS = 8,360 psi; UDW = 165 pcf; Mohs Hardness = 4.5
515	60										
		100		R10	95						Run 10 - 12 minute run Excellent rock quality
510	65										
		100		R11	83						Run 11 - 15 minute run Good rock quality
505	70										
		100		R12	72						Run 12 - 17 minute run Fair rock quality
500	75										

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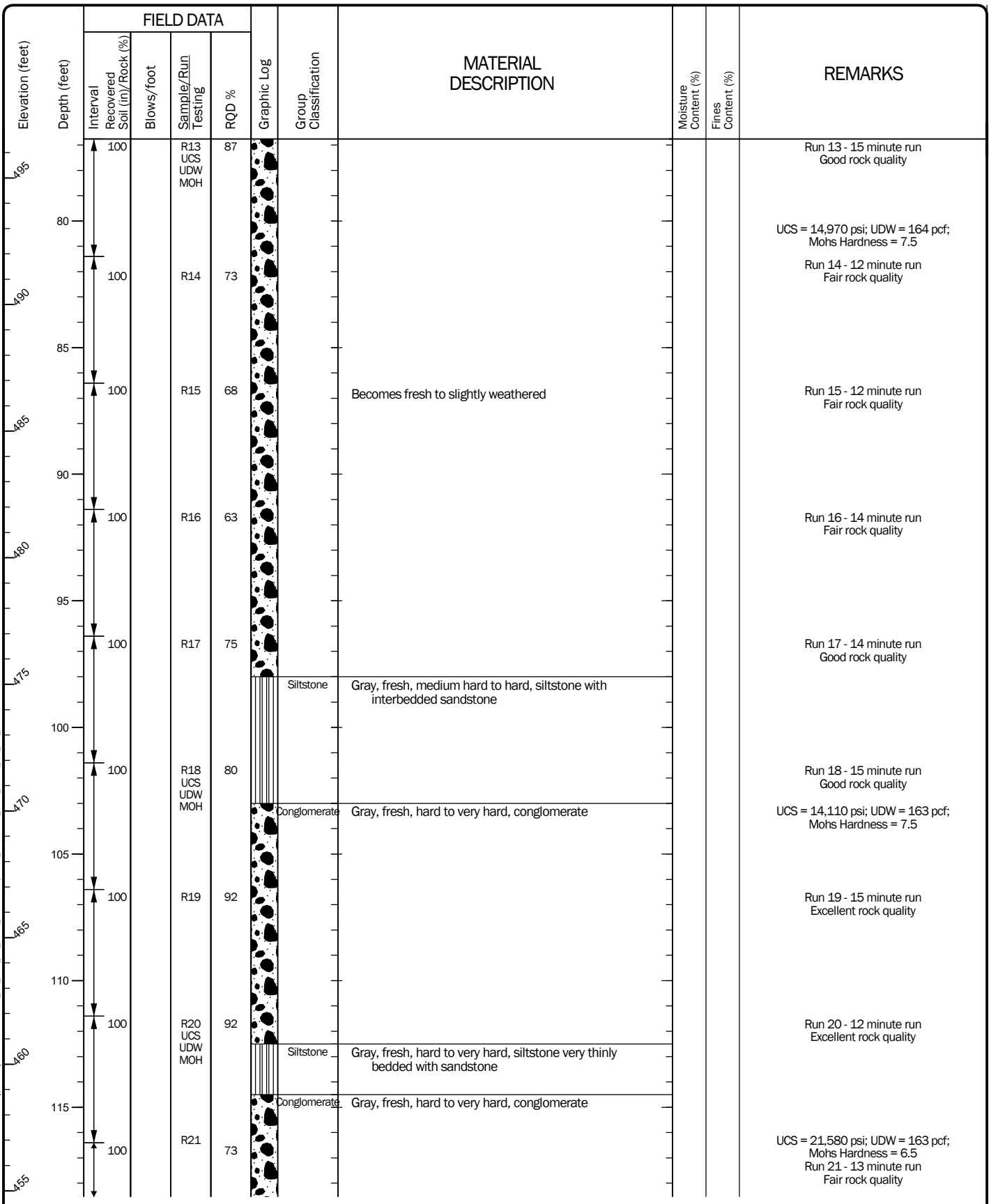
Log of Boring SR-B-3 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-5



Log of Boring SR-B-3 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-5
Sheet 3 of 5

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_SOIL_ROCK_%F_NO_GW

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
450	120										
	125	100		R22	77						Run 22 - 13 minute run Good rock quality
445		100		R23	52						Run 23 - 13 minute run Fair rock quality
	130	100		R24 UCS UDW MOH YM (E) CAI	31						Run 24 - 14 minute run Poor rock quality UCS = 23,105 psi; UDW = 166 pcf; Mohs Hardness = 6.5; E = 11,360,000 CAI = 4.18
440	135	100		R25 PLS	23			Becomes fresh to slightly weathered			Point Load Index = 748 psi; Estimated UCS = 17,041 psi Run 25 - 12 minute run Very poor rock quality
435	140	100		R26	35						Run 26 - 12 minute run Poor rock quality
430	145	100		R27 UCS UDW MOH	48						Run 27 - 12 minute run Poor rock quality
425	150										UCS = 6,570 psi; UDW = 165 pcf; Mohs Hardness = 7.5
		100		R28	60						Run 28 - 16 minute run Fair rock quality
420	155										
		100		R29	75						Run 29 - 14 minute run Good rock quality
415	160										

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Log of Boring SR-B-3 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-5

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
410	165	100		R30 UCS UDW MOH	68						Run 30 - 21 minute run Fair rock quality UCS = 11,130 psi; UDW = 163 pcf; Mohs Hardness = 6.5
405	170	100		R31	75			Becomes fresh			Run 31 - 21 minute run Good rock quality

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Log of Boring SR-B-3 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Drilled: Start 5/20/2024 End 5/21/2024	Total Depth (ft) 141	Logged By GLH / Checked By TJP	Driller S&ME, Inc.	Drilling Method Mud Rotary and NQ Wireline Rock Coring	
Surface Elevation (ft) 587.4 / Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment CME 550X Rubber Tire Drill Rig	
Latitude 36.6375 / Longitude -79.5381		System Datum North Carolina State Plane North NSRS 2011		Groundwater not observed at time of exploration	

Notes: Borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0	17	8	S1			CL	Red lean clay with sand (medium stiff, moist)			
585		12	17	S2			SM	Brown fine to coarse silty sand (medium dense, moist)			
	5	8	64	S3				Becomes fine to medium and very dense			
580		12	50/3"	S4				Becomes fine to coarse and decomposed bedrock			
	10	0	50/.5"	S5				No recovery			Moderate drill chatter observed
575	15										
		1	50/1"	S6							
570	20	80		R1	100		Conglomerate	Brown, fresh to slightly weathered, medium hard to hard, conglomerate			Run 1 - 8 minute core run Excellent rock quality
		100		R2	78						Run 2 - 11 minute core run Good rock quality
565	25										
		100		R3	43						Run 3 - 8 minute core run Poor rock quality
560	30						Siltstone	Gray, fresh, hard to very hard, siltstone			
		100		R4 UCS UDW MOH	50						Run 4 - 7 minute core run Poor rock quality UCS = 11,780 psi; UDW = 164 pcf Mohs Hardness = 6.5
555	35						Conglomerate	Gray, fresh to slightly weathered, medium hard to hard, conglomerate			

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Survey). Vertical approximated based on GPS (Survey).

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Log of Boring SR-B-4

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-6
Sheet 1 of 4

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
550	35	100		R5	65						Run 5 - 9 minute core run Fair rock quality
	40										
545		100		R6	93						Run 6 - 11 minute core run Excellent rock quality
	45										
540		100		R7	78						Run 7 - 8 minute core run Good rock quality
	50										
535		100		R8	73						Run 8 - 10 minute core run Fair rock quality
	55						Siltstone	Gray, fresh, medium hard to hard, siltstone			
530		100		R9 UCS UDW MOH	68						Run 9 - 10 minute core run Fair rock quality UCS = 25,410 psi; UDW = 163 pcf Mohs Hardness = 4.5
							Conglomerate	Gray, fresh, hard to very hard, conglomerate			
	60										
525		100		R10	85						Run 10 - 11 minute core run Good rock quality
	65						Siltstone	Gray, fresh, medium hard to hard, siltstone			
520		100		R11	100		Conglomerate	Gray, fresh, hard to very hard, conglomerate			Run 11 - 13 minute core run Excellent rock quality
							Siltstone	Gray, fresh, hard to very hard, siltstone			
	70										
515		100		R12 UCS UDW MOH	100						Run 12 - 13 minute core run Excellent rock quality UCS = 8,190 psi; UDW = 164 pcf Mohs Hardness = 5.5
							Conglomerate	Gray, fresh, hard to very hard, conglomerate			
	75										
		100		R13	100						

Log of Boring SR-B-4 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-6
Sheet 2 of 4

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_SOIL_ROCK_%F_NO_GW

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
510	80										Run 13 - 14 minute core run Excellent rock quality
505		100		R14	100						Run 14 - 14 minute core run Excellent rock quality
	85										
500		100		R15 UCS UDW MOH	100						Run 15 - 15 minute core run Excellent rock quality UCS = 7,450 psi; UDW = 163 pcf Mohs Hardness = 5.5
	90										
495		100		R16	100						Run 16 - 14 minute core run Excellent rock quality
	95										
490		100		R17	90						Run 17 - 14 minute core run Good rock quality
	100			CAI							CAI = 4.33
485		100		R18 UCS UDW MOH YM(E)	77						Run 18 - 13 minute core run Good rock quality UCS = 23,140 psi; UDW = 164 pcf Mohs Hardness = 7.5; E = 14,060,000 psi
	105										
480		100		R19	85						Run 19 - 14 minute core run Good rock quality
	110										
475		100		R20	92						Run 20 - 15 minute core run Excellent rock quality
	115										
470		100		R21 UCS UDW MOH	77						Run 21 - 15 minute core run Good rock quality UCS = 14,880 psi; UDW = 163 pcf; Mohs Hardness = 5.5

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-4 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
465	120										
		100		R22	92						Run 22 - 16 minute core run Excellent rock quality
	125										
		100		R23	97						Run 23 - 16 minute core run Excellent rock quality
460	130										
		100		R24	83						Run 24 - 16 minute core run Good rock quality
455							Siltstone	Gray, fresh, hard to very hard, siltstone			
	135										
		100		R25 UCS UDW MOH	100						Run 25 - 16 minute core run Excellent rock quality UCS = 8,550 psi; UDW = 161 pcf; Mohs Hardness = 6.5
450							Conglomerate	Gray, fresh, hard to very hard, conglomerate			
							Siltstone	Gray, fresh, hard to very hard, siltstone			
	140										

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-4 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Drilled: Start 5/13/2024 End 5/16/2024	Total Depth (ft) 155	Logged By GLH / Checked By TJP	Driller S&ME, Inc.	Drilling Method Mud Rotary and NQ Wireline Rock Coring	
Surface Elevation (ft) 607.2 / Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment CME 550X Rubber Tire Drill Rig	
Latitude 36.6389 / Longitude -79.5374		System Datum North Carolina State Plane North NSRS 2011		Groundwater not observed at time of exploration	

Notes: Borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0	12	15	S1			TS	Topsoil - 6 inches			
605							CL	Reddish brown lean clay with trace sand (stiff, moist)			
	5	15	13	S2 %F			ML	Brown sandy silt (stiff, moist)		62	
600		14	13	S3 AL							Non-plastic
	10	14	17	S4				Becomes very stiff			
595											
	15	12	50/5"	S5 SA			SM	Brown fine to medium silty sand with trace gravel (very dense, moist)		36	Gravel content (%) = 2
590											
	20	4	50/5"	S6				Becomes decomposed bedrock			
585											Slow drilling observed
		0	50/0"	S7				No recovery			
	25	100		R1	100		Conglomerate	Gray, fresh to slightly weathered, medium hard to very hard, conglomerate			Run 1 - 6 minute core run Excellent rock quality
580		100		R2 UCS UDW MOH	87						Run 2 - 15 minute core run Good rock quality UCS = 7,780 psi; UDW = 162 pcf Mohs Hardness = 6.5
	30										
575		100		R3	80						Run 3 - 16 minute core run Good rock quality
	35			CAI							CAI = 3.08

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Survey). Vertical approximated based on GPS (Survey).

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-5

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-7
Sheet 1 of 4

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35										
570		100		R4	78						Run 4 - 14 minute core run Good rock quality
							Siltstone	Gray, fresh, hard to very hard, siltstone			
	40										
565		100		R5 UCS UDW MOH YM(E)	92						Run 5 - 14 minute core run Excellent rock quality UCS = 31,343 psi; UDW = 166 pcf Mohs Hardness = 7.5; E = 14,570,000 psi
	45										
560		100		R6	65						Run 6 - 15 minute core run Fair rock quality
							Conglomerate	Gray, fresh, hard to very hard, conglomerate			
	50										
555		100		R7	78						Run 7 - 21 minute core run Good rock quality UCS = 9,970 psi; UDW = 163 pcf Mohs Hardness = 5.5
							Siltstone	Gray, medium hard to hard, siltstone			
	55										
550		100		R8 UCS UDW MOH	33						Run 8 - 14 minute core run Poor rock quality
							Mudstone	Dark gray, fresh, soft to medium hard, mudstone			
	60										
545		100		R9	27						Run 9 - 15 minute core run Poor rock quality
	65										
540		100		R10	100						Run 10 - 11 minute core run Excellent rock quality
							Conglomerate	Gray, fresh, hard to very hard, conglomerate			
	70										
535		100		R11	100						Run 11 - 20 minute core run Excellent rock quality
	75										
		100		R12	82						

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-5 (continued)

Elevation (feet)	Depth (feet)	Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
530				UCS UDW MOH							Run 12 - 21 minute core run Good rock quality UCS = 11,040 psi; UDW = 164 pcf Mohs Hardness = 6.5
	80										
525		100		R13	87						Run 13 - 20 minute core run Good rock quality
	85						Siltstone	Gray, fresh, medium hard to hard, siltstone			
520		100		R14	87						Run 14 - 18 minute core run Good rock quality
							Conglomerate	Gray, fresh, hard to very hard, conglomerate			
	90										
515		100		R15	95						Run 15 - 18 minute core run Excellent rock quality
	95										
510		100		R16 UCS UDW MOH	90						Run 16 - 18 minute core run Good rock quality UCS = 18,610 psi; UDW = 162 pcf Mohs Hardness = 6.5
	100										
505		100		R17	95						Run 17 - 17 minute core run Excellent rock quality
							Siltstone	Gray, fresh, hard to very hard, siltstone			
	105										
500		100		R18	67						Run 18 - 13 minute core run Fair rock quality
	110										
495		100		R19	95						Run 19 - 15 minute core run Excellent rock quality
							Sandstone	Gray, fresh, medium hard to hard, sandstone, fine to medium grained, interbedded with siltstone			
	115										
490		100		R20	92						Run 20 - 13 minute core run Excellent rock quality

FIELD DATA

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEIB_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-5 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	120							Becomes very fine to medium grained			
485		100		R21 UCS UDW MOH	98						Run 21 - 16 minute core run Excellent rock quality UCS = 22,280 psi; UDW = 167 pcf Mohs Hardness = 4.5
	125										
480		100		R22	88		Conglomerate	Gray, fresh, hard to very hard, conglomerate			Run 22 - 15 minute core run Good rock quality
	130										
475		100		R23	95						Run 23 - 17 minute core run Excellent rock quality
	135										
470		100		R24	100						Run 24 - 17 minute core run Excellent rock quality
	140										
465		100		R25	88						Run 25 - 18 minute core run Good rock quality
	145						Sandstone	Gray, fresh, medium hard to hard, sandstone, fine to coarse grained			
460		100		R26 UCS UDW MOH	100		Conglomerate	Gray, fresh, hard to very hard, conglomerate			Run 26 - 23 minute core run Excellent rock quality UCS = 13,100 psi; UDW = 164 pcf Mohs Hardness = 4.5
	150										
455		100		R27	52						Run 27 - 31 minute core run Fair rock quality
	155										

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-5 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Drilled: Start 6/9/2024 End 6/12/2024	Total Depth (ft) 142.5	Logged By GLH Checked By TJP	Driller S&ME, Inc.	Drilling Method Mud Rotary and NQ Wireline Rock Coring	
Surface Elevation (ft) 636.5 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment CME 550X Rubber Tire Drill Rig	
Latitude 36.633 Longitude -79.5437		System Datum North Carolina State Plane North NSRS 2011		Groundwater not observed at time of exploration	

Notes: Borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0						TS	Brown silty fine to coarse sand (topsoil)			
635		11	15	S1			ML	Brown silt with fine to coarse sand (stiff, moist)			
	5	6	17	S2			SM	Brown silty fine to medium sand (medium dense, moist)			
630		12	18	S3 SA				Becomes fine to coarse with trace fine gravel		38	Gravel content (%) = 3
		12	17	S4							
	10										Drill chatter observed at 12 feet bgs
625		5	50/5"	S5				Becomes with trace fine gravel and very dense (decomposed bedrock)			
	15										Drill chatter observed at 15½ feet bgs
620		4	50/4"	S6				Becomes without gravel			
	20										
615		3	50/3"	S7							
	25										Drill chatter observed at 25½ feet bgs
610		5	50/5"	S8			SP-SM	Brown fine to coarse sand with silt and trace fine gravel (very dense, moist) (decomposed bedrock)			
	30										Drill chatter observed at 30 feet bgs
605		3	50/3"	S9							
	35										Drill chatter observed at 34½ feet bgs

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Survey). Vertical approximated based on GPS (Survey).

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-6

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-8

Elevation (feet)	Depth (feet)	Interval Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35										
600		0	50/0"	S10				No recovery			
	40	100		R1	0		Conglomerate	Brown, moderately to highly weathered, soft to medium hard, conglomerate			Run 1 - 4 minute run Very poor rock quality
595		100		R2	7			Becomes very soft to medium hard			Run 2 - 12 minute run Very poor rock quality
	45										
590		100		R3	42			Becomes brown to gray, moderately weathered and soft to medium hard			Run 3 - 10 minute run Poor rock quality
	50										
585		100		R4 UCS UDW MOH YM (E)	60						Run 4 - 11 minute run Fair rock quality UCS = 18,354 psi; UDW = 163 pcf; Mohs Hardness = 6.5; E = 7,768,000
	55										
580		100		R5 UCS UDW MOH CAI	53			Becomes moderately to slightly weathered			Run 5 - 9 minute run Poor rock quality
	60										UCS = 9,470 psi; UDW = 157 pcf; Mohs Hardness = 6.5; CAI = 4.05
575		92		R6	47			Becomes with infilled soil			Run 6 - 10 minute run Poor rock quality
	65							Becomes without infilled soil			
570		100		R7	53						Run 7 - 12 minute run Fair rock quality
	70							Becomes medium hard to hard			
565		100		R8	35						Run 8 - 9 minute run Poor rock quality
	75										
560											

Date:9/5/24 Path:P:\8\8169235\GINT\8169235000I.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-6 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
555	80	100		R9 UCS UDW MOH	75						Run 9 - 8 minute run Good rock quality UCS = 11,870 psi; UDW = 163 pcf; Mohs Hardness = 7.5;
		100		R10	70						Run 10 - 10 minute run Fair rock quality
550	85	100		CAI R11	65						CAI = 3.74 Run 11 - 10 minute run Fair rock quality
545	90	100		R12 UCS UDW MOH	53						Run 12 - 8 minute run Fair rock quality UCS = 5,780 psi; UDW = 157 pcf; Mohs Hardness = 4.5
540	95	100		R13	70			Becomes gray and slightly weathered			Run 13 - 12 minute run Fair rock quality
535	100	100		R14	67						Run 14 - 11 minute run Fair rock quality
530	105	100		R15	53						Run 15 - 10 minute run Fair rock quality
525	110	100		R16 UCS UDW MOH	75						Run 16 - 11 minute run Good rock quality UCS = 15,850 psi; UDW = 159 pcf; Mohs Hardness = 4.5
520	115	100		R17	80						Run 17 - 12 minute run Good rock quality

Log of Boring SR-B-6 (continued)

GeoEngineers

Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-8
Sheet 3 of 4

Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	120										
515							Siltstone	Gray, slightly weathered, medium hard to hard, siltstone			
		100		R18	92		Conglomerate	Gray, slightly weathered, medium hard to hard, conglomerate			Run 18 - 12 minute run Excellent rock quality
	125						Siltstone	Gray, slightly weathered, medium hard to hard, siltstone			
510		100		R19	95		Conglomerate	Gray, slightly weathered to fresh, hard to very hard, conglomerate			Run 19 - 10 minute run Excellent rock quality
	130										
505		100		R20 UCS UDW MOH	87						Run 20 - 12 minute run Good rock quality UCS = 10,690 psi; UDW = 162 pcf; Mohs Hardness = 4.5
	135										
500		100		R21	100						Run 21 - 12 minute run Excellent rock quality
	140										
495											

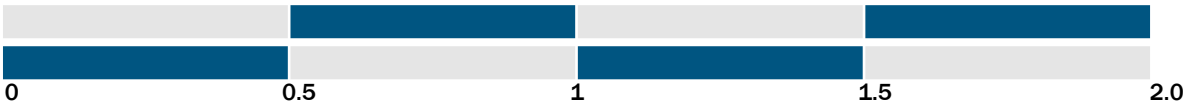
Date:9/5/24 Path:P:\8\8169235\GINT\8169235001.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F_NO_GW

Log of Boring SR-B-6 (continued)

GeoEngineers

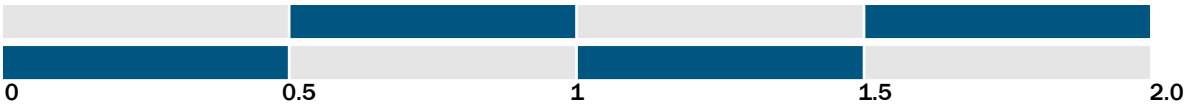
Project: SSE Project: Eden Loop - Sandy River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

SR-B-1: 59.4' to 61.0'



Scale in Feet

SR-B-1: 61.0' to 66.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-9

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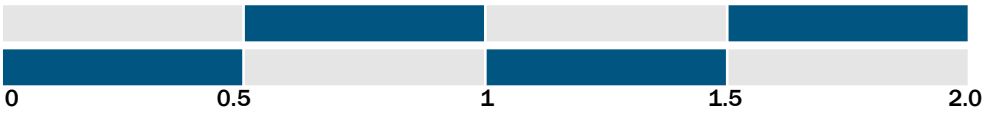
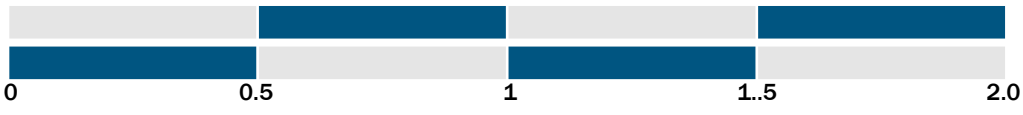
SR-B-1: 66.0' to 71.0'



Scale in Feet

SR-B-1: 71.0' to 76.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-10

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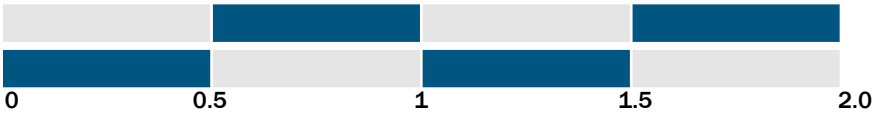
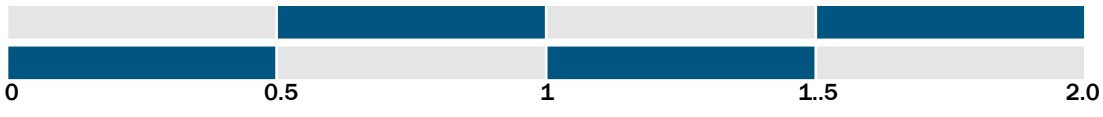
SR-B-1: 76.0' to 81.0'



Scale in Feet

SR-B-1: 81.0' to 86.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-11

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SR-B-1: 86.0' to 91.0'

SR-B-1: 91.0' to 96.0'

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-12

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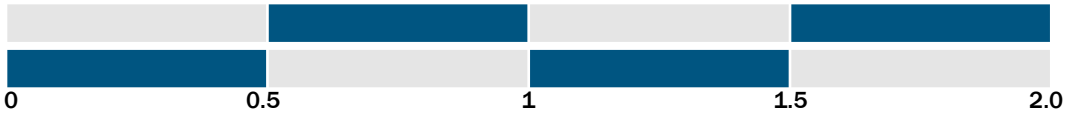
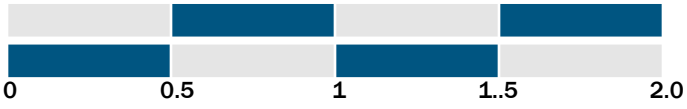
SR-B-1: 96.0' to 101.0'



Scale in Feet

SR-B-1: 101.0' to 106.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-13

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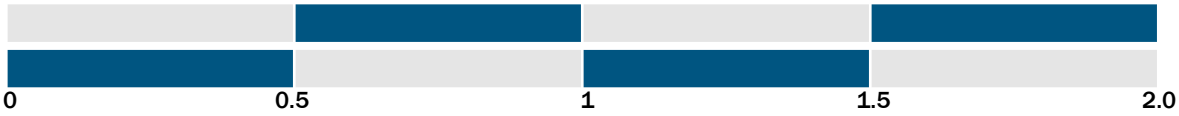
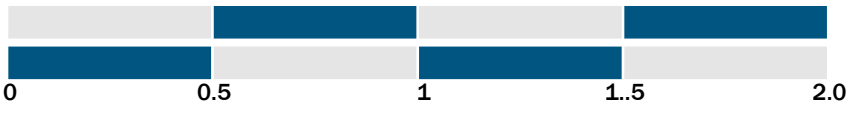
SR-B-1: 106.0’ to 111.0’



Scale in Feet

SR-B-1: 111.0’ to 116.0’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-14

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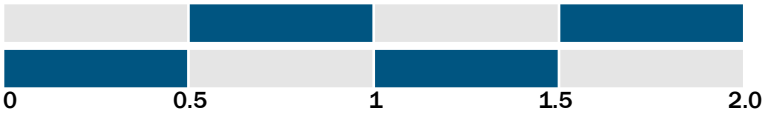
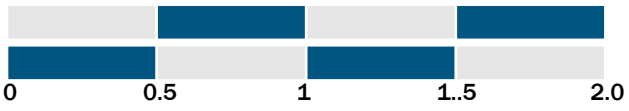
SR-B-1: 116.0' to 121.0'



Scale in Feet

SR-B-1: 121.0' to 126.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-15

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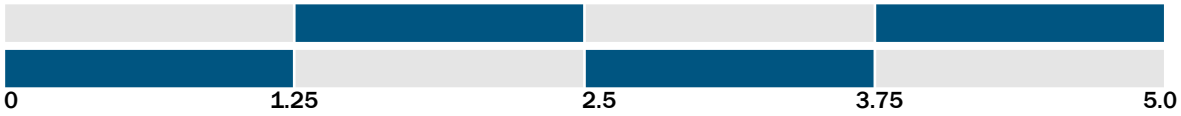
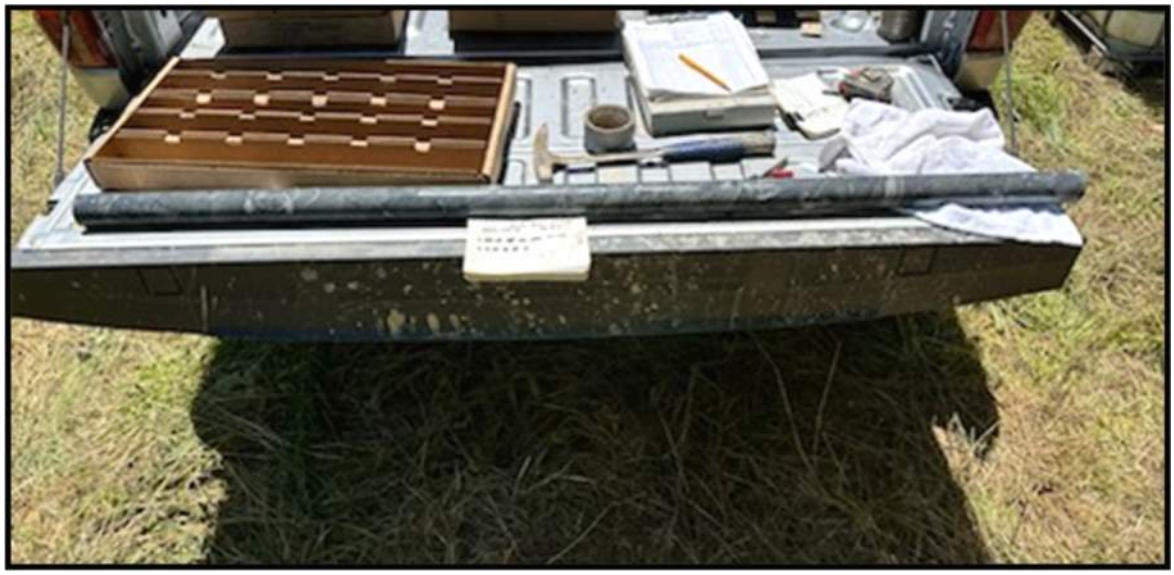
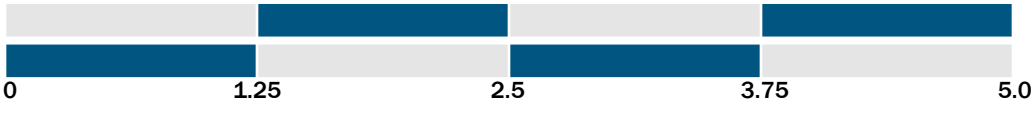
SR-B-1: 126.0' to 131.0'



Scale in Feet

SR-B-1: 131.0' to 136.0'





Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-16

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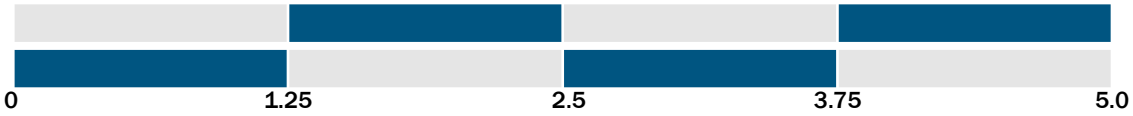
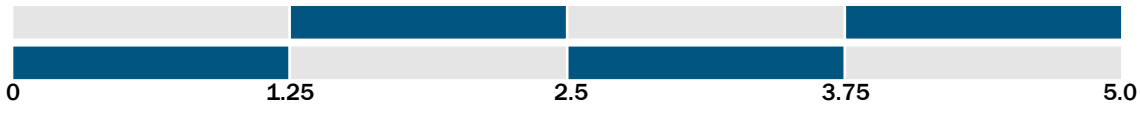
SR-B-1: 136.0' to 141.0'



Scale in Feet

SR-B-1: 141.0' to 146.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-17

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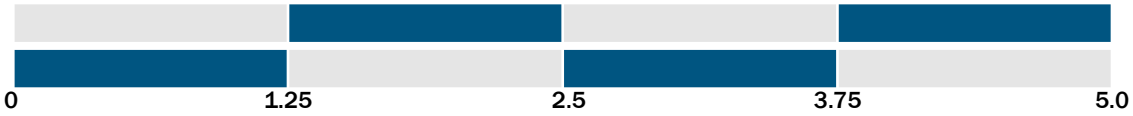
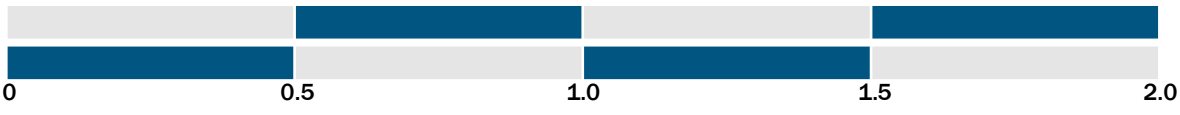
8169-235-00 Date Exported: 09/06/2024

SR-B-1: 146.0' to 151.0'



Scale in Feet

SR-B-1: 151.0' to 156.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-18

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SR-B-1: 156.0' to 161.0'

SR-B-1: 161.0' to 166.0'

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-19

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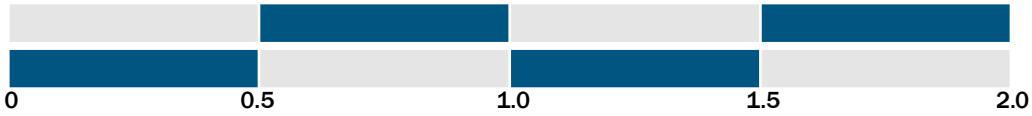
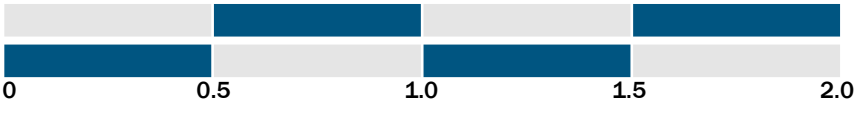
SR-B-1: 166.0' to 171.0'



Scale in Feet

SR-B-1: 171.0' to 176.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-20

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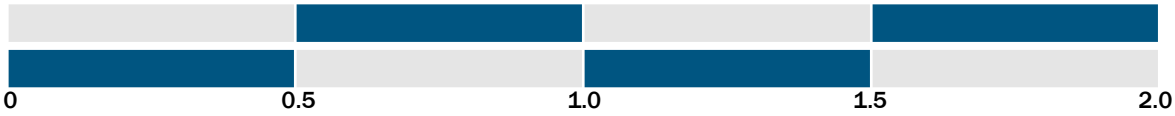
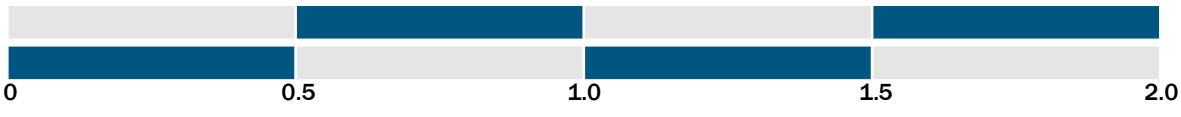
SR-B-1: 176.0' to 181.0'



Scale in Feet

SR-B-1: 181.0' to 186.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-21

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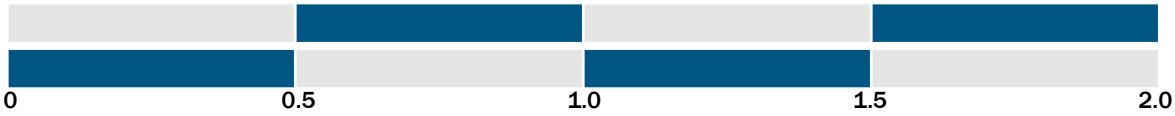
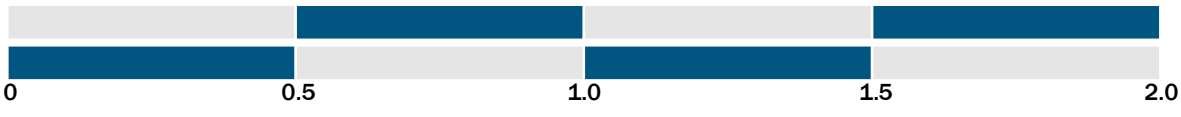
SR-B-1: 186.0' to 191.0'



Scale in Feet

SR-B-1: 191.0' to 196.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-22

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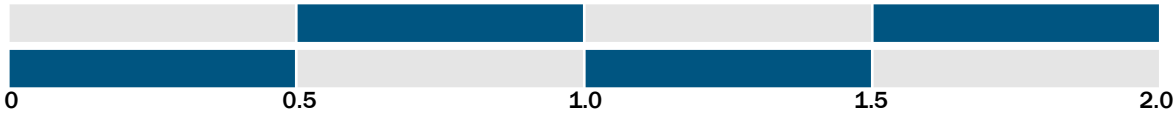
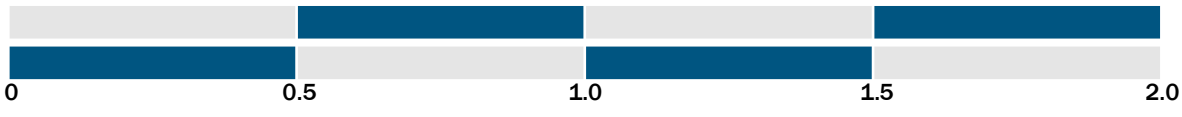
SR-B-1: 196.0' to 201.0'



Scale in Feet

SR-B-2: 19.5' to 21.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-23

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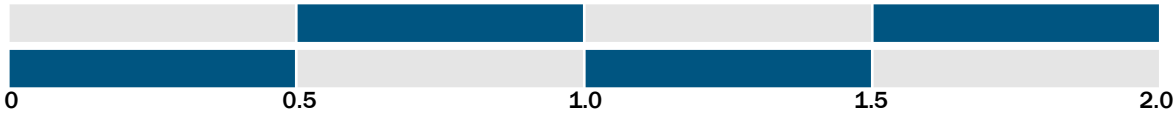
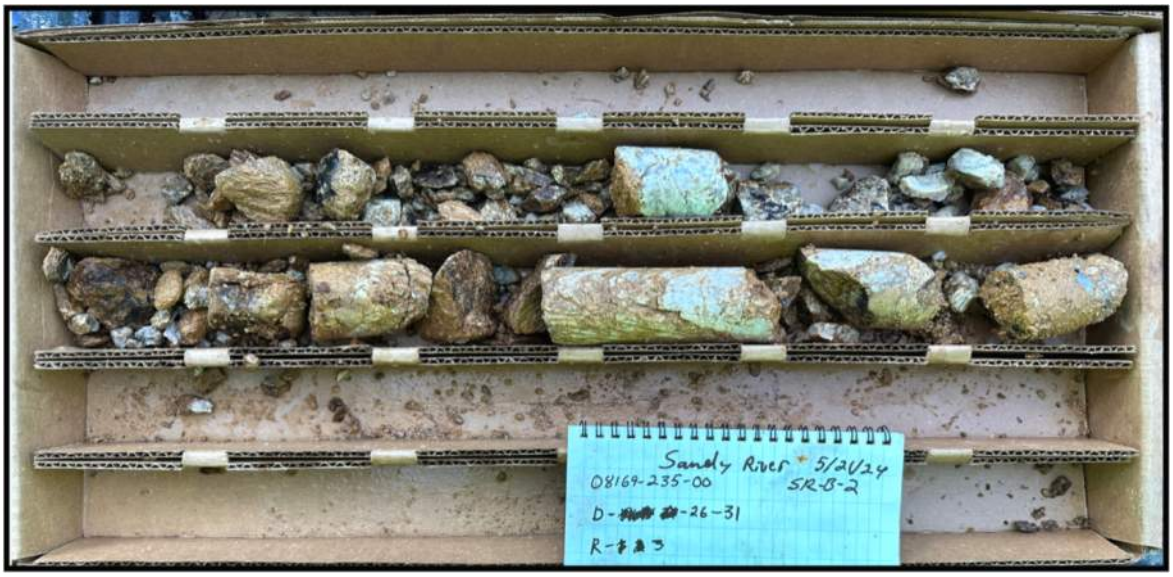
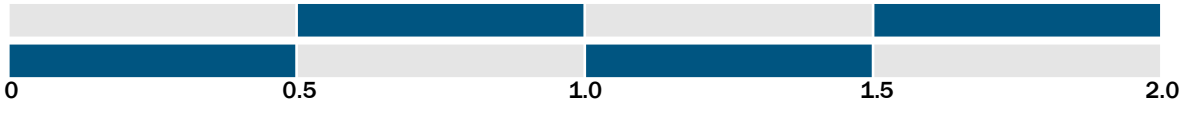
SR-B-2: 21.0' to 26.0'



Scale in Feet

SR-B-2: 26.0' to 31.0'





Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-24

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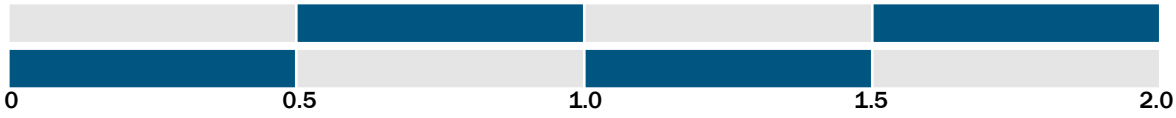
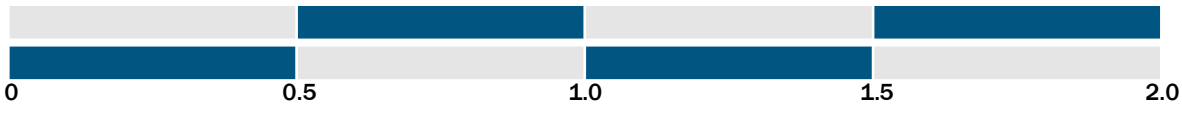
SR-B-2: 31.0' to 36.0'



Scale in Feet

SR-B-2: 36.0' to 41.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-25

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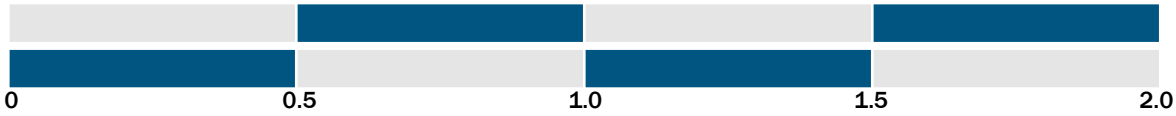
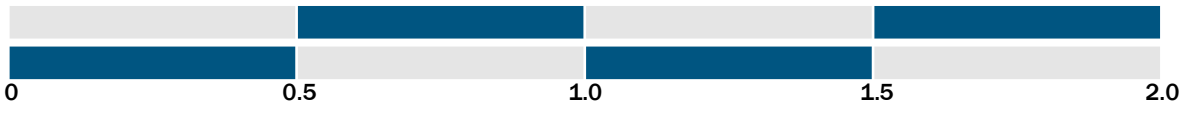
SR-B-2: 41.0' to 46.0'



Scale in Feet

SR-B-2: 46.0' to 51.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-26

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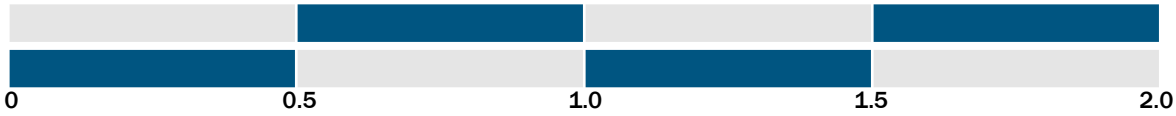
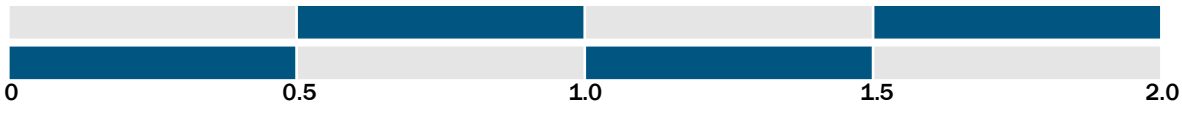
SR-B-2: 51.0’ to 56.0’



Scale in Feet

SR-B-2: 56.0’ to 61.0’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-27

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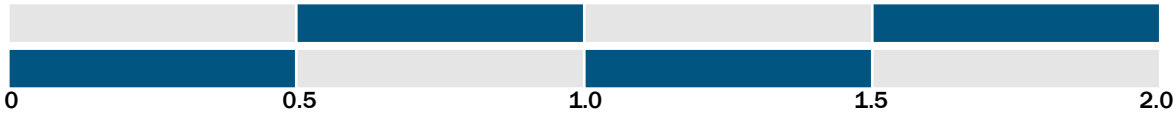
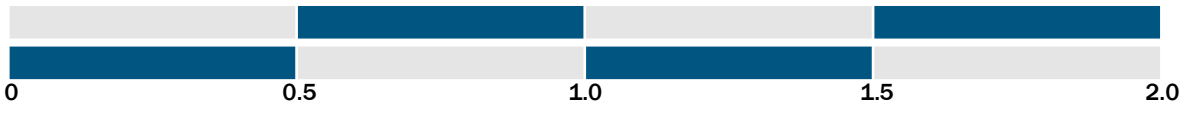
SR-B-2: 61.0' to 66.0'



Scale in Feet

SR-B-2: 66.0' to 71.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-28

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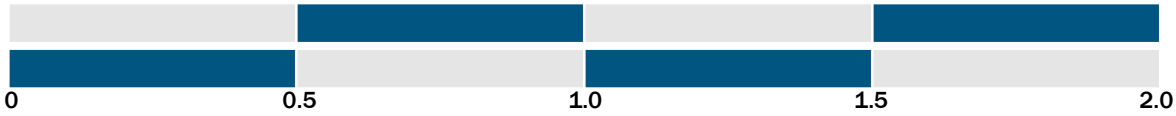
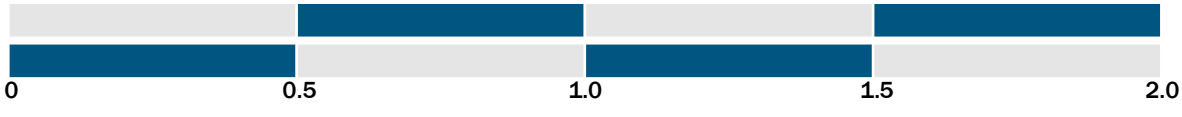
SR-B-2: 71.0' to 76.0'



Scale in Feet

SR-B-2: 76.0' to 81.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-29

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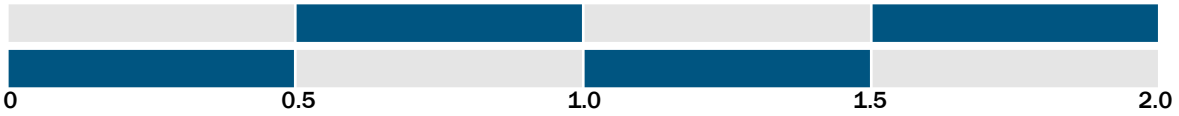
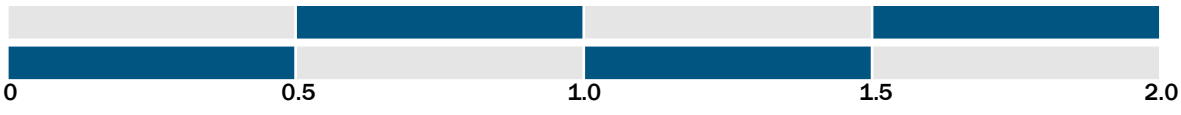
SR-B-2: 81.0' to 86.0'



Scale in Feet

SR-B-2: 86.0' to 91.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-30

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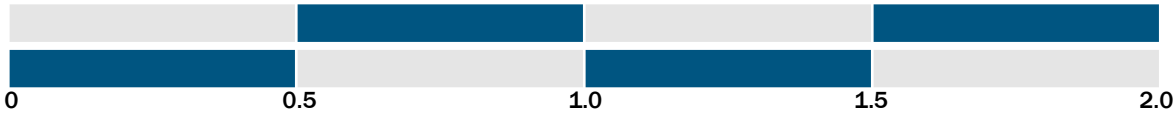
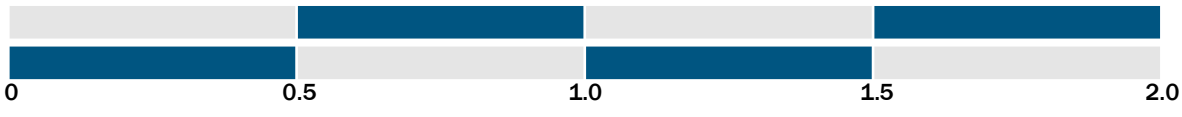
SR-B-2: 91.0' to 96.0'



Scale in Feet

SR-B-2: 96.0' to 101.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-31

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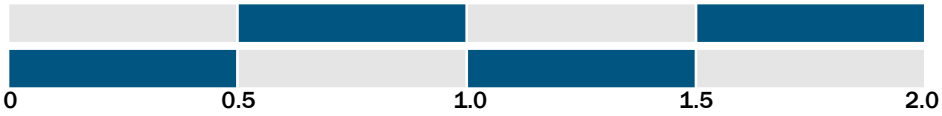
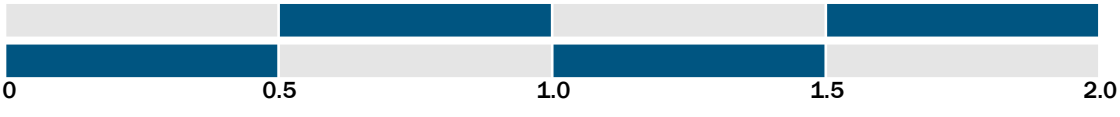
SR-B-2: 101.0' to 106.0'



Scale in Feet

SR-B-2: 106.0' to 111.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-32

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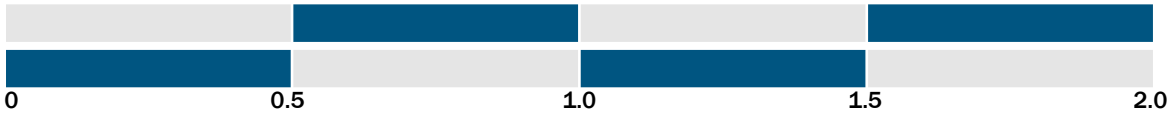
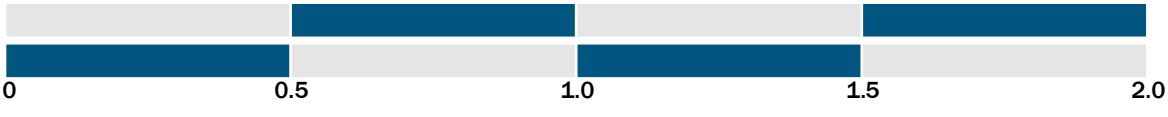
SR-B-2: 111.0' to 116.0'



Scale in Feet

SR-B-2: 116.0' to 121.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-33

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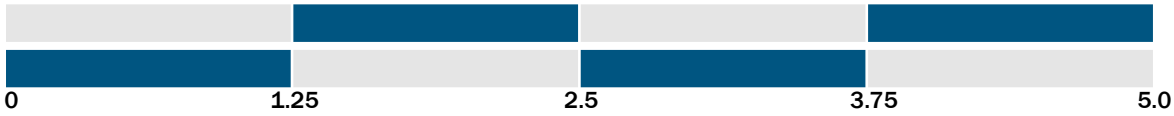
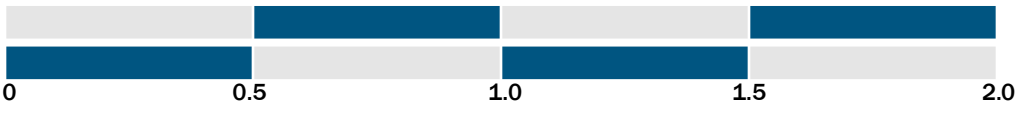
SR-B-2: 121.0' to 126.0'



Scale in Feet

SR-B-2: 126.0' to 131.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-34

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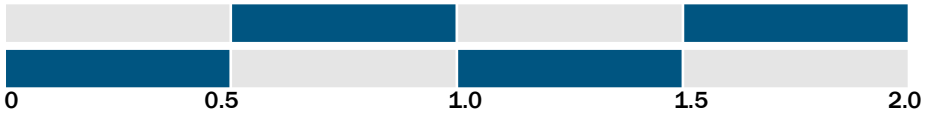
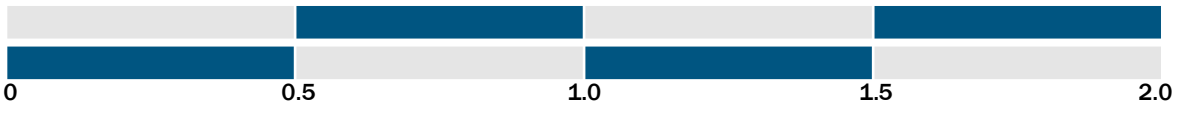
8169-235-00 Date Exported: 09/06/2024

SR-B-2: 131.0’ to 136.0’



Scale in Feet

SR-B-2: 136.0’ to 141.0’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-35

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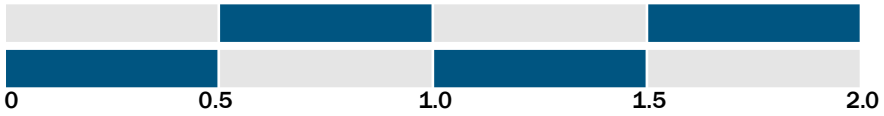
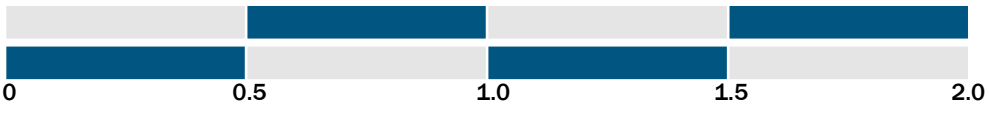
SR-B-2: 141.0' to 146.0'



Scale in Feet

SR-B-2: 146.0' to 151.0'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-36

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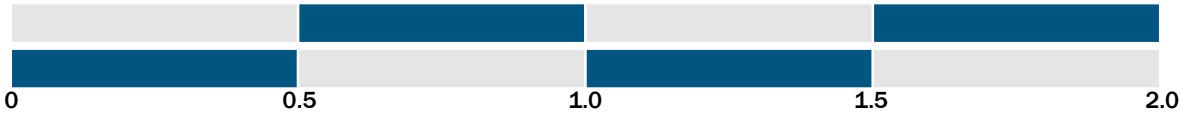
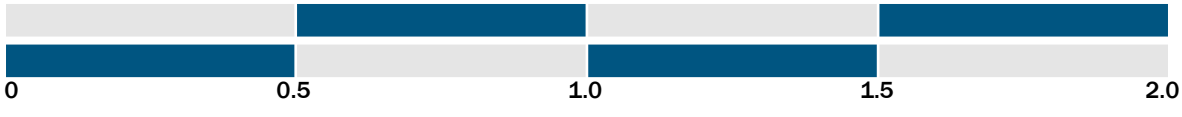
SR-B-3: 16.7' to 21.4'



Scale in Feet

SR-B-3: 21.4' to 26.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-37

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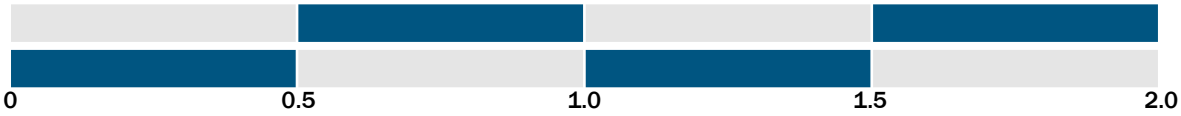
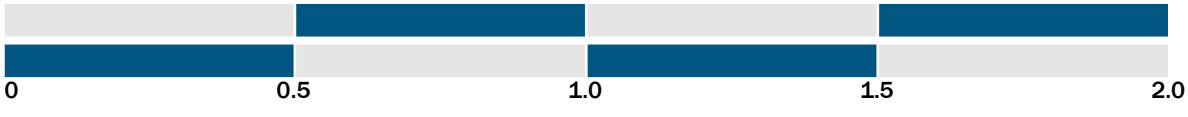
SR-B-3: 26.4' to 31.4'



Scale in Feet

SR-B-3: 31.4' to 36.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-38

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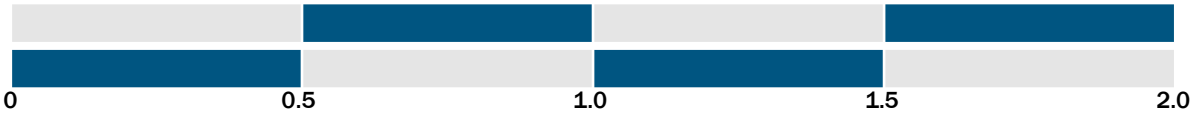
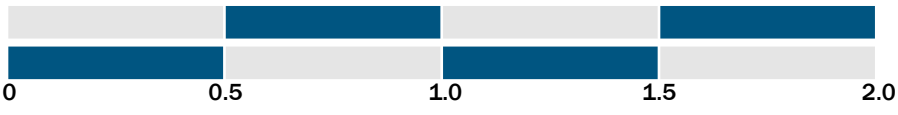
SR-B-3: 36.4' to 41.4'



Scale in Feet

SR-B-3: 41.4' to 46.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-39

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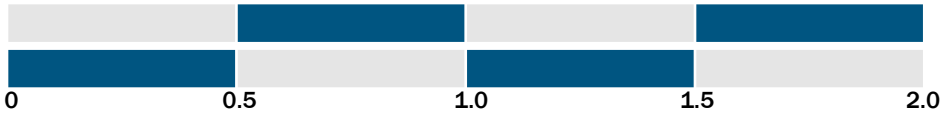
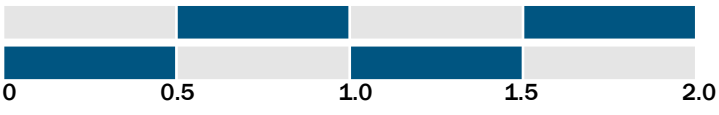
SR-B-3: 46.4’ to 51.4’



Scale in Feet

SR-B-3: 51.4’ to 56.4’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-40

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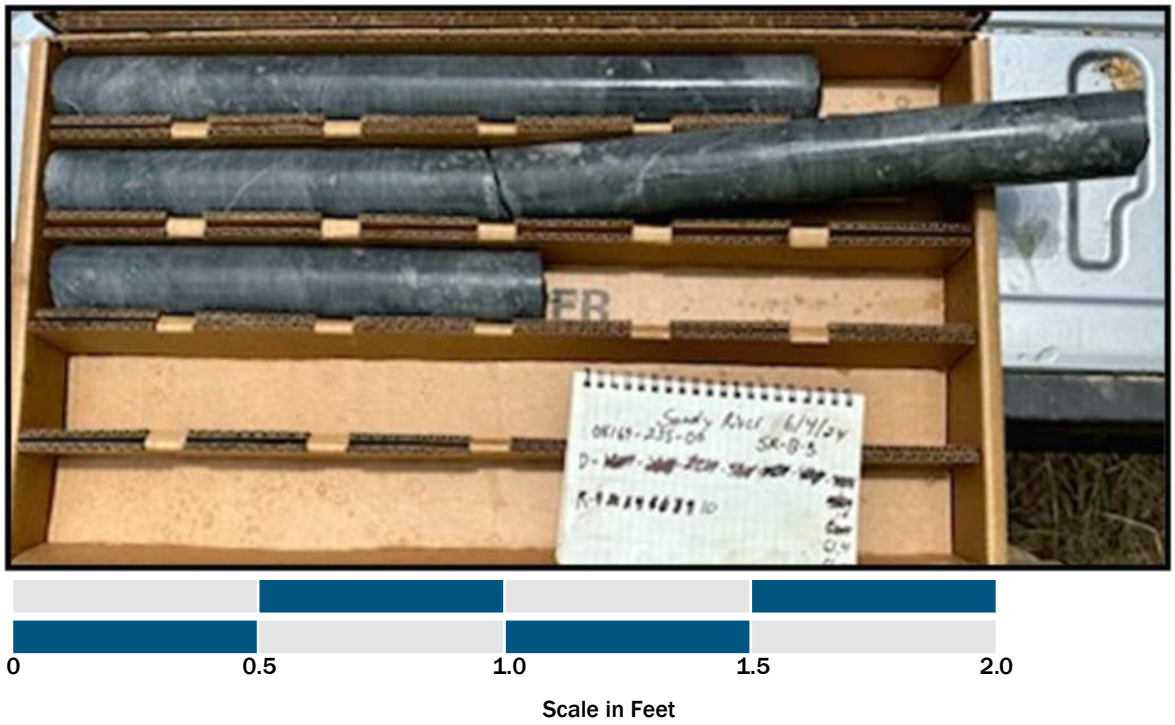
SR-B-3: 56.4' to 61.4'

SR-B-3: 61.4' to 66.4'



Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-41

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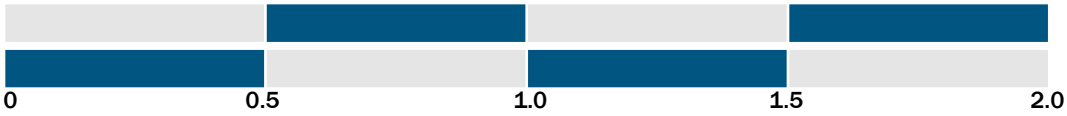
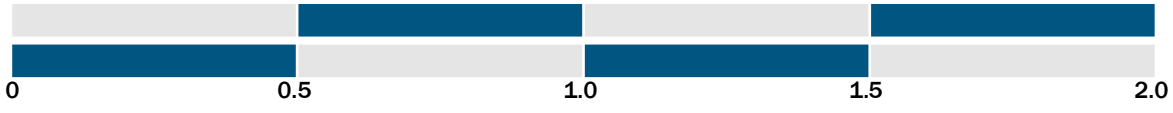
SR-B-3: 66.4' to 71.4'



Scale in Feet

SR-B-3: 71.4' to 76.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-42

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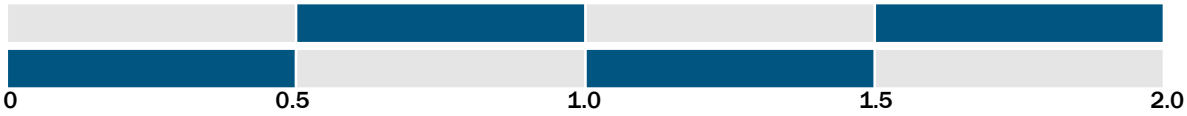
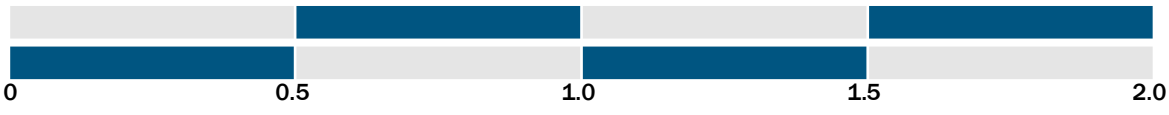
SR-B-3: 76.4' to 81.4'



Scale in Feet

SR-B-3: 81.4' to 86.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-43

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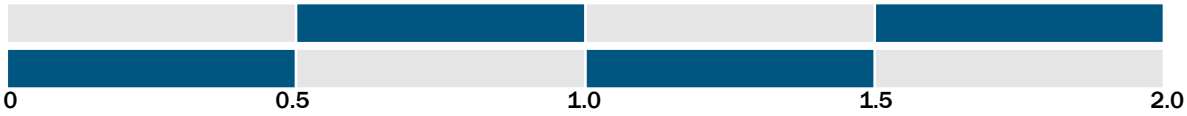
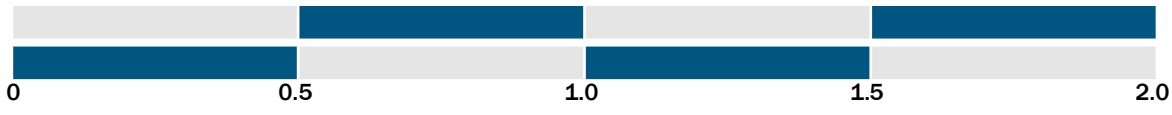
SR-B-3: 86.4' to 91.4'



Scale in Feet

SR-B-3: 91.4' to 96.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-44

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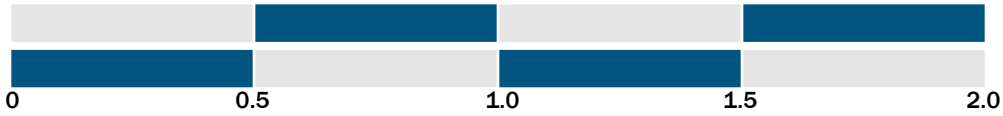
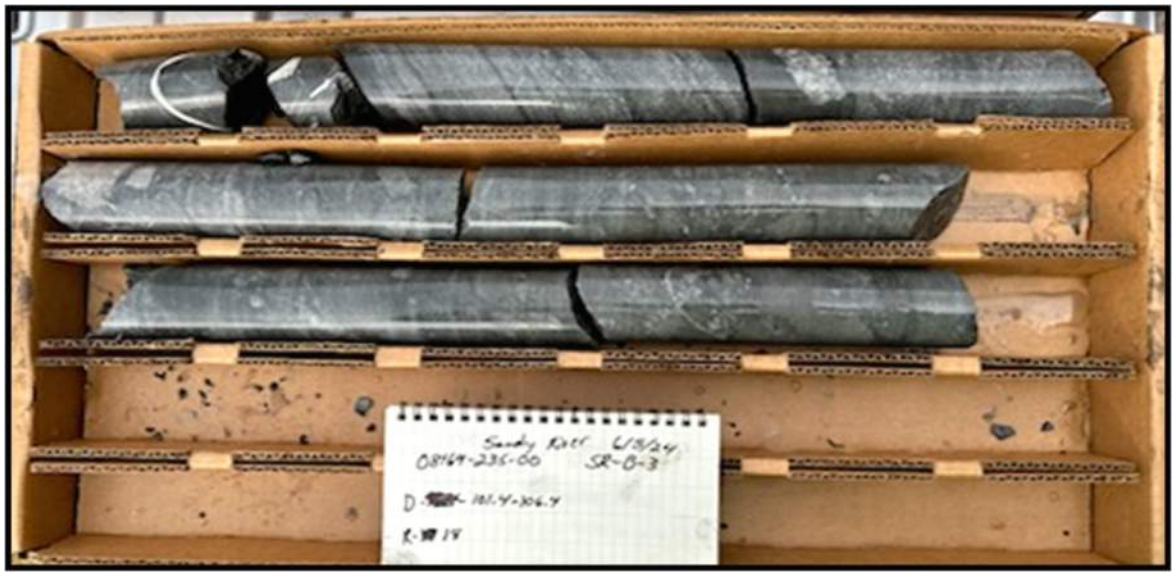
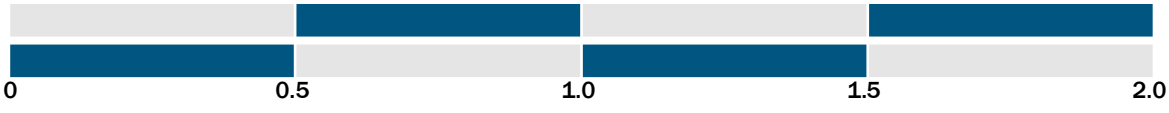
SR-B-3: 96.4' to 101.4'



Scale in Feet

SR-B-3: 101.4' to 106.4'





Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-45

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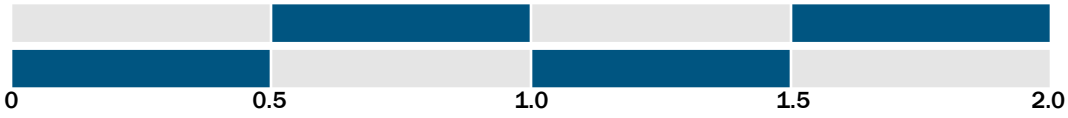
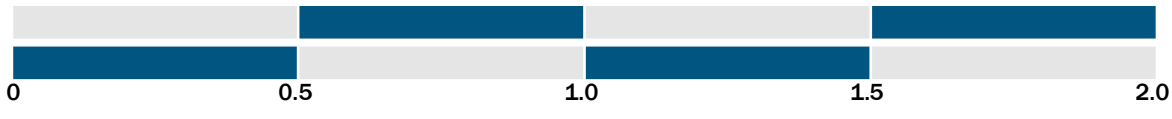
SR-B-3: 106.4' to 111.4'



Scale in Feet

SR-B-3: 111.4' to 116.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-46

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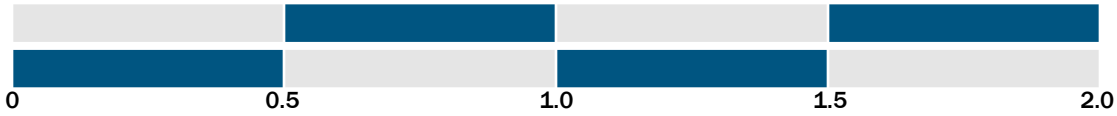
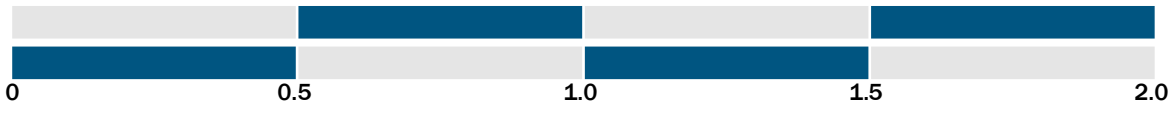
SR-B-3: 116.4' to 121.4'



Scale in Feet

SR-B-3: 121.4' to 126.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-47

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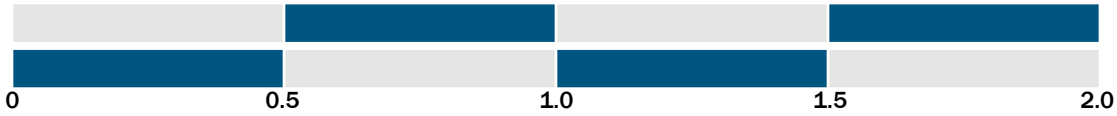
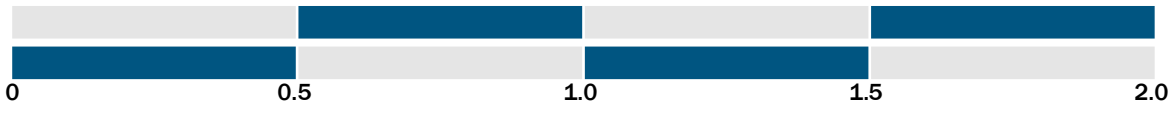
8169-235-00 Date Exported: 09/06/2024

SR-B-3: 116.4' to 121.4'



Scale in Feet

SR-B-3: 121.4' to 126.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-48

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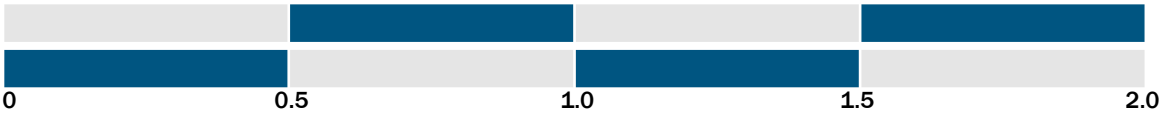
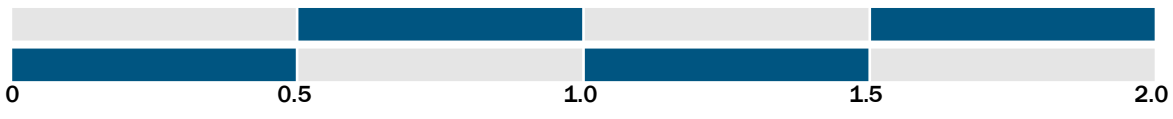
SR-B-3: 126.4' to 131.4'



Scale in Feet

SR-B-3: 131.4' to 136.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-49

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8169-235-00 Date Exported: 09/06/2024

SR-B-3: 136.4' to 141.4'

SR-B-3: 141.4' to 146.4'

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-50

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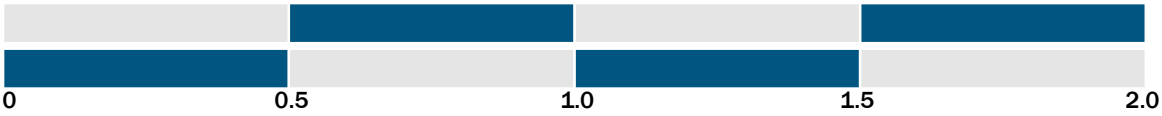
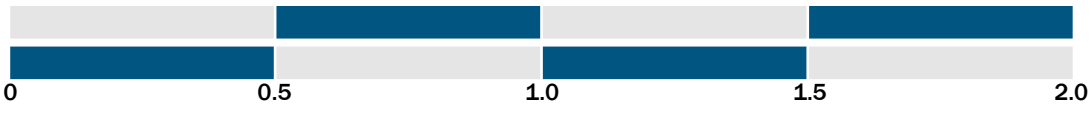
SR-B-3: 146.4’ to 151.4’



Scale in Feet

SR-B-3: 151.4’ to 156.4’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-51

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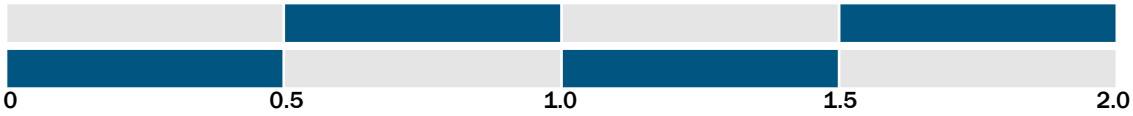
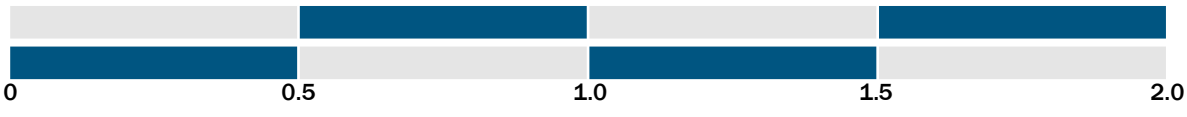
8169-235-00 Date Exported: 09/06/2024

SR-B-3: 156.4' to 161.4'



Scale in Feet

SR-B-3: 161.4' to 166.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-52

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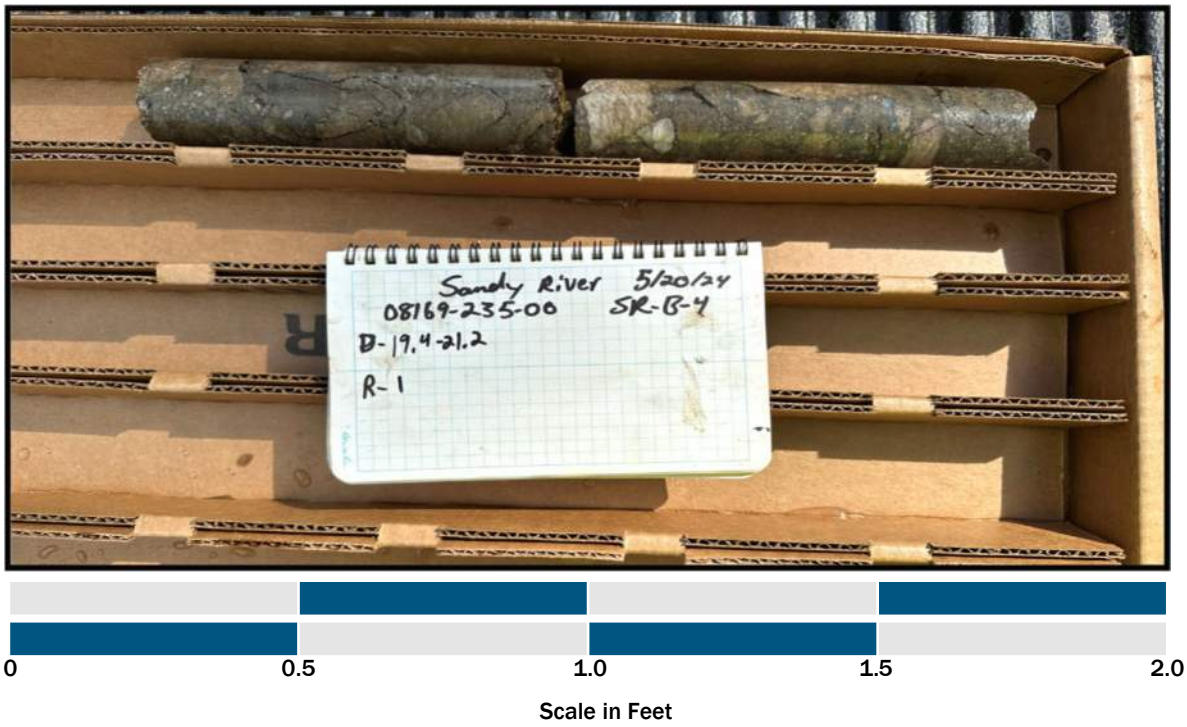
SR-B-3: 166.4’ to 171.4’

SR-B-4: 19.4’ to 21.2’



Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-53

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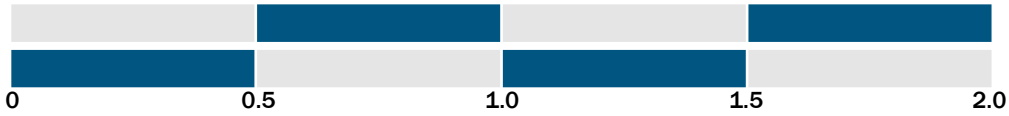
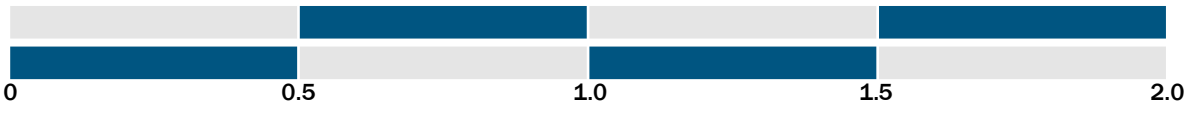
SR-B-4: 21.2' to 26.2'



Scale in Feet

SR-B-4: 26.2' to 31.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-54

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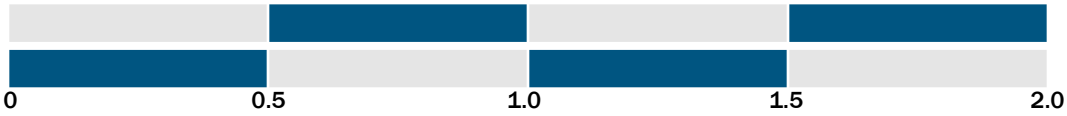
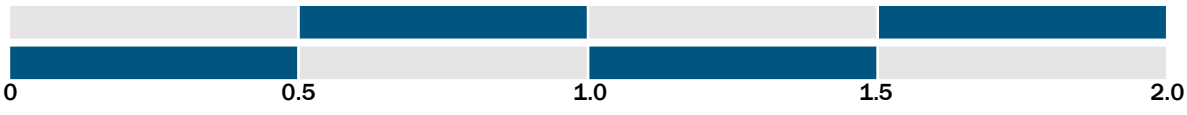
SR-B-4: 31.2' to 36.2'



Scale in Feet

SR-B-4: 36.2' to 41.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-55

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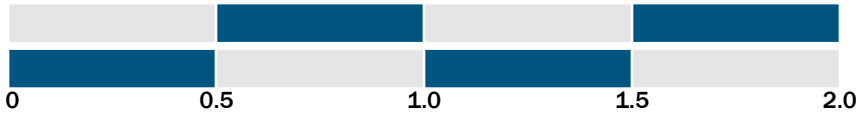
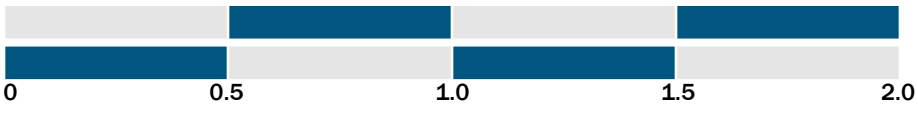
SR-B-4: 41.2’ to 46.2’



Scale in Feet

SR-B-4: 46.2’ to 51.2’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-56

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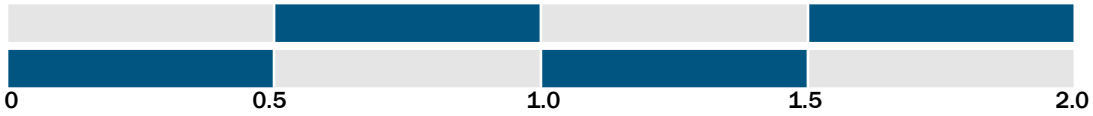
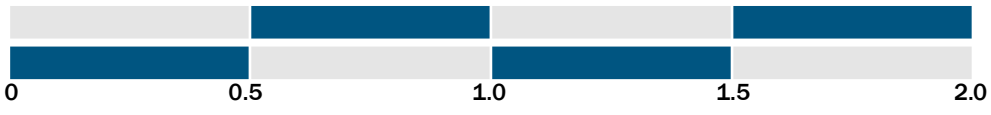
SR-B-4: 51.2' to 56.2'



Scale in Feet

SR-B-4: 56.2' to 61.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-57

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SR-B-4: 61.2' to 66.2'

SR-B-4: 66.2' to 71.2'

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-58

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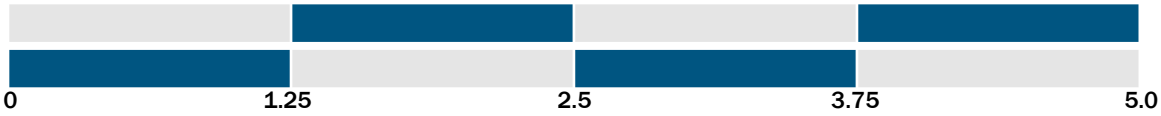
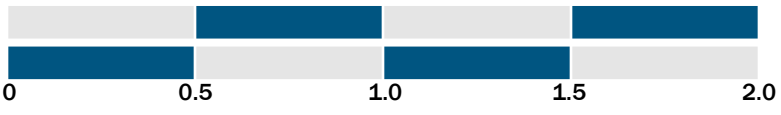
SR-B-4: 71.2' to 76.2'



Scale in Feet

SR-B-4: 76.2' to 81.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-59

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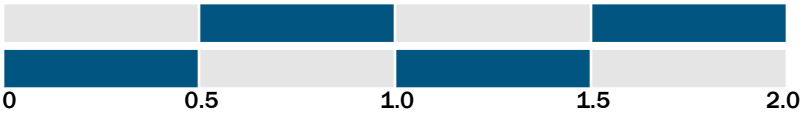
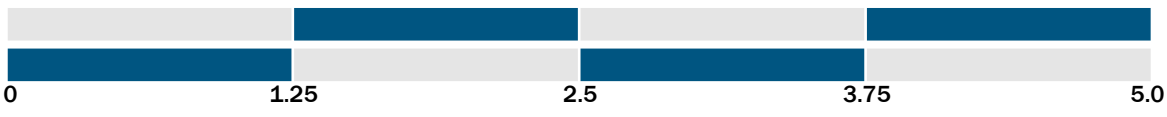
SR-B-4: 81.2' to 86.2'



Scale in Feet

SR-B-4: 86.2' to 91.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-60

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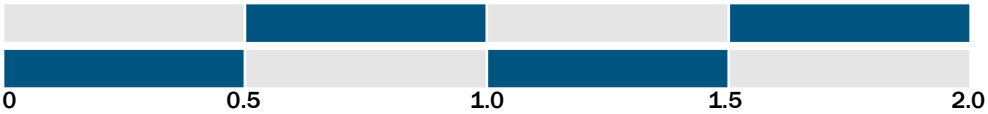
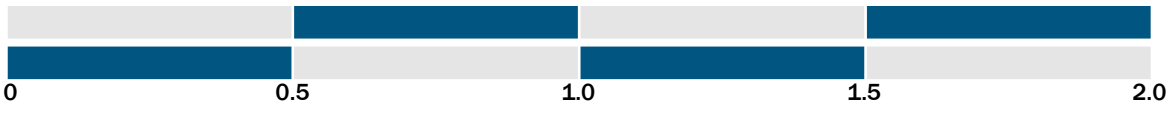
SR-B-4: 91.2' to 96.2'



Scale in Feet

SR-B-4: 96.2' to 101.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-61

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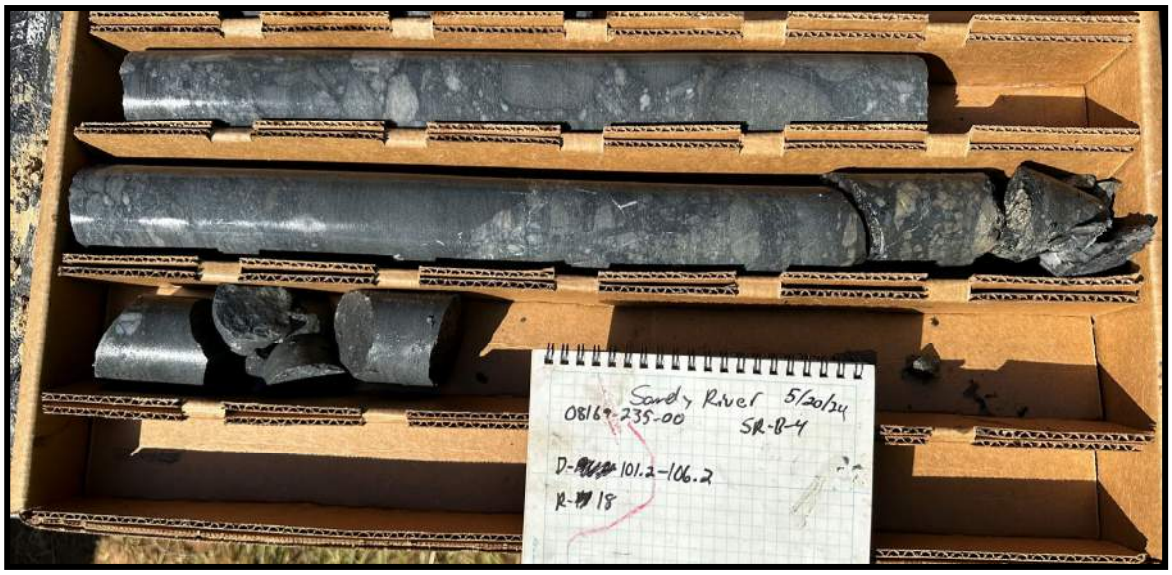
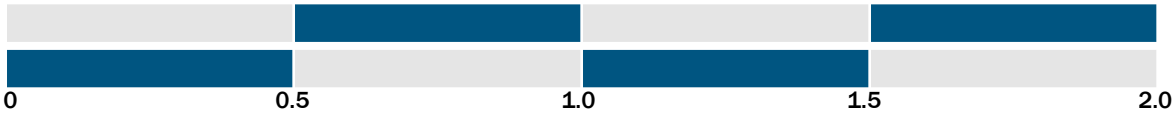
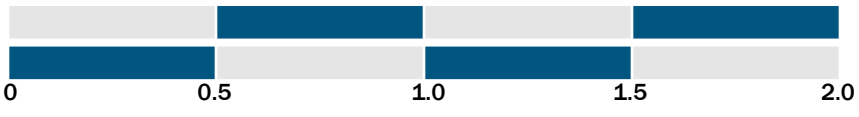
SR-B-4: 101.2' to 106.2'





Scale in Feet

SR-B-4: 106.2' to 111.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-62

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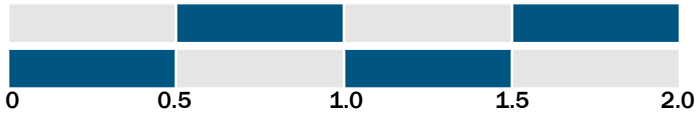
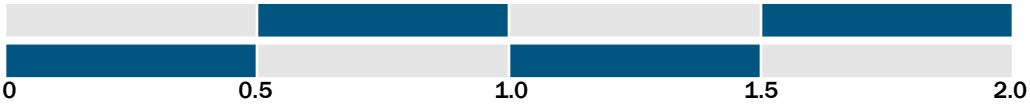
SR-B-4: 111.2' to 116.2'



Scale in Feet

SR-B-4: 116.2' to 121.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-63

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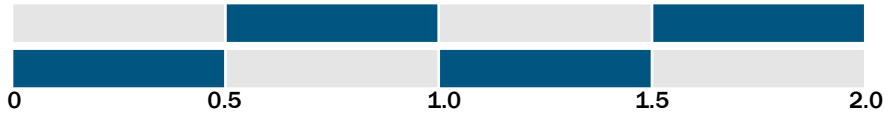
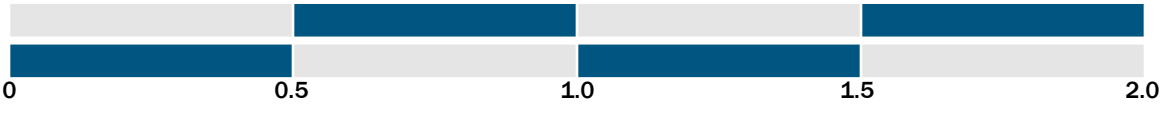
SR-B-4: 121.2' to 126.2'



Scale in Feet

SR-B-4: 126.2' to 131.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-64

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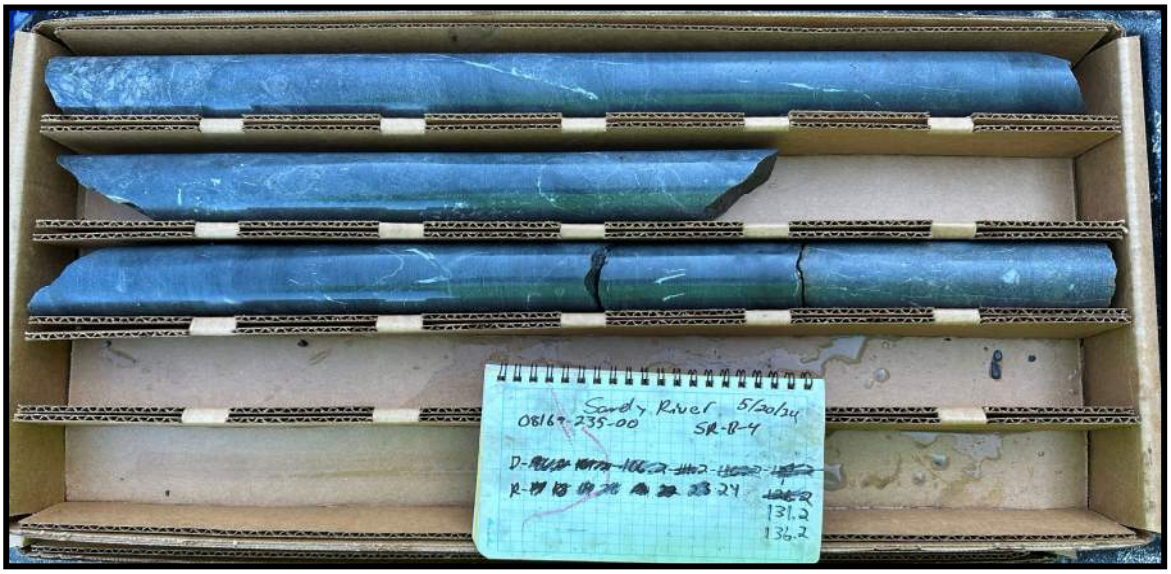
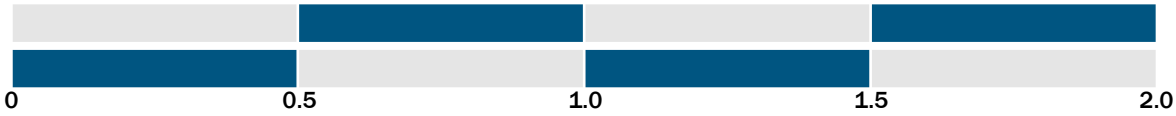
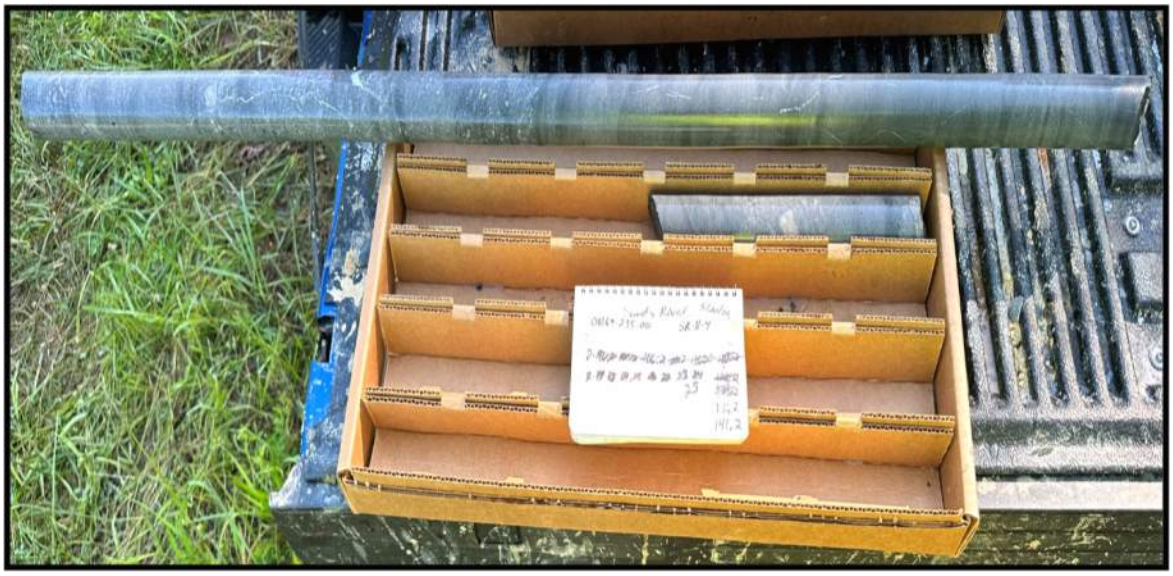
SR-B-4: 131.2' to 136.2'

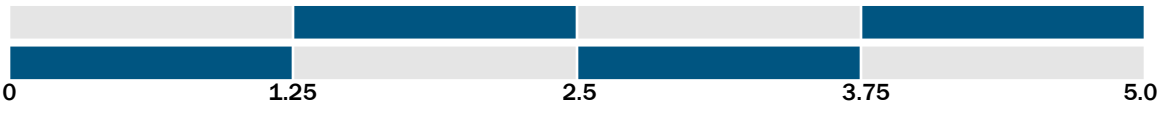




Scale in Feet

SR-B-4: 136.2' to 141.2'





Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-65

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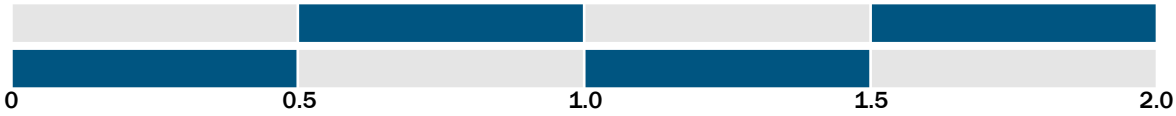
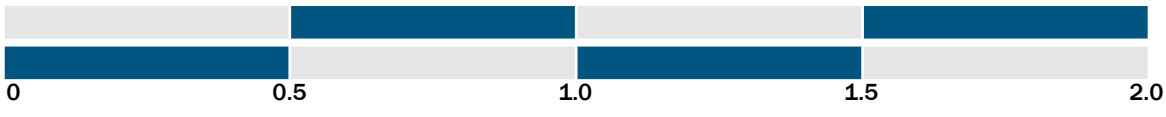
SR-B-5: 24.4' to 26.2'



Scale in Feet

SR-B-5: 126.2' to 31.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-66

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SR-B-5: 31.2' to 36.2'

Scale in Feet

SR-B-5: 36.2' to 41.2'

Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-67

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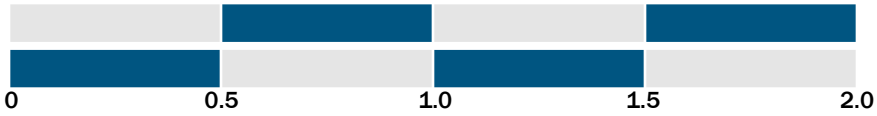
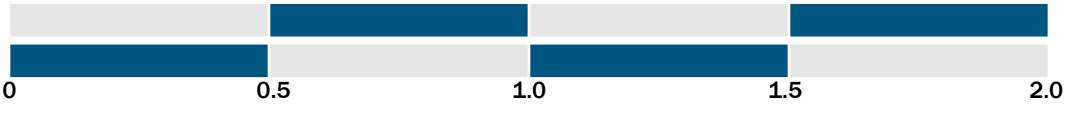
SR-B-5: 41.2’ to 46.2’



Scale in Feet

SR-B-5: 46.2’ to 51.2’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-68

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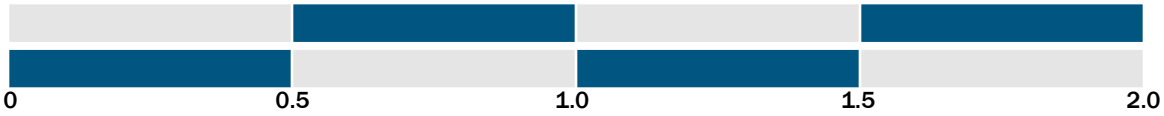
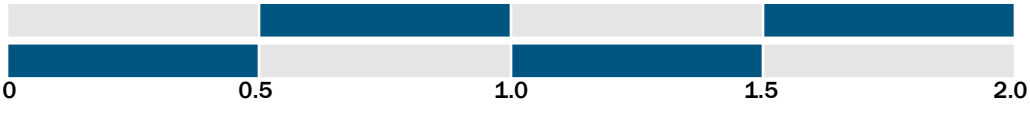
8169-235-00 Date Exported: 09/06/2024

SR-B-5: 51.2' to 56.2'



Scale in Feet

SR-B-5: 56.2' to 61.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-69

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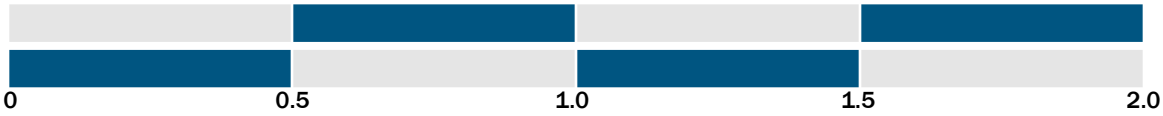
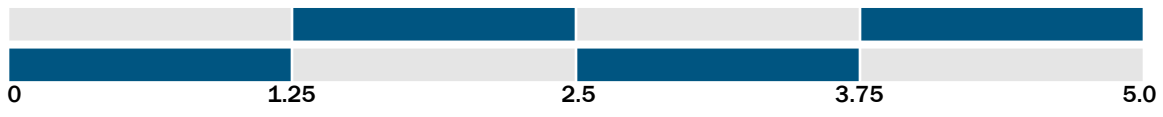
SR-B-5: 61.2' to 66.2'



Scale in Feet

SR-B-5: 66.2' to 71.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-70

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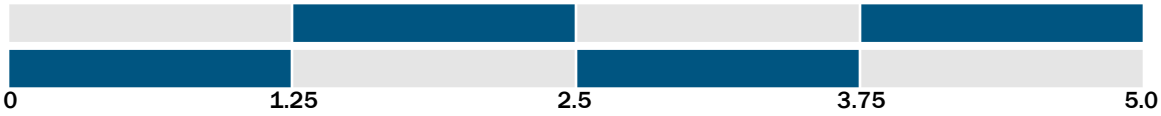
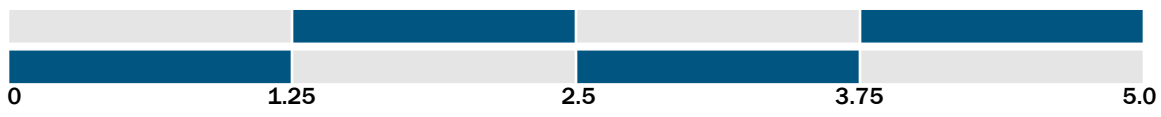
SR-B-5: 71.2' to 76.2'



Scale in Feet

SR-B-5: 76.2' to 81.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-71

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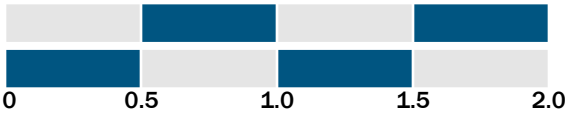
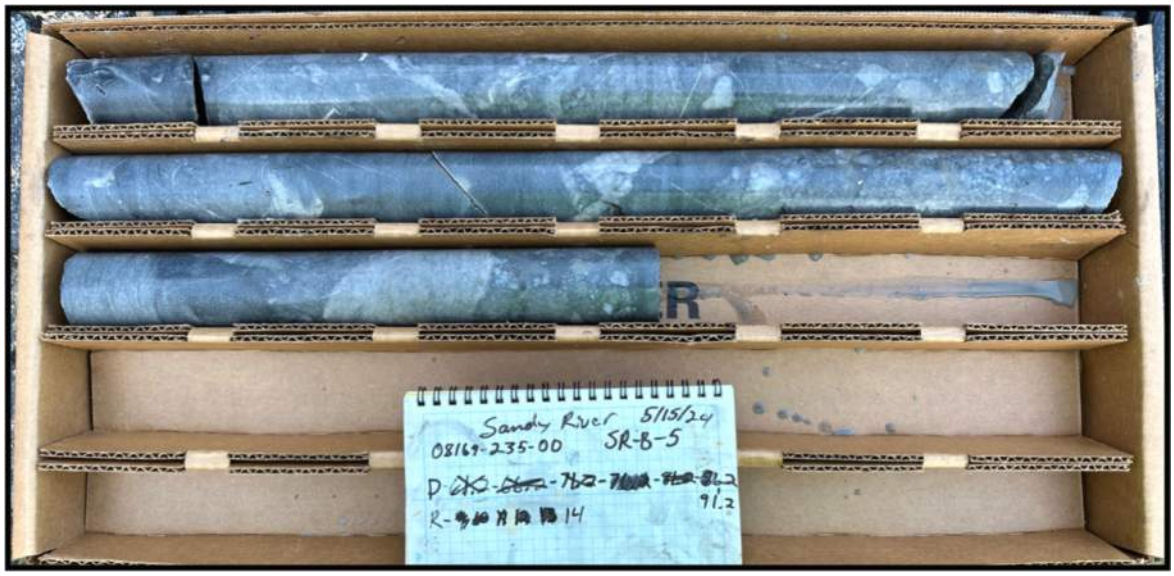
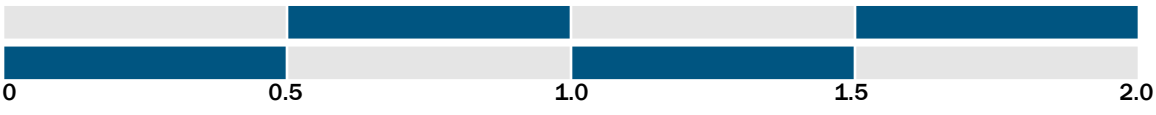
SR-B-5: 81.2' to 86.2'



Scale in Feet

SR-B-5: 86.2' to 91.2'





Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-72

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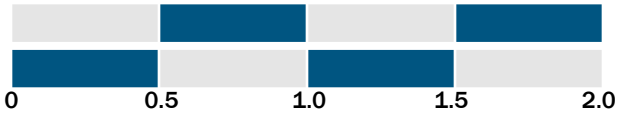
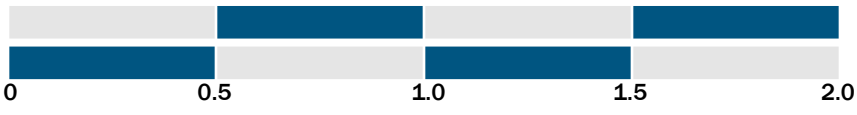
SR-B-5: 91.2' to 96.2'



Scale in Feet

SR-B-5: 96.2' to 101.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-73

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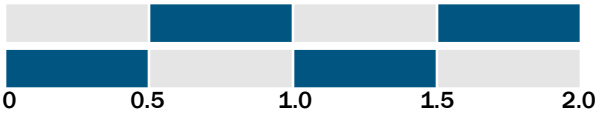
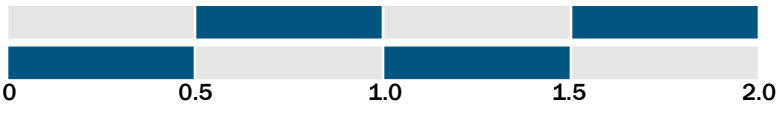
SR-B-5: 101.2' to 106.2'



Scale in Feet

SR-B-5: 106.2' to 111.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-74

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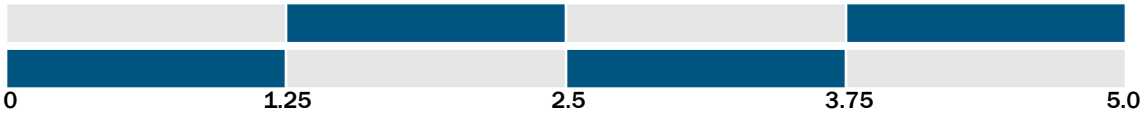
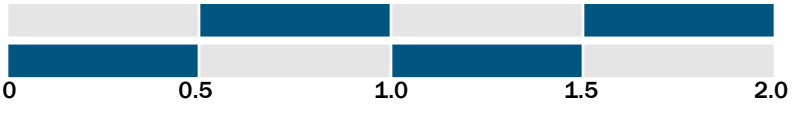
SR-B-5: 111.2' to 116.2'



Scale in Feet

SR-B-5: 116.2' to 121.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-75

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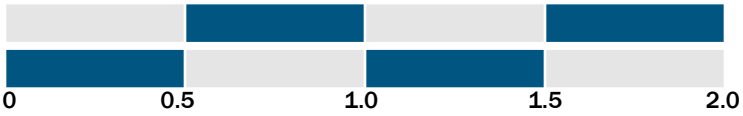
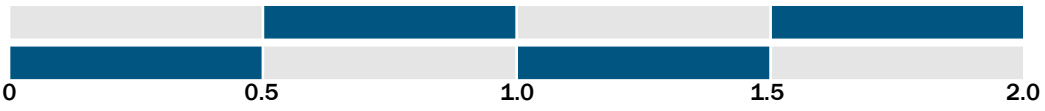
SR-B-5: 121.2' to 126.2'



Scale in Feet

SR-B-5: 126.2' to 131.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

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Figure A-76

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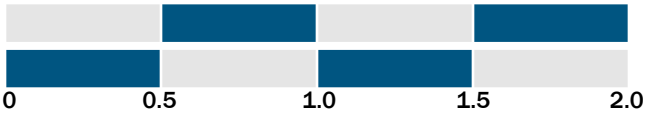
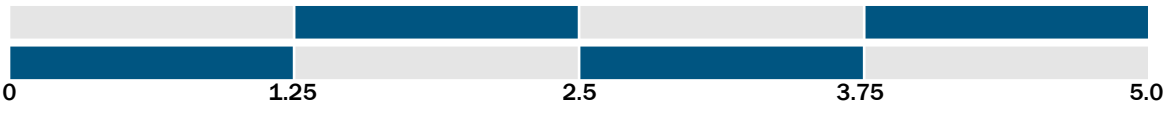
SR-B-5: 131.2' to 136.2'



Scale in Feet

SR-B-5: 136.2' to 141.2'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

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Figure A-77

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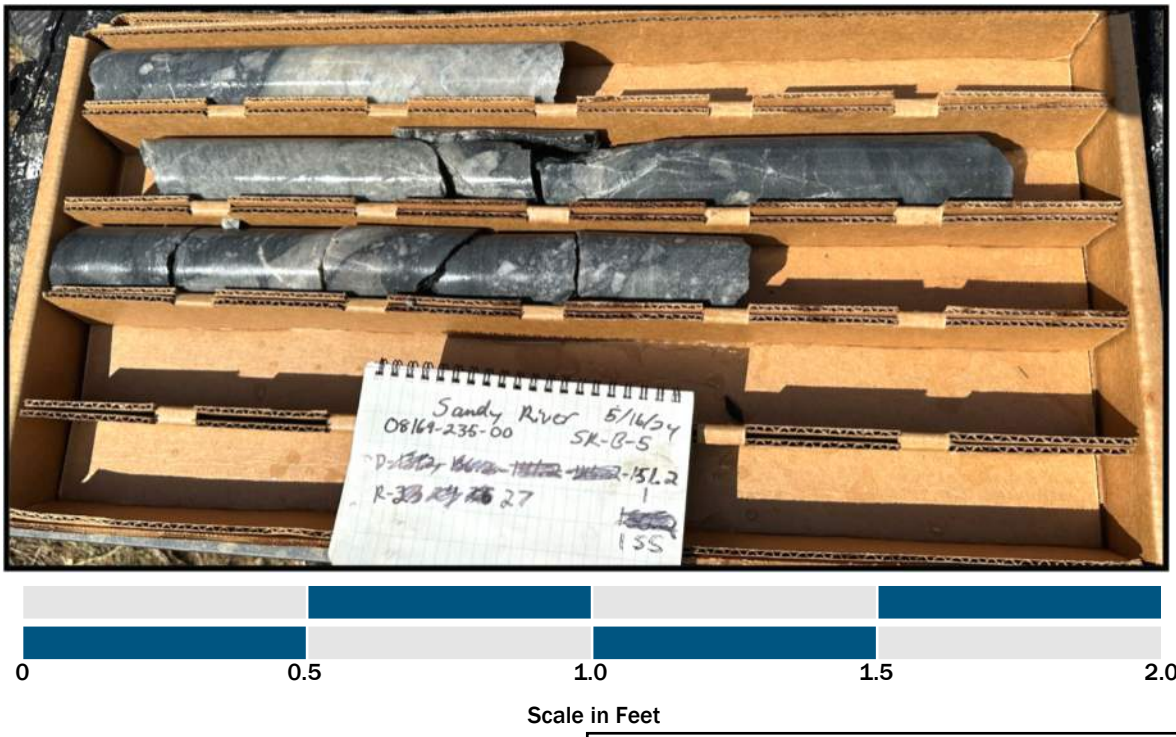
SR-B-5: 141.2' to 146.2'

SR-B-5: 146.2' to 151.2'



Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-78

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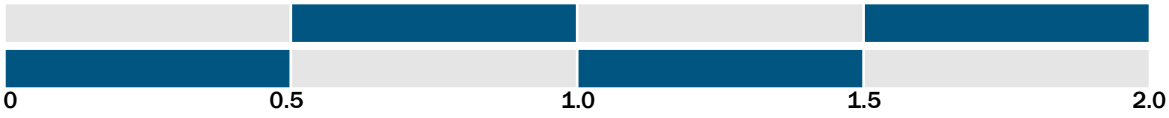
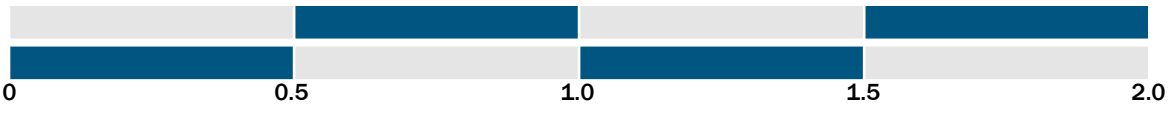
SR-B-6: 39.7' to 42.4'



Scale in Feet

SR-B-6: 42.4' to 47.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-79

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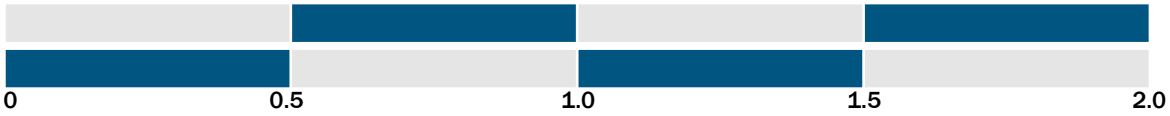
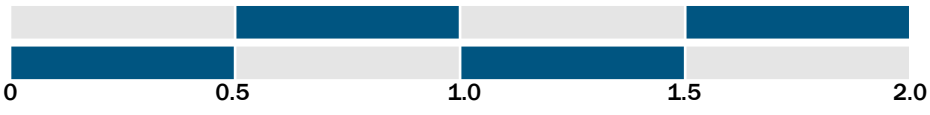
SR-B-6: 47.4’ to 52.4’



Scale in Feet

SR-B-6: 52.4’ to 57.4’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-80

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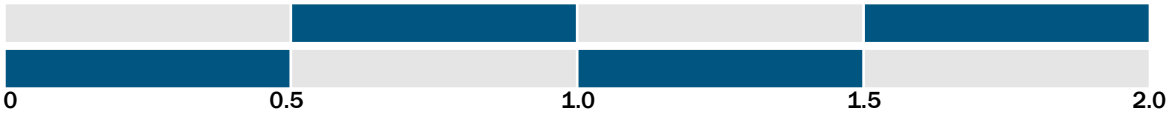
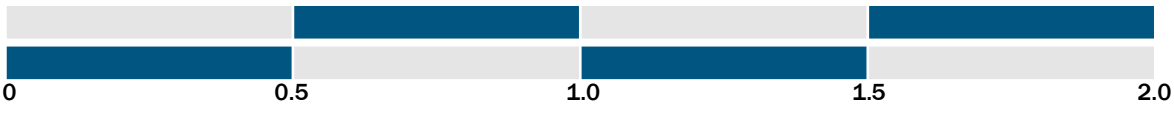
SR-B-6: 57.4’ to 62.4’



Scale in Feet

SR-B-6: 62.4’ to 67.4’



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-81

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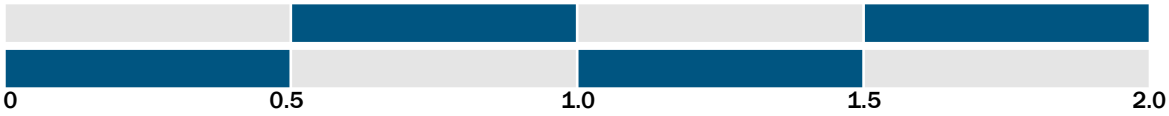
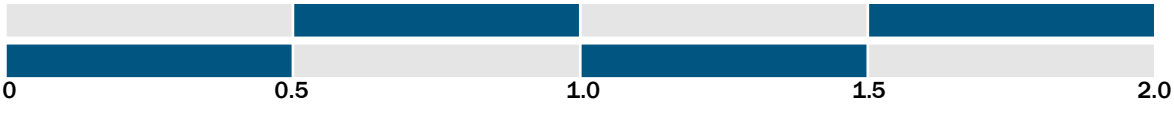
SR-B-6: 67.4' to 72.4'



Scale in Feet

SR-B-6: 72.4' to 77.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-82

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SR-B-6: 77.4' to 82.4'

SR-B-6: 82.4' to 87.4'

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-83

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SR-B-6: 87.4' to 92.4'

0 0.5 1.0 1.5 2.0

Scale in Feet

SR-B-6: 92.4' to 97.4'

0 0.5 1.0 1.5 2.0

Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-84

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SR-B-6: 97.4' to 102.4'

SR-B-6: 102.4' to 107.4'

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-85

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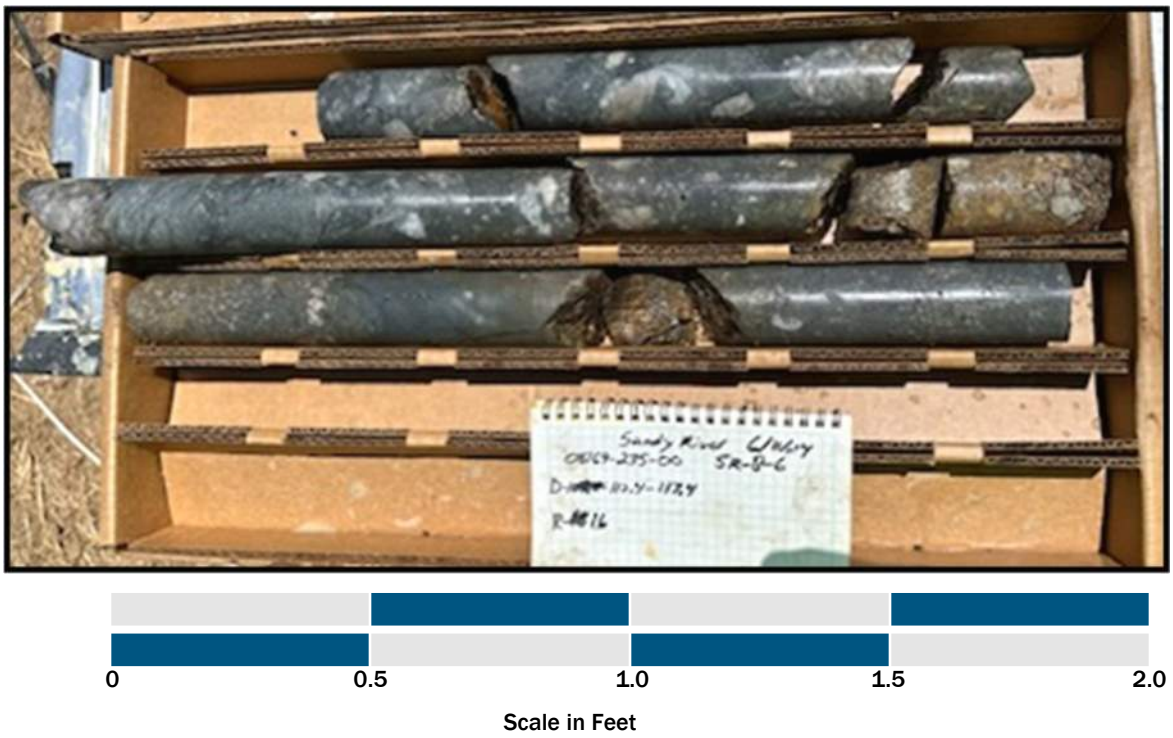
SR-B-6: 107.4' to 112.4'

SR-B-6: 112.4' to 117.4'



Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-86

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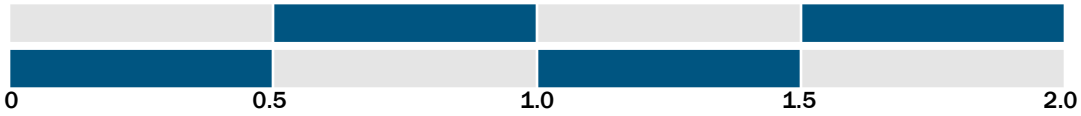
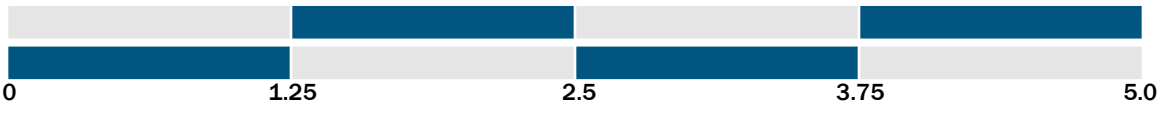
SR-B-6: 117.4' to 122.4'



Scale in Feet

SR-B-6: 122.4' to 127.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-87

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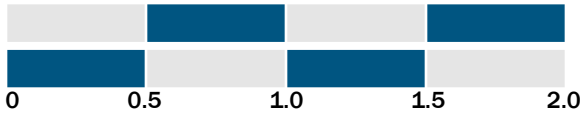
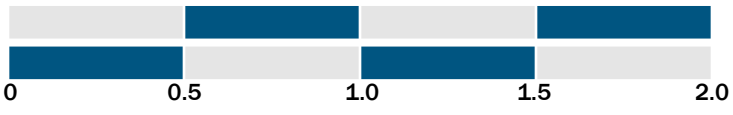
SR-B-6: 127.4' to 132.4'



Scale in Feet

SR-B-6: 132.4' to 137.4'



Scale in Feet

Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

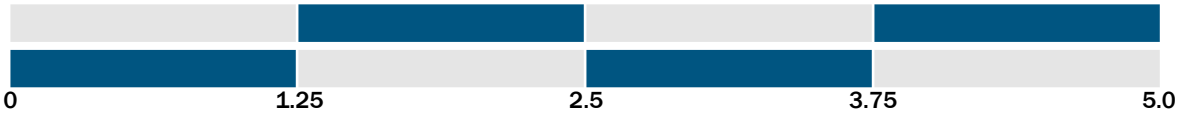
GeoEngineers

Figure A-88

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers. The locations of features shown may be approximate. GeoEngineers makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers and is the official document of record.

8169-235-00 Date Exported: 09/06/2024

SR-B-6: 137.4' to 142.4'



Scale in Feet

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Rock Core Photographs

Sandy River Crossing
Pittsylvania County. Virginia

GeoEngineers

Figure A-89

8169-235-00 Date Exported: 09/06/2024

Geotechnic’s Laboratory Test Results

June 21, 2024

Project No. R-2024-175-001

Tim Pierce
GeoEngineers
1100 Crescent Green Drive Suite 204
Cary, NC 27518

tpierce@geoengineers.com

Transmittal
Laboratory Test Results
SSE Project: Salem Loop – Sandy River

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was transmitted to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

PERCENT PASSING # 200 SIEVE

ASTM D 1140-17

Client	GeoEngineers
Client Reference	SSE Project: Eden Loop- Sandy River
Project No.	2024-175-001

Lab Id.	.002
Boring No.	SR-B-5
Depth (ft)	3.5-5
Sample No.	S-2
Tare Number	720
Wt. of Tare & WS (gm)	335.87
Wt. of Tare & DS (gm)	278.61
Wt. of Tare (gm)	89.91
Wt. of Water (gm)	57.26
Wt. of DS (gm)	188.7
Water Content (%)	**30.3**
Wt. of Washed Soil & Tare	160.84
Percent Passing #200	**62.4**

Tested By BS *5/28/24* *Checked By* MBS *5/29/24*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (2007)

Client	GeoEngineers	Boring No.	SR-B-2
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	8.5-10
Project No.	R-2024-175-001	Sample No.	S-4
Lab ID	R-2024-175-001-001	Soil Color	**Brown Gray**

Minus #10 for Hygroscopic Moisture Content		**Hydrometer Specimen Data**	
Tare No.	33	Air Dried - #10 Hydrometer Material (g)	78.76
Wgt.Tare + Wet Soil (g)	50.98	Corrected Dry Wt. of - #10 Material (g)	78.43
Wgt.Tare + Dry Soil (g)	50.92		
Weight of Tare (g)	36.58	Weight of - #200 Material (g)	13.45
Weight of Water (g)	0.06	Weight of - #10 ; + #200 Material (g)	64.98
Weight of Dry Soil (g)	14.34		
Moisture Content (%)	**0.4**	**J-FACTOR (%FINER THAN #10)**	**91.70%**
Soil Specimen Data			
Tare No.	922		
Wgt.Tare + Air Dry Soil (g)	476.98		
Weight of Tare (g)	222.86		
Air Dried Wgt. Total Sample (g)	254.12	Dry Weight of Material Retained on #10 (g)	21.02
Total Dry Sample Weight (g)	253.15	Corrected Dry Sample Wt - #10 (g)	232.13

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.5	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	2.35	0.9	0.9	99.1	**99.1**
#4	4.75	3.62	1.4	2.4	97.6	**97.6**
#10	2.00	15.05	5.9	8.3	91.7	**91.7**
#20	0.85	6.01	7.7	7.7	92.3	**84.7**
#40	0.425	13.61	17.4	25.0	75.0	**68.8**
#60	0.250	18.15	23.1	48.2	51.8	**47.5**
#140	0.106	23.12	29.5	77.6	22.4	**20.5**
#200	0.075	4.09	5.2	82.8	17.2	**15.7**
Pan	-	13.45	17.2	100.0	-	**-**

Notes :

Tested By EH Date 5/30/24 Checked By AES Date 6/6/24

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HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	GeoEngineers	Boring No.	SR-B-2
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	8.5-10
Project No.	R-2024-175-001	Sample No.	S-4
Lab ID	R-2024-175-001-001	Soil Color	**Brown Gray**

Elapsed Time (min)	R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA
2	15.5	22.2	6.24	9.3	11.7	0.01310	0.0343	**10.7**
5	13.0	22.2	6.24	6.8	8.5	0.01310	0.0220	**7.8**
15	11.8	22.3	6.20	5.5	7.0	0.01308	0.0128	**6.4**
30	11.0	22.3	6.20	4.8	6.1	0.01308	0.0091	**5.6**
60	10.0	22.3	6.20	3.8	4.8	0.01308	0.0065	**4.4**
250	8.8	22.5	6.13	2.6	3.3	0.01305	0.0032	**3.0**
1440	7.5	21.9	6.34	1.2	1.5	0.01314	0.0013	**1.3**

Soil Specimen Data		**Other Corrections**		
Wgt. of Dry Material (g)	78.43	Hygroscopic Moisture Factor	0.996	
Weight of Deflocculant (g)	5.0			
		a - Factor	0.99	
		Percent Finer than # 10	91.70	
		Specific Gravity	2.70	Assumed

Notes:

Tested By RVB Date 5/30/24 Checked By AES Date 6/6/24

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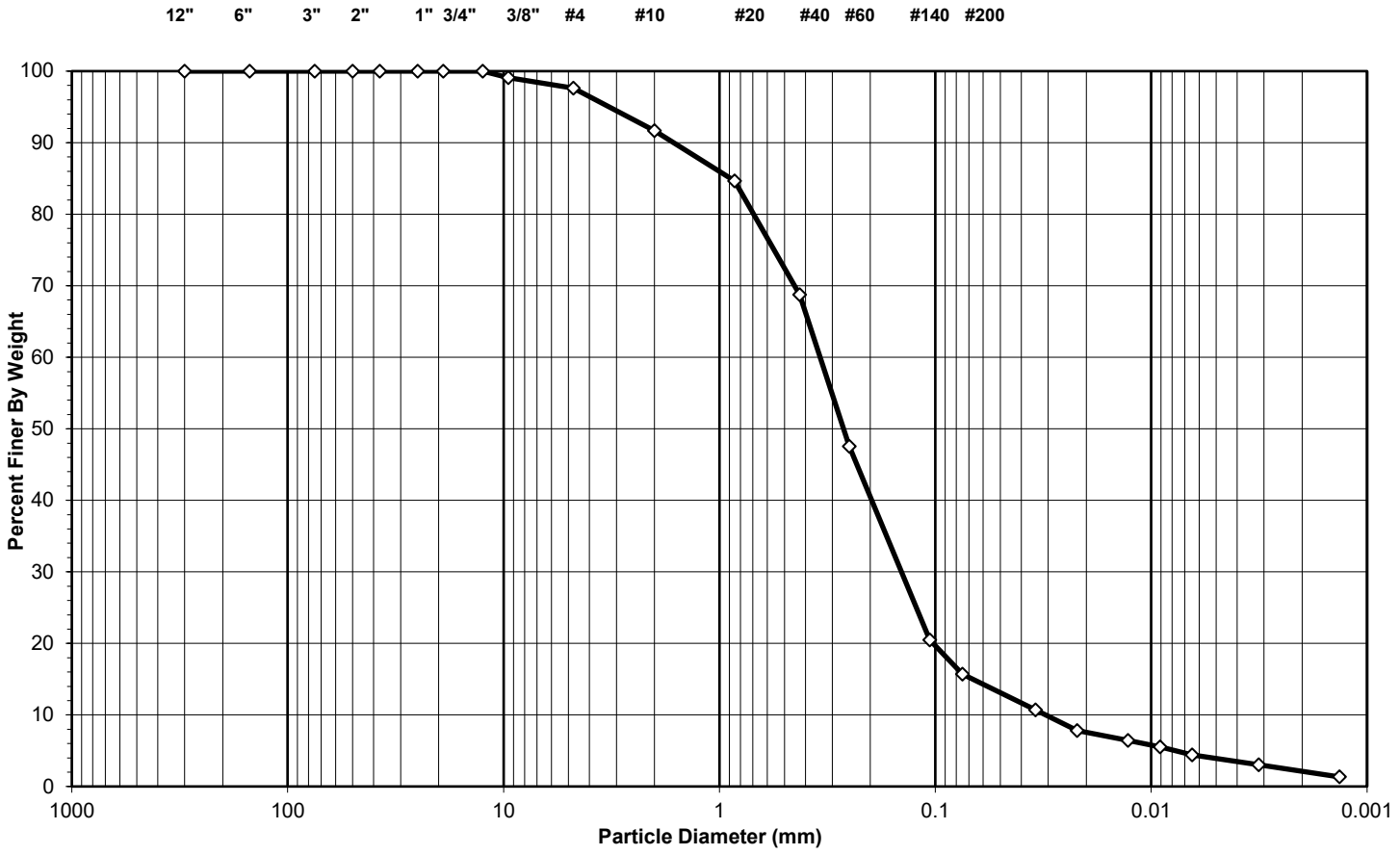
SIEVE AND HYDROMETER ANALYSIS

ASTM D 422-63 (2007)

Client	GeoEngineers	Boring No.	SR-B-2
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	8.5-10
Project No.	R-2024-175-001	Sample No.	S-4
Lab ID	R-2024-175-001-001	Soil Color	**Brown Gray**

	SIEVE ANALYSIS			HYDROMETER	
USCS	**cobbles**	**gravel**	**sand**	**silt and clay fraction**	
USDA	**cobbles**	**gravel**	**sand**	**silt**	**clay**



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	2.36
#4 To #200	*Sand*	81.91
Finer Than #200	*Silt & Clay*	15.73

USCS Symbol ***sm, ASSUMED***

USCS Classification ***SILTY SAND***

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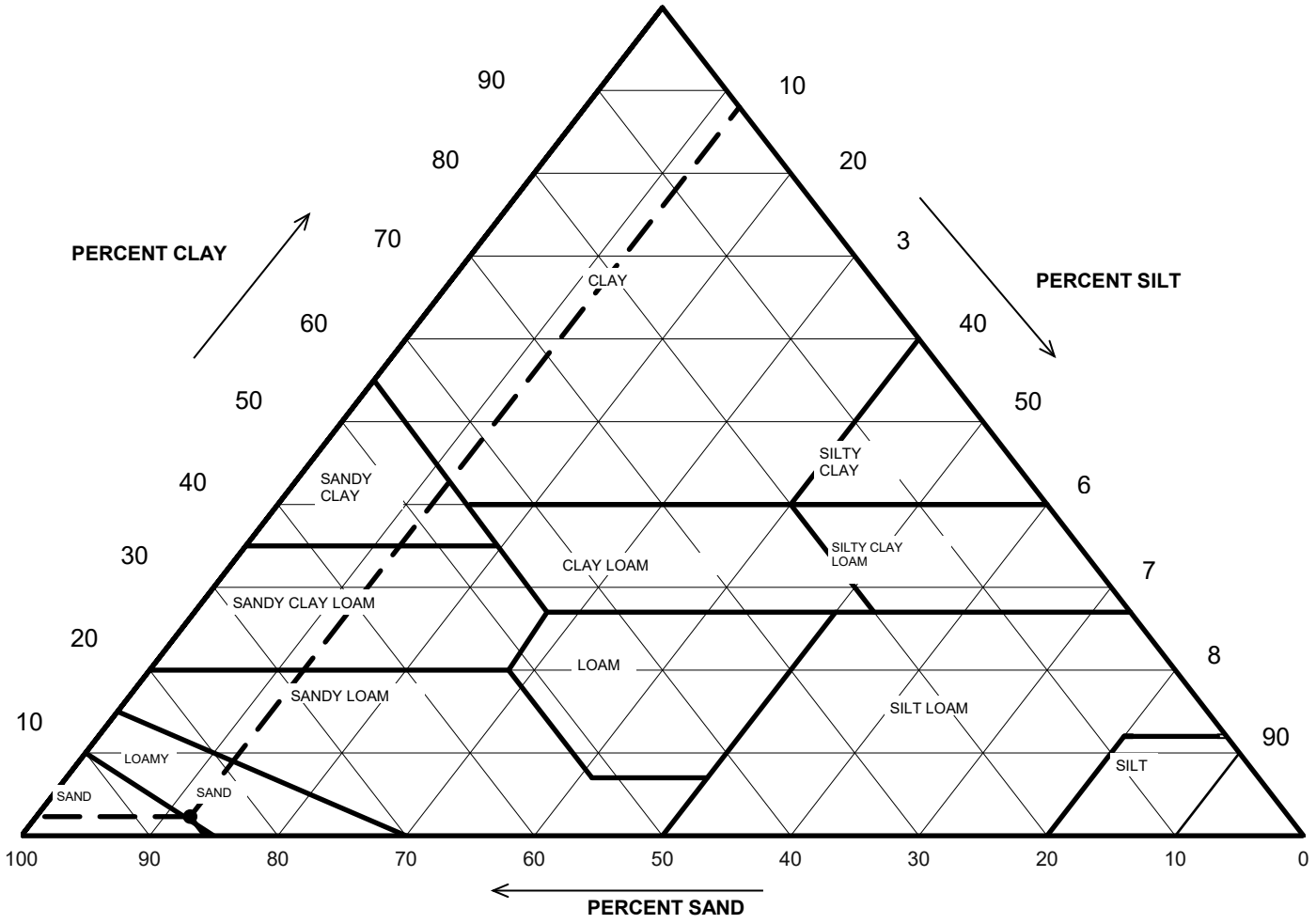
USDA CLASSIFICATION CHART

Client	GeoEngineers	Boring No.	SR-B-2
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	8.5-10
Project No.	R-2024-175-001	Sample No.	S-4
Lab ID	R-2024-175-001-001	Soil Color	Brown Gray



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	8.30	**0.00**
2	91.70	*Sand*	78.57	**85.68**
0.05	13.13	*Silt*	11.01	**12.01**
0.002	2.12	*Clay*	2.12	**2.31**

USDA Classification: ***LOAMY SAND***

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ATTERBERG LIMITS

ASTM D 4318-17

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Reference:	SSE Project: Eden Loop- Sandy River	Depth (ft):	6-7.5
Project No.:	2024-175-001	Sample No.:	S-3
Lab ID:	2024-175-001-003	Color:	Brown/Orange
			(MInus No. 40 sieve material)

As Received
Water Content

Tare Number	273
Wt. of Tare & Wet Sample (g)	99.43
Wt. of Tare & Dry Sample (g)	84.89
Weight of Tare (g)	36.48
Weight of Water (g)	14.54
Weight of Dry Sample (g)	48.41
Water Content (%)	**30.0**

NON - PLASTIC MATERIAL

Tested By *EH* *Date* *5/29/24* *Checked By* *MBS* *Date* *5/29/24*

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SIEVE AND HYDROMETER ANALYSIS

ASTM D6913 / D7928

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Reference:	SSE Project: Eden Loop- Sandy River	Depth (ft):	13.5-15
Project No.:	2024-175-001	Sample No.:	S-5
Lab ID:	2024-175-001-004	Soil Color:	Light Brown

Sieve Size		Percentage (%)
Greater than #4	***Gravel***	**1.52**
#4 to #200	***Sand***	**62.31**
Finer than #200	***Silt & Clay***	**36.16**

USCS Symbol:
sm, ASSUMED

D50 = 0.15

USCS Classification:
SILTY SAND

Tested By EH Date 5/30/24 Checked By MBS Date 5/30/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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WASH SIEVE ANALYSIS

ASTM D6913-17

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Reference:	SSE Project: Eden Loop- Sandy River	Depth (ft):	13.5-15
Project No.:	2024-175-001	Sample No.:	S-5
Lab ID:	2024-175-001-004	Soil Color:	Light Brown

Moisture Content of Passing 3/4" Material		Moisture Content of Retained 3/4" Material	
Tare No.:	726	Tare No.:	NA
Wt. of Tare & Wet Sample (g):	419.29	Weight of Tare & Wet Sample (g):	NA
Wt. of Tare & Dry Sample (g):	378.61	Weight of Tare & Dry Sample (g):	NA
Weight of Tare (g):	142.99	Weight of Tare (g):	NA
Weight of Water (g):	40.68	Weight of Water (g):	NA
Weight of Dry Soil (g):	235.62	Weight of Dry Soil (g):	NA
Moisture Content (%):	**17.3**	**Moisture Content (%):**	**0.0**

Dry Weight of Sample (g):	NA	Total Dry Weight of Sample (g):	235.62
Tare No. (Sub-Specimen)	726	Wet Weight of +3/4" Sample (g):	0.00
Wt. of Tare & Wet Sub-Specimen (g):	419.29	Dry Weight of + 3/4" Sample (g):	0.00
Weight of Tare (g):	142.99	Dry Weight of - 3/4" Sample (g):	235.62
Sub-Specimen Wet Weight (g):	276.30	Dry Weight -3/4" +3/8" Sample (g):	0.00
Tare No. (-3/8" Sub-Specimen):	NA	Dry Weight of -3/8" Sample (g):	235.62
Wt. of Tare & Wet -3/8" Sub-Specimen (g):	NA	J - Factor (% Finer than 3/4"):	NA
Weight of Tare (g):	NA	J - Factor (% Finer than 3/8"):	NA
Sub-Specimen -3/8" Wet Weight (g):	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)		Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00		0.00	0.00	100.00	**100**
6"	150	0.00		0.00	0.00	100.00	**100**
3"	75	0.00		0.00	0.00	100.00	**100**
2"	50	0.00	(*)	0.00	0.00	100.00	**100**
1 1/2"	37.5	0.00		0.00	0.00	100.00	**100**
1"	25	0.00		0.00	0.00	100.00	**100**
3/4"	19	0.00		0.00	0.00	100.00	**100**
1/2"	12.5	0.00	(**)	0.00	0.00	100.00	**100**
3/8"	9.5	0.00		0.00	0.00	100.00	**100**
#4	4.75	3.59		1.52	1.52	98.48	**98**
#10	2	11.36		4.82	6.34	93.66	**94**
#20	0.85	24.14	(**)	10.25	16.59	83.41	**83**
#40	0.425	30.51		12.95	29.54	70.46	**70**
#60	0.25	24.87		10.56	40.09	59.91	**60**
#100	0.15	24.67		10.47	50.56	49.44	**49**
#140	0.106	16.68		7.08	57.64	42.36	**42**
#200	0.075	14.59		6.19	63.84	36.16	**36**
Pan	-	85.21		36.16	100.00	-	**-**

Notes : *(*) The + 3/4" sieve analysis is based on the Total Dry Weight of the Sample*
*(**) The - 3/4" and - 3/8" sieve analysis is based on the Weight of the Dry Specimen*

Tested By EH Date 5/30/24 Checked By MBS Date 5/30/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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POINT LOAD STRENGTH OF ROCK - AXIAL / BLOCK

ASTM D5731-08

Client:	GeoEngineers	Boring No.:	SR-B-2
Client Reference:	SSE Project: Eden Loop-Sandy River	Depth (ft):	26-31
Project No.:	2024-175-001	Sample No.:	Run 3
Lab ID:	2024-175-001-005	Description:	Rock Core
		Moisture Condition:	As Received-Unpreserved

Sample Height Measurements, (D)	
Height 1 (in):	1.818
Height 2 (in):	1.818
Height 3, Test Contact Point (in):	1.818
Test Contact Point (mm):	46.2
Average Height (in):	1.818
Equivalent Core Diam. (Axial/Block), (in):	4.561

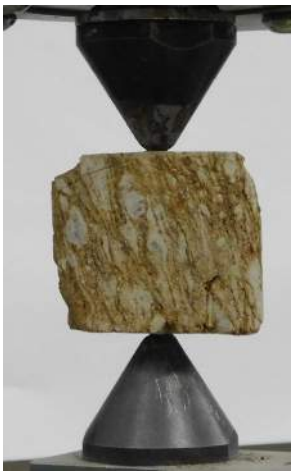
Moisture Content	
Tare No.:	2803
Weight of Tare & Wet Rock (g):	216.69
Weight of Tare & Dry Rock (g):	215.14
Weight of Tare (g):	8.16
Moisture Content (%):	***0.7***

Sample Length Measurements, (W)	
Length 1 (in):	1.970
Length 2 (in):	1.970
Length 3 (in):	1.971
Average Length (in):	1.970
Length/Diameter Ratio (D/W):	0.923

Sample Length Measurements, (L)	
Length 1 (in):	0.985
Length 2 (in):	0.985
Length 3 (in):	0.986
Average Length (in):	0.985

Test Data		**Index & Strength Computations**	
Core Diameter (mm):	50.046	I_S - Point Load Index (psi):	**29.2**
		$I_{S(50)}$ - Corrected Point Load Index (psi):	**30.3**
		K - Index To Strength Conversion Factor:	**22.7**
P - Gauge Pressure @ Failure (lbf):	133	δ_{UC} **- Est. Unconfined Compressive Strength (psi):**	**663**

SAMPLE SHOWN IN THE SAME ORIENTATION AS TESTED



Tested By JAC *Date* 6/11/24 *Checked By* NJM *Date* 6/13/24

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POINT LOAD STRENGTH OF ROCK - AXIAL / BLOCK

ASTM D5731-08

Client:	GeoEngineers	Boring No.:	SR-B-2
Client Reference:	SSE Project: Eden Loop-Sandy River	Depth (ft):	61-66
Project No.:	2024-175-001	Sample No.:	Run 10
Lab ID:	2024-175-001-006	Description:	Rock Core
		Moisture Condition:	As Received-Unpreserved

Sample Height Measurements, (D)	
Height 1 (in):	1.950
Height 2 (in):	1.950
Height 3, Test Contact Point (in):	1.950
Test Contact Point (mm):	49.5
Average Height (in):	1.950
Equivalent Core Diam. (Axial/Block), (in):	4.900

Moisture Content	
Tare No.:	3316
Weight of Tare & Wet Rock (g):	247.86
Weight of Tare & Dry Rock (g):	244.94
Weight of Tare (g):	8.12
Moisture Content (%):	***1.2***

Sample Length Measurements, (W)	
Length 1 (in):	1.974
Length 2 (in):	1.975
Length 3 (in):	1.972
Average Length (in):	1.974
Length/Diameter Ratio (D/W):	0.988

Sample Length Measurements, (L)	
Length 1 (in):	0.987
Length 2 (in):	0.988
Length 3 (in):	0.986
Average Length (in):	0.987

Test Data		**Index & Strength Computations**	
Core Diameter (mm):	50.131	I_S - Point Load Index (psi):	**40.7**
		$I_{S(50)}$ - Corrected Point Load Index (psi):	**42.9**
		K - Index To Strength Conversion Factor:	**22.7**
P - Gauge Pressure @ Failure (lbf):	200	δ_{vx} **- Est. Unconfined Compressive Strength (psi):**	**924**

SAMPLE SHOWN IN THE SAME ORIENTATION AS TESTED

Tested By JAC *Date* 6/11/24 *Checked By* NJM *Date* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-2
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	101-106
Project No.:	R-2024-175-001	Sample ID:	RUN 18
Lab ID No.:	R-2024-175-001-008	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 589.20

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.43	Reading 1:	2.00
Reading 2:	4.43	Reading 2:	2.00
Reading 3:	4.43	Average:	**2.00**
Average:	**4.43**	Area (in^2):	3.13
		L/D:	2.22

MOISTURE CONTENT			
Tare Number:	484	Total Load (lb):	24,430
Wt. of Tare & Wet Sample (g):	588.50	**Uniaxial Compressive Strength (psi):**	**7,810**
Wt. of Tare & Dry Sample (g):	588.31		
Weight of Tare (g):	99.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	488.90		
Sample Volume (cm^3):	227.53	Rate of Loading (lb/sec):	274
Moisture Content (%):	0.04	Time to Break (min:sec):	01:59.03
Unit Wet Weight (g/cm^3):	2.590	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	161.6		
Unit Dry Weight (g/cm^3):	2.589	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	161.5		

Physical Description: White/Gray Shale Rock Mohs Hardness: **6-7**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-2
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	116-121
Project No.:	R-2024-175-001	Sample ID:	RUN 21
Lab ID No.:	R-2024-175-001-009	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 588.50

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.38	Reading 1:	1.99
Reading 2:	4.38	Reading 2:	1.99
Reading 3:	4.38	Average:	**1.99**
Average:	**4.38**	Area (in^2):	3.12
		L/D:	2.20

MOISTURE CONTENT			
Tare Number:	X-12	Total Load (lb):	27,430
Wt. of Tare & Wet Sample (g):	636.20	**Uniaxial Compressive Strength (psi):**	**8,790**
Wt. of Tare & Dry Sample (g):	635.79		
Weight of Tare (g):	142.90	Fracture Type:	**Shear**
Weight of Wet Sample (g):	493.30		
Sample Volume (cm^3):	223.79	Rate of Loading (lb/sec):	307
Moisture Content (%):	0.08	Time to Break (min:sec):	02:03.14
Unit Wet Weight (g/cm^3):	2.630	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	164.1		
Unit Dry Weight (g/cm^3):	2.628	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	164.0		

Physical Description: White Slate Rock Mohs Hardness: **6-7**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-2
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	131-136
Project No.	2024-175-001	Sample No.	Run 24
Lab ID	2024-175-001-010	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.621	Top Dia. (in)	1.990
Length 2 (in)	4.621	Mid. Dia. (in)	1.990
Length 3 (in)	4.621	Bot. Dia. (in)	1.989
Avg. Length (in)	4.621	Area (in.^{2})	3.11
Gauge Length (in)	3.411		

WATER CONTENT AFTER TEST	
Tare No.	3316
Wt. Tare + WS.(gms)	588.29
Wt. Tare + DS.(gms)	586.97
Wt. of Tare (gms)	8.10
% Moisture	0.23

UNIT WEIGHT			
Wet Wt. of Core (gms.)	621.94	Sample Volume(cc.)	235.4
Diameter (in.)	1.99	Unit Wet Wt.(gms/cc)	2.64
Length (in.)	4.62	Unit Wet Wt.(pcf.)	164.83
Length (cm.)	11.74	Moisture Content, %	0.23
		Unit Dry Wt.(pcf.)	164.46

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0000456	N/A	1,884	32	0.0000134	N/A	605.9
0.0001452	N/A	3,400	65	0.0000426	N/A	1,093.6
0.0002957	N/A	5,014	98	0.0000867	N/A	1,612.5
0.0004386	N/A	6,714	131	0.0001286	N/A	2,159.5
0.0006090	N/A	8,573	163	0.0001786	N/A	2,757.4
0.0008210	N/A	10,604	196	0.0002407	N/A	3,410.5
0.0010354	N/A	12,693	229	0.0003036	N/A	4,082.3
0.0012548	N/A	14,820	262	0.0003679	N/A	4,766.3
0.0014663	N/A	16,980	295	0.0004299	N/A	5,461.2
0.0016767	N/A	19,148	327	0.0004916	N/A	6,158.6
0.0021290	N/A	23,794	393	0.0006242	N/A	7,652.7
0.0023595	N/A	26,230	426	0.0006918	N/A	8,436.3
0.0025908	N/A	28,714	458	0.0007596	N/A	9,235.1
0.0024001	N/A	31,650	491	0.0007037	N/A	10,179.3
0.0031936	N/A	34,876	524	0.0009364	N/A	11,217.1
0.0035246	N/A	38,158	557	0.0010334	N/A	12,272.7
0.0039076	N/A	41,816	590	0.0011457	N/A	13,449.1
0.0042418	N/A	45,358	622	0.0012437	N/A	14,588.3
0.0046082	N/A	49,059	655	0.0013511	N/A	15,778.5
0.0049792	N/A	52,821	688	0.0014599	N/A	16,988.6
0.0053499	N/A	56,576	721	0.0015686	N/A	18,196.2
0.0057114	N/A	60,232	753	0.0016746	N/A	19,372.0
0.0060941	N/A	64,065	786	0.0017868	N/A	20,604.8
0.0064884	N/A	67,893	819	0.0019024	N/A	21,836.1
0.0069743	N/A	71,453	852	0.0020448	N/A	22,981.1
0.0075683	N/A	74,745	885	0.0022190	N/A	24,039.9

Tested By	JAC	Date	6/18/24	Input Checked By:	NJM	Date	6/20/24

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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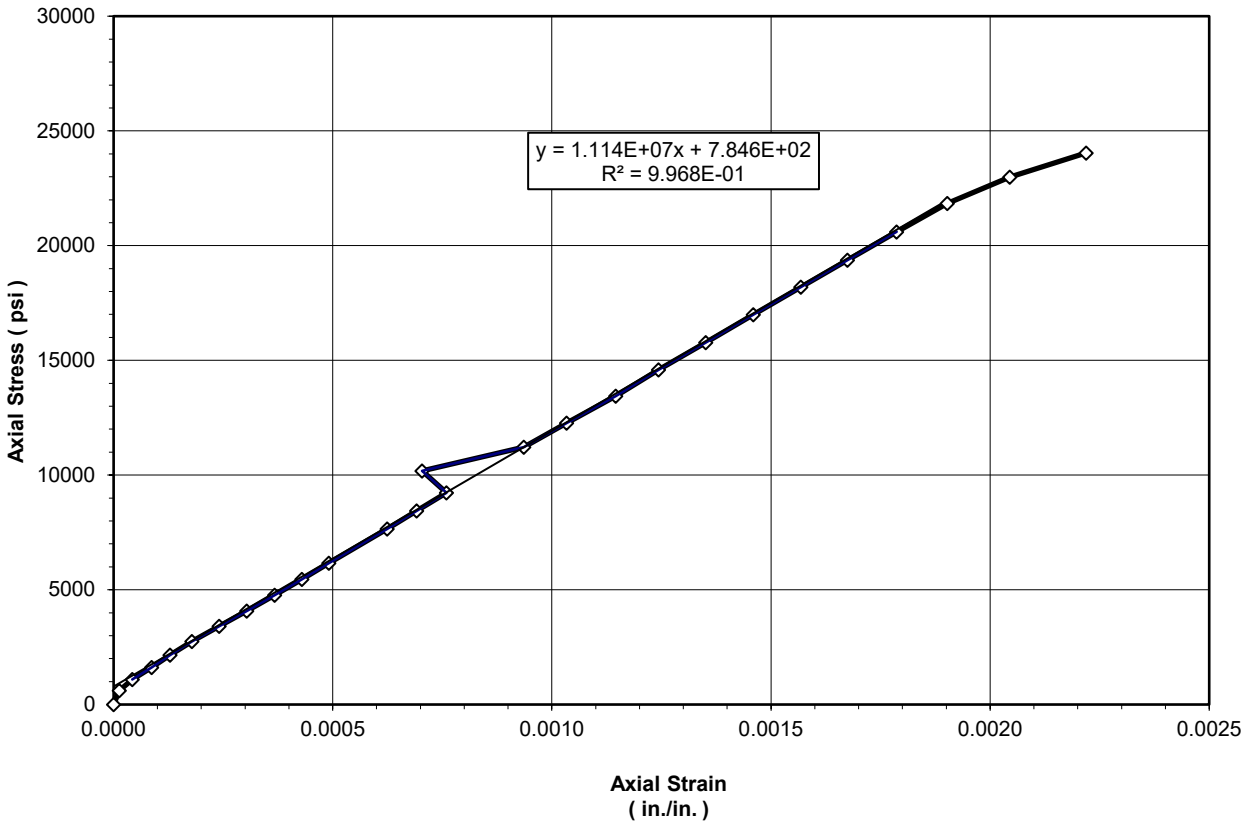
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-2
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	131-136
Project No.	2024-175-001	Sample No.	Run 24
Lab ID	2024-175-001-010	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	74,745	Pounds
Peak Compressive Strength:	24,040	psi
Break Type:	Cone & Split	
Break Time (min. : sec.):	14:45	

Moh's Hardness: ***7 - 8***

Stress Range (psi)	*Young's Modulus (psi)*
1,093 - 20,604	11,140,000

Tested By JAC Date 6/18/24 Approved By NJM Date 6/20/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK
ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	SR-B-2
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	131-136
Project No.	2024-175-001	Sample No.	Run 24
Lab ID	2024-175-001-010	Visual Description:	Gray Rock Core

Tested By	JAC	Date	6/18/24	Input Checked By:	NJM	Date	6/20/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-2
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	146-151
Project No.:	R-2024-175-001	Sample ID:	RUN 27
Lab ID No.:	R-2024-175-001-011	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 581.00

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.38	Reading 1:	1.99
Reading 2:	4.38	Reading 2:	1.99
Reading 3:	4.38	Average:	**1.99**
Average:	**4.38**	Area (in^2):	3.12
		L/D:	2.20

MOISTURE CONTENT			
Tare Number:	X-16	Total Load (lb):	24,830
Wt. of Tare & Wet Sample (g):	564.00	**Uniaxial Compressive Strength (psi):**	**7,960**
Wt. of Tare & Dry Sample (g):	563.80		
Weight of Tare (g):	141.70	Fracture Type:	**Shear**
Weight of Wet Sample (g):	422.30		
Sample Volume (cm^3):	223.79	Rate of Loading (lb/sec):	278
Moisture Content (%):	0.05	Time to Break (min:sec):	02:19.09
Unit Wet Weight (g/cm^3):	2.596	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	162.0		
Unit Dry Weight (g/cm^3):	2.595	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	161.9		

Physical Description: Gray Slate Rock

Mohs Hardness: **4-5**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-4
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	31.2-36.2
Project No.:	R-2024-175-001	Sample ID:	RUN 4
Lab ID No.:	R-2024-175-001-012	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 584.90

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.39	Reading 1:	1.98
Reading 2:	4.39	Reading 2:	1.98
Reading 3:	4.39	Average:	**1.98**
Average:	**4.39**	Area (in^2):	3.09
		L/D:	2.21

MOISTURE CONTENT			
Tare Number:	X-17	Total Load (lb):	36,410
Wt. of Tare & Wet Sample (g):	642.70	**Uniaxial Compressive Strength (psi):**	**11,780**
Wt. of Tare & Dry Sample (g):	642.37		
Weight of Tare (g):	143.50	Fracture Type:	**Shear**
Weight of Wet Sample (g):	499.20		
Sample Volume (cm^3):	222.49	Rate of Loading (lb/sec):	408
Moisture Content (%):	0.07	Time to Break (min:sec):	02:17.49
Unit Wet Weight (g/cm^3):	2.629	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	164.0		
Unit Dry Weight (g/cm^3):	2.627	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.9		

Physical Description: Gray Slate Rock

Mohs Hardness: **6-7**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-4
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	59-61.2
Project No.:	R-2024-175-001	Sample ID:	RUN 9
Lab ID No.:	R-2024-175-001-013	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 594.40

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.48	Reading 1:	1.99
Reading 2:	4.48	Reading 2:	1.99
Reading 3:	4.48	Average:	**1.99**
Average:	**4.48**	Area (in^2):	3.09
		L/D:	2.26

MOISTURE CONTENT			
Tare Number:	X-1	Total Load (lb):	78,510
Wt. of Tare & Wet Sample (g):	681.80	**Uniaxial Compressive Strength (psi):**	**25,410**
Wt. of Tare & Dry Sample (g):	681.59		
Weight of Tare (g):	142.30	Fracture Type:	**Shear**
Weight of Wet Sample (g):	539.50		
Sample Volume (cm^3):	227.04	Rate of Loading (lb/sec):	880
Moisture Content (%):	0.04	Time to Break (min:sec):	03:07.26
Unit Wet Weight (g/cm^3):	2.618	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.4		
Unit Dry Weight (g/cm^3):	2.617	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.3		

Physical Description: Gray Slate Rock

Mohs Hardness: **4-5**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-4
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	71.2-76.2
Project No.:	R-2024-175-001	Sample ID:	RUN 12
Lab ID No.:	R-2024-175-001-014	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 577.20

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.34	Reading 1:	1.98
Reading 2:	4.34	Reading 2:	1.98
Reading 3:	4.34	Average:	**1.98**
Average:	**4.34**	Area (in^2):	3.08
		L/D:	2.19

MOISTURE CONTENT			
Tare Number:	X-5	Total Load (lb):	25,230
Wt. of Tare & Wet Sample (g):	598.40	**Uniaxial Compressive Strength (psi):**	**8,190**
Wt. of Tare & Dry Sample (g):	597.83		
Weight of Tare (g):	143.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	454.80		
Sample Volume (cm^3):	218.76	Rate of Loading (lb/sec):	283
Moisture Content (%):	0.13	Time to Break (min:sec):	02:19.21
Unit Wet Weight (g/cm^3):	2.638	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	164.6		
Unit Dry Weight (g/cm^3):	2.635	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	164.4		

Physical Description: Gray Slate Rock

Mohs Hardness: **5-6**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-4
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	86.2-91.2
Project No.:	R-2024-175-001	Sample ID:	RUN 15
Lab ID No.:	R-2024-175-001-015	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 576.10

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.33	Reading 1:	1.99
Reading 2:	4.33	Reading 2:	1.99
Reading 3:	4.33	Average:	**1.99**
Average:	**4.33**	Area (in^2):	3.10
		L/D:	2.18

MOISTURE CONTENT			
Tare Number:	X-5	Total Load (lb):	23,100
Wt. of Tare & Wet Sample (g):	598.40	**Uniaxial Compressive Strength (psi):**	**7,450**
Wt. of Tare & Dry Sample (g):	597.83		
Weight of Tare (g):	143.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	454.80		
Sample Volume (cm^3):	220.13	Rate of Loading (lb/sec):	259
Moisture Content (%):	0.13	Time to Break (min:sec):	01:55.42
Unit Wet Weight (g/cm^3):	2.617	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.3		
Unit Dry Weight (g/cm^3):	2.614	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.1		

Physical Description: Gray Slate Rock

Mohs Hardness: **5-6**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-4
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	101.2-106.2
Project No.	2024-175-001	Sample No.	Run 18
Lab ID	2024-175-001-016	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.675	Top Dia. (in)	1.983
Length 2 (in)	4.674	Mid. Dia. (in)	1.983
Length 3 (in)	4.674	Bot. Dia. (in)	1.983
Avg. Length (in)	4.674	Area (in.^{2})	3.09
Gauge Length (in)	3.399		

WATER CONTENT AFTER TEST	
Tare No.	3181
Wt. Tare + WS.(gms)	598.65
Wt. Tare + DS.(gms)	597.68
Wt. of Tare (gms)	8.06
% Moisture	0.16

UNIT WEIGHT			
Wet Wt. of Core (gms.)	621.87	Sample Volume(cc.)	236.6
Diameter (in.)	1.98	Unit Wet Wt.(gms/cc)	2.63
Length (in.)	4.67	Unit Wet Wt.(pcf.)	164.03
Length (cm.)	11.87	Moisture Content, %	0.16
		Unit Dry Wt.(pcf.)	163.76

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0000039	N/A	564	31	0.0000011	N/A	182.8
0.0000169	N/A	1,829	63	0.0000050	N/A	592.2
0.0000466	N/A	3,573	94	0.0000137	N/A	1,157.0
0.0001820	N/A	5,517	126	0.0000535	N/A	1,786.5
0.0003800	N/A	7,557	157	0.0001118	N/A	2,446.9
0.0005670	N/A	9,738	189	0.0001668	N/A	3,152.9
0.0007532	N/A	11,773	220	0.0002216	N/A	3,812.0
0.0009549	N/A	14,022	252	0.0002809	N/A	4,540.2
0.0011564	N/A	16,341	283	0.0003402	N/A	5,291.1
0.0013696	N/A	18,855	315	0.0004029	N/A	6,105.2
0.0018214	N/A	24,343	378	0.0005358	N/A	7,881.9
0.0020457	N/A	27,081	409	0.0006018	N/A	8,768.6
0.0022703	N/A	29,976	441	0.0006679	N/A	9,706.1
0.0024849	N/A	32,883	472	0.0007310	N/A	10,647.1
0.0027066	N/A	35,875	504	0.0007962	N/A	11,615.9
0.0029268	N/A	38,800	535	0.0008610	N/A	12,563.1
0.0031580	N/A	41,863	567	0.0009290	N/A	13,554.7
0.0033792	N/A	44,885	598	0.0009941	N/A	14,533.3
0.0036192	N/A	48,180	630	0.0010647	N/A	15,600.1
0.0038584	N/A	51,349	661	0.0011351	N/A	16,626.3
0.0041035	N/A	54,698	693	0.0012071	N/A	17,710.7
0.0043380	N/A	58,039	724	0.0012761	N/A	18,792.6
0.0045836	N/A	61,395	756	0.0013484	N/A	19,879.1
0.0048112	N/A	64,650	787	0.0014153	N/A	20,932.9
0.0050673	N/A	68,140	819	0.0014907	N/A	22,063.2
0.0053531	N/A	71,467	851	0.0015748	N/A	23,140.3

Tested By	JAC	Date	6/18/24	Input Checked By:	NJM	Date	6/20/24

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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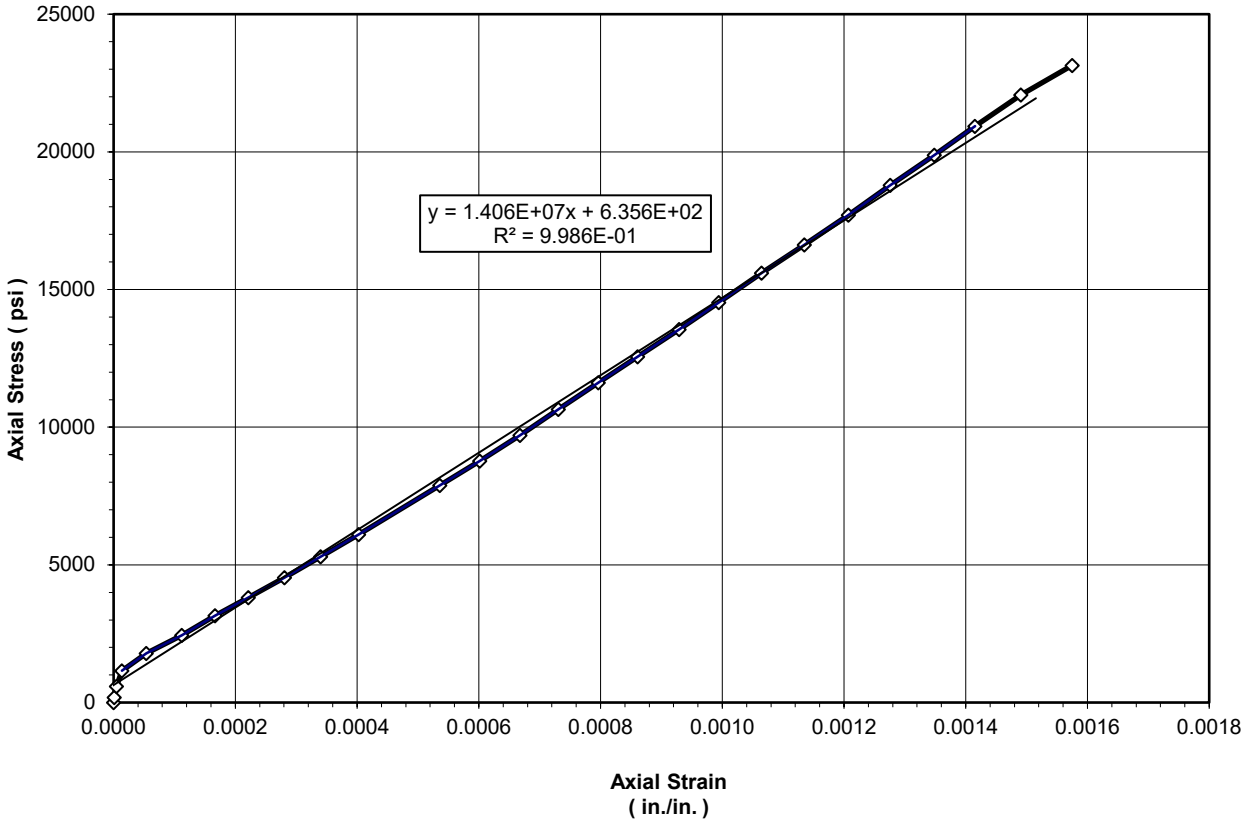
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-4
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	101.2-106.2
Project No.	2024-175-001	Sample No.	Run 18
Lab ID	2024-175-001-016	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	71,467	Pounds
Peak Compressive Strength:	23,140	psi
Break Type:	Cone & Split	
Break Time (min. : sec.):	14:11	

Moh's Hardness: ***7 - 8***

Stress Range (psi)	*Young's Modulus (psi)*
1,157 - 20,932	14,060,000

Tested By JAC Date 6/18/24 Approved By NJM Date 6/20/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK
ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	SR-B-4
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	101.2-106.2
Project No.	2024-175-001	Sample No.	Run 18
Lab ID	2024-175-001-016	Visual Description:	Gray Rock Core

Tested By JAC Date 6/18/24 Input Checked By: NJM Date 6/20/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-4
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	116.2-121.2
Project No.:	R-2024-175-001	Sample ID:	RUN 21
Lab ID No.:	R-2024-175-001-017	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 587.40

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.42	Reading 1:	1.99
Reading 2:	4.42	Reading 2:	1.99
Reading 3:	4.42	Average:	**1.99**
Average:	**4.42**	Area (in^2):	3.11
		L/D:	2.22

MOISTURE CONTENT			
Tare Number:	X-14	Total Load (lb):	46,290
Wt. of Tare & Wet Sample (g):	462.90	**Uniaxial Compressive Strength (psi):**	**14,880**
Wt. of Tare & Dry Sample (g):	462.66		
Weight of Tare (g):	142.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	320.30		
Sample Volume (cm^3):	225.07	Rate of Loading (lb/sec):	519
Moisture Content (%):	0.07	Time to Break (min:sec):	02:10.10
Unit Wet Weight (g/cm^3):	2.610	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	162.9		
Unit Dry Weight (g/cm^3):	2.608	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	162.7		

Physical Description: Gray Shale Rock Mohs Hardness: **5-6**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-4
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	136.2-138-.2
Project No.:	R-2024-175-001	Sample ID:	RUN 25
Lab ID No.:	R-2024-175-001-018	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 587.40

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.46	Reading 1:	1.99
Reading 2:	4.46	Reading 2:	1.99
Reading 3:	4.46	Average:	**1.99**
Average:	**4.46**	Area (in^2):	3.11
		L/D:	2.24

MOISTURE CONTENT			
Tare Number:	X-2	Total Load (lb):	26,600
Wt. of Tare & Wet Sample (g):	610.10	**Uniaxial Compressive Strength (psi):**	**8,550**
Wt. of Tare & Dry Sample (g):	609.54		
Weight of Tare (g):	141.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	468.50		
Sample Volume (cm^3):	227.32	Rate of Loading (lb/sec):	298
Moisture Content (%):	0.12	Time to Break (min:sec):	02:10.10
Unit Wet Weight (g/cm^3):	2.584	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	161.2		
Unit Dry Weight (g/cm^3):	2.581	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	161.1		

Physical Description: Gray Shale Rock Mohs Hardness: **6-7**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	30-31
Project No.:	R-2024-175-001	Sample ID:	RUN
Lab ID No.:	R-2024-175-001-019	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 573.90

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.36	Reading 1:	1.99
Reading 2:	4.36	Reading 2:	1.99
Reading 3:	4.36	Average:	**1.99**
Average:	**4.36**	Area (in^2):	3.10
		L/D:	2.19

MOISTURE CONTENT			
Tare Number:	X-7	Total Load (lb):	24,120
Wt. of Tare & Wet Sample (g):	532.40	**Uniaxial Compressive Strength (psi):**	**7,780**
Wt. of Tare & Dry Sample (g):	532.21		
Weight of Tare (g):	142.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	389.80		
Sample Volume (cm^3):	221.45	Rate of Loading (lb/sec):	270
Moisture Content (%):	0.05	Time to Break (min:sec):	02:10.09
Unit Wet Weight (g/cm^3):	2.592	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	161.7		
Unit Dry Weight (g/cm^3):	2.590	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	161.6		

Physical Description: Gray Shale Rock

Mohs Hardness: **6-7**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-5
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	41-46
Project No.	2024-175-001	Sample No.	N/A
Lab ID	2024-175-001-020	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.670	Top Dia. (in)	1.982
Length 2 (in)	4.670	Mid. Dia. (in)	1.982
Length 3 (in)	4.670	Bot. Dia. (in)	1.984
Avg. Length (in)	4.670	Area (in.^{2})	3.09
Gauge Length (in)	3.353		

WATER CONTENT AFTER TEST	
Tare No.	3138
Wt. Tare + WS.(gms)	583.11
Wt. Tare + DS.(gms)	581.82
Wt. of Tare (gms)	8.15
% Moisture	0.22

UNIT WEIGHT			
Wet Wt. of Core (gms.)	631.27	Sample Volume(cc.)	236.3
Diameter (in.)	1.98	Unit Wet Wt.(gms/cc)	2.67
Length (in.)	4.67	Unit Wet Wt.(pcf.)	166.72
Length (cm.)	11.86	Moisture Content, %	0.22
		Unit Dry Wt.(pcf.)	166.35

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0000070	N/A	1,956	38	0.0000021	N/A	633.5
0.0000264	N/A	3,744	76	0.0000079	N/A	1,212.8
0.0001511	N/A	5,687	115	0.0000451	N/A	1,842.1
0.0003385	N/A	7,721	153	0.0001010	N/A	2,500.8
0.0005366	N/A	10,019	192	0.0001600	N/A	3,245.2
0.0007349	N/A	12,401	230	0.0002192	N/A	4,016.5
0.0009552	N/A	15,036	268	0.0002849	N/A	4,870.3
0.0011790	N/A	17,745	307	0.0003517	N/A	5,747.5
0.0013831	N/A	20,503	345	0.0004125	N/A	6,640.9
0.0016059	N/A	23,417	384	0.0004790	N/A	7,584.8
0.0020684	N/A	29,530	460	0.0006169	N/A	9,564.7
0.0023085	N/A	32,900	499	0.0006885	N/A	10,656.2
0.0025585	N/A	36,262	537	0.0007631	N/A	11,745.1
0.0028125	N/A	39,845	576	0.0008389	N/A	12,905.9
0.0030694	N/A	43,487	614	0.0009155	N/A	14,085.5
0.0033332	N/A	47,209	652	0.0009942	N/A	15,291.0
0.0036223	N/A	51,263	691	0.0010804	N/A	16,604.0
0.0039233	N/A	55,421	729	0.0011702	N/A	17,950.7
0.0042416	N/A	59,875	768	0.0012652	N/A	19,393.6
0.0046170	N/A	64,839	806	0.0013771	N/A	21,001.4
0.0050068	N/A	70,035	844	0.0014934	N/A	22,684.3
0.0054075	N/A	75,347	883	0.0016129	N/A	24,405.0
0.0058099	N/A	80,514	921	0.0017329	N/A	26,078.5
0.0062153	N/A	85,770	960	0.0018538	N/A	27,780.8
0.0066407	N/A	91,248	998	0.0019807	N/A	29,555.3
0.0071734	N/A	96,766	1036	0.0021396	N/A	31,342.6

Tested By	JAC	Date	6/18/24	Input Checked By:	NJM	Date	6/20/24

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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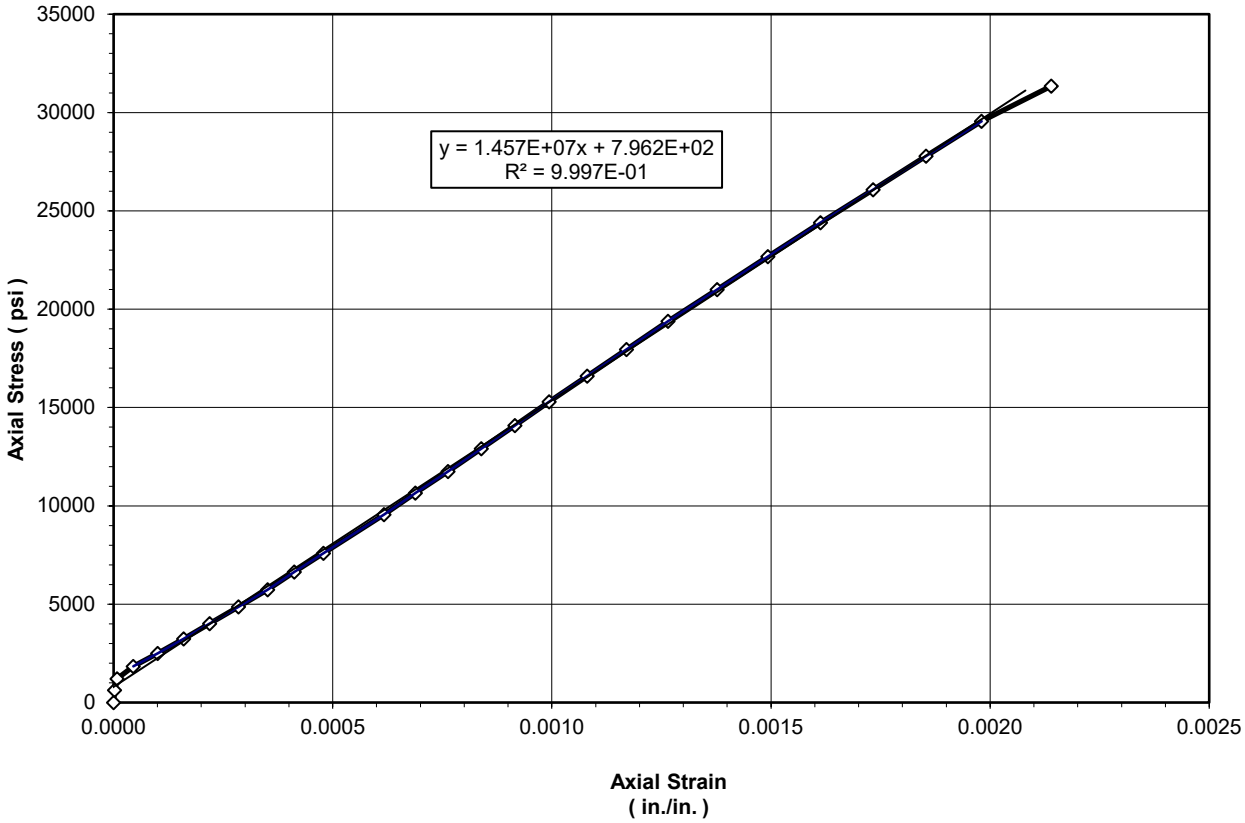
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-5
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	41-46
Project No.	2024-175-001	Sample No.	N/A
Lab ID	2024-175-001-020	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	96,766	Pounds
Peak Compressive Strength:	31,343	psi
Break Type:	Cone & Split	
Break Time (min. : sec.):	17:16	

Moh's Hardness: ***7 - 8***

Stress Range (psi)	*Young's Modulus (psi)*
1,842 - 29,555	14,570,000

Tested By JAC Date 6/18/24 Approved By NJM Date 6/20/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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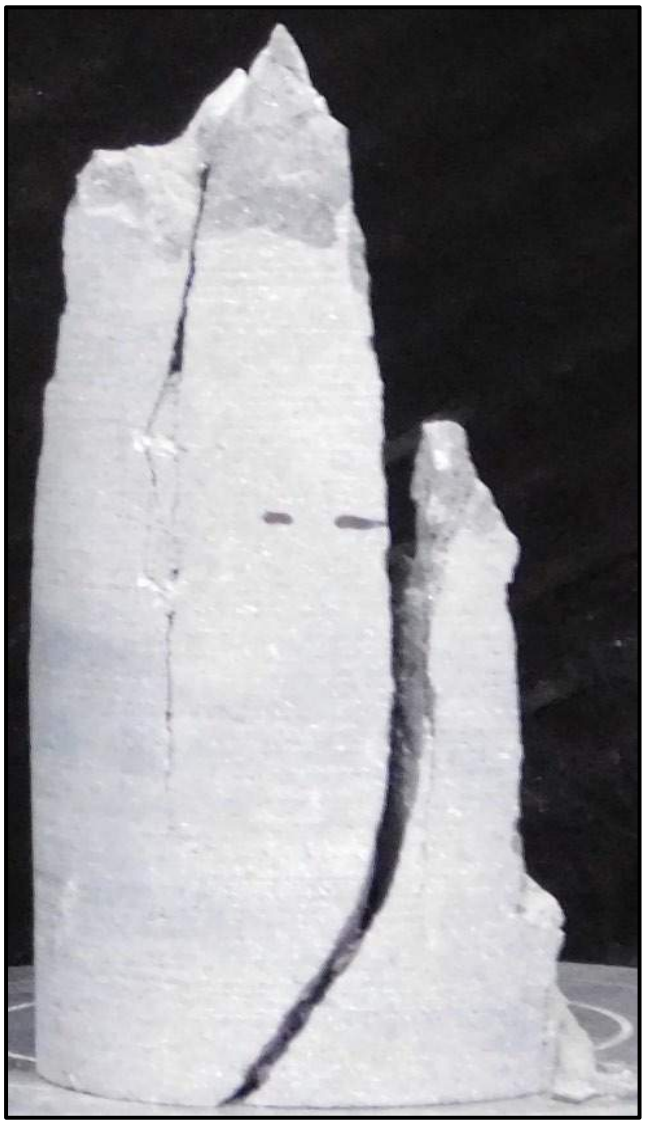
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	SR-B-5
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	41-46
Project No.	2024-175-001	Sample No.	N/A
Lab ID	2024-175-001-020	Visual Description:	Gray Rock Core



Tested By	JAC	Date	6/18/24	Input Checked By:	NJM	Date	6/20/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	56-58
Project No.:	R-2024-175-001	Sample ID:	RUN
Lab ID No.:	R-2024-175-001-021	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 580.80

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.35	Reading 1:	1.99
Reading 2:	4.35	Reading 2:	1.99
Reading 3:	4.35	Average:	**1.99**
Average:	**4.35**	Area (in^2):	3.10
		L/D:	2.19

MOISTURE CONTENT			
Tare Number:	X-69	Total Load (lb):	30,900
Wt. of Tare & Wet Sample (g):	459.90	**Uniaxial Compressive Strength (psi):**	**9,970**
Wt. of Tare & Dry Sample (g):	458.79		
Weight of Tare (g):	142.80	Fracture Type:	**Shear**
Weight of Wet Sample (g):	317.10		
Sample Volume (cm^3):	221.08	Rate of Loading (lb/sec):	346
Moisture Content (%):	0.35	Time to Break (min:sec):	02:03.03
Unit Wet Weight (g/cm^3):	2.627	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.9		
Unit Dry Weight (g/cm^3):	2.618	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.4		

Physical Description: Gray Shale Rock Mohs Hardness: **5-6**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	76-81
Project No.:	R-2024-175-001	Sample ID:	RUN
Lab ID No.:	R-2024-175-001-022	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 584.30

SPECIMEN LENGTH (in)	
Reading 1:	4.38
Reading 2:	4.38
Reading 3:	4.38
Average:	**4.38**

SPECIMEN DIAMETER (in):	
Reading 1:	1.99
Reading 2:	1.99
Average:	**1.99**
Area (in^2):	3.10
L/D:	2.21

MOISTURE CONTENT

Tare Number:	X-11
Wt. of Tare & Wet Sample (g):	610.00
Wt. of Tare & Dry Sample (g):	609.76
Weight of Tare (g):	142.70
Weight of Wet Sample (g):	467.30
Sample Volume (cm^3):	222.67
Moisture Content (%):	0.05
Unit Wet Weight (g/cm^3):	2.624
Unit Wet Weight (pcf):	163.7
Unit Dry Weight (g/cm^3):	2.623
Unit Dry Weight (pcf):	163.7

Total Load (lb):	34,210
Uniaxial Compressive Strength (psi):	**11,040**
Fracture Type:	**Shear**
Rate of Loading (lb/sec):	383
Time to Break (min:sec):	02:49.32
Deviation From Straightness[2]:	

AXIAL: *Pass* TOP: *Pass* BOTTOM: *Pass*

Physical Description: Gray Shale Rock

Mohs Hardness: **6-7**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	98-100
Project No.:	R-2024-175-001	Sample ID:	RUN
Lab ID No.:	R-2024-175-001-023	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 585.20

SPECIMEN LENGTH (in)	
Reading 1:	4.43
Reading 2:	4.43
Reading 3:	4.43
Average:	**4.43**

SPECIMEN DIAMETER (in):	
Reading 1:	1.99
Reading 2:	1.99
Average:	**1.99**
Area (in^2):	3.11
L/D:	2.22

MOISTURE CONTENT

Tare Number:	491
Wt. of Tare & Wet Sample (g):	450.30
Wt. of Tare & Dry Sample (g):	450.06
Weight of Tare (g):	100.30
Weight of Wet Sample (g):	350.00
Sample Volume (cm^3):	225.96
Moisture Content (%):	0.07
Unit Wet Weight (g/cm^3):	2.590
Unit Wet Weight (pcf):	161.6
Unit Dry Weight (g/cm^3):	2.588
Unit Dry Weight (pcf):	161.5

Total Load (lb):	57,890
Uniaxial Compressive Strength (psi):	**18,610**
Fracture Type:	**Shear**
Rate of Loading (lb/sec):	649
Time to Break (min:sec):	02:30.30
Deviation From Straightness[2]:	

AXIAL: *Pass* TOP: *Pass* BOTTOM: *Pass*

Physical Description: Gray Slate Rock Mohs Hardness: **6-7**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	121-123
Project No.:	R-2024-175-001	Sample ID:	RUN
Lab ID No.:	R-2024-175-001-024	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 568.60

SPECIMEN LENGTH (in)	
Reading 1:	4.20
Reading 2:	4.20
Reading 3:	4.20
Average:	**4.20**

SPECIMEN DIAMETER (in):	
Reading 1:	1.98
Reading 2:	1.98
Average:	**1.98**
Area (in^2):	3.09
L/D:	2.12

MOISTURE CONTENT

Tare Number:	715
Wt. of Tare & Wet Sample (g):	495.00
Wt. of Tare & Dry Sample (g):	494.77
Weight of Tare (g):	90.20
Weight of Wet Sample (g):	404.80
Sample Volume (cm^3):	212.98
Moisture Content (%):	0.06
Unit Wet Weight (g/cm^3):	2.670
Unit Wet Weight (pcf):	166.6
Unit Dry Weight (g/cm^3):	2.668
Unit Dry Weight (pcf):	166.5

Total Load (lb):	68,860
Uniaxial Compressive Strength (psi):	**22,280**
Fracture Type:	**Shear**
Rate of Loading (lb/sec):	772
Time to Break (min:sec):	03:19.01
Deviation From Straightness[2]:	

AXIAL: *Pass* TOP: *Pass* BOTTOM: *Pass*

Physical Description: White Shale Rock

Mohs Hardness: **4-5**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-5
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	146-148
Project No.:	R-2024-175-001	Sample ID:	RUN
Lab ID No.:	R-2024-175-001-025	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 600.20

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.45	Reading 1:	2.00
Reading 2:	4.45	Reading 2:	2.00
Reading 3:	4.45	Average:	**2.00**
Average:	**4.45**	Area (in^2):	3.13
		L/D:	2.23

MOISTURE CONTENT			
Tare Number:	19-A	Total Load (lb):	40,990
Wt. of Tare & Wet Sample (g):	532.00	**Uniaxial Compressive Strength (psi):**	**13,100**
Wt. of Tare & Dry Sample (g):	531.51		
Weight of Tare (g):	87.70	Fracture Type:	**Shear**
Weight of Wet Sample (g):	444.30		
Sample Volume (cm^3):	228.33	Rate of Loading (lb/sec):	459
Moisture Content (%):	0.11	Time to Break (min:sec):	02:19.19
Unit Wet Weight (g/cm^3):	2.629	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	164.0		
Unit Dry Weight (g/cm^3):	2.626	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.8		

Physical Description: White Slate Rock

Mohs Hardness: **4-5**

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 6/12/24 *Checked By:* AES *Date:* 6/13/24

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August 07, 2024

Project No. R-2024-175-002

Tim Pierce
GeoEngineers
1100 Crescent Green Drive Suite 204
Cary, NC 27518

tpierce@geoengineers.com

Transmittal
Laboratory Test Results
SSE Project: Eden Loop –Sandy River

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was transmitted to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

PERCENT PASSING # 200 SIEVE

ASTM D 1140-17

Client	GeoEngineers
Client Reference	SSE Project: Eden Loop - Sandy River
Project No.	R-2024-175-002

Lab Id.	.001
Boring No.	SR-B-1
Depth (ft)	8.5-10
Sample No.	S4
Tare Number	456
Wt. of Tare & WS (gm)	545.44
Wt. of Tare & DS (gm)	451.22
Wt. of Tare (gm)	137.25
Wt. of Water (gm)	94.22
Wt. of DS (gm)	313.97
Water Content (%)	**30.0**
Wt. of Washed Soil & Tare	309.77
Percent Passing #200	**45.1**

Tested By EH *Date* 7/31/24 *Checked By* EH *Date* 7-Aug

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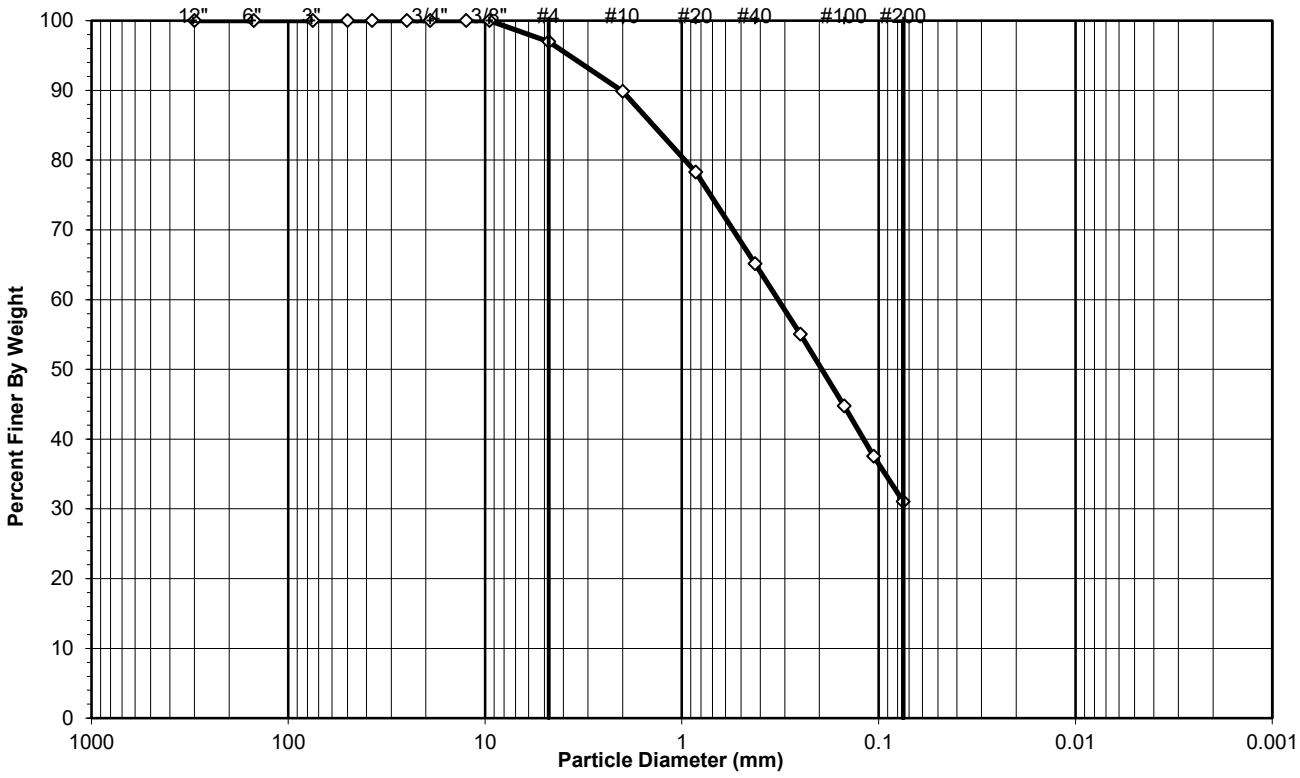
SIEVE AND HYDROMETER ANALYSIS

ASTM D6913 / D7928

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Reference:	SSE Project: Eden Loop - Sandy River	Depth (ft):	23.5-25
Project No.:	R-2024-175-002	Sample No.:	S7
Lab ID:	R-2024-175-002-002	Soil Color:	Brown

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



Sieve Size		Percentage (%)
Greater than #4	***Gravel***	**3.01**
#4 to #200	***Sand***	**65.92**
Finer than #200	***Silt & Clay***	**31.06**

USCS Symbol:
sm, ASSUMED

D50 = 0.19

USCS Classification:
SILTY SAND

Tested By BS Date 8/2/24 Checked By AES Date 8/2/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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WASH SIEVE ANALYSIS

ASTM D6913-17

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Reference:	SSE Project: Eden Loop - Sandy River	Depth (ft):	23.5-25
Project No.:	R-2024-175-002	Sample No.:	S7
Lab ID:	R-2024-175-002-002	Soil Color:	Brown

Moisture Content of Passing 3/4" Material		Moisture Content of Retained 3/4" Material	
Tare No.:	740	Tare No.:	NA
Wt. of Tare & Wet Sample (g):	459.42	Weight of Tare & Wet Sample (g):	NA
Wt. of Tare & Dry Sample (g):	411.69	Weight of Tare & Dry Sample (g):	NA
Weight of Tare (g):	143.60	Weight of Tare (g):	NA
Weight of Water (g):	47.73	Weight of Water (g):	NA
Weight of Dry Soil (g):	268.09	Weight of Dry Soil (g):	NA
Moisture Content (%):	**17.8**	**Moisture Content (%):**	**0.0**

Dry Weight of Sample (g):	NA	Total Dry Weight of Sample (g):	268.09
Tare No. (Sub-Specimen)	740	Wet Weight of +3/4" Sample (g):	0.00
Wt. of Tare & Wet Sub-Specimen (g):	459.42	Dry Weight of + 3/4" Sample (g):	0.00
Weight of Tare (g):	143.60	Dry Weight of - 3/4" Sample (g):	268.09
Sub-Specimen Wet Weight (g):	315.82	Dry Weight -3/4" +3/8" Sample (g):	0.00
Tare No. (-3/8" Sub-Specimen):	NA	Dry Weight of -3/8" Sample (g):	268.09
Wt. of Tare & Wet -3/8" Sub-Specimen (g):	NA	J - Factor (% Finer than 3/4"):	NA
Weight of Tare (g):	NA	J - Factor (% Finer than 3/8"):	NA
Sub-Specimen -3/8" Wet Weight (g):	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)		Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00		0.00	0.00	100.00	**100**
6"	150	0.00		0.00	0.00	100.00	**100**
3"	75	0.00		0.00	0.00	100.00	**100**
2"	50	0.00	(*)	0.00	0.00	100.00	**100**
1 1/2"	37.5	0.00		0.00	0.00	100.00	**100**
1"	25	0.00		0.00	0.00	100.00	**100**
3/4"	19	0.00		0.00	0.00	100.00	**100**
1/2"	12.5	0.00	(**)	0.00	0.00	100.00	**100**
3/8"	9.5	0.00		0.00	0.00	100.00	**100**
#4	4.75	8.08		3.01	3.01	96.99	**97**
#10	2	19.14		7.14	10.15	89.85	**90**
#20	0.85	30.99	(**)	11.56	21.71	78.29	**78**
#40	0.425	35.24		13.14	34.86	65.14	**65**
#60	0.25	27.04		10.09	44.94	55.06	**55**
#100	0.15	27.66		10.32	55.26	44.74	**45**
#140	0.106	19.23		7.17	62.43	37.57	**38**
#200	0.075	17.43		6.50	68.94	31.06	**31**
Pan	-	83.28		31.06	100.00	-	**-**

Notes : *(*) The + 3/4" sieve analysis is based on the Total Dry Weight of the Sample*
*(**) The - 3/4" and - 3/8" sieve analysis is based on the Weight of the Dry Specimen*

Tested By	BS	Date	8/2/24	Checked By	AES	Date	8/2/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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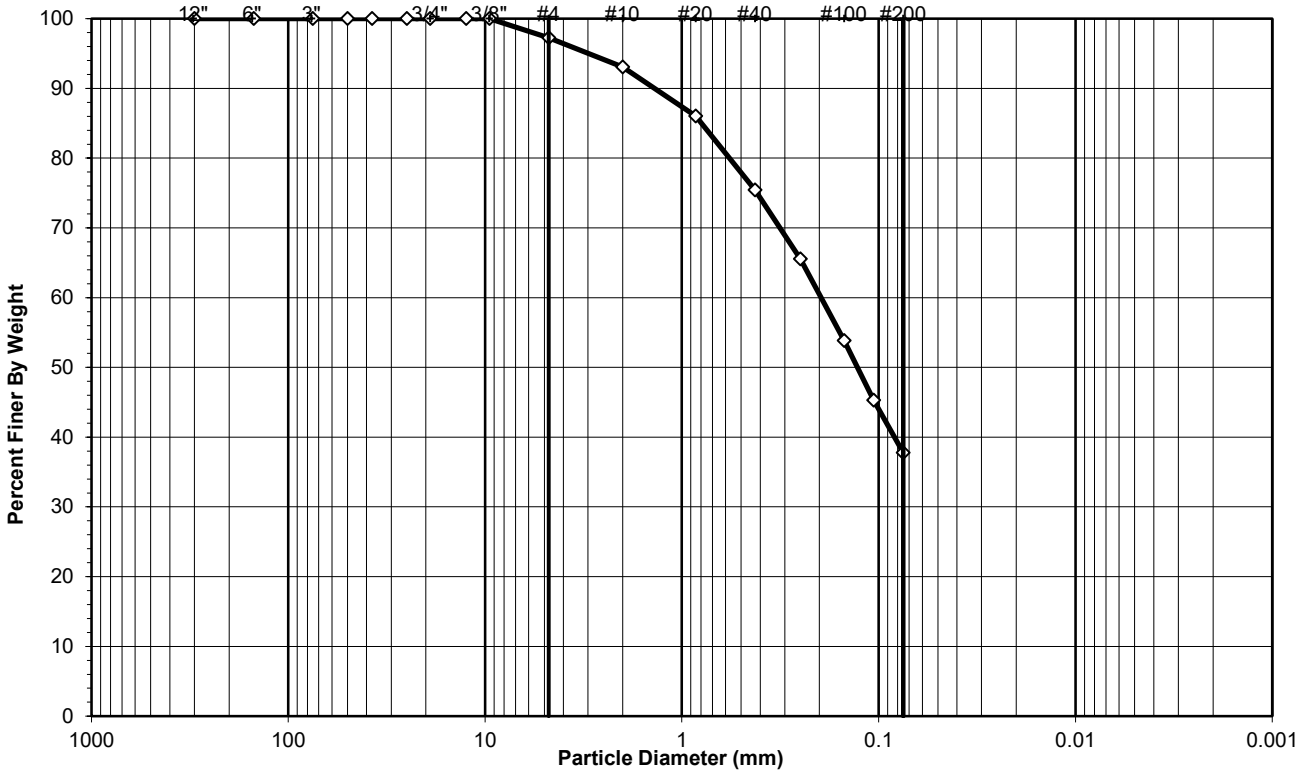
SIEVE AND HYDROMETER ANALYSIS

ASTM D6913 / D7928

Client:	GeoEngineers	Boring No.:	SR-B-6
Client Reference:	SSE Project: Eden Loop - Sandy River	Depth (ft):	6-7.5
Project No.:	R-2024-175-002	Sample No.:	S3
Lab ID:	R-2024-175-002-003	Soil Color:	Light Brown

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



Sieve Size		Percentage (%)
Greater than #4	***Gravel***	**2.75**
#4 to #200	***Sand***	**59.47**
Finer than #200	***Silt & Clay***	**37.77**

USCS Symbol:
sm, ASSUMED

D50 = 0.13

USCS Classification:
SILTY SAND

Tested By BS Date 8/2/24 Checked By AES Date 8/2/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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WASH SIEVE ANALYSIS

ASTM D6913-17

Client:	GeoEngineers	Boring No.:	SR-B-6
Client Reference:	SSE Project: Eden Loop - Sandy River	Depth (ft):	6-7.5
Project No.:	R-2024-175-002	Sample No.:	S3
Lab ID:	R-2024-175-002-003	Soil Color:	Light Brown

Moisture Content of Passing 3/4" Material		Moisture Content of Retained 3/4" Material	
Tare No.:	452	Tare No.:	NA
Wt. of Tare & Wet Sample (g):	535.85	Weight of Tare & Wet Sample (g):	NA
Wt. of Tare & Dry Sample (g):	471.61	Weight of Tare & Dry Sample (g):	NA
Weight of Tare (g):	146.38	Weight of Tare (g):	NA
Weight of Water (g):	64.24	Weight of Water (g):	NA
Weight of Dry Soil (g):	325.23	Weight of Dry Soil (g):	NA
Moisture Content (%):	**19.8**	**Moisture Content (%):**	**0.0**

Dry Weight of Sample (g):	NA	Total Dry Weight of Sample (g):	325.23
Tare No. (Sub-Specimen)	452	Wet Weight of +3/4" Sample (g):	0.00
Wt. of Tare & Wet Sub-Specimen (g):	535.85	Dry Weight of + 3/4" Sample (g):	0.00
Weight of Tare (g):	146.38	Dry Weight of - 3/4" Sample (g):	325.23
Sub-Specimen Wet Weight (g):	389.47	Dry Weight -3/4" +3/8" Sample (g):	0.00
Tare No. (-3/8" Sub-Specimen):	NA	Dry Weight of -3/8" Sample (g):	325.23
Wt. of Tare & Wet -3/8" Sub-Specimen (g):	NA	J - Factor (% Finer than 3/4"):	NA
Weight of Tare (g):	NA	J - Factor (% Finer than 3/8"):	NA
Sub-Specimen -3/8" Wet Weight (g):	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)		Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00		0.00	0.00	100.00	**100**
6"	150	0.00		0.00	0.00	100.00	**100**
3"	75	0.00		0.00	0.00	100.00	**100**
2"	50	0.00	(*)	0.00	0.00	100.00	**100**
1 1/2"	37.5	0.00		0.00	0.00	100.00	**100**
1"	25	0.00		0.00	0.00	100.00	**100**
3/4"	19	0.00		0.00	0.00	100.00	**100**
1/2"	12.5	0.00	(**)	0.00	0.00	100.00	**100**
3/8"	9.5	0.00		0.00	0.00	100.00	**100**
#4	4.75	8.95		2.75	2.75	97.25	**97**
#10	2	13.55		4.17	6.92	93.08	**93**
#20	0.85	22.91	(**)	7.04	13.96	86.04	**86**
#40	0.425	34.53		10.62	24.58	75.42	**75**
#60	0.25	32.05		9.85	34.43	65.57	**66**
#100	0.15	38.07		11.71	46.14	53.86	**54**
#140	0.106	27.84		8.56	54.70	45.30	**45**
#200	0.075	24.48		7.53	62.23	37.77	**38**
Pan	-	122.85		37.77	100.00	-	**-**

Notes : *(*) The + 3/4" sieve analysis is based on the Total Dry Weight of the Sample*
*(**) The - 3/4" and - 3/8" sieve analysis is based on the Weight of the Dry Specimen*

Tested By	BS	Date	8/2/24	Checked By	AES	Date	8/2/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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August 26, 2024

Project No. R-2024-175-003

Tim Pierce
GeoEngineers
1100 Crescent Green Drive Suite 204
Cary, NC 27518

tpierce@geoengineers.com

Transmittal
Laboratory Test Results
SSE Proj: Eden Loop - Sandy River

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was transmitted to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	67-68
Project No.:	R-2024-175-003	Sample ID:	RUN 3
Lab ID No.:	R-2024-175-003-001	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 568.80

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.31	Reading 1:	1.99
Reading 2:	4.31	Reading 2:	1.99
Reading 3:	4.31	Average:	**1.99**
Average:	**4.31**	Area (in^2):	3.11
		L/D:	2.17

MOISTURE CONTENT			
Tare Number:	472	Total Load (lb):	26,730
Wt. of Tare & Wet Sample (g):	461.50	**Uniaxial Compressive Strength (psi):**	**8,590**
Wt. of Tare & Dry Sample (g):	460.58		
Weight of Tare (g):	99.20	Fracture Type:	**Shear**
Weight of Wet Sample (g):	362.30		
Sample Volume (cm^3):	220.10	Rate of Loading (lb/sec):	299
Moisture Content (%):	0.25	Time to Break (min:sec):	02:20.20
Unit Wet Weight (g/cm^3):	2.584	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	161.3		
Unit Dry Weight (g/cm^3):	2.578	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	160.9		

Mohs Hardness: 5-6

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	90.5-91
Project No.:	R-2024-175-003	Sample ID:	RUN 7
Lab ID No.:	R-2024-175-003-002	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 581.20

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.38	Reading 1:	2.01
Reading 2:	4.38	Reading 2:	2.01
Reading 3:	4.39	Average:	**2.01**
Average:	**4.38**	Area (in^2):	3.19
		L/D:	2.18

MOISTURE CONTENT			
Tare Number:	475	Total Load (lb):	40,450
Wt. of Tare & Wet Sample (g):	644.60	**Uniaxial Compressive Strength (psi):**	**12,680**
Wt. of Tare & Dry Sample (g):	643.12		
Weight of Tare (g):	98.20	Fracture Type:	**Shear**
Weight of Wet Sample (g):	546.40		
Sample Volume (cm^3):	228.88	Rate of Loading (lb/sec):	453
Moisture Content (%):	0.27	Time to Break (min:sec):	03:30.49
Unit Wet Weight (g/cm^3):	2.539	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	158.5		
Unit Dry Weight (g/cm^3):	2.532	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	158.0		

Mohs Hardness: 7-8

Physical Description: White Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	108-109
Project No.:	R-2024-175-003	Sample ID:	RUN 11
Lab ID No.:	R-2024-175-003-003	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 593.10

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.43	Reading 1:	2.00
Reading 2:	4.43	Reading 2:	2.00
Reading 3:	4.43	Average:	**2.00**
Average:	**4.43**	Area (in^2):	3.15
		L/D:	2.21

MOISTURE CONTENT			
Tare Number:	21-9	Total Load (lb):	63,960
Wt. of Tare & Wet Sample (g):	556.10	**Uniaxial Compressive Strength (psi):**	**20,300**
Wt. of Tare & Dry Sample (g):	555.21		
Weight of Tare (g):	91.40	Fracture Type:	**Shear**
Weight of Wet Sample (g):	464.70		
Sample Volume (cm^3):	229.10	Rate of Loading (lb/sec):	717
Moisture Content (%):	0.19	Time to Break (min:sec):	02:59.50
Unit Wet Weight (g/cm^3):	2.589	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	161.5		
Unit Dry Weight (g/cm^3):	2.584	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	161.2		

Mohs Hardness: 7-8

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	121-122
Project No.:	R-2024-175-003	Sample ID:	RUN 14
Lab ID No.:	R-2024-175-003-004	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 588.50

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.39	Reading 1:	1.99
Reading 2:	4.39	Reading 2:	1.99
Reading 3:	4.39	Average:	**1.99**
Average:	**4.39**	Area (in^2):	3.12
		L/D:	2.20

MOISTURE CONTENT			
Tare Number:	721	Total Load (lb):	35,260
Wt. of Tare & Wet Sample (g):	568.80	**Uniaxial Compressive Strength (psi):**	**11,300**
Wt. of Tare & Dry Sample (g):	567.40		
Weight of Tare (g):	90.10	Fracture Type:	**Shear**
Weight of Wet Sample (g):	478.70		
Sample Volume (cm^3):	224.05	Rate of Loading (lb/sec):	395
Moisture Content (%):	0.29	Time to Break (min:sec):	03:29.11
Unit Wet Weight (g/cm^3):	2.627	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.9		
Unit Dry Weight (g/cm^3):	2.619	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.4		

Mohs Hardness: 4-5

Physical Description: White Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	136-137
Project No.:	R-2024-175-003	Sample ID:	RUN 17
Lab ID No.:	R-2024-175-003-005	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 591.70

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.42	Reading 1:	1.99
Reading 2:	4.42	Reading 2:	1.99
Reading 3:	4.42	Average:	**1.99**
Average:	**4.42**	Area (in^2):	3.12
		L/D:	2.22

MOISTURE CONTENT			
Tare Number:	711	Total Load (lb):	28,050
Wt. of Tare & Wet Sample (g):	488.50	**Uniaxial Compressive Strength (psi):**	**8,990**
Wt. of Tare & Dry Sample (g):	487.78		
Weight of Tare (g):	92.20	Fracture Type:	**Shear**
Weight of Wet Sample (g):	396.30		
Sample Volume (cm^3):	225.48	Rate of Loading (lb/sec):	314
Moisture Content (%):	0.18	Time to Break (min:sec):	02:20.40
Unit Wet Weight (g/cm^3):	2.624	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.8		
Unit Dry Weight (g/cm^3):	2.619	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.5		

Mohs Hardness: 6-7

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-1
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	153-154
Project No.	2024-175-003	Sample No.	Run 20
Lab ID	2024-175-003-006	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.615	Top Dia. (in)	1.991
Length 2 (in)	4.615	Mid. Dia. (in)	1.991
Length 3 (in)	4.615	Bot. Dia. (in)	1.992
Avg. Length (in)	4.615	Area (in.^{2})	3.11
Gauge Length (in)	3.389		

WATER CONTENT AFTER TEST	
Tare No.	3340
Wt. Tare + WS.(gms)	648.36
Wt. Tare + DS.(gms)	647.60
Wt. of Tare (gms)	8.14
% Moisture	0.12

UNIT WEIGHT			
Wet Wt. of Core (gms.)	661.36	Sample Volume(cc.)	235.5
Diameter (in.)	1.99	Unit Wet Wt.(gms/cc)	2.81
Length (in.)	4.62	Unit Wet Wt.(pcf.)	175.22
Length (cm.)	11.72	Moisture Content, %	0.12
		Unit Dry Wt.(pcf.)	175.01

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0000106	N/A	791	16	0.0000031	N/A	253.9
0.0000146	N/A	1,026	32	0.0000043	N/A	329.4
0.0000201	N/A	1,505	48	0.0000059	N/A	483.1
0.0000350	N/A	2,438	64	0.0000103	N/A	782.9
0.0000642	N/A	3,565	80	0.0000190	N/A	1,144.5
0.0001394	N/A	4,751	96	0.0000411	N/A	1,525.5
0.0002423	N/A	6,002	112	0.0000715	N/A	1,927.1
0.0003457	N/A	7,298	128	0.0001020	N/A	2,343.3
0.0004589	N/A	8,687	144	0.0001354	N/A	2,789.4
0.0005677	N/A	10,042	160	0.0001675	N/A	3,224.4
0.0007738	N/A	12,555	192	0.0002283	N/A	4,031.2
0.0008989	N/A	13,826	208	0.0002652	N/A	4,439.3
0.0014265	N/A	14,578	224	0.0004209	N/A	4,680.8
0.0016229	N/A	15,848	240	0.0004788	N/A	5,088.6
0.0018130	N/A	17,134	256	0.0005349	N/A	5,501.4
0.0020031	N/A	18,445	272	0.0005910	N/A	5,922.3
0.0021988	N/A	19,782	288	0.0006487	N/A	6,351.8
0.0023946	N/A	21,126	304	0.0007065	N/A	6,783.3
0.0026200	N/A	22,472	320	0.0007730	N/A	7,215.5
0.0028275	N/A	23,828	336	0.0008342	N/A	7,650.7
0.0030405	N/A	25,211	352	0.0008971	N/A	8,095.1
0.0032990	N/A	26,807	368	0.0009733	N/A	8,607.3
0.0035577	N/A	28,433	384	0.0010497	N/A	9,129.4
0.0038133	N/A	30,046	400	0.0011251	N/A	9,647.5
0.0041455	N/A	31,559	416	0.0012231	N/A	10,133.3
0.0045024	N/A	33,213	432	0.0013284	N/A	10,664.2

Tested By	JAC	Date	8/21/24	Input Checked By:	NJM	Date	8/23/24

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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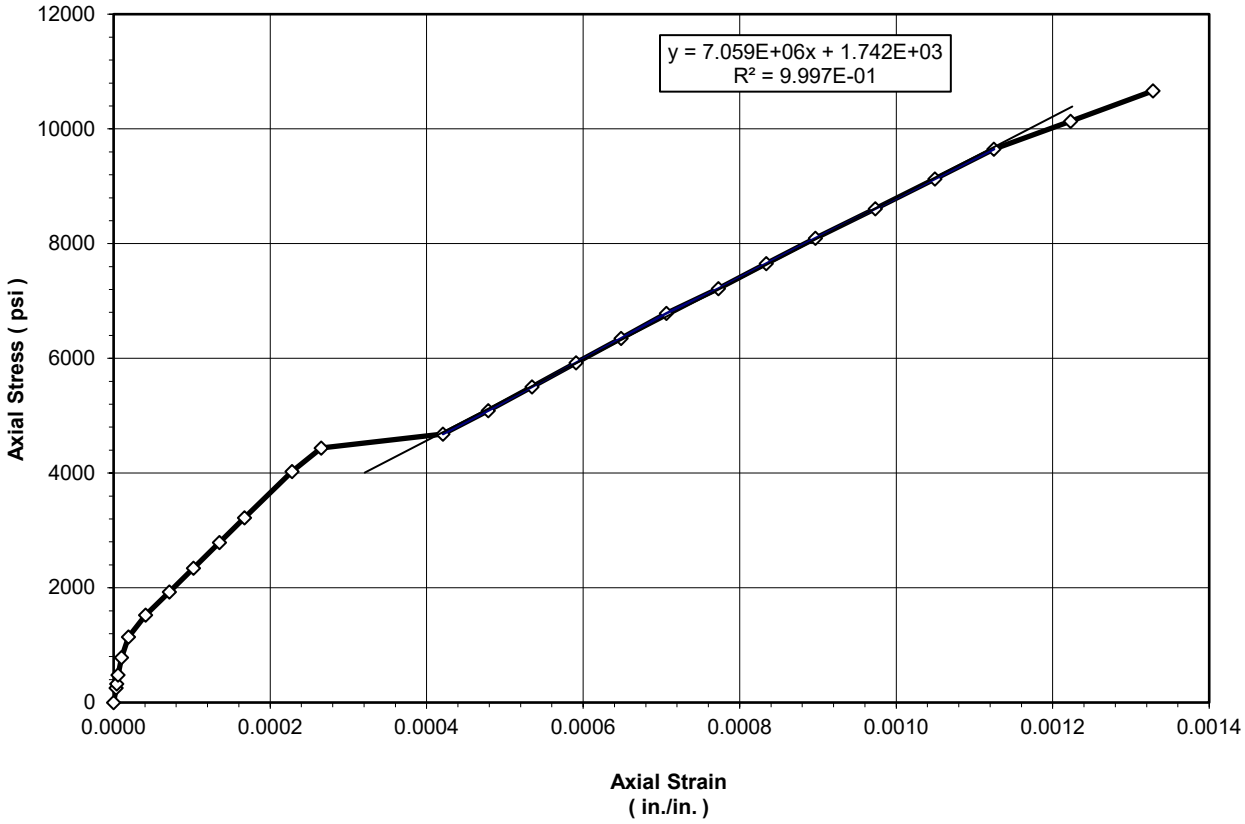
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-1
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	153-154
Project No.	2024-175-003	Sample No.	Run 20
Lab ID	2024-175-003-006	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	33,213	Pounds
Peak Compressive Strength:	10,664	psi
Break Type:	Cone & Split	
Break Time (min. : sec.):	07:12	

Moh's Hardness: 4 - 5

Stress Range (psi)	*Young's Modulus (psi)*
4,680 - 9,647	7,059,000

Tested By JAC Date 8/21/24 Approved By NJM Date 8/23/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK
ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	SR-B-1
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	153-154
Project No.	2024-175-003	Sample No.	Run 20
Lab ID	2024-175-003-006	Visual Description:	Gray Rock Core

Tested By	JAC	Date	8/21/24	Input Checked By:	NJM	Date	8/23/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	168-169
Project No.:	R-2024-175-003	Sample ID:	RUN 23
Lab ID No.:	R-2024-175-003-007	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 642.40

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.48	Reading 1:	2.00
Reading 2:	4.48	Reading 2:	2.00
Reading 3:	4.48	Average:	**2.00**
Average:	**4.48**	Area (in^2):	3.14
		L/D:	2.24

MOISTURE CONTENT			
Tare Number:	713	Total Load (lb):	20,530
Wt. of Tare & Wet Sample (g):	583.90	**Uniaxial Compressive Strength (psi):**	**6,540**
Wt. of Tare & Dry Sample (g):	581.07		
Weight of Tare (g):	91.40	Fracture Type:	**Shear**
Weight of Wet Sample (g):	492.50		
Sample Volume (cm^3):	230.48	Rate of Loading (lb/sec):	230
Moisture Content (%):	0.58	Time to Break (min:sec):	03:00.01
Unit Wet Weight (g/cm^3):	2.787	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	173.9		
Unit Dry Weight (g/cm^3):	2.771	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	172.9		

Mohs Hardness : 4-5

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-1
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	181-182
Project No.:	R-2024-175-003	Sample ID:	RUN 26
Lab ID No.:	R-2024-175-003-008	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 639.70

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.38	Reading 1:	1.99
Reading 2:	4.38	Reading 2:	1.99
Reading 3:	4.38	Average:	**1.99**
Average:	**4.38**	Area (in^2):	3.11
		L/D:	2.20

MOISTURE CONTENT			
Tare Number:	477	Total Load (lb):	7,080
Wt. of Tare & Wet Sample (g):	721.80	**Uniaxial Compressive Strength (psi):**	**2,280**
Wt. of Tare & Dry Sample (g):	720.02		
Weight of Tare (g):	100.20	Fracture Type:	**Shear**
Weight of Wet Sample (g):	621.60		
Sample Volume (cm^3):	223.36	Rate of Loading (lb/sec):	79
Moisture Content (%):	0.29	Time to Break (min:sec):	02:19.19
Unit Wet Weight (g/cm^3):	2.864	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	178.7		
Unit Dry Weight (g/cm^3):	2.856	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	178.2		

Mohs Hardness: 5-6

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	35-36
Project No.:	R-2024-175-003	Sample ID:	RUN 4
Lab ID No.:	R-2024-175-003-009	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 577.20

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.38	Reading 1:	2.00
Reading 2:	4.38	Reading 2:	2.00
Reading 3:	4.38	Average:	**2.00**
Average:	**4.38**	Area (in^2):	3.13
		L/D:	2.19

MOISTURE CONTENT			
Tare Number:	426	Total Load (lb):	40,750
Wt. of Tare & Wet Sample (g):	554.00	**Uniaxial Compressive Strength (psi):**	**13,020**
Wt. of Tare & Dry Sample (g):	552.80		
Weight of Tare (g):	99.30	Fracture Type:	**Shear**
Weight of Wet Sample (g):	454.70		
Sample Volume (cm^3):	224.32	Rate of Loading (lb/sec):	457
Moisture Content (%):	0.26	Time to Break (min:sec):	02:30.30
Unit Wet Weight (g/cm^3):	2.573	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	160.6		
Unit Dry Weight (g/cm^3):	2.566	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	160.1		

Mohs Hardness: 5-6

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	58-59
Project No.:	R-2024-175-003	Sample ID:	RUN 9
Lab ID No.:	R-2024-175-003-010	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 591.90

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.40	Reading 1:	1.99
Reading 2:	4.40	Reading 2:	1.99
Reading 3:	4.40	Average:	**1.99**
Average:	**4.40**	Area (in^2):	3.10
		L/D:	2.22

MOISTURE CONTENT			
Tare Number:	722	Total Load (lb):	25,920
Wt. of Tare & Wet Sample (g):	609.30	**Uniaxial Compressive Strength (psi):**	**8,360**
Wt. of Tare & Dry Sample (g):	608.27		
Weight of Tare (g):	89.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	519.70		
Sample Volume (cm^3):	223.39	Rate of Loading (lb/sec):	290
Moisture Content (%):	0.20	Time to Break (min:sec):	02:31.19
Unit Wet Weight (g/cm^3):	2.650	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	165.3		
Unit Dry Weight (g/cm^3):	2.644	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	165.0		

Mohs Hardness: 4-5

Physical Description: White Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	80-81
Project No.:	R-2024-175-003	Sample ID:	RUN 13
Lab ID No.:	R-2024-175-003-011	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 589.80

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.42	Reading 1:	1.99
Reading 2:	4.42	Reading 2:	1.99
Reading 3:	4.42	Average:	**1.99**
Average:	**4.42**	Area (in^2):	3.09
		L/D:	2.23

MOISTURE CONTENT			
Tare Number:	21-a	Total Load (lb):	46,260
Wt. of Tare & Wet Sample (g):	499.60	**Uniaxial Compressive Strength (psi):**	**14,970**
Wt. of Tare & Dry Sample (g):	499.62		
Weight of Tare (g):	90.60	Fracture Type:	**Shear**
Weight of Wet Sample (g):	409.00		
Sample Volume (cm^3):	224.23	Rate of Loading (lb/sec):	518
Moisture Content (%):	0.00	Time to Break (min:sec):	04:01.12
Unit Wet Weight (g/cm^3):	2.630	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	164.1		
Unit Dry Weight (g/cm^3):	2.630	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	164.1		

Mohs Hardness: 7-8

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/7/24 *Checked By:* AES *Date:* 8/9/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	103-104
Project No.:	R-2024-175-003	Sample ID:	RUN 18
Lab ID No.:	R-2024-175-003-012	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 584.00

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.40	Reading 1:	1.98
Reading 2:	4.40	Reading 2:	1.98
Reading 3:	4.40	Average:	**1.98**
Average:	**4.40**	Area (in^2):	3.09
		L/D:	2.22

MOISTURE CONTENT

Tare Number:	11-a	Total Load (lb):	43,600
Wt. of Tare & Wet Sample (g):	499.10	**Uniaxial Compressive Strength (psi):**	**14,110**
Wt. of Tare & Dry Sample (g):	497.42		
Weight of Tare (g):	88.70	Fracture Type:	**Shear**
Weight of Wet Sample (g):	410.40		
Sample Volume (cm^3):	222.68	Rate of Loading (lb/sec):	489
Moisture Content (%):	0.41	Time to Break (min:sec):	02:29.03
Unit Wet Weight (g/cm^3):	2.623	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.6		
Unit Dry Weight (g/cm^3):	2.612	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.0		

Mohs Hardness: 7-8

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/9/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	116-117
Project No.:	R-2024-175-003	Sample ID:	RUN 20
Lab ID No.:	R-2024-175-003-013	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 574.00

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.33	Reading 1:	1.98
Reading 2:	4.33	Reading 2:	1.98
Reading 3:	4.33	Average:	**1.98**
Average:	**4.33**	Area (in^2):	3.09
		L/D:	2.18

MOISTURE CONTENT			
Tare Number:	427	Total Load (lb):	66,680
Wt. of Tare & Wet Sample (g):	465.40	**Uniaxial Compressive Strength (psi):**	**21,580**
Wt. of Tare & Dry Sample (g):	465.22		
Weight of Tare (g):	98.70	Fracture Type:	**Shear**
Weight of Wet Sample (g):	366.70		
Sample Volume (cm^3):	219.28	Rate of Loading (lb/sec):	747
Moisture Content (%):	0.05	Time to Break (min:sec):	06:30.13
Unit Wet Weight (g/cm^3):	2.618	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.3		
Unit Dry Weight (g/cm^3):	2.616	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.3		

Mohs Hardness: 6-7

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-3
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	131.7-132.5
Project No.	2024-175-003	Sample No.	Run 23
Lab ID	2024-175-003-014	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.598	Top Dia. (in)	1.978
Length 2 (in)	4.598	Mid. Dia. (in)	1.977
Length 3 (in)	4.598	Bot. Dia. (in)	1.977
Avg. Length (in)	4.598	Area (in.^{2})	3.07
Gauge Length (in)	3.310		

WATER CONTENT AFTER TEST	
Tare No.	4027
Wt. Tare + WS.(gms)	617.91
Wt. Tare + DS.(gms)	617.06
Wt. of Tare (gms)	8.12
% Moisture	0.14

UNIT WEIGHT			
Wet Wt. of Core (gms.)	614.71	Sample Volume(cc.)	231.4
Diameter (in.)	1.98	Unit Wet Wt.(gms/cc)	2.66
Length (in.)	4.60	Unit Wet Wt.(pcf.)	165.78
Length (cm.)	11.68	Moisture Content, %	0.14
		Unit Dry Wt.(pcf.)	165.55

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0000080	N/A	509	30	0.0000024	N/A	165.7
0.0000323	N/A	1,917	60	0.0000098	N/A	624.2
0.0000771	N/A	3,563	90	0.0000233	N/A	1,160.3
0.0003887	N/A	6,285	121	0.0001174	N/A	2,046.6
0.0006794	N/A	8,755	151	0.0002052	N/A	2,850.9
0.0009680	N/A	11,333	181	0.0002924	N/A	3,690.6
0.0012100	N/A	13,599	211	0.0003655	N/A	4,428.7
0.0014629	N/A	16,076	242	0.0004419	N/A	5,235.0
0.0017128	N/A	18,539	272	0.0005174	N/A	6,037.1
0.0019676	N/A	21,074	302	0.0005944	N/A	6,862.8
0.0024928	N/A	26,424	363	0.0007530	N/A	8,605.0
0.0027507	N/A	29,176	393	0.0008310	N/A	9,501.1
0.0030124	N/A	31,961	423	0.0009100	N/A	10,407.9
0.0032788	N/A	34,774	453	0.0009905	N/A	11,324.1
0.0035537	N/A	37,731	484	0.0010735	N/A	12,287.2
0.0038185	N/A	40,619	514	0.0011535	N/A	13,227.5
0.0040867	N/A	43,593	544	0.0012345	N/A	14,196.0
0.0043469	N/A	46,412	574	0.0013131	N/A	15,113.9
0.0046050	N/A	49,145	605	0.0013911	N/A	16,004.0
0.0048542	N/A	51,807	635	0.0014664	N/A	16,871.0
0.0051028	N/A	54,542	665	0.0015415	N/A	17,761.5
0.0053484	N/A	57,274	695	0.0016157	N/A	18,651.3
0.0056457	N/A	60,513	726	0.0017055	N/A	19,705.9
0.0059722	N/A	64,018	756	0.0018041	N/A	20,847.4
0.0063151	N/A	67,535	786	0.0019077	N/A	21,992.7
0.0066958	N/A	70,949	816	0.0020227	N/A	23,104.6

Tested By	JAC	Date	8/21/24	Input Checked By:	NJM	Date	8/23/24

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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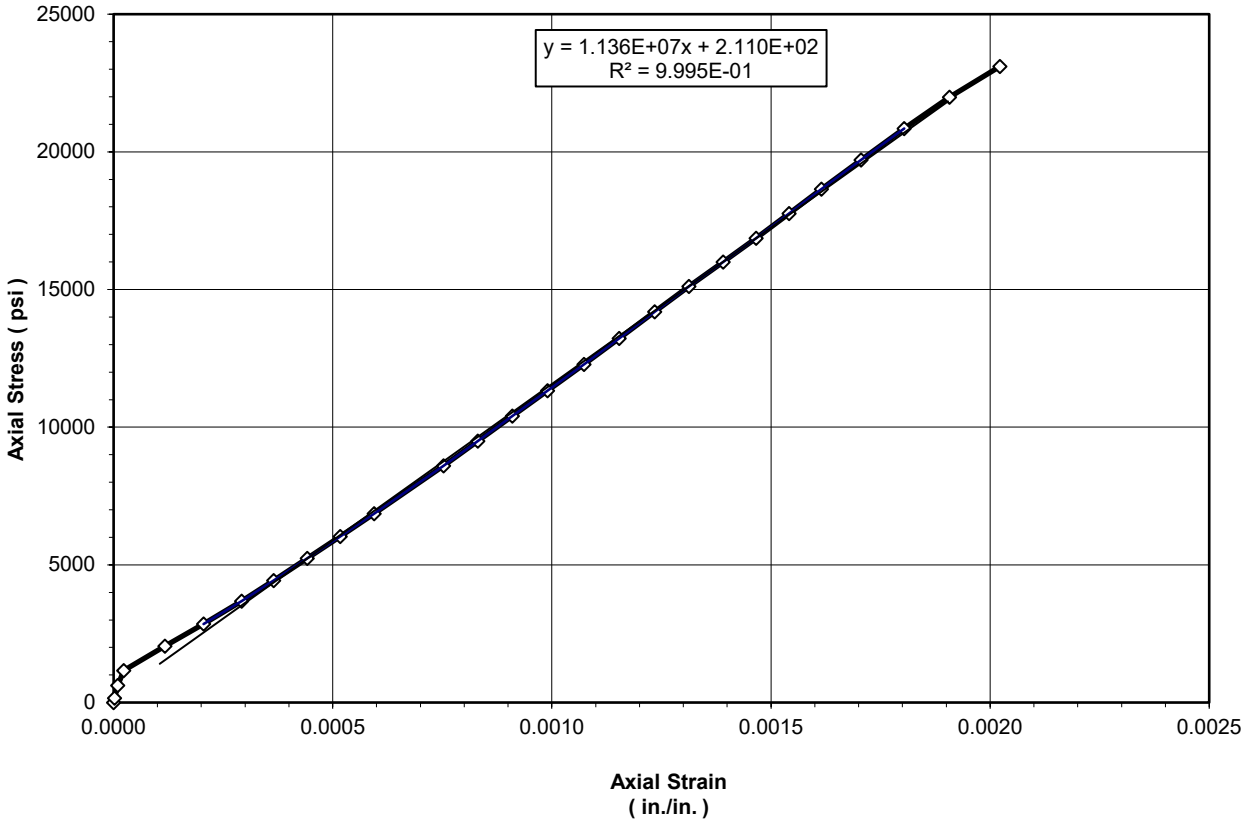
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-3
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	131.7-132.5
Project No.	2024-175-003	Sample No.	Run 23
Lab ID	2024-175-003-014	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	70,949	Pounds
Peak Compressive Strength:	23,105	psi
Break Type:	Cone & Shear	
Break Time (min. : sec.):	13:36	

Moh's Hardness: 6 - 7

Stress Range (psi)	*Young's Modulus (psi)*
2,850 - 20,847	11,360,000

Tested By JAC Date 8/21/24 Approved By NJM Date 8/23/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK
ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	SR-B-3
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	131.7-132.5
Project No.	2024-175-003	Sample No.	Run 23
Lab ID	2024-175-003-014	Visual Description:	Gray Rock Core

Tested By JAC Date 8/21/24 Input Checked By: NJM Date 8/23/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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POINT LOAD STRENGTH OF ROCK - AXIAL

ASTM D5731-08

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Reference:	SSE Project: Eden Loop-Sandy River	Depth (ft):	136-141
Project No.:	2024-175-003	Sample No.:	Run 25
Lab ID:	2024-175-003-015	Description:	Rock Core
		Moisture Condition:	As Received-Unpreserved

Sample Height Measurements, (D)

Height 1 (in):	1.859
Height 2 (in):	1.859
Height 3, Test Contact Point (in):	1.859
Test Contact Point (mm):	47.2
Average Height (in):	1.859
Equivalent Core Diam. (Axial/Block), (in):	4.705

Sample Length Measurements, (W)

Length 1 (in):	1.988
Length 2 (in):	1.988
Length 3 (in):	1.988
Average Length (in):	1.988
Length/Diameter Ratio (D/W):	0.935

Sample Length Measurements, (L)

Length 1 (in):	0.994
Length 2 (in):	0.994
Length 3 (in):	0.994
Average Length (in):	0.994
L > 0.5D (in):	0.929

Specimen Weight (g):	**244.63**
Moisture Content (%):	
Tare Number:	3084
Wt. of Tare & Wet Sample (g):	251.85
Wt. of Tare & Dry Sample (g):	251.50
Weight of Tare (g):	8.08
Weight of Wet Sample (g):	243.77
Sample Volume (cm^3):	94.55
Moisture Content (%):	0.14
Unit Wet Weight (g/cm^3):	2.587
Unit Wet Weight (pcf):	161.4
Unit Dry Weight (g/cm^3):	2.584
Unit Dry Weight (pcf):	161.2

Test Data

Core Diameter (mm):	50.4952
P - Gauge Pressure @ Failure (lbf):	3519

Index & Strength Computations

I_S - Point Load Index (psi):	**748.0**
$I_{S(50)}$ - Corrected Point Load Index (psi):	**781.4**
K - Index To Strength Conversion Factor:	**22.8**
δ_{vx} - Est. Unconfined Compressive Strength (psi):	**17,041**

Moh's Hardness: 6 - 7

SAMPLE SHOWN IN THE SAME ORIENTATION AS TESTED

Tested By JAC *Date* 8/20/24 *Checked By* NJM *Date* 8/21/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	150-151
Project No.:	R-2024-175-003	Sample ID:	RUN 27
Lab ID No.:	R-2024-175-003-016	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 600.20

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.44	Reading 1:	1.99
Reading 2:	4.44	Reading 2:	1.99
Reading 3:	4.44	Average:	**1.99**
Average:	**4.44**	Area (in^2):	3.09
		L/D:	2.23

MOISTURE CONTENT			
Tare Number:	424	Total Load (lb):	19,690
Wt. of Tare & Wet Sample (g):	605.60	**Uniaxial Compressive Strength (psi):**	**6,370**
Wt. of Tare & Dry Sample (g):	602.16		
Weight of Tare (g):	100.90	Fracture Type:	**Shear**
Weight of Wet Sample (g):	504.70		
Sample Volume (cm^3):	224.94	Rate of Loading (lb/sec):	221
Moisture Content (%):	0.69	Time to Break (min:sec):	03:00.41
Unit Wet Weight (g/cm^3):	2.668	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	166.5		
Unit Dry Weight (g/cm^3):	2.650	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	165.4		

Mohs Hardness: 7-8

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/7/24 *Checked By:* AES *Date:* 8/9/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-3
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	165-166
Project No.:	R-2024-175-003	Sample ID:	RUN 30
Lab ID No.:	R-2024-175-003-017	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 590.40

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.38	Reading 1:	2.00
Reading 2:	4.38	Reading 2:	2.00
Reading 3:	4.38	Average:	**2.00**
Average:	**4.38**	Area (in^2):	3.13
		L/D:	2.19

MOISTURE CONTENT			
Tare Number:	433	Total Load (lb):	34,830
Wt. of Tare & Wet Sample (g):	462.20	**Uniaxial Compressive Strength (psi):**	**11,130**
Wt. of Tare & Dry Sample (g):	459.35		
Weight of Tare (g):	99.30	Fracture Type:	**Shear**
Weight of Wet Sample (g):	362.90		
Sample Volume (cm^3):	224.14	Rate of Loading (lb/sec):	390
Moisture Content (%):	0.79	Time to Break (min:sec):	04:00.10
Unit Wet Weight (g/cm^3):	2.634	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	164.4		
Unit Dry Weight (g/cm^3):	2.613	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	163.1		

Mohs Hardness: 6-7

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/9/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-6
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	52.4-57.4
Project No.	2024-175-003	Sample No.	Run 4
Lab ID	2024-175-003-018	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.559	Top Dia. (in)	1.993
Length 2 (in)	4.559	Mid. Dia. (in)	1.993
Length 3 (in)	4.557	Bot. Dia. (in)	1.994
Avg. Length (in)	4.558	Area (in.^{2})	3.12
Gauge Length (in)	3.339		

WATER CONTENT AFTER TEST	
Tare No.	3138
Wt. Tare + WS.(gms)	585.84
Wt. Tare + DS.(gms)	584.90
Wt. of Tare (gms)	8.16
% Moisture	0.16

UNIT WEIGHT			
Wet Wt. of Core (gms.)	611.08	Sample Volume(cc.)	233.1
Diameter (in.)	1.99	Unit Wet Wt.(gms/cc)	2.62
Length (in.)	4.56	Unit Wet Wt.(pcf.)	163.58
Length (cm.)	11.58	Moisture Content, %	0.16
		Unit Dry Wt.(pcf.)	163.31

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0005295	N/A	2,649	31	0.0001586	N/A	848.9
0.0008924	N/A	4,170	50	0.0002672	N/A	1,336.1
0.0012176	N/A	5,532	70	0.0003646	N/A	1,772.6
0.0015852	N/A	7,112	90	0.0004747	N/A	2,279.0
0.0019849	N/A	8,907	110	0.0005944	N/A	2,854.1
0.0023321	N/A	10,569	129	0.0006984	N/A	3,386.7
0.0026791	N/A	12,365	149	0.0008023	N/A	3,962.3
0.0030225	N/A	14,251	169	0.0009051	N/A	4,566.7
0.0033658	N/A	16,234	189	0.0010079	N/A	5,202.1
0.0036904	N/A	18,209	208	0.0011051	N/A	5,835.0
0.0043604	N/A	22,595	248	0.0013058	N/A	7,240.4
0.0046941	N/A	24,918	268	0.0014057	N/A	7,984.7
0.0050030	N/A	27,137	287	0.0014982	N/A	8,696.0
0.0053333	N/A	29,570	307	0.0015971	N/A	9,475.5
0.0056561	N/A	32,016	327	0.0016938	N/A	10,259.3
0.0059782	N/A	34,509	347	0.0017902	N/A	11,058.0
0.0062859	N/A	36,919	366	0.0018824	N/A	11,830.6
0.0066080	N/A	39,474	386	0.0019788	N/A	12,649.1
0.0069322	N/A	42,045	406	0.0020759	N/A	13,472.9
0.0072515	N/A	44,645	426	0.0021715	N/A	14,306.3
0.0075611	N/A	47,147	445	0.0022642	N/A	15,107.8
0.0078838	N/A	49,770	465	0.0023609	N/A	15,948.3
0.0104599	N/A	52,364	485	0.0031323	N/A	16,779.8
0.0094373	N/A	53,907	504	0.0028261	N/A	17,274.1
0.0096371	N/A	55,044	513	0.0028859	N/A	17,638.6
0.0101120	N/A	57,277	532	0.0030282	N/A	18,354.1

Tested By	JAC	Date	8/21/24	Input Checked By:	NJM	Date	8/23/24

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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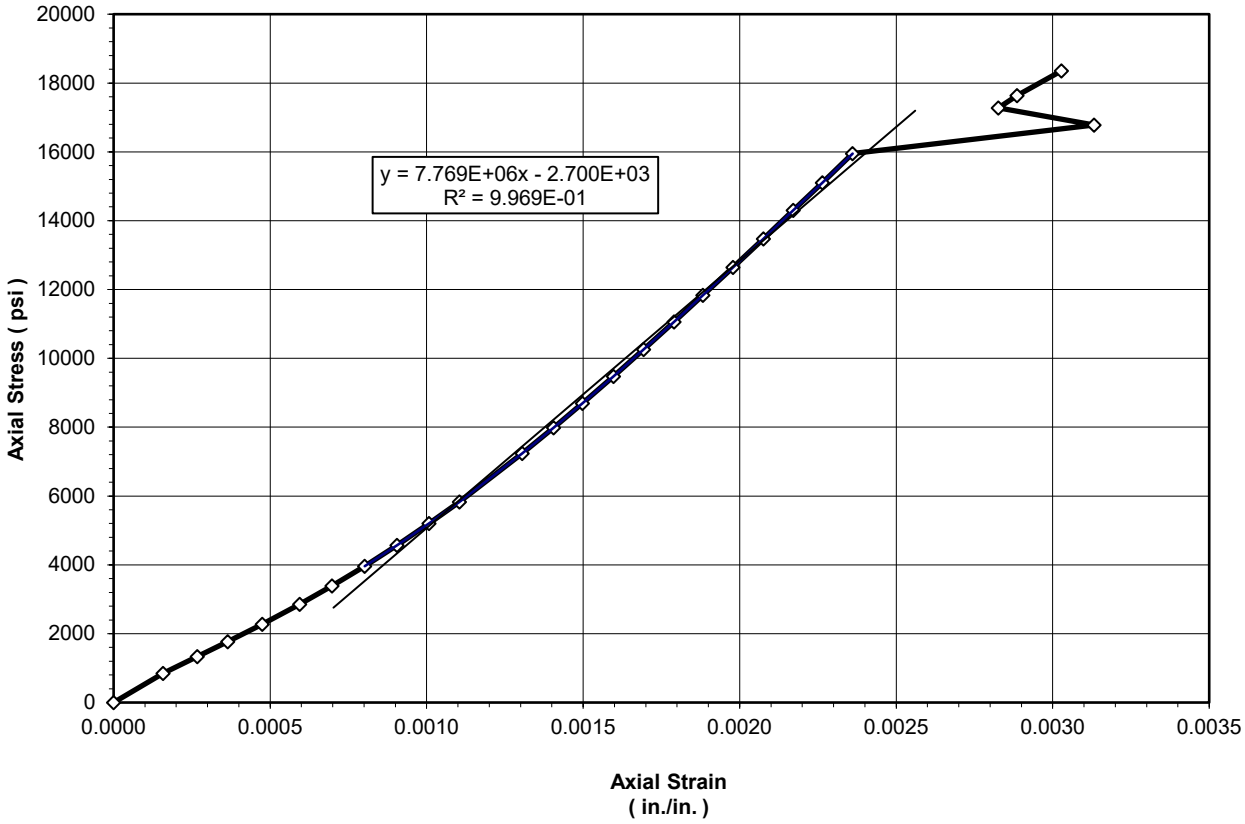
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	SR-B-6
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	52.4-57.4
Project No.	2024-175-003	Sample No.	Run 4
Lab ID	2024-175-003-018	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	57,277	Pounds
Peak Compressive Strength:	18,354	psi
Break Type:	Cone & Split	
Break Time (min. : sec.):	08:52	

Moh's Hardness: 6 - 7

Stress Range (psi)	*Young's Modulus (psi)*
3,962 - 15,948	7,768,000

Tested By JAC Date 8/21/24 Approved By NJM Date 8/23/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	SR-B-6
Client Reference	SSE Project: Eden Loop - Sandy River	Depth (ft)	52.4-57.4
Project No.	2024-175-003	Sample No.	Run 4
Lab ID	2024-175-003-018	Visual Description:	Gray Rock Core

Tested By	JAC	Date	8/21/24	Input Checked By:	NJM	Date	8/23/2024

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-6
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	60.5-61.2
Project No.:	R-2024-175-003	Sample ID:	RUN 5
Lab ID No.:	R-2024-175-003-019	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): **569.30**

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.34	Reading 1:	2.01
Reading 2:	4.34	Reading 2:	2.01
Reading 3:	4.34	Average:	**2.01**
Average:	**4.34**	Area (in^2):	3.17
		L/D:	2.16

MOISTURE CONTENT			
Tare Number:	432	Total Load (lb):	30,010
Wt. of Tare & Wet Sample (g):	552.60	**Uniaxial Compressive Strength (psi):**	**9,470**
Wt. of Tare & Dry Sample (g):	551.70		
Weight of Tare (g):	99.00	Fracture Type:	**Shear**
Weight of Wet Sample (g):	453.60		
Sample Volume (cm^3):	225.51	Rate of Loading (lb/sec):	336
Moisture Content (%):	0.20	Time to Break (min:sec):	02:59.50
Unit Wet Weight (g/cm^3):	2.524	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	157.5		
Unit Dry Weight (g/cm^3):	2.519	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	157.2		

Mohs Hardness: 6-7

Physical Description: White Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-6
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	77.4-78.4
Project No.:	R-2024-175-003	Sample ID:	RUN 9
Lab ID No.:	R-2024-175-003-020	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 586.80

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.37	Reading 1:	2.00
Reading 2:	4.37	Reading 2:	2.00
Reading 3:	4.37	Average:	**2.00**
Average:	**4.37**	Area (in^2):	3.13
		L/D:	2.19

MOISTURE CONTENT			
Tare Number:	707	Total Load (lb):	37,140
Wt. of Tare & Wet Sample (g):	547.30	**Uniaxial Compressive Strength (psi):**	**11,870**
Wt. of Tare & Dry Sample (g):	545.55		
Weight of Tare (g):	91.00	Fracture Type:	**Shear**
Weight of Wet Sample (g):	456.30		
Sample Volume (cm^3):	223.87	Rate of Loading (lb/sec):	416
Moisture Content (%):	0.38	Time to Break (min:sec):	03:40.30
Unit Wet Weight (g/cm^3):	2.621	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	163.6		
Unit Dry Weight (g/cm^3):	2.611	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	162.9		

Mohs Hardness: 7-8

Physical Description: White Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-6
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	94-95
Project No.:	R-2024-175-003	Sample ID:	RUN 12
Lab ID No.:	R-2024-175-003-021	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 566.30

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.37	Reading 1:	1.99
Reading 2:	4.37	Reading 2:	1.99
Reading 3:	4.37	Average:	**1.99**
Average:	**4.37**	Area (in^2):	3.12
		L/D:	2.19

MOISTURE CONTENT			
Tare Number:	700	Total Load (lb):	18,030
Wt. of Tare & Wet Sample (g):	635.60	**Uniaxial Compressive Strength (psi):**	**5,780**
Wt. of Tare & Dry Sample (g):	631.89		
Weight of Tare (g):	91.10	Fracture Type:	**Shear**
Weight of Wet Sample (g):	544.50		
Sample Volume (cm^3):	223.59	Rate of Loading (lb/sec):	202
Moisture Content (%):	0.69	Time to Break (min:sec):	02:50.50
Unit Wet Weight (g/cm^3):	2.533	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	158.0		
Unit Dry Weight (g/cm^3):	2.515	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	157.0		

Mohs Hardness: 4-5

Physical Description: Gray Tan Gneiss Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

2200 Westinghouse Blvd., Suite 103 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460 • www.geotechnics.net

UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-6
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	114-115
Project No.:	R-2024-175-003	Sample ID:	RUN 16
Lab ID No.:	R-2024-175-003-022	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 577.60

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.33	Reading 1:	2.01
Reading 2:	4.33	Reading 2:	2.02
Reading 3:	4.33	Average:	**2.01**
Average:	**4.33**	Area (in^2):	3.19
		L/D:	2.15

MOISTURE CONTENT			
Tare Number:	479	Total Load (lb):	50,560
Wt. of Tare & Wet Sample (g):	546.20	**Uniaxial Compressive Strength (psi):**	**15,850**
Wt. of Tare & Dry Sample (g):	545.11		
Weight of Tare (g):	98.90	Fracture Type:	**Shear**
Weight of Wet Sample (g):	447.30		
Sample Volume (cm^3):	226.19	Rate of Loading (lb/sec):	566
Moisture Content (%):	0.24	Time to Break (min:sec):	04:10.01
Unit Wet Weight (g/cm^3):	2.554	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	159.3		
Unit Dry Weight (g/cm^3):	2.547	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	159.0		

Mohs Hardness: 4-5

Physical Description: White Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	SR-B-6
Client Project:	SSE Project: Eden Loop - Sandy River	Depth (ft):	133-134
Project No.:	R-2024-175-003	Sample ID:	RUN 20
Lab ID No.:	R-2024-175-003-023	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 588.10

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.41	Reading 1:	2.00
Reading 2:	4.41	Reading 2:	2.00
Reading 3:	4.41	Average:	**2.00**
Average:	**4.41**	Area (in^2):	3.13
		L/D:	2.21

MOISTURE CONTENT			
Tare Number:	445	Total Load (lb):	33,470
Wt. of Tare & Wet Sample (g):	433.70	**Uniaxial Compressive Strength (psi):**	**10,690**
Wt. of Tare & Dry Sample (g):	432.85		
Weight of Tare (g):	98.90	Fracture Type:	**Shear**
Weight of Wet Sample (g):	334.80		
Sample Volume (cm^3):	225.76	Rate of Loading (lb/sec):	375
Moisture Content (%):	0.25	Time to Break (min:sec):	04:01.09
Unit Wet Weight (g/cm^3):	2.605	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	162.5		
Unit Dry Weight (g/cm^3):	2.598	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	162.1		

Mohs Hardness: 4-5

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 8/6/24 *Checked By:* AES *Date:* 8/7/24

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Geo Testing Express Test Results

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

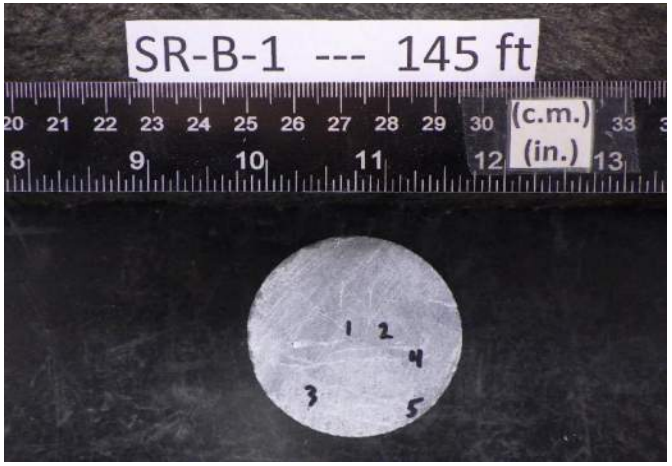
Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-1	---	145	1	3.4	3.9	3.65	
			2	3.4	4.0	3.70	
			3	3.5	4.1	3.80	
			4	3.8	3.8	3.80	
			5	4.7	4.2	4.45	
			Average CAIs			3.88	
			Average CAI *			4.42	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

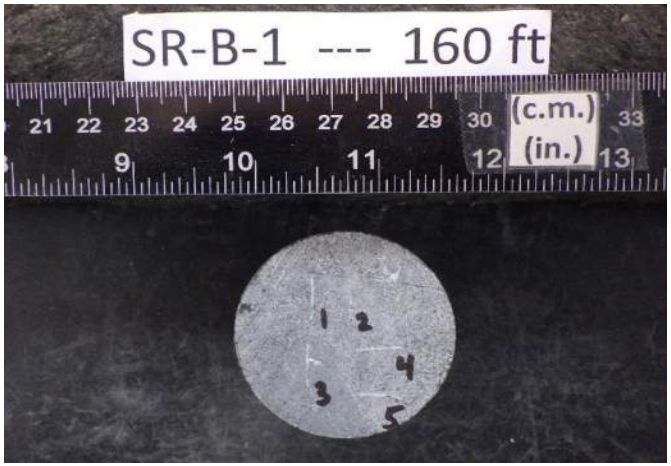
Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-1	---	160	1	2.1	2.4	2.25	
			2	4.2	4.2	4.20	
			3	2.9	3.0	2.95	
			4	2.8	2.2	2.50	
			5	3.2	2.8	3.00	
			Average CAIs			2.98	
			Average CAI *			3.40	
CERCHAR Abrasiveness Index Classification						High Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-2	---	120	1	3.3	3.4	3.35	
			2	4.1	4.6	4.35	
			3	4.3	4.4	4.35	
			4	3.7	2.3	3.00	
			5	4.0	4.6	4.30	
			Average CAIs			3.87	
			Average CAI *			4.41	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface

After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

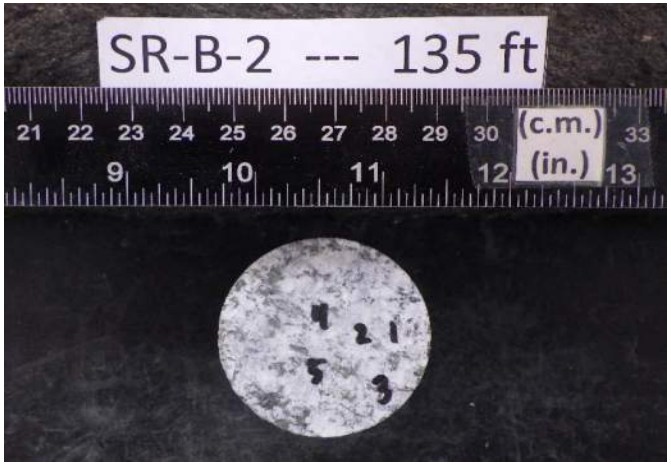
Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-2	---	135	1	3.8	4.2	4.00	
			2	3.6	2.9	3.25	
			3	3.2	3.6	3.40	
			4	5.0	5.3	5.15	
			5	4.0	4.2	4.10	
			Average CAIs			3.98	
			Average CAI *			4.54	
			CERCHAR Abrasiveness Index Classification			Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-3	---	132	1	3.4	3.3	3.35	
			2	4.2	4.0	4.10	
			3	4.2	4.0	4.10	
			4	3.3	3.3	3.30	
			5	4.0	3.0	3.50	
			Average CAIs			3.67	
			Average CAI *			4.18	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface

After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

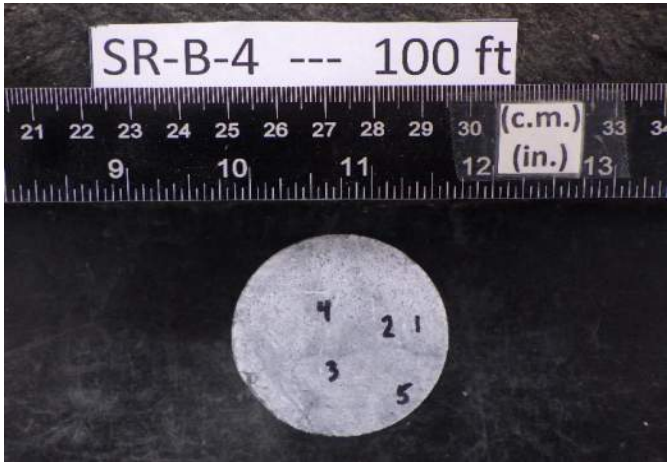
Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-4	---	100	1	4.3	5.0	4.65	
			2	4.0	3.8	3.90	
			3	3.3	3.2	3.25	
			4	3.7	3.8	3.75	
			5	3.5	3.4	3.45	
			Average CAIs			3.80	
			Average CAI *			4.33	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

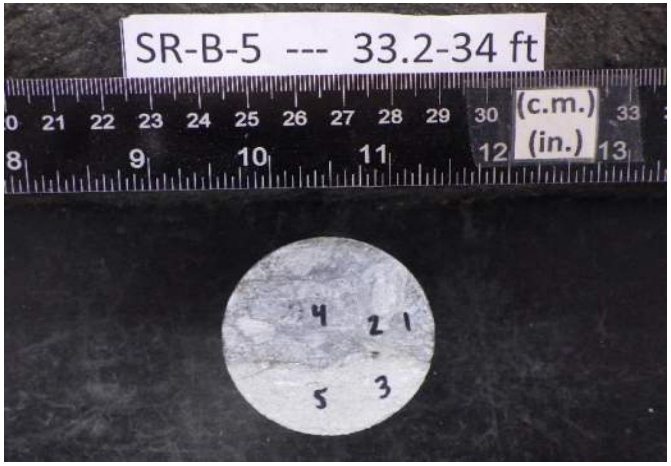
Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-5	---	33.2-34	1	3.3	3.0	3.15	
			2	2.4	3.2	2.80	
			3	1.9	2.3	2.10	
			4	2.8	3.4	3.10	
			5	2.7	2.0	2.35	
			Average CAIs			2.70	
			Average CAI *			3.08	
CERCHAR Abrasiveness Index Classification						High Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-6	---	60.5-61	1	3.9	4.0	3.95	
			2	4.0	4.1	4.05	
			3	3.7	3.6	3.65	
			4	3.0	3.4	3.20	
			5	3.2	2.6	2.90	
			Average CAIs			3.55	
			Average CAI *			4.05	
			CERCHAR Abrasiveness Index Classification			Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface

After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Sandy River
Project Location:	VA
GTX #:	319564
Test Date:	8/12/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

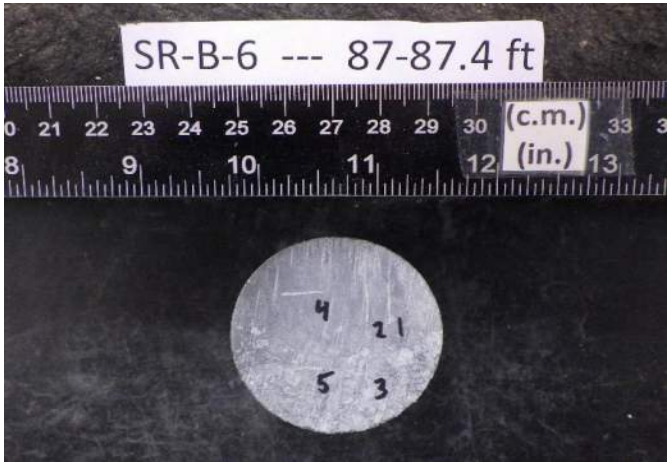
Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
SR-B-6	---	87-87.4	1	2.7	3.2	2.95	
			2	3.2	3.0	3.10	
			3	3.9	4.2	4.05	
			4	3.6	3.4	3.50	
			5	2.8	2.8	2.80	
			Average CAIs			3.28	
			Average CAI *			3.74	
CERCHAR Abrasiveness Index Classification						High Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Appendix B

Report Limitations and Guidelines for Use

Appendix B
Report Limitations and Guidelines for Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers, Inc. (GeoEngineers) includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for Transcontinental Gas Pipeline Company, LLC and the project team for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with terms and conditions in our Request for Services (RFS) purchase order dated April 16, 2024, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the Southeast Supply Enhancement Project – Sandy River crossing located in Pittsylvania County, Virginia. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,

[1] Developed based on material provided by ASFE/The Best People on Earth, Professional Firms Practicing in the Geosciences; www.asfe.org.

- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Bedrock classification shown in our boring logs is based on visual inspection and field observation with the unaided eye. While effort has been made to strive for accuracy, visual rock classification is inherently subjective. This method does not substitute for detailed laboratory testing and may not fully capture the variability and complexity of the subsurface conditions. GeoEngineers laboratory testing program typically

focuses on the physical/mechanical rock properties such as compressive strength, hardness and abrasivity. To classify rock type with near certainty, additional mineralogical and chemical laboratory testing may be required including petrographic analysis (thin section microscopy), xray diffraction, and scanning electron microscopy.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these

"Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Appendix C

Hydraulic Fracture Analysis and Results

Appendix C
Hydraulic Fracture Analysis and Results

GENERAL

Drilling fluid surface releases, commonly referred to as "inadvertent returns" (IR) or "Frac Outs," occur when drilling fluid emerges at the ground surface or in any other undesired location such as waterbodies, or other environmentally sensitive features or utilities. Hydraulic fracture is a term typically used to describe the condition in which the annular drilling fluid pressure exceeds the capacity of the surrounding soil to resist that pressure (formation limit pressure). Once the formation limit pressure is exceeded, drilling fluid is lost either through crack propagation (fracture) or by uncontrolled cavity expansion (blowout).

Hydraulic fracture typically occurs when the drill path passes through relatively weak cohesive soils or loose granular soils with low shear strength. Very loose to loose sands and silty sands, and soft to medium stiff silts and clays typically have a higher hydraulic fracture potential. Medium dense to very dense sands, and very stiff to hard silts and clays have a low to moderate hydraulic fracture potential. However, the HDD contractor's construction procedures are an important factor influencing the risk of hydraulic fracture and inadvertent drilling fluid releases. If the contractor operates with insufficient drilling fluid flow rates, inadequate drilling fluid properties or excessive rates of penetration, the annulus may become blocked through an accumulation of drill cuttings falling out of suspension. This can occur within formations that typically have a low potential for hydraulic fracture. If the accumulation of cuttings creates a blockage downhole, the annulus may become over-pressurized, leading to hydraulic fracturing and potentially, drilling fluid surface releases. The hydraulic fracture analysis does not account for this over-pressurized condition.

Bedrock, because of its high shear strength, has a relatively low potential for hydraulic fracture. Hydraulic fracture of soil is defined by and can be quantitatively analyzed by cavity expansion theory. However, cavity expansion theory cannot be applied to bedrock conditions. The annular drilling fluid pressures associated with the HDD construction method are typically not capable of hydraulically fracturing competent bedrock.

However, inadvertent returns of drilling fluid to the ground surface can occur during HDD operations in bedrock by following existing fractures and planes of weakness. Currently, there are no widely accepted methods for calculating the safety factor against inadvertent returns occurring from within bedrock during HDD operations. However, the risk can be qualitatively characterized based on the type and quality of the bedrock.

Our analysis computes the factors of safety against hydraulic fracture by dividing the calculated formation limit pressure by the estimated annular drilling fluid pressure along the profile. The formation limit pressure varies depending on the soil properties anticipated along the HDD profile. The estimated drilling fluid pressure also varies along the HDD profile and is a function of the drilling fluid properties, size and condition of annulus, and groundwater conditions.

METHODOLOGY

Cavity expansion behavior in a soil mass has been considered and evaluated for a number of geotechnical problems including bearing capacity of deep foundations, interpretation of pressuremeter testing, breakout resistance of anchors, and most recently for drilling fluid loss during HDD operations. Specifically, Luger and Hergarden (1988) of Delft Geotechnics developed a method largely based on cavity expansion theory

(Vesic, 1972) to estimate the maximum allowable annular drilling fluid pressures before hydrofracture or blowout will occur during HDD operations. Subsequently, the United States Army Corps of Engineers (USACE) worked with Delft Geotechnics to develop formal guidelines as discussed in Appendix B of the U.S. Army Corps of Engineers (USACE) Report CPAR-98-1 (Staheli, et al. 1998).

The Delft method is based on equations specifically developed for use in analyzing cavity expansion in granular (sandy) soils in a drained loading condition, although this was not clearly stated in the original USACE CPAR-98-1 guidelines. The USACE published updated guidelines (USACE, 2020) which attempt to improve the methodology from USACE CPAR-98-1. The clarifications include but are not limited to 1) accounting for anisotropic stress conditions in calculating the formation limit pressure by multiplying the vertical effective stress by the lateral earth pressure coefficient (K_0) and 2) providing a simplified equation for calculating the formation limit pressure for undrained (phi=0) conditions in low permeability soils. The simplified equation conservatively neglects soil stiffness and plastic deformation by assuming the formation limit pressure is equal to the effective confining pressure plus the soil cohesion (undrained shear strength or "C").

For projects that are not regulated by the USACE, alternative methods, including the method developed by Queen's university (Xia and Moore, 2006) are available to estimate the formation limit pressure of clay soils in undrained conditions that consider soil stiffness and plastic deformation.

Formation Limit Pressure

Estimating the formation limit pressure requires the selection and input of a number of geotechnical soil parameters that are estimated based on a site-specific geotechnical evaluation including in-situ and laboratory soil testing. The required parameters include the unit weight, shear strength (phi and/or C), coefficient of lateral earth pressure (K0), Poisson's ratio, and the modulus of elasticity.

We estimate the formation limit pressure for each unique soil strata at least 10 feet thick observed in the geotechnical borings. Because the formation limit pressure varies along the HDD profile with depth and as it passes through variable soil strata, our model generates a plot depicting the variable formation limit pressure along the length of the HDD.

For all HDD design projects that are under the jurisdiction of the USACE or by client request, GeoEngineers performs a hydraulic fracture analysis in accordance with the updated USACE guidelines (USACE, 2020).

For projects that are not regulated by the USACE, GeoEngineers estimates the formation limit pressures in general accordance with cavity expansion theory using equations proposed by Queen's University (Xia and Moore, 2006) for clay soils and the Delft equation as proposed by Luger and Hergarden (1988) for granular soils.

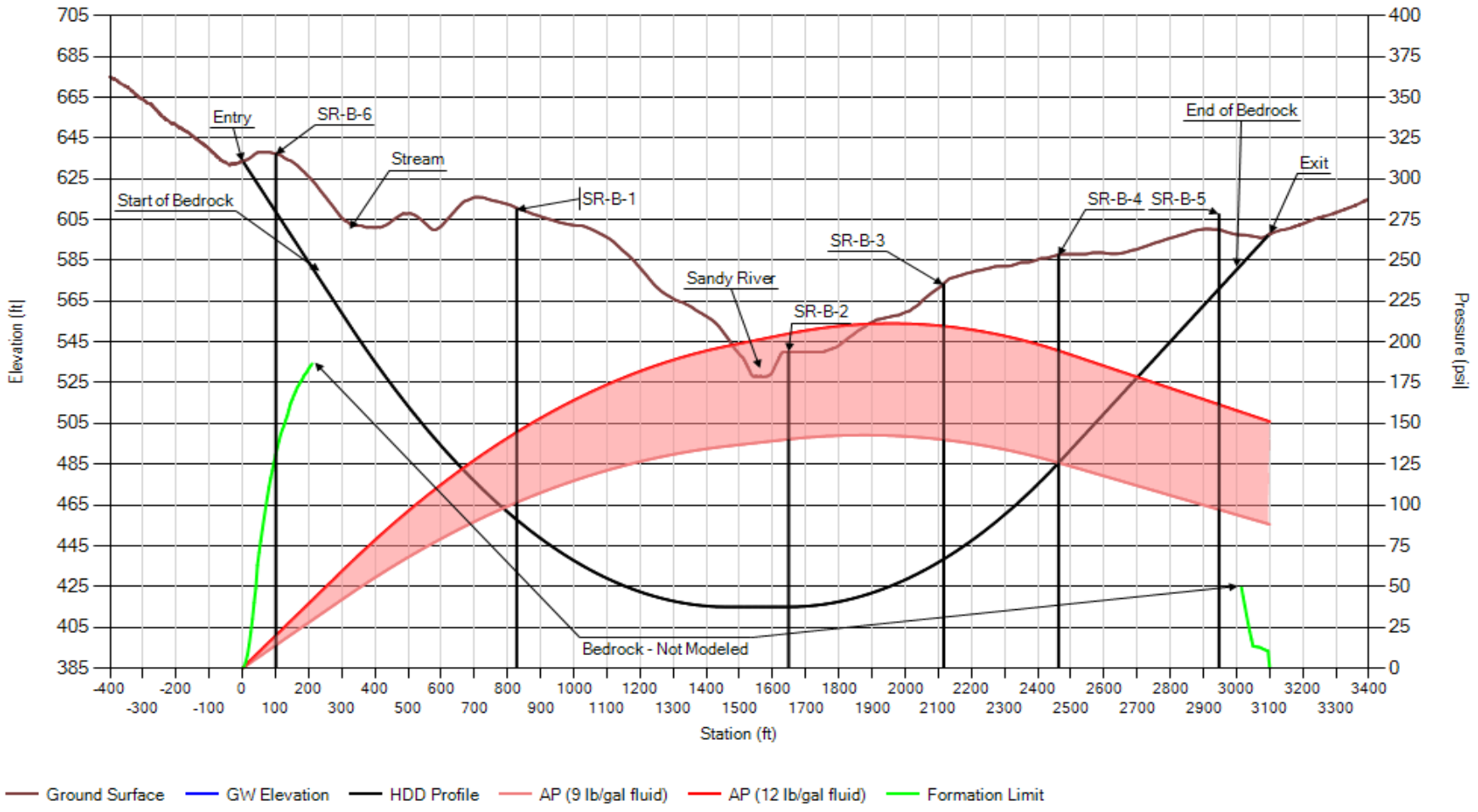
Annular Drilling Fluid Pressure

We estimate the anticipated annular drilling fluid pressure along the length of the pilot hole based on the Bingham plastic model as presented by Bourgoyne, A.T., et al. (1991). Calculating the anticipated annular drilling fluid pressure along the HDD profile requires selection and input of the drilling fluid rheological properties, anticipated tool dimensions and pump rates which are estimated based on our experience and generally accepted best practices of the HDD industry. Our model assumes that no obstructions are present within the drilled hole, drilling fluid returns are maintained at all times and the drilled hole is completely

cylindrical. Because these parameters are subject to change depending on the HDD contractor's means and methods, the hydraulic fracture analysis can be refined once the HDD contractor is selected, and the input parameters are known.

Safety Factor and Graphical Results of Analysis

Once the formation limit pressures and annular drilling fluid pressures are estimated along the HDD profile, the referenced pressures are plotted relative to each other and the HDD alignment in profile view as shown in this appendix. A second plot is prepared showing the safety factor against hydraulic fracture along the HDD alignment. The safety factor is calculated by dividing the formation limit pressure by the anticipated annular drilling fluid pressure. The target minimum safety factor against hydraulic fracture beneath critical infrastructure or environmental resources varies according to project and client requirements as well as the analysis method but typically ranges from 1.5 to 2.0. The evaluation considers only the hydraulic fracture potential during pilot hole operations assuming that drilling fluid returns are continuously maintained to the entry point.



Crossing Length:	3,100.00 ft
Hole Diameter:	12.25 Inches
Drill Pipe Diameter:	6.625 Inches
Drilling Fluid Weight:	9 lbs/gallon
Plastic Viscosity:	13 CP
Yield Point:	25 lbs/100 ft^2

Estimated Formation Limit and Drilling Fluid Pressures (Entry to Exit) (Delft Eqn.)

SSE Project - Eden Loop - Sandy River HDD

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Figure C-1

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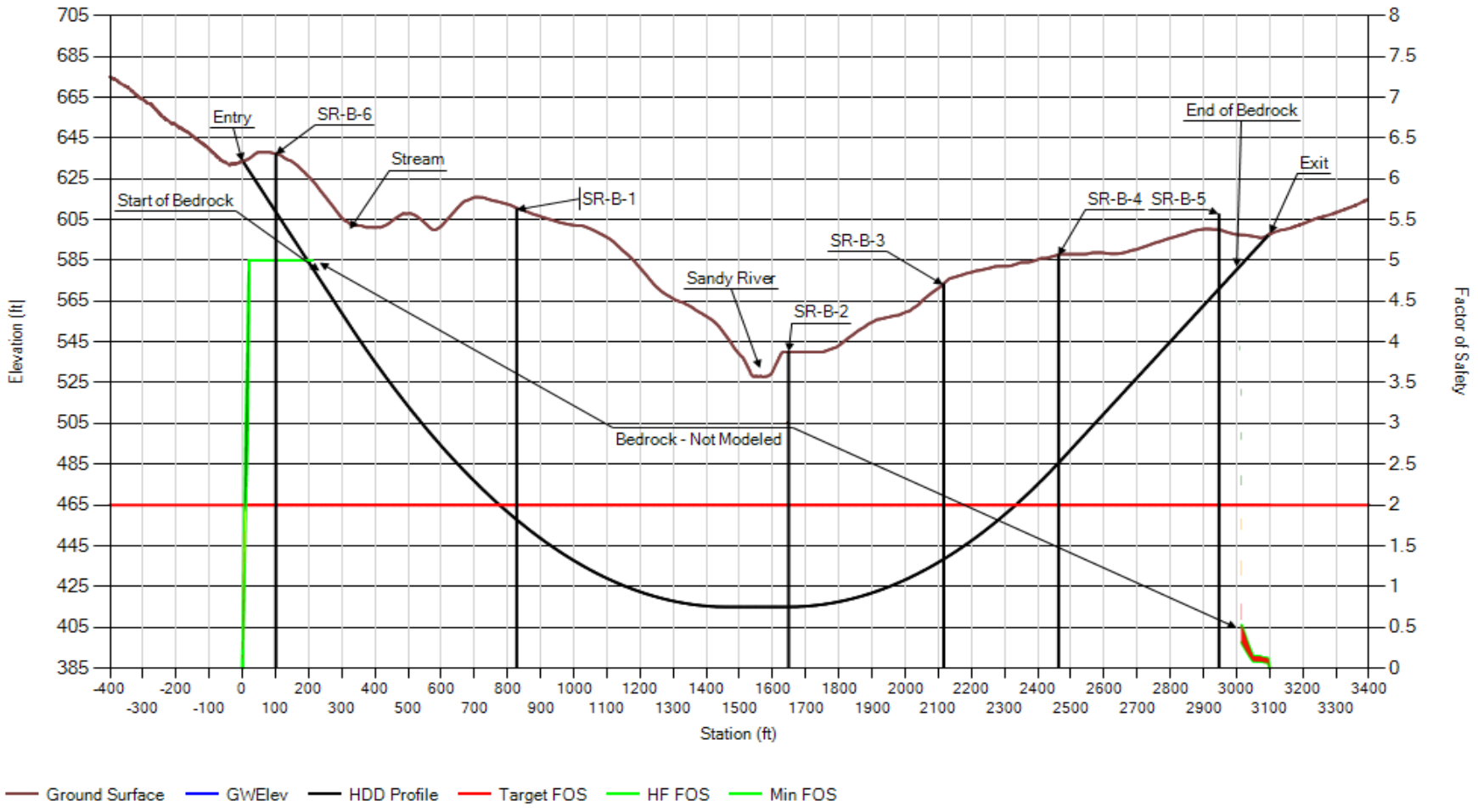

Crossing Length:	3,100.00 ft
Hole Diameter:	12.25 Inches
Drill Pipe Diameter:	6.625 Inches
Drilling Fluid Weight:	9 lbs/gallon
Plastic Viscosity:	13 CP
Yield Point:	25 lbs/100 ft^2

Hydraulic Fracture and Inadvertent Fluid Release Factors of Safety (Entry to Exit)

SSE Project - Eden Loop - Sandy River HDD

GeoEngineers

Figure C-2

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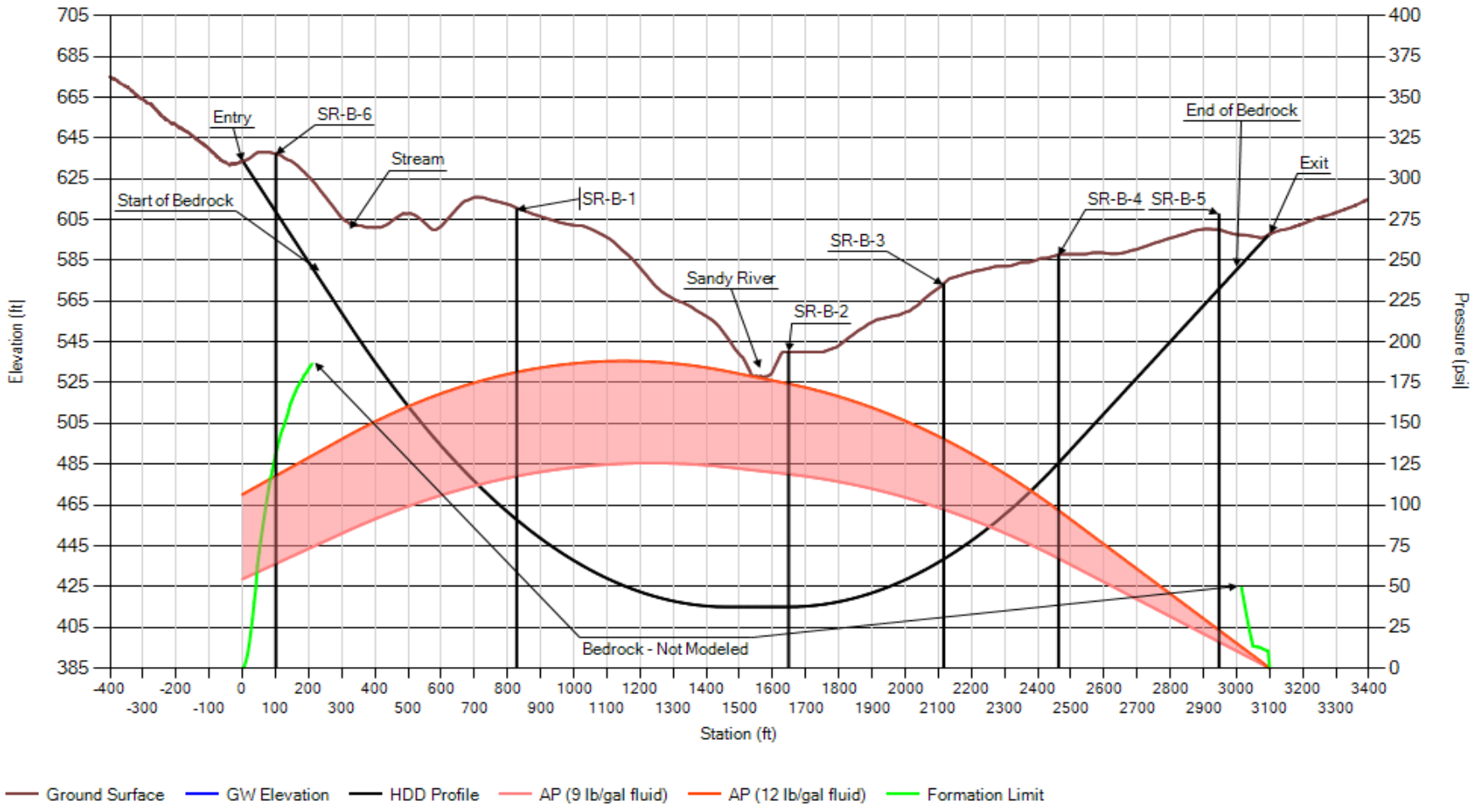

Crossing Length: 3,100.00 ft

Hole Diameter: 12.25 Inches

Drill Pipe Diameter: 6.625 Inches

Drilling Fluid Weight: 9 lbs/gallon

Plastic Viscosity: 13 CP

Yield Point: 25 lbs/100 ft^2

Estimated Formation Limit and Drilling Fluid Pressures (Exit to Entry) (Delft Eqn.)

SSE Project - Eden Loop - Sandy River HDD

GeoEngineers

Figure C-3

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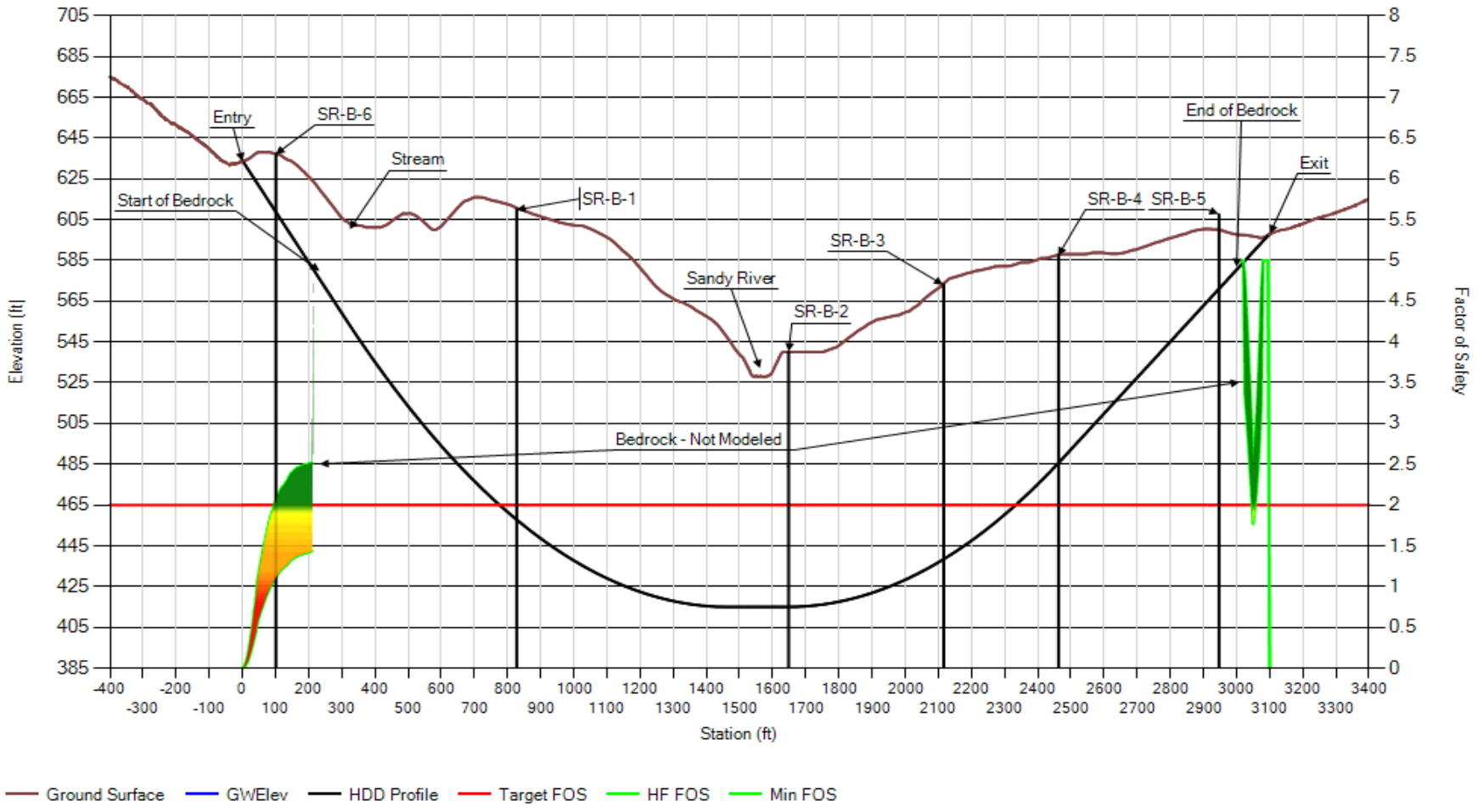

Crossing Length:	3,100.00 ft
Hole Diameter:	12.25 Inches
Drill Pipe Diameter:	6.625 Inches
Drilling Fluid Weight:	9 lbs/gallon
Plastic Viscosity:	13 CP
Yield Point:	25 lbs/100 ft^2

Hydraulic Fracture and Inadvertent Fluid Release Factors of Safety (Exit to Entry)

SSE Project - Eden Loop - Sandy River HDD

GeoEngineers

Figure C-4

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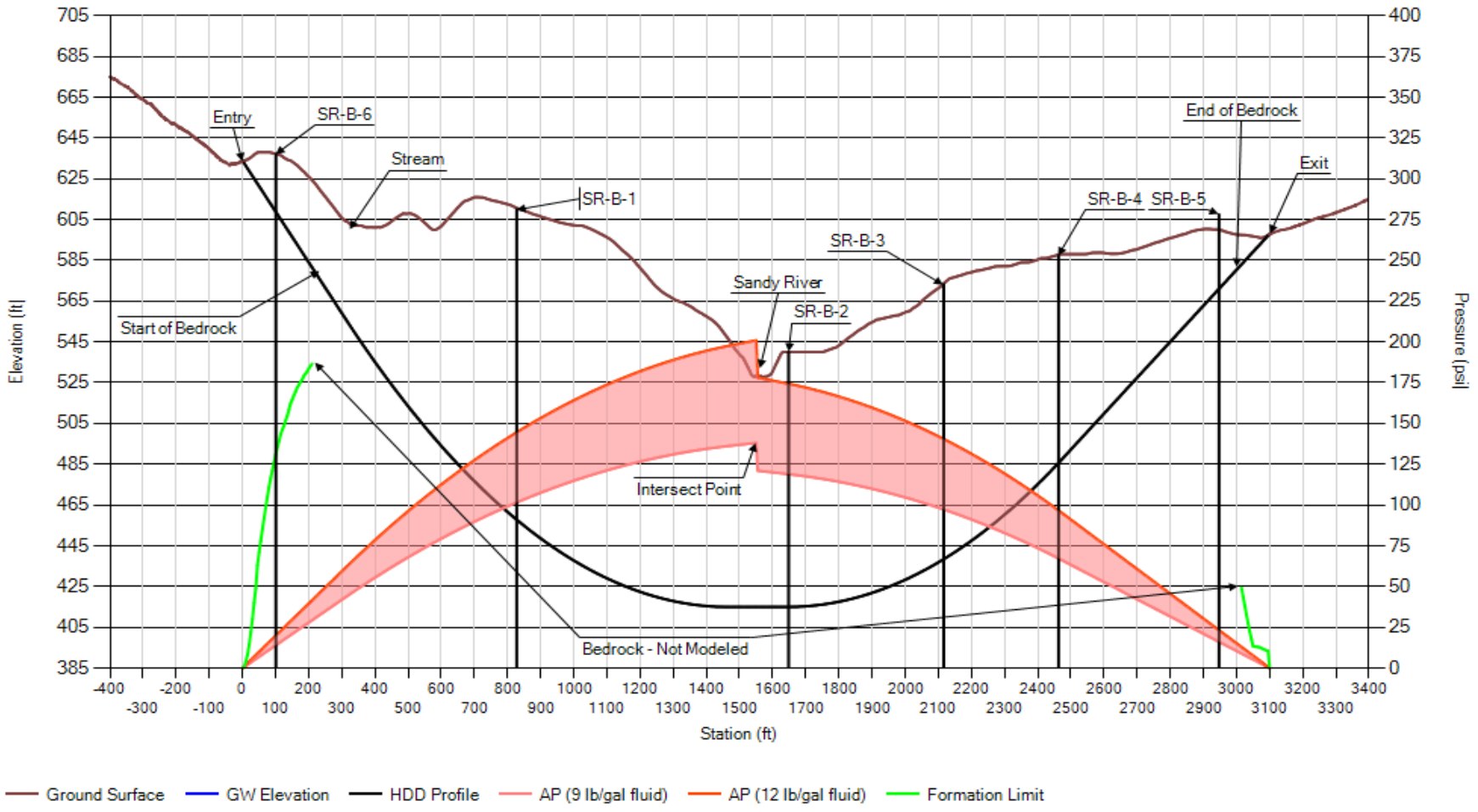

Crossing Length: 3,100.00 ft

Hole Diameter: 12.25 Inches

Drill Pipe Diameter: 6.625 Inches

Drilling Fluid Weight: 9 lbs/gallon

Plastic Viscosity: 13 CP

Yield Point: 25 lbs/100 ft^2

Estimated Formation Limit and Drilling Fluid Pressures (Intersect) (Delft Eqn.)

SSE Project - Eden Loop - Sandy River HDD

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Figure C-5

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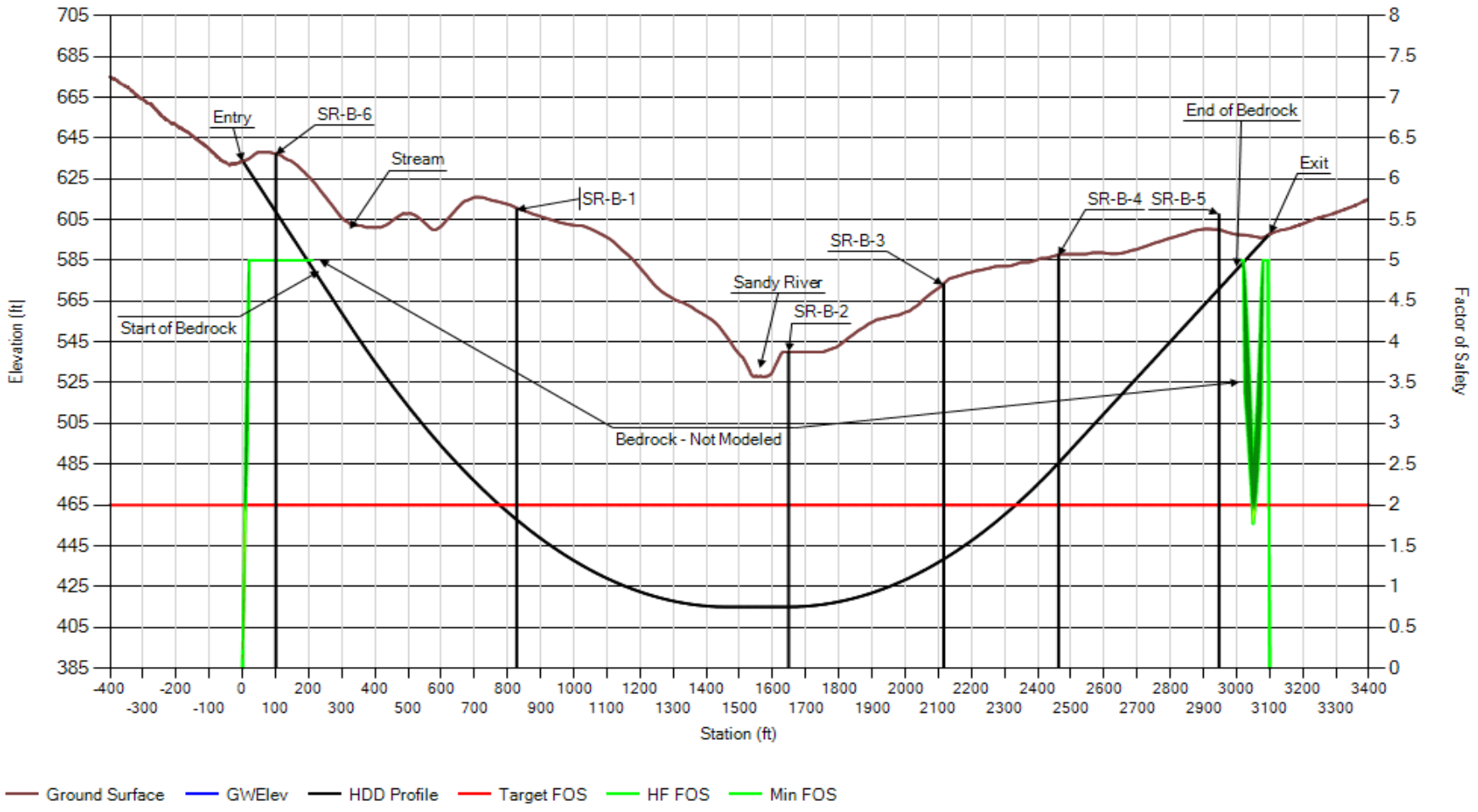

Crossing Length:	3,100.00 ft
Hole Diameter:	12.25 Inches
Drill Pipe Diameter:	6.625 Inches
Drilling Fluid Weight:	9 lbs/gallon
Plastic Viscosity:	13 CP
Yield Point:	25 lbs/100 ft^2

Hydraulic Fracture and Inadvertent Fluid Release Factors of Safety (Intersect)

SSE Project - Eden Loop - Sandy River HDD

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Figure C-6

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Appendix D

HDD Operating Stress and Pullback Force Calculations

HDD Design Summary

Project: SSE Project - Eden Loop | **HDD Name:** Sandy River HDD | **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 | **By:** TJP | **Ck'd By:** MAM | **Location:** Pittsylvania County, VA | **Date:** Tuesday, September 10, 2024

Design Parameters

Pipe Diameter =	42.000 in	**Min. Operating Temp =**	50 °F
Wall Thickness =	0.888 in	**Max. Operating Temp =**	70 °F
Yield Stress =	70,000 psi	**Design Factor =**	0.5
Pipe Material =	Steel	**MAOP =**	1,480 psi

Drill Data Box

Point	Station (ft)	Elevation (ft)
ENTRY @ 14°	0.00	633.82
PVC1 (14.00° @ 4,800 ft R.)	305.77	557.58
PVT1	1,466.99	415.00
PVC2 (10.00° @ 4,800 ft R.)	1,642.22	415.00
PVT2	2,475.73	487.92
EXIT @ 10°	3,100.00	598.00

Horizontal Alignment Length = 3,100.00 ft

Profile Segment Information

Segment Name	Segment Type	Segment Length (ft)
Entry Tangent	Straight	315.13
Entry Curve	Vertical Curve	1,172.86
Bottom Tangent	Straight	175.23
Exit Curve	Vertical Curve	837.76
Exit Tangent	Straight	633.90

Pipe Length = 3,134.87 ft

Installation Load Summary

Drilling Fluid Weight (lb/gal)	Buoyancy Condition	Buoyancy Control (lb/ft)	Effective Pipe Weight (lb/ft)	Total Installation Force* (lb)
9.50	Empty	0.00	-292.86	598,900
9.50	Full	550.66	257.80	484,400
12.00	Empty	0.00	-472.79	791,800
12.00	Full	550.66	77.87	302,200
12.00	Neutral	472.79	0.00	277,700

* Pull forces are rounded to the nearest 100 lb

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Minimum Radius Calculations

Project:	SSE Project - Eden Loop	**HDD Name:**	Sandy River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** MAM	**Location:**	Pittsylvania County, VA	**Date:**	Tuesday, September 10, 2024

Design Parameters:

Pipe Diameter =	42.000 in	**MAOP =**	1,480 psi	**Factor of Safety =**	2.10
Wall Thickness =	0.888 in	**SMYS =**	70,000 psi	**Min. Operating Temp. =**	50 °F
D/t Ratio =	47.30	**Modulus (E) =**	2.96E+007 psi	**Max. Operating Temp. =**	70 °F
Thermal Coeff. =	6.50E-006 in/in/°F	**Poisson Ratio =**	0.30		

Hoop Stress:

Calculated Hoop Stress = (MAOP * Pipe Diameter) / (2 * Wall Thickness) = 35,000 psi

Longitudinal Stress from Hoop:

Longitudinal Stress from Hoop = Hoop Stress * Poisson Ratio = 10,500 psi

Thermal Stress:

Thermal Stress = E * Thermal Coeff * (Min. Operating Temp - Max. Operating Temp) = -3,849 psi

Bending Stress Capacity:

Bending Stress Capacity = 0.9 * SMYS - Hoop + Long. from Hoop +/- Thermal = 34,651 psi

Allowable Bending Stress:

Allowable Bending Stress = Bending Stress Capacity / FOS = 16,501 psi

Minimum Allowable Radius:

Calculated Minimum Radius = (E * Pipe Diameter) / (2 * Allowable Bending Stress) = 3,140 ft

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Operating Stress Summary

Project Name:	SSE Project - Eden Loop	**HDD Name:**	Sandy River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** MAM	**Location:**	Pittsylvania County, VA	**Date:**	Tuesday, September 10, 2024

Design Parameters

Pipe diameter =	42.000 in	**Minimum Allowable Radius =**	3,200 ft
Wall Thickness =	0.888 in	**Coefficient of Thermal Expansion =**	6.5E-06 in/in/°F
SMYS =	70,000 psi	**Min. Operating Temperature =**	50 °F
MAOP =	1,480 psi	**Max. Operating Temperature =**	70 °F
Poissons's Ratio =	0.30	**Temperature Derating Factor =**	1.00
Young's Modulus (E) =	2.96E+007 psi	**Groundwater Table Head =**	0.00 ft
Design Factor =	0.5	**MAOP From Barlow's Equation**	1,480 psi

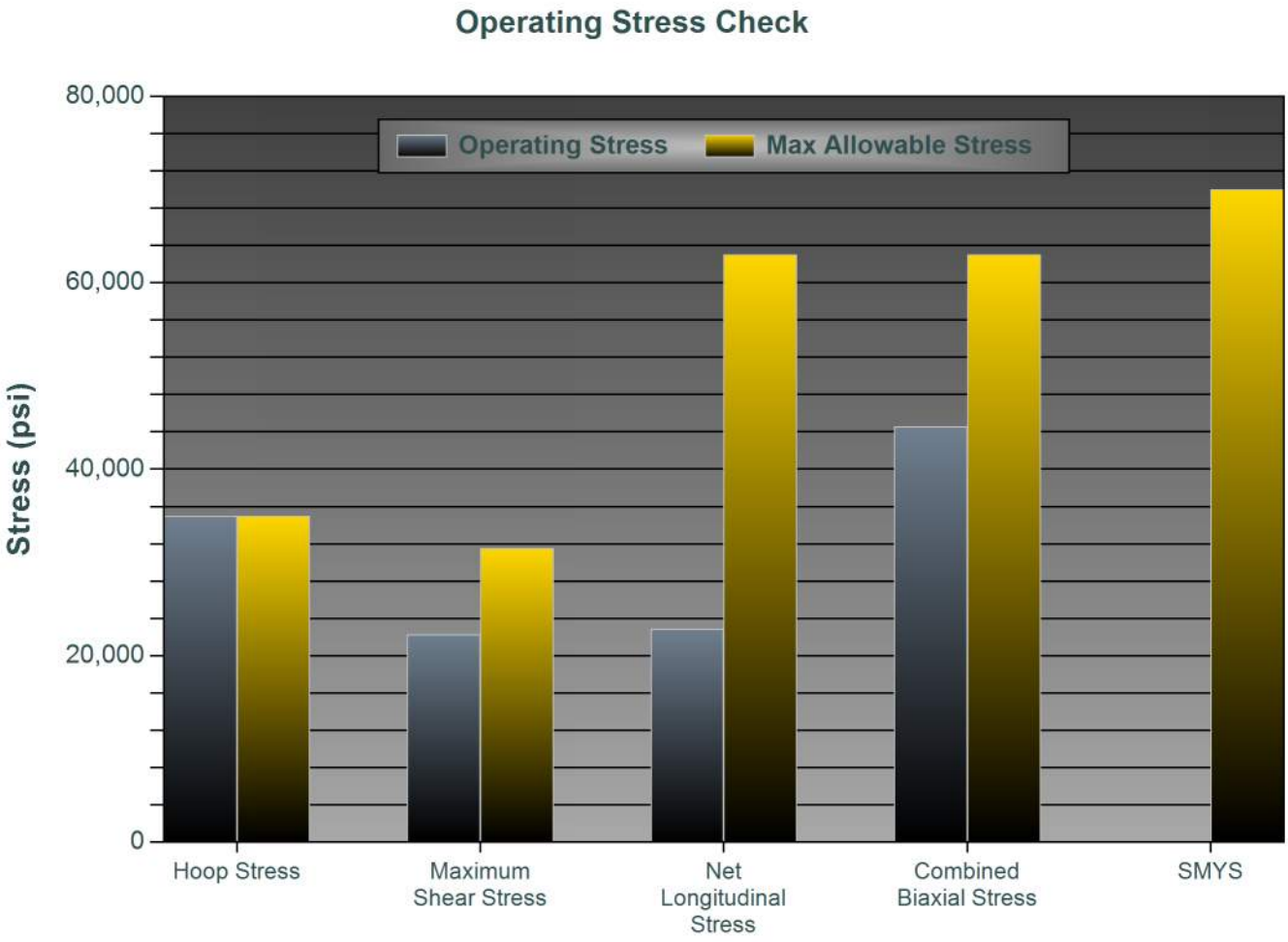
Stress Analyses

Longitudinal Stress from Bending =	16,190 psi	
Percent SMYS =	23.13 %	
Hoop Stress =	35,000 psi	
Percent SMYS =	50.00 %	Limited by Design Factor according to 49 CFR 192.111
Longitudinal Tensile Stress from Hoop Stress =	10,500 psi	
Percent SMYS =	15.00 %	
Longitudinal Stress from Thermal Expansion =	-3,849 psi	
Percent SMYS =	5.50 %	Limited to 90% SMYS by ASME/ANSI B31.4 Table 403.3.1-1
Net Longitudinal Stress (Comp. side of Curve) =	-9,538 psi	
Percent SMYS =	13.63 %	Limited to 90% SMYS by ASME/ANSI B31.8 section 833.3
Net Longitudinal Stress (Tension side of Curve) =	22,841 psi	
Percent SMYS =	32.63 %	Limited to 90% SMYS by ASME/ANSI B31.8 section 833.3
Maximum Shear Stress =	22,269 psi	
Percent SMYS =	31.81 %	Limited to 45% SMYS by ASME/ANSI B31.4 section 403.12
Combined Biaxial Stress Check =	44,538 psi	
Percent SMYS =	63.63 %	Limited to 90% SMYS by ASME/ANSI B31.8 section 833.4

Operating Stress Summary

Project Name: SSE Project - Eden Loop **HDD Name:** Sandy River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** MAM **Location:** Pittsylvania County, VA **Date:** Tuesday, September 10, 2024



Installation Load Calculations

Project:	SSE Project - Eden Loop	**HDD Name:**	Sandy River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** MAM	**Location:**	Pittsylvania County, VA	**Date:**	Tuesday, September 10, 2024

Installation Case: 9.50 lb/gal Drilling Fluid With the Pipe Empty

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	3,135 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	683.72 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	-292.86 lb/ft

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	633.90 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	50,185 lb
Friction Force =	54,847 lb
Segment Weight =	32,236 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	137,268 lb
Cumulative Force =	**137,268 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	1,197 psi	
Cumulative Axial Stress =	1,197 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,703 psi	7,605 psi
Combined Stress =	0.0214	< 1.0
Total Stress =	0.0510	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 2 of 5**

Segment Parameters			
Segment Name =	Exit Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	10.00 deg
Segment Length =	837.76 ft	Center Displacement =	18.27 ft

Segment Force Components	
Normal Force =	177,632 lb
Drag Force =	66,324 lb
Friction Force =	53,290 lb
Segment Weight =	21,383 lb
Tension =	331,554 lb
Average Tension =	234,411 lb
Segment Force =	194,286 lb
Cumulative Force =	**331,554 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	1,694 psi	
Cumulative Axial Stress =	2,891 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,554 psi	7,605 psi
Combined Stress =	0.3982	< 1.0
Total Stress =	0.2730	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 3 of 5**

Segment Parameters			
Segment Name =	Bottom Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	175.23 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	13,872 lb
Friction Force =	15,395 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	29,267 lb
Cumulative Force =	**360,821 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	255 psi	
Cumulative Axial Stress =	3,146 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,554 psi	7,605 psi
Combined Stress =	0.0562	< 1.0
Total Stress =	0.1206	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	14.00 deg
Segment Length =	1,172.86 ft	Center Displacement =	35.78 ft

Segment Force Components	
Normal Force =	262,744 lb
Drag Force =	92,853 lb
Friction Force =	78,823 lb
Segment Weight =	-41,860 lb
Tension =	569,461 lb
Average Tension =	465,141 lb
Segment Force =	208,640 lb
Cumulative Force =	**569,461 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	1,819 psi	
Cumulative Axial Stress =	4,965 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,554 psi	7,605 psi
Combined Stress =	0.4352	< 1.0
Total Stress =	0.3049	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	315.13 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	24,948 lb
Friction Force =	26,864 lb
Segment Weight =	-22,327 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	29,486 lb
Cumulative Force =	**598,947 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	257 psi	
Cumulative Axial Stress =	5,222 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	890 psi	7,605 psi
Combined Stress =	0.0933	< 1.0
Total Stress =	0.0270	< 1.0

Installation Load Calculations

Project: SSE Project - Eden Loop **HDD Name:** Sandy River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** MAM **Location:** Pittsylvania County, VA **Date:** Tuesday, September 10, 2024

Installation Case: 9.50 lb/gal Drilling Fluid With the Pipe Full

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	3,135 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	683.72 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	257.80 lb/ft

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full

Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	633.90 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	50,185 lb
Friction Force =	48,281 lb
Segment Weight =	-28,378 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	70,088 lb
Cumulative Force =	**70,088 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	611 psi	
Cumulative Axial Stress =	611 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,703 psi	7,605 psi
Combined Stress =	0.0109	< 1.0
Total Stress =	0.0507	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 2 of 5**

Segment Parameters

Segment Name =	Exit Curve	**Radius of Curvature =**	4,800 ft
Segment Type =	Vertical Curve	**Angle Turned =**	10.00 deg
Segment Length =	837.76 ft	**Center Displacement =**	18.27 ft

Segment Force Components

Normal Force =	-110,707 lb
Drag Force =	66,324 lb
Friction Force =	33,212 lb
Segment Weight =	-18,823 lb
Tension =	184,013 lb
Average Tension =	127,051 lb
Segment Force =	113,925 lb
Cumulative Force =	**184,013 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	993 psi	
Cumulative Axial Stress =	1,604 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,554 psi	7,605 psi
Combined Stress =	0.3752	< 1.0
Total Stress =	0.2545	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 3 of 5**

Segment Parameters

Segment Name =	Bottom Tangent	**Radius of Curvature =**	0 ft
Segment Type =	Straight	**Angle Turned =**	0.00 deg
Segment Length =	175.23 ft	**Center Displacement =**	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	13,872 lb
Friction Force =	13,552 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	27,424 lb
Cumulative Force =	**211,437 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	239 psi	
Cumulative Axial Stress =	1,844 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,554 psi	7,605 psi
Combined Stress =	0.0329	< 1.0
Total Stress =	0.1149	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	14.00 deg
Segment Length =	1,172.86 ft	Center Displacement =	35.78 ft

Segment Force Components	
Normal Force =	-125,081 lb
Drag Force =	92,853 lb
Friction Force =	37,524 lb
Segment Weight =	36,849 lb
Tension =	416,188 lb
Average Tension =	313,812 lb
Segment Force =	204,751 lb
Cumulative Force =	**416,188 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	1,785 psi	
Cumulative Axial Stress =	3,629 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,554 psi	7,605 psi
Combined Stress =	0.4113	< 1.0
Total Stress =	0.2840	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	315.13 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	24,948 lb
Friction Force =	23,648 lb
Segment Weight =	19,654 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	68,251 lb
Cumulative Force =	**484,438 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	595 psi	
Cumulative Axial Stress =	4,224 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	890 psi	7,605 psi
Combined Stress =	0.0754	< 1.0
Total Stress =	0.0230	< 1.0

Installation Load Calculations

Project: SSE Project - Eden Loop **HDD Name:** Sandy River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** MAM **Location:** Pittsylvania County, VA **Date:** Tuesday, September 10, 2024

Installation Case: 12.00 lb/gal Drilling Fluid With the Pipe Empty

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	3,135 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	863.65 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	-472.79 lb/ft

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty

Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	633.90 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	50,185 lb
Friction Force =	88,543 lb
Segment Weight =	52,042 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	190,770 lb
Cumulative Force =	**190,770 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	1,663 psi	
Cumulative Axial Stress =	1,663 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,151 psi	7,605 psi
Combined Stress =	0.0297	< 1.0
Total Stress =	0.0819	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 2 of 5**

Segment Parameters			
Segment Name =	Exit Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	10.00 deg
Segment Length =	837.76 ft	Center Displacement =	18.27 ft

Segment Force Components	
Normal Force =	273,920 lb
Drag Force =	66,324 lb
Friction Force =	82,176 lb
Segment Weight =	34,521 lb
Tension =	455,967 lb
Average Tension =	323,368 lb
Segment Force =	265,197 lb
Cumulative Force =	**455,967 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	2,312 psi	
Cumulative Axial Stress =	3,976 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.4175	< 1.0
Total Stress =	0.3686	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 3 of 5**

Segment Parameters			
Segment Name =	Bottom Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	175.23 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	13,872 lb
Friction Force =	24,853 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	38,726 lb
Cumulative Force =	**494,692 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	338 psi	
Cumulative Axial Stress =	4,313 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.0770	< 1.0
Total Stress =	0.1945	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	14.00 deg
Segment Length =	1,172.86 ft	Center Displacement =	35.78 ft

Segment Force Components	
Normal Force =	399,321 lb
Drag Force =	92,853 lb
Friction Force =	119,796 lb
Segment Weight =	-67,578 lb
Tension =	759,560 lb
Average Tension =	627,126 lb
Segment Force =	264,868 lb
Cumulative Force =	**759,560 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	2,309 psi	
Cumulative Axial Stress =	6,623 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.4648	< 1.0
Total Stress =	0.4136	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	315.13 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	24,948 lb
Friction Force =	43,369 lb
Segment Weight =	-36,044 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	32,274 lb
Cumulative Force =	**791,834 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	281 psi	
Cumulative Axial Stress =	6,904 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,124 psi	7,605 psi
Combined Stress =	0.1233	< 1.0
Total Stress =	0.0447	< 1.0

Installation Load Calculations

Project: SSE Project - Eden Loop **HDD Name:** Sandy River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** MAM **Location:** Pittsylvania County, VA **Date:** Tuesday, September 10, 2024

Installation Case: 12.00 lb/gal Drilling Fluid With the Pipe Full

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	3,135 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	863.65 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	77.87 lb/ft

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full

Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	633.90 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	50,185 lb
Friction Force =	14,584 lb
Segment Weight =	-8,572 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	56,197 lb
Cumulative Force =	**56,197 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	490 psi	
Cumulative Axial Stress =	490 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,151 psi	7,605 psi
Combined Stress =	0.0087	< 1.0
Total Stress =	0.0819	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 2 of 5**

Segment Parameters

Segment Name =	Exit Curve	**Radius of Curvature =**	4,800 ft
Segment Type =	Vertical Curve	**Angle Turned =**	10.00 deg
Segment Length =	837.76 ft	**Center Displacement =**	18.27 ft

Segment Force Components

Normal Force =	-22,998 lb
Drag Force =	66,324 lb
Friction Force =	6,899 lb
Segment Weight =	-5,686 lb
Tension =	130,634 lb
Average Tension =	93,415 lb
Segment Force =	74,437 lb
Cumulative Force =	**130,634 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	649 psi	
Cumulative Axial Stress =	1,139 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.3669	< 1.0
Total Stress =	0.3253	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 3 of 5**

Segment Parameters

Segment Name =	Bottom Tangent	**Radius of Curvature =**	0 ft
Segment Type =	Straight	**Angle Turned =**	0.00 deg
Segment Length =	175.23 ft	**Center Displacement =**	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	13,872 lb
Friction Force =	4,094 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	17,966 lb
Cumulative Force =	**148,599 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	157 psi	
Cumulative Axial Stress =	1,296 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.0231	< 1.0
Total Stress =	0.1814	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	14.00 deg
Segment Length =	1,172.86 ft	Center Displacement =	35.78 ft

Segment Force Components	
Normal Force =	-19,247 lb
Drag Force =	92,853 lb
Friction Force =	5,774 lb
Segment Weight =	11,131 lb
Tension =	264,132 lb
Average Tension =	206,366 lb
Segment Force =	115,532 lb
Cumulative Force =	**264,132 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	1,007 psi	
Cumulative Axial Stress =	2,303 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.3877	< 1.0
Total Stress =	0.3424	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	315.13 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	24,948 lb
Friction Force =	7,143 lb
Segment Weight =	5,937 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	38,028 lb
Cumulative Force =	**302,160 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	332 psi	
Cumulative Axial Stress =	2,635 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,124 psi	7,605 psi
Combined Stress =	0.0470	< 1.0
Total Stress =	0.0265	< 1.0

Installation Load Calculations

Project:	SSE Project - Eden Loop	**HDD Name:**	Sandy River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** MAM	**Location:**	Pittsylvania County, VA	**Date:**	Tuesday, September 10, 2024

Installation Case: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	3,135 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	863.65 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	0.00 lb/ft

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy — Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	633.90 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	50,185 lb
Friction Force =	0 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	50,185 lb
Cumulative Force =	**50,185 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	438 psi	
Cumulative Axial Stress =	438 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,151 psi	7,605 psi
Combined Stress =	0.0078	< 1.0
Total Stress =	0.0820	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 2 of 5**

Segment Parameters			
Segment Name =	Exit Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	10.00 deg
Segment Length =	837.76 ft	Center Displacement =	18.27 ft

Segment Force Components	
Normal Force =	16,483 lb
Drag Force =	66,324 lb
Friction Force =	4,945 lb
Segment Weight =	0 lb
Tension =	126,398 lb
Average Tension =	88,291 lb
Segment Force =	76,213 lb
Cumulative Force =	**126,398 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	665 psi	
Cumulative Axial Stress =	1,102 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.3662	< 1.0
Total Stress =	0.3248	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 3 of 5**

Segment Parameters			
Segment Name =	Bottom Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	175.23 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	13,872 lb
Friction Force =	0 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	13,872 lb
Cumulative Force =	**140,270 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	121 psi	
Cumulative Axial Stress =	1,223 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.0218	< 1.0
Total Stress =	0.1817	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,800 ft
Segment Type =	Vertical Curve	Angle Turned =	14.00 deg
Segment Length =	1,172.86 ft	Center Displacement =	35.78 ft

Segment Force Components	
Normal Force =	32,760 lb
Drag Force =	92,853 lb
Friction Force =	9,828 lb
Segment Weight =	0 lb
Tension =	252,780 lb
Average Tension =	196,525 lb
Segment Force =	112,509 lb
Cumulative Force =	**252,780 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	981 psi	
Cumulative Axial Stress =	2,204 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	3,226 psi	7,605 psi
Combined Stress =	0.3859	< 1.0
Total Stress =	0.3410	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	315.13 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	24,948 lb
Friction Force =	0 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	24,948 lb
Cumulative Force =	**277,728 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	218 psi	
Cumulative Axial Stress =	2,422 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,124 psi	7,605 psi
Combined Stress =	0.0432	< 1.0
Total Stress =	0.0259	< 1.0

Overbend Radius Calculations

Project: SSE Project - Eden Loop **HDD Name:** Sandy River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** MAM **Location:** Pittsylvania County, VA **Date:** Wednesday, August 14, 2024

Design Parameters:

Pipe Diameter =	42.000 in	**MAOP =**	0 psi	**Factor of Safety =**	2.85
Wall Thickness =	0.888 in	**SMYS =**	70,000 psi		
D/t Ratio =	47.30	**Modulus (E) =**	2.96E+007 psi		

Hoop Stress:

Calculated Hoop Stress = **(MAOP * Pipe Diameter) / (2 * Wall Thickness) =** **0 psi**

Longitudinal Stress:

Calculated Longitudinal Stress = **Hoop Stress / 2 =** **0 psi**

Allowable Stress:

Calculated Allowable Stress = **SMYS / Factor of Safety =** 24,561 psi

Bending Stress:

Calculated Bending Stress = **Allowable Stress - Longitudinal Stress =** 24,561 psi

Minimum Radius:

Calculated Minimum Radius = **(E * Pipe Diameter) / (2 * Bending Stress) =** 2,066 ft

Overbend Stress Summary

Project:	SSE Project - Eden Loop	**HDD Name:**	Sandy River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** MAM	**Location:**	Pittsylvania County, VA	**Date:**	Wednesday, August 14, 2024

Design Parameters

Pipe diameter =	42.000 in	**Factor of Safety =**	2.85
Wall Thickness =	0.888 in	**Overbend Radius of Curvature =**	2.066 ft
SMYS =	70,000 psi	**Assumed Installation Temperature =**	50 °F
Internal Pressure =	0 psi		
Poissons's Ratio =	0.30		
Young's Modulus (E) =	2.96E+007 psi		

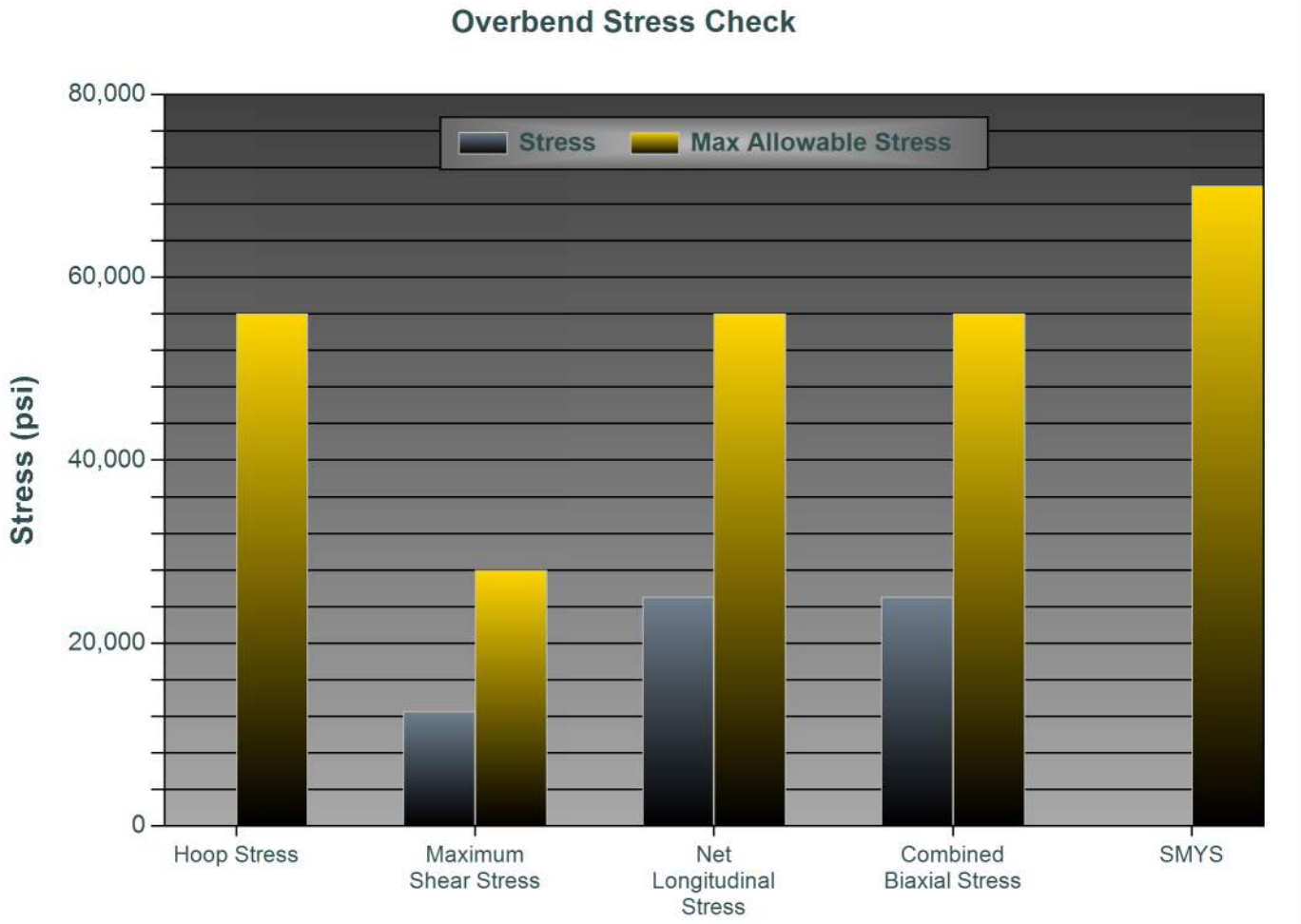
Stress Analyses

Longitudinal Stress from Bending =	25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS
Hoop Stress =	0 psi	
Percent SMYS =	0 %	
Longitudinal Tensile Stress from Hoop Stress =	0 psi	
Percent SMYS =	0 %	
Longitudinal Stress from Thermal Expansion =	0 psi	
Percent SMYS =	0 %	
Net Longitudinal Stress (Comp. side of Curve) =	-25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS
Net Longitudinal Stress (Tension side of Curve) =	25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS
Maximum Shear Stress =	12,536 psi	
Percent SMYS =	17.91 %	Limited to 40% SMYS
Combined Biaxial Stress Check =	25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS

Overbend Stress Summary

Project Name: SSE Project - Eden Loop **HDD Name:** Sandy River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** MAM **Location:** Pittsylvania County, VA **Date:** Wednesday, August 14, 2024



Appendix E
HDD Best Practices

Appendix E
HDD Best Practices

GENERAL

The chosen HDD contractor should follow industry standard HDD construction best practices. The purpose of this appendix is to provide HDD construction best practices that are recommended by GeoEngineers and are in addition to industry standard HDD construction best practices. The following best practices do not constitute all HDD construction best practices that are the standard of practice in the HDD industry.

PILOT HOLE CONSIDERATIONS

Under the generally accepted industry standard, the design radius in feet for the entry and exit vertical curves is typically 100 times the carrier pipe diameter in inches (for example, 42-inch-nominal-diameter pipe 42 x 100 = 4,200-foot design radius). Depending on the proposed operating conditions, pipe specification and geometric considerations, the design radii for the horizontal and vertical curves may vary from normal industry design standards and pipe materials.

The minimum allowable three-joint radius over any consecutive three-joint drill pipe section is established to reduce the risk of overstressing the carrier pipe during installation. The HDD contractor's means and methods during construction are critical to the successful completion of the HDD. Specifically, while completing the pilot hole, only small deviations from the design for horizontal and vertical curvature should be allowed so that pull load forces and operational stresses similar to those estimated by the calculations can be maintained.

The HDD contractor should complete the pilot hole as closely as possible to the designed HDD alignment and profile while still maintaining three-joint vertical and horizontal radii equal to or greater than the minimum allowable radius specified on the HDD Design Drawing . We recommend that the three-joint radius be calculated for each three-joint section (for Range 2 Drill Pipe, approximately 90 feet) completed during pilot hole operations. We recommend that the contractor drill the pilot hole within the specified horizontal and vertical tolerances. We also recommend that, upon completion of the pilot hole, GeoEngineers have the opportunity to review the pilot hole survey data prior to the start of reaming operations.

We recommend that a secondary survey system (TruTracker, ParaTrack or equivalent) be used along the entire length of the HDD. If a secondary surface survey coil is required for the secondary survey system, we recommend that the wire grids be placed at least as wide as the survey probe is deep plus 20 feet. The placement of the coils is typically limited to areas where ground surface conditions, permit requirements and landowner permissions allow.

The HDD contractor should be responsible for producing and submitting an as-built drawing of the pilot hole survey data within 2 weeks of the completion of the pilot hole. The HDD contractor's as-built drawing should be reviewed by GeoEngineers prior to storing the data in the project file.

During pilot hole operations, hydraulic fracture of the formation and drilling fluid surface releases may occur as a result of high annular pressures in the hole. Causes of high annular pressures include insufficient removal of cuttings, hole collapse and excessive penetration rates. The annular pressures should be closely monitored during the pilot hole process to help identify when the potential for drilling fluid surface releases

may be possible. Annular pressures can be monitored through the use of a downhole annular pressure tool as part of the bottom hole assembly and compared with the anticipated drilling fluid pressures.

REAMING/SWABBING CONSIDERATIONS

During reaming operations, the HDD contractor will likely ream the hole by conducting one or more successive ream passes to enlarge the hole to a minimum final hole diameter that is typically 12 inches larger than the carrier pipe for diameters equal to or greater than 24 inches or 1.5 times larger than the carrier pipe for diameters less than 24 inches. While conducting a pull ream pass (from exit to entry), a drilling fluid recycling system and high-pressure drilling fluid pump may be positioned on the exit side of the crossing to facilitate the pumping and recycling of the drilling fluid at exit. Conversely, the drilling fluid recycling system could remain at the entry side of the crossing, and drilling fluid returns could be collected with vacuum tankers and hauled to the entry side of the crossing.

In some instances, the contactor may elect to conduct forward reaming passes to promote drilling fluid returns to the entry side of the crossing while enlarging the pilot hole. The process involves keeping the drill rig on the entry side of the crossing and advancing the reamer from entry (away from the drill rig) towards the exit side of the crossing. If the contractor elects to conduct forward reaming passes, we recommend utilizing a large excavator or bulldozer positioned on the exit side of the HDD alignment to apply most of the pull force required to advance the reamer toward the exit point. Additionally, we recommend that the HDD contractor maintain a continuous string of drill pipe in the hole at all times during reaming and swabbing operations. Maintaining a drill pipe string in the hole at all times will reduce the risk of the reamer not following the pilot hole and could eliminate the need for to conduct operations to recover lost tooling in the event that the drill pipe string breaks and the reamer is lost downhole.

During the reaming operations, the rate of penetration and drilling fluid flow rates should be evaluated to reduce potential problems with inadequate removal of cuttings, hydraulic fracturing and drilling fluid surface releases. Generally accepted best practices within the HDD industry recommend an annular solids percentage of 30 percent or less, which requires pumping drilling fluid at a flow rate such that the volume of drilling fluid is more than three times the volume of soil cuttings being generated. The annular solids percentage can be adjusted by varying either penetration or pumping rates. If cuttings begin to build up in the hole because of high annular solids content, high drill string torque, stuck tooling or hydraulic fracture and drilling fluid surface release could occur.

When the reaming process is completed, and prior to pullback operations, we recommend conducting at least one swab pass to (1) check the stability of the hole; (2) help remove any excess cuttings remaining in the hole; (3) provide fresh drilling fluid immediately prior to pullback; and (4) help confirm that the hole is in a condition to receive the carrier pipe. The pullback process typically begins after completing one or more acceptable swab passes.

PULLBACK CONSIDERATIONS

Our analysis of the installation loads assumes that cuttings are removed from the hole prior to attempting pullback. Improper conditioning of the hole prior to pullback could result in higher installation forces.

We recommend that the HDD contractor utilize a drill rig with a capacity of at least 1.5 times the anticipated pull loads. In addition, the HDD contractor should install a deadman anchor of sufficient capacity to

withstand the anticipated pull loads; these aspects are generally left to the HDD contractor's discretion as approved by the owner. We also recommend that during pullback, the minimum allowable carrier pipe over bend radius be assessed to reduce the risk of damaging the carrier pipe during installation.

For carrier pipes less than 24 inches in diameter, it is uncommon for the contractor to use buoyancy control (typically water) during pullback. However, If the diameter of the carrier pipe is greater than 24 inches, the HDD contractor should consider using buoyancy control in the carrier pipe during pullback to reduce the positive buoyancy. In some instances, if buoyancy control measures are not utilized during the pullback process, the carrier pipe(s) may float in the drilling fluid and exert pressure against the top of the hole, increasing the risk for the following problems:

- Increased skin friction between the carrier pipe(s) and formation could lead to an increase in the drill rig pull load. The carrier pipe(s) and/or the protective coatings could be damaged if excessive pull force is applied to them.
- The leading edge of the pullhead could dislodge a cobble or rock fragment, in formations where such subsurface materials are present, binding the carrier pipe(s) and making it impossible to move it in either direction.
- The external coatings could be damaged by sharp and/or protruding material and highly abrasive material (like coarse sands) if such subsurface materials are present.

During pullback, the pull section(s) is/are typically supported with a combination of roller stands and/or carrier pipe handling equipment (cranes, side booms and/or excavators) to direct the carrier pipe(s) into the hole at the correct angle, to help prevent excessive bending of the carrier pipe(s), to reduce tension during pullback and to help protect the carrier pipe(s) from being damaged.

USE OF CASING IN HDD OPERATIONS

When hole stability or drilling fluid surface releases are a concern within the entry or exit tangents, the HDD contractor may choose to install a casing to mitigate these risks. In addition to providing hole stability and reducing the potential for drilling fluid surface releases, the casing can provide a reaction mass for allowing a greater transfer of axial loads through the downhole drill pipe string to the drill bit.

Casing is typically pushed and/or rotated over the drill pipe string in 15- to 40-foot sections. These sections are typically welded together during installation. However, if hydraulic fracture and drilling fluid surface release is a concern near the entry or exit points where casing will be installed, the casing should be advanced prior to initiating pilot hole operations. As sections are added, the casing will continue to be advanced to a depth necessary to maintain hole stability or reduce the risk of hydraulic fracture and drilling fluid surface release. The casing is then typically extracted before or during the hole opening process but may remain in place until pullback operations are complete if necessary. This methodology is most commonly used in soft or loose soil where the drill path is shallow and where gravel or cobbles are anticipated.

UTILITIES

We recommend that the HDD contractor physically locate (pothole) all utilities that are within the entry and exit workspaces, or crossed by the proposed HDD alignment, prior to initiating pilot hole operations to verify the location and depth of each utility and confirm that HDD operations will not conflict with the utilities.

DRILLING FLUID CONTAINMENT PITS AND TEMPORARY EXCAVATIONS

Drilling fluid containment pits will be required at the drill entry and exit work areas. Depending on the practices of the HDD contractor, drilling fluid containment pit excavations are typically constructed adjacent to the centerline near the entry and exit point locations and are approximately 10 feet long by 10 feet wide and up to 8 feet deep.

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the HDD contractor. All temporary cuts in excess of 4 feet in height should be shored or sloped in accordance with Occupational Safety and Health Administration (OSHA) regulation 1926 Subpart P, Appendix B – Sloping and Benching. For planning purposes, soils in the vicinity of the excavation areas are often assumed to be classified as Type C. Temporary excavations in Type C soil should be inclined no steeper than 1.5H:1V (horizontal to vertical). These allowable cut slope inclinations are applicable to excavations above the groundwater table only. Steeper temporary slope inclinations may be allowed if soil conditions are determined to be suitable by the field geotechnical engineer. For open cuts, we recommend that:

- No traffic, construction equipment, stockpiles or supplies should be allowed within a distance of at least 5 feet from the top of the cut.
- Construction activities should be scheduled to reduce the length of time the cuts are left open.
- Erosion control measures should be implemented as appropriate to limit runoff from the site.
- Surface water should be diverted away from the excavations.

DRILLING FLUID CONSIDERATIONS

The HDD contractor's ability to maintain proper drilling fluid properties with appropriate penetration and drilling fluid flow rates will be important factors to consider during drilling, because hole conditions and risk of drilling fluid surface releases will be directly affected by these operations. The contractor's means and methods will be instrumental in maintaining a clean pilot hole and reamed hole and in maintaining drilling fluid returns to the entry point throughout the drilling process so that the risk of hydraulic fracture and drilling fluid releases is not increased during the pilot hole and reaming operations.

Maintaining appropriate drilling fluid properties during HDD operations will be vital for effective cuttings removal and maintaining hole stability during all aspects of HDD operations. We recommend that the HDD contractor employ the use of a qualified drilling fluid engineer/technician to develop a drilling fluid program and assist with maintaining appropriate drilling fluid properties during HDD operations.

CUTTINGS REMOVAL AND ANNULAR SOLIDS

Based on our experience, cuttings removal in clays is typically more challenging than in other non-cohesive soils. In some cases, relatively dry clays or high plasticity silts may swell and block the drill hole.

Alternatively, the clay cuttings may “ball up” forming large diameter particles that fall out of suspension and are more difficult to remove than smaller clay particles that remain in suspension. Cuttings removal can also be difficult when drilling through gravel because the relatively heavy gravels tend to fall out of suspension and accumulate within the bore hole. Therefore, the potential for the hole to become plugged with cuttings is elevated along proposed HDD crossings where the drill path is within clay, high plasticity silt and gravel. In the event that the hole becomes plugged, and drilling fluid circulation ceases, downhole annular pressures can increase dramatically. This temporary spike in downhole annular pressure can dramatically increase the risk of hydraulic fracture and drilling fluid surface release.

If cuttings are not effectively removed from the hole during HDD operations, pullback forces could be excessively high during pipe pullback, the pipe could become lodged in the hole, or the pipe could become damaged. The failure to effectively remove cuttings from the hole could potentially result in failure of the HDD installations.

We recommend that the HDD contractor maintain drilling fluid returns at all times and use appropriate means and methods (appropriate penetration rates, drilling fluid management, mechanical methods) to adequately remove the cuttings from the hole during the HDD process.

Appendix F

Report Limitations and Guidelines for Use

Appendix F
Report Limitations and Guidelines for Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology, and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers, Inc. (GeoEngineers) includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for Transcontinental Gas Pipeline Company, LLC and the design team for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with the existing blanket Professional Services Terms and Conditions negotiated as referenced in Purchase Order No. WPO159056 dated April 16, 2024, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR ENVIRONMENTAL REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the Sandy River horizontal directional drill, located in Pittsylvania County, Virginia. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,

[1] Developed based on material provided by ASFE/The Best People on Earth, Professional Firms Practicing in the Geosciences; www.asfe.org.

- Not prepared for the specific site explored, or
- Completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Bedrock classification shown in our boring logs is based on visual inspection and field observation with the unaided eye. While effort has been made to strive for accuracy, visual rock classification is inherently subjective. This method does not substitute for detailed laboratory testing and may not fully capture the variability and complexity of the subsurface conditions. GeoEngineers laboratory testing program typically

focuses on the physical/mechanical rock properties such as compressive strength, hardness and abrasivity. To classify rock type with near certainty, additional mineralogical and chemical laboratory testing may be required including petrographic analysis (thin section microscopy), xray diffraction, and scanning electron microscopy.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by subcontractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable but separating logs from the report can create a risk of misinterpretation.

GIVE SUBCONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving subcontractors the complete geotechnical engineering or geologic report, including

these “Report Limitations and Guidelines for Use.” When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises subcontractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages subcontractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

SUBCONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the subcontractor’s procedures, methods, schedule, or management of the work site. The subcontractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers’ Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing, or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term “Biological Pollutants” includes, but is not limited to, molds, fungi, spores, bacteria, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

HDD Design Services

Southeast Supply Enhancement
Banister River HDD
Pittsylvania County, Virginia

for
Transcontinental Gas Pipeline Company, LLC

January 24, 2025

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GeoEngineers

HDD Design Services

Southeast Supply Enhancement –
Banister River HDD
Pittsylvania County, Virginia

File No. 08169-235-00
January 24, 2025

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Executive Summary

This report provides GeoEngineers, Inc.'s (GeoEngineers') horizontal directional drill (HDD) design and construction recommendations for the proposed 42-inch-diameter Banister River HDD as part of the Southeast Supply Enhancement (SSE) Eden Loop (Project) located in Pittsylvania County, Virginia.

We understand that Transco is planning to install a new section of 42-inch steel pipe under the Banister River utilizing the HDD method of construction. The designed horizontal length of the Banister River HDD is 2,390 feet. The proposed HDD alignment is oriented southwest to northeast (entry to exit) and is part of a segment of the proposed pipeline alignment that has been routed beyond the extents of the existing pipeline corridor and occupies new proposed pipeline right-of-way, as shown on the HDD Design Drawing in Appendix A.

We explored the subsurface conditions along the Banister River HDD alignment by completing a total of four (4) geotechnical borings, the results of which are summarized in our Geotechnical Data Report which is included in Appendix B. Relating the geotechnical conditions to the proposed HDD construction, a primary point of emphasis is the very high abrasivity of the gneiss bedrock on site. Prospective contractors should carefully consider and plan for tooling wear and other risks associated with hard and abrasive rock.

Based on the information available at this time, the results of the geotechnical borings completed at the site, our geotechnical engineering evaluation, and detailed HDD design analyses, it is our opinion that the proposed Banister River HDD has a high probability of a successful installation. Our assessment of the construction risks is based upon the contractor adhering to the recommendations contained herein and implementing plans and procedures that are in accordance with Project requirements. The HDD contractor should address the items in Sections 6.0 and 7.2 of this report in the preconstruction and construction phases of the project to facilitate a successful HDD installation and to mitigate possible difficulties from arising during construction. We anticipate contractor selection will be critically important to the ultimate success of this HDD installation, and we recommend the Project team consider engaging an HDD contractor experienced in projects of similar length and diameter in similar subsurface conditions well in advance of construction to provide feedback on the project plans and specifications.

The Executive Summary should be used only in context of the full report for which it is intended.

1.0 Introduction

1.1 GENERAL

This report provides GeoEngineers, Inc.'s (GeoEngineers') horizontal directional drill (HDD) design and construction recommendations for the proposed 42-inch-diameter Banister River HDD located in Pittsylvania County, Virginia. The project site is shown in the Vicinity Map, Figure 1.

1.2 PROJECT DESCRIPTION

We understand that Transcontinental Gas Pipeline Company, LLC (Transco) is proposing to construct a new approximately 30.8-mile-long 42-inch-diameter steel pipeline as part of the Southeast Supply Enhancement (SSE) Eden Loop project (Project). The Project route, located in Rockingham County, North Carolina and Pittsylvania County, Virginia generally follows Transco's existing pipeline corridor. The Banister River crossing, for which this report has been prepared, is part of a segment of the proposed pipeline alignment that has been routed beyond the extents of the existing pipeline corridor and occupies new proposed pipeline right-of-way (ROW). The designed horizontal length of the Banister River HDD is 2,390 feet. The proposed HDD alignment is oriented southwest to northeast (entry to exit), as shown on the HDD Design Drawing in Appendix A. The HDD design is based on the design parameters presented below in Table 1.

TABLE 1. PIPELINE DESIGN PARAMETERS

CARRIER PIPE DATA	DESIGN PARAMETER
Carrier Pipe Specifications	42 inches O.D x 0.888 inches w.t.[A] API-5L X70
Maximum Allowable Operating Pressure (MAOP)	1,480 psig[B]
Assumed Operating Temperature	70 degrees F
Assumed Tie-In Temperature	50 degrees F
Design Factor[C]	0.5

Notes:
[A] w.t. – wall thickness
[B] psig – pounds per square inch gauge
[C] As defined in CFR Title 49, Parts 192.5 and 192.111

2.0 Scope of Services

The work described in this section was undertaken by GeoEngineers to design the HDD, perform the HDD engineering, and prepare this HDD design report for the proposed Banister River HDD. The following provides an abbreviated list of our scope of services for the design phase of the project. Refer to our proposal, dated January 17, 2024, for our original scope of services for the entire project.

1. Completed a conceptual design for the Banister River HDD.
2. Explored the subsurface conditions at the crossing site by completing four geotechnical borings to depths up to approximately 134.75 feet below ground surface (bgs) and summarized the results of the geotechnical explorations and subsequent laboratory testing program in our geotechnical data report

titled, "Southeast Supply Enhancement – Banister River Crossing Geotechnical Data Report," dated January 23, 2025.

3. Performed an HDD feasibility evaluation considering the subsurface conditions encountered during the exploration program.
4. Completed an HDD design and performed engineering and design analyses. Our design and calculations were performed in accordance with Sections 833.3 and 833.4 of American Society of Mechanical Engineers (ASME) B31.8 for steel pipe, PRCI Catalog No. PR-277-144507-E01, FERC HDD Plan Guidance (October 2019), Transco's specifications, and generally accepted practices within the pipeline industry.
5. Completed quantitative and qualitative hydraulic fracture and drilling fluid surface release analyses for portions of the HDD profile within the overburden soils and bedrock, respectively. Our qualitative evaluation includes considerations from the Federal Energy Regulatory Commission (FERC) 2019 "Guidance for Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan".
6. Prepared and submitted Issued for Review (IFR) HDD design drawings for review and comment by the project team.
7. Prepared a HDD engineering and design report for the crossing for review by the project team.
8. Prepared and submitted this Final HDD design report, including Issued for Permit (IFP) drawings and engineering calculations, sealed by a licensed professional engineer in the state of Virginia.

3.0 Site Conditions

The proposed Banister River HDD is located east of Highway 29, roughly 3.2 miles south of Chatham, Virginia. As part of our scope of work for the project, we performed a site reconnaissance with Transco personnel and conducted a site-specific geotechnical exploration program. Please see our geotechnical data report titled, "Southeast Supply Enhancement – Banister River Crossing Geotechnical Data Report," dated January 23, 2025, in Appendix B for further details of the regional and local geologic setting at the site and a description of the mapped surficial materials and bedrock geology at the site.

3.1 SURFACE CONDITIONS

We evaluated the surface conditions at the Banister River site during our initial site reconnaissance with Transco personnel on October 14, 2024, and during our subsurface exploration program conducted from October 29 through November 6, 2024. We also reviewed aerial photographs viewed on Google Earth® software. The proposed HDD alignment is shown relative to an aerial photograph base map in the HDD Design Drawing included in Appendix A. Photographs of the site conditions in the vicinity of the proposed entry, exit, and pipe stringing and fabrication workspace areas are included in Figures 2 through 4. A photograph of the Banister River is included in Figure 5.

The proposed HDD alignment is roughly oriented southwest to northeast and deviates from Transco's existing pipeline corridor, including crossing the Banister River before converging with the existing pipeline corridor northeast of the Banister River. Generally, the ground surface between the entry and exit points of the HDD slopes downward to the broader Banister River floodplain at an elevation of roughly 590 to 595

feet North American Vertical Datum (NAVD) 88. As crossed by the proposed pipeline alignment, the mud line of the Banister River is at an elevation of approximately 586 feet NAVD88. The ground surface elevations on either side of the river above the floodplain range from roughly 595 feet NAVD 88 to approximately 657 feet NAVD 88.

The project area is generally undeveloped and consists of open, grassy fields on the southwest side of the river and agricultural cropland on the northeast side of the river. The alignment crosses the Banister River at an oblique angle over a distance of roughly 70 feet.

Refer to Section 4.2 of this report for a more detailed discussion regarding the conditions and layout of the entry, exit, and pipe stringing workspaces.

3.2 SUBSURFACE CONDITIONS

3.2.1 General

The subsurface conditions at the site were explored from October 29 through November 6, 2024 by drilling four geotechnical borings (ABR-B-1 through ABR-B-4) to depths of up to approximately 134.75 feet bgs using a rubber-tracked drill rig.

To characterize the subsurface conditions for the crossing design, the borings were drilled as close as practical to the alignment of the proposed crossing, but generally no closer than 25 feet. A description of the geologic conditions at the site, field exploration and laboratory testing procedures, laboratory test results, as well as logs of the borings are presented in our geotechnical data report included in Appendix B.

3.2.2 Subsurface Description

Our geotechnical exploration program encountered predominantly residual soil consisting of medium stiff to stiff cohesive soil (silt) with varying sand content and loose to medium dense sand with silt/silty sand overlying decomposed bedrock (medium dense to very dense sand with variable silt and gravel content) grading to competent gneiss bedrock. Our core samples indicate the bedrock quality along the HDD profile is generally fair to excellent with some isolated portions where the bedrock quality is very poor to poor, which was generally limited to the upper approximately 15 feet or less of competent bedrock. Table 2 below provides a range of the unconfined compressive strength, Mohs hardness, and Cerchar Abrasivity Index (CAI) test results completed for selected samples. Table 7 in this report provides a detailed summary of the boring identification and sample depth for each sample tested.

TABLE 2. SUMMARY OF ROCK CORE TEST RESULTS

TEST TYPE	RANGE
Unconfined Compressive Strength (UCS)	1,390 – 13,730 psi[A]
Mohs Hardness	4½ – 8½
Cerchar Abrasivity Index (CAI)	3.29 – 5.15

Notes:
[A] psi – pounds per square inch

3.2.3 Groundwater Conditions

Groundwater was not observed at the time of drilling borings ABR-B-1 and ABR-B-2 before beginning rock coring. Groundwater was initially encountered at depths of approximately 13.5 and 28.5 feet bgs in borings ABR-B-3 and ABR-B-4, respectively. The groundwater level at the time of drilling may not be representative of present or future levels within the subsurface. The groundwater level likely fluctuates because of seasonal variation and precipitation, recharge and other factors, and may be present at different elevations during construction.

4.0 HDD Design Elements

4.1 BASIS OF DESIGN

The following sections discuss the design elements of the proposed Banister River HDD as depicted in Appendix A.

The horizontal length of the proposed HDD alignment is within the limitations of crossings capable of being completed with a single HDD drill rig. However, **because of the hardness and abrasivity of the bedrock, we anticipate that the selected HDD contractor could utilize a second drill rig at some point during construction. We do not anticipate the selected HDD contractor requiring the pilot hole intersect method to complete the pilot hole; however, factors unknown at the time this report was prepared (schedule, project progress, etc.) may affect that decision.** Additionally, using a drill rig on both sides of the crossing during reaming operations would allow for increased flexibility of operations and other advantages, including the following:

- Reduction in overall project schedule, particularly during the pilot hole;
- Increasing the contractor's ability to complete the pilot hole within the specified tolerance should they encounter steering difficulties;
- Being able to more easily ream the hole in either direction; and,
- Increasing the likelihood of recovering tooling in the event of a downhole tooling failure.

Because the HDD contractor may elect to use a drill rig on both sides of the crossing, the HDD geometry and workspaces were laid out to accommodate this possibility.

4.1.1 HDD Geometry

The design geometry is primarily based on the following factors:

- Entering and exiting the bedrock within the steepest portions (the entry and exit tangents) of the profile.
- Utilizing entry and exit tangents of suitable length for large HDD drill rigs.
- Designing the profile to target the better-quality bedrock to reduce the risk of formational fluid loss and hole instabilities.
- Using larger than standard (100D) design radii for the vertical curves to provide a reasonable variance between the design radii and the minimum allowable radius.

The proposed Banister River HDD alignment is 2,390 feet long as measured along the HDD centerline, with a pipe length of approximately 2,411 feet. The entry and exit angles are 12 and 10 degrees, respectively, and the design radius of curvature for the entry and exit curves is 4,500 feet.

4.2 HDD WORKSPACE AREAS

The proposed temporary workspaces at entry and exit and the pipe stringing and fabrication workspace are situated within the project's limits of disturbance composed of the proposed permanent easement, temporary workspace, and additional temporary workspace. The following sections provide relevant details regarding the proposed workspace areas.

4.2.1 Entry Workspace

The proposed entry workspace is located on the southwest side of the crossing and occupies private property in an area consisting of entirely new pipeline ROW. The workspace area is grass covered, and the ground surface within the workspace is generally relatively flat to gently sloping. The ground surface generally slopes down from the south side of the workspace to the north side. The HDD entry point is positioned 250 feet southwest of the northeast edge of the additional temporary workspace to include the portion of the HDD alignment where we anticipate the risk of inadvertent drilling fluid returns (IR) is very high. Photographs of the proposed entry workspace are provided in Figure 2.

4.2.2 Exit and Pipe Stringing and Fabrication Workspaces

The proposed exit workspace is located on the northeast side of the crossing and occupies private property in an area consisting of entirely new pipeline ROW. The workspace area is within an agricultural field, and the ground surface within the workspace slopes gently upward from the front (southwest side) of the workspace to the back (northeast side). The HDD exit point is situated 330 feet northeast of the southwestern edge of the additional temporary workspace to include the portion of the HDD alignment where we anticipate the risk of IR is very high. Photographs of the proposed exit workspace are provided in Figure 3.

The proposed pipe stringing and fabrication workspace extends northeast of the exit point approximately 1,500 feet to a wooded area. The workspace is within an agricultural field, and the ground surface within the workspace slopes gently upward from the front (southwest) side of the workspace to a point of intersection (PI) in the proposed pipeline alignment where the workspace begins descending to a wooded area. The pipe stringing and fabrication workspace also includes areas of workspace which will have gentle side slopes. The workspace is not long enough to accommodate a single string of carrier pipe, and therefore, a minimum of two sections will need to be fabricated before pullback and require at least one mid-weld during pullback. Photographs of the proposed pipe stringing, and fabrication workspace, including an area of gentle side slope (photograph 5), are provided in Figure 4.

5.0 Engineering and Analysis

5.1 HYDRAULIC FRACTURE AND INADVERTENT RETURNS EVALUATION

5.1.1 General

Drilling fluid surface releases, commonly referred to as "inadvertent returns" (IRs) or "Frac Outs," occur when drilling fluid emerges at the ground surface or in any other undesired location such as waterbodies, or other environmentally sensitive features or utilities. Hydraulic fracture is a term typically used to describe the condition in which the annular drilling fluid pressure exceeds the capacity of the surrounding formation to resist that pressure (formation limit pressure). Once the formation limit pressure (FLP) is exceeded, drilling fluid is lost either through crack propagation (fracture) or by uncontrolled cavity expansion (blowout).

Hydraulic fracture typically occurs when the drill path passes through relatively weak cohesive soils or loose granular soils with low shear strength. Very loose to loose sands and silty sands, and soft to medium stiff silts and clays typically have a higher hydraulic fracture potential. Medium dense to very dense sands and very stiff to hard silts and clays have a low to moderate hydraulic fracture potential. However, the HDD contractor's construction procedures are an important factor influencing the risk of hydraulic fracture and inadvertent drilling fluid returns. If the contractor operates with insufficient drilling fluid flow rates, inadequate drilling fluid properties or excessive rates of penetration, the annulus may become blocked through an accumulation of drill cuttings falling out of suspension. This can occur within formations that typically have a low potential for hydraulic fracture. If the accumulation of cuttings creates a blockage downhole, the annulus may become over-pressurized, leading to hydraulic fracturing and potentially, drilling fluid surface releases. The hydraulic fracture analysis does not account for this over-pressurized condition.

The FLP of a given soil strata can be estimated based on cavity expansion theory (Vesic, 1972). Our analysis computes the factors of safety against hydraulic fracture in soil. The factor of safety against hydraulic fracture is the ratio of the soil formation limit pressure to the estimated drilling fluid pressure along the profile. The formation limit pressure varies depending on the soil properties anticipated along the HDD profile as described in Section 5.1.2. The estimated drilling fluid pressure also varies along the HDD profile and is a function of the drilling fluid and tooling properties as described in Section 5.1.2. A more detailed explanation of our hydraulic fracture analysis methodology is presented in Appendix C.

Bedrock, because of its high shear strength, has a relatively low potential for hydraulic fracture. Hydraulic fracture of soil is defined by and can be quantitatively analyzed by cavity expansion theory. However, cavity expansion theory cannot be applied to bedrock conditions. The annular drilling fluid pressures associated with the HDD construction method are typically not capable of hydraulically fracturing competent bedrock.

However, inadvertent returns of drilling fluid to the ground surface can occur during HDD operations in bedrock by following existing fractures and planes of weakness within the formation. Currently, there are no widely accepted methods for calculating the safety factor against inadvertent returns occurring from within bedrock during HDD operations. However, the risk can be qualitatively characterized based on the type and quality of the bedrock as discussed further in Section 5.1.4.

5.1.2 Model Input Parameters

The HDD geometry used for our analyses of the Banister River HDD is shown on the HDD Design Drawing in Appendix A. The soil units along the HDD profile are characterized by borings ABR-B-1 through ABR-B-4.

We developed the following soil properties based on laboratory-testing data and published correlations with standard penetration testing (SPT) for use in our hydraulic fracture analysis. Please see Appendix C for a more detailed discussion of the hydraulic fracture analysis methodology.

TABLE 3. ESTIMATED SOIL PROPERTIES

SOIL DESCRIPTIONS	USCS[B] CLASSIFICATION	WET UNIT WEIGHT (PCF)[C]	FRICTION ANGLE/ PHI (DEGREES)	K_0 VALUE	COHESION (PSF)[D]
Stiff Silt	ML	105	0	1	1,000
Loose Silty Sand	SM	110	26	0.56	0
Medium Dense Silty Sand	SM	115	28	0.53	0
Very Dense Silty Sand	SM	125	32	0.47	0
Gneiss Bedrock[A]	N/A	N/A	N/A	N/A	N/A

Notes:
[A] Profile segments where bedrock conditions are anticipated were qualitatively evaluated for risk of IR.
[B] USCS = Unified Soil Classification System
[C] pcf = pounds per cubic foot
[D] psf = pounds per square foot

We estimated the anticipated annular drilling fluid pressure using the Bingham Plastic model. Downhole drilling fluid pressures are influenced by the tool dimensions and rheological drilling fluid properties selected by the contractor. For the purposes of our analysis, we selected a range of rheological properties and typical tooling dimensions for the length of the crossing and subsurface conditions expected along the HDD profile, as summarized in Table 4. The range of drilling fluid properties was chosen based on our experience with crossings in similar subsurface conditions. Our model assumes that no obstructions are present within the drill hole, drilling fluid returns are maintained at all times, and the drill hole is completely cylindrical. Because these parameters are subject to change depending on HDD contractor's means and methods, the hydraulic fracture analysis can and should be refined once the HDD contractor is selected, and these parameters are known.

TABLE 4. ESTIMATED TOOL DIMENSIONS AND RHEOLOGICAL PROPERTIES

PARAMETER	VALUE
Pilot Hole Bit Diameter	12.25 inches
Drill Pipe Diameter	6.625 inches
Drilling Fluid Weight	9.5 – 12 ppg[A]
Plastic Viscosity	13 – 25 cP[B]
Yield Point	25 – 45 lb/100 sf[C]

Notes:
[A] ppg = pounds per gallon
[B] cP = centipoise
[C] lb/100 sf = pounds per 100 square feet

5.1.3 Results of Quantitative Hydraulic Fracture Evaluation

The estimated formation limit pressure and the estimated annular drilling fluid pressure (AP) along the HDD profile are shown as the green line and the red line, respectively, in Figure C-1. A range of calculated drilling fluid pressures is shown in Figure C-1 based on the lower bound and upper bound values for the drilling fluid properties shown in Table 4. The calculated safety factor against hydraulic fracture along the HDD profile is shown in Figure C-2. As shown in Figure C-2, our hydraulic fracture analysis indicates the risk of hydraulic fracture and IR is relatively low (safety factors above 2.0) for the portions of the pilot hole anticipated to be within soil except where the profile transitions from bedrock to soil near the exit point, where the analysis indicates a high to very high risk of hydraulic fracture and IR if the pilot hole is advanced entirely from entry to exit. Our analysis assumes that the HDD contractor follows the HDD Best Practices presented in Appendix E and maintains annular drilling fluid pressures below the calculated values included in this report.

5.1.4 Inadvertent Returns Risk

For this crossing, we anticipate there is a high risk of IR within approximately 100 feet of the proposed HDD entry point and within approximately 300 feet of the exit point, assuming the pilot hole is advanced solely from entry to exit. Based on our analysis, if the pilot hole were to be completed using the intersect method, we estimate the risk near exit to be high within approximately 100 feet of the exit point. We understand that there are no environmentally sensitive features or settlement sensitive structures within these high-risk zones.

The bedrock observed in the borings ranged in quality, as previously described. It is our opinion that the risk of significant formational fluid loss along the proposed HDD is generally low, but there is a localized risk of fluid loss within the zones of poor rock quality observed in the borings. We should note that during the geotechnical explorations, drilling fluid returns were maintained during rock coring operations, suggesting that formational drilling fluid loss during HDD operations will likely not be significant. It is also our opinion that there is generally a low risk of drilling fluid surface release along the portions of the HDD profile that are within the bedrock.

5.1.5 Calculated Drilling Fluid Pressure

The calculated fluid pressures presented in Figure C-1 are intended to provide a baseline of estimated annular drilling fluid pressures based on assumed drilling fluid properties and the HDD contractor's tooling parameters. Variations to one or both will affect the fluid pressures. Transco's Horizontal Directional Drilling – Construction specification 33 05 07P, requires the contractor to monitor annular pressures during pilot hole operations. If the annular pressures are higher than the calculated values, it could be indicative of a downhole obstruction or other problem that should be addressed by the HDD contractor to limit the risk of inadvertent returns. In addition, annular pressures higher than anticipated will result in a reduction in the calculated safety factor against hydraulic fracture.

In accordance with Transco's specification, we recommend that the HDD contractor utilize an annular pressure tool to monitor downhole annular pressures while drilling the pilot hole. We recommend that the contractor take necessary and reasonable steps to maintain the annular drilling fluid pressure within the expected range of calculated pressures presented in Figure C-1. The calculated drilling fluid pressures are presented in tabular form on the HDD Design Drawing – Sheet 4 in Appendix A.

5.2 OPERATING CONDITIONS

For our analyses, the tie-in and operating temperatures used for the 42-inch pipeline were 50 degrees and 70 degrees Fahrenheit, respectively. We can further evaluate different installation and operating temperatures, if necessary. The design radius of curvature for the HDD is 4,500 feet. However, the operating stresses in Table 5 below are based on an allowable minimum radius of curvature of 3,200 feet at the maximum allowable operating pressure (MAOP) provided in Table 1. If the pilot hole is completed with a minimum radius of curvature less than 3,200 feet, the operating stresses will be increased. Table 5 below presents a summary of the operating stresses for the carrier pipe specifications proposed for the HDD. Detailed operating stress calculations are included in Appendix D.

TABLE 5. CALCULATED OPERATING STRESSES*

STRESS COMPONENT	STRESS (PSI)	PERCENT SMYS[A] (%)	MAXIMUM ALLOWABLE PERCENT SMYS[A] (%)
Longitudinal Bending Stress	16,200	23	-
Hoop Stress	35,000	50	50[B]
Longitudinal Tensile Stress from Hoop Stress	10,500	15	-
Longitudinal Stress from Thermal Expansion	-3,800	6	90[C]
Maximum Net Longitudinal Stress	22,800	33	90[D]
Maximum Shear Stress	22,300	32	45[E]
Maximum Combined Biaxial Stress	44,500	64	90[F]

Notes:

* Operating Stresses are based on an Allowable Minimum Radius of 3,200 feet.

A SMYS - Specified Minimum Yield Stress

B Limited by design factor from DOT regulations, CFR Title 49 Part 192.111 for gas.

C Limited by Table 403.3.1-1 of ASME B31.4 for liquids.

D Limited by Table 403.3.1-1 of ASME B31.4 for liquids and Section 833.3 of ASME B31.8 for gas.

E Limited by Section 403.12 of ASME B31.4 for liquids.

F Limited by Section 833.4 of ASME B31.8 for gas.

5.3 PULLBACK LOADS

The installation loads are estimated based on the designed geometry and the methods developed by the Pipeline Research Committee International (PRCI) of the American Gas Association (PRCI 2015). To calculate the safe pull force for a given installation, we first assume that during pullback the pipe experiences the maximum hoop stress and minimum bending radius at the deepest part of the proposed drill profile. We then utilize the equation for combined stress found in Section 5.2.4 of the PRCI Guidelines (PRCI 2015) to back-calculate the allowable tensile stress that may be applied to the pipe at that point. With the allowable tensile stress known, we can estimate the safe pull force at that same point. It should be noted that this can be conservative because the maximum hoop stress and bending stress may not be acting on the pipe at the same location. For this installation, the calculated safe pull force exceeds the limitations of HDD drill rigs which may be used to complete the installation.

For the proposed HDD, we analyzed the anticipated pull loads based upon different drilling fluid weights in the hole during pullback with the pipe empty and full of water. Based on our analysis of the installation loads (see Table 6), the pullback force during installation of the 42-inch-diameter carrier pipe may be as high as approximately 631,300 pounds, depending on the weight of the drilling fluid in the hole at the time of pullback, the buoyancy control measures employed by the contractor, and how well the hole is prepared for pullback. Detailed installation load and stress calculations are provided in Appendix D.

The five cases analyzed are as follows:

1. The annulus contains 9.5 pounds per gallon (lb/gal) drilling fluid and the carrier pipe is empty.
2. The annulus contains 9.5 lb/gal drilling fluid and the carrier pipe is full of water.
3. The annulus contains 12 lb/gal drilling fluid and the carrier pipe is empty.
4. The annulus contains 12 lb/gal drilling fluid and the carrier pipe is full of water.
5. The annulus contains 12 lb/gal drilling fluid and the carrier pipe is filled such that neutral buoyancy is achieved.

TABLE 6. INSTALLATION LOADS[A]

DRILLING FLUID WEIGHT (LB/GAL)	BUOYANCY CONDITION	BUOYANCY CONTROL (LB/FT)	EFFECTIVE PIPE WEIGHT (LB/FT)[B]	PULLBACK FORCE[C] (LB)
9.5	Empty	0	-292.9	475,200
9.5	Full	550.7	257.8	370,800
12.0	Empty	0	-472.8	631,300
12.0	Full	550.7	77.9	230,400
12.0	Neutral	472.8	0	215,500

Notes:
[A] See Appendix D for detailed calculations.
[B] Negative values indicate upward force (positive buoyancy). .
[C] Assumes a fully open drilled hole.

6.0 HDD Construction Risks and Considerations

6.1 GENERAL

The HDD contractor's means and methods during construction are critical to the successful completion of the HDD. The contractor should follow HDD Best Practices during construction, including those recommended by GeoEngineers in Appendix E. The HDD Best Practices in Appendix E are not site-specific best practices, rather they are applicable to HDD construction in general. The following sections summarize site-specific conditions to be considered during construction.

6.2 TEMPORARY WORKSPACE AREAS

The entry and exit workspaces are located within the Project limits of disturbance of the proposed permanent easement, temporary workspace, and additional temporary workspace and will be accessed via approved access roads. The entry and exit workspace areas will require relatively level areas for staging equipment such as the drill rig, drilling fluid recycling system, and high pressure drilling fluid pump. Depending on the ground conditions at the time of construction, timber matting or similar might be needed to provide a stable platform within the workspaces. **The contractor should evaluate the existing ground conditions and provide a site-specific plan to stabilize and prepare the ground for construction in the entry and exit workspaces.**

All temporary site improvements should be removed upon completion of the carrier pipe installation and the areas should be restored in accordance with the project site restoration plan and in Transco's construction specification. Temporary workspaces for the trenchless operations are shown on the design drawings in Appendix A.

6.2.1 Workspace Preparation

The entry and exit workspaces are situated on relatively flat to gently sloping terrain which will require some grading to create level workspace areas for HDD equipment. The pipe stringing and fabrication workspace includes gently sloping side slopes which will require consideration by the general contractor when selecting and staging pullback support equipment, as discussed further in Section 6.5.4 below.

To reduce ground disturbance to the extent possible, we recommend temporary construction entrances, access roads and work pad areas (as appropriate) be improved by placing temporary board or timber mats. Temporary entrances and access roads should be constructed with culverts and other improvements necessary to allow surface water runoff to drain without ponding or changing off-site drainage patterns.

6.2.2 Noise Mitigation

We understand that Transco has engaged an acoustic engineering consultant to evaluate the current ambient noise levels and develop mitigation measures. The noise modeling for the Banister River HDD assumed HDD equipment operating in both the entry and exit workspaces simultaneously, 24 hours per day. The acoustic assessment completed for the Banister River HDD indicates that the unmitigated sound level attributable to drilling operations at the HDD entry workspace is likely to exceed the maximum allowable sound level criterion of 55 A-weighted decibels (day-night sound level) at the closest noise sensitive areas. As a result, implementing noise mitigation measures at the HDD entry workspace during construction will be necessary.

Often noise mitigation measures may include outfitting diesel power units and other stationary equipment with noise-reducing mufflers. In addition, the workspaces can be muffled by placing baffles around the equipment to further reduce noise emissions when needed. The provisions of the noise reduction measures are generally implemented by the selected contractor, when necessary. Please refer to the project noise study report for details related to specific mitigation recommendations.

6.3 UTILITIES

The locations of all currently known underground utilities are shown on the design drawing. The selected contractor should complete one-calls and implement appropriate measures to positively identify public and private utilities along the access routes and HDD alignment prior to mobilizing equipment and beginning drilling operations. Additionally, the contractor should implement all reasonable measures to protect these utilities during mobilization, construction, and demobilization.

We understand that the proposed ROW at the Banister River site does not include any existing Transco pipelines within the proposed pipeline ROW. Based on the project civil survey, there were no existing utilities identified within the proposed HDD entry and exit workspaces.

The contractor should ensure that equipment can be safely operated at the required distance beneath and adjacent to existing utilities. GeoEngineers should be notified if a potential conflict between the HDD profile and existing utilities is identified.

6.4 HARD AND ABRASIVE BEDROCK

Our Geotechnical Data Report completed for the crossing reports unconfined compressive strength test results up to approximately 13,730 psi, indicating that very hard rock is present at the site. While rock with compressive strength values of greater than 15,000 psi may or may not be extensive at the site, **the HDD contractor should be prepared to encounter hard rock with compressive strength values greater than 15,000 psi along the designed HDD profile.** Furthermore, as noted in the Geotechnical Data Report, **the results of CAI testing ranged from 3.29 to 5.15, indicating highly to extremely abrasive bedrock at the site.** Mohs hardness values ranged from 4.5 to 8.5 on samples selected for unconfined compressive strength testing. Based on the laboratory testing results described above, accelerated downhole tooling wear is considered likely.

The compressive strength of the rock samples tested suggests the rock has low to high compressive strength with a relatively large range in strength between samples of similar composition, state of weathering, and hardness. The HDD contractor should consider these factor's effects on penetration rates and their implications on an estimated construction schedule, necessary drill bit and hole opener specifications, and the number of drill bits and hole openers in their estimate.

In accordance with Transco's specification for pipe coating thickness, because of the extreme abrasivity of the bedrock at the site the HDD pipe shall be coated with 12 mils of base fusion bonded epoxy (FBE), 30 mils of FBE-abrasion resistant overlay (ARO), and 50 mils of liquid ARO.

6.5 OPERATIONAL CONSIDERATIONS

Ultimately, the means and methods of daily HDD operations will vary based on the selected HDD contractor and their typical approach for completing projects of similar length and diameter. However, site and project-specific factors should also be considered by the HDD contractor to inform their decisions during pre-construction planning regarding tooling and equipment selection, workspace configuration, and scheduling, among other items.

6.5.1 Downhole Tooling

Based on the subsurface conditions observed in the geotechnical explorations completed at the site and results from the subsequent laboratory testing program, we recommend that the following be considered by prospective HDD contractors:

- Drill pipe and crossover sub wear may be excessive. Because of the projected long duration of the project, a monitoring and inspection program during construction should be considered for all drill pipe and subs used downhole. **We recommend that the drill pipe and crossover subs used during drilling be inspected and results turned into Transco prior to the start of drilling and that reinspection be completed after a pre-determined time frame to reduce the risk of downhole drill pipe failures.**
- A positive displacement mud motor will be required to complete the pilot hole. Because of the strength and abrasivity of the bedrock, multiple mud motors may be required.
- The HDD contractor should closely monitor the hours and/or cone revolutions on all tooling to reduce the risk of bearing failure and tool loss downhole.
- The cutting structure design of roller cone drill bits and reamers should be appropriately selected based on the bedrock strength and abrasivity. The profile of the tungsten carbide inserts in the cones on the drill bits and reamers may have a large influence on the rate of penetration (ROP).
- For pipe diameters greater than 24 inches the final hole diameter is generally 12 inches larger than the carrier pipe diameter, or in this case with a 42-inch-diameter carrier pipe, roughly 54 inches. Multiple hole openers of various sizes will be required to enlarge the hole to a minimum final hole diameter of 54 inches which may present challenges for procuring hole openers on short notice.

6.5.2 Pilot Hole - Survey

According to Transco's Horizontal Directional Drilling – Construction specification 33 05 07P, "the position of the drill string must be monitored by contractor with precise downhole survey instruments and verified with secondary survey location equipment (i.e., TruTracker, ParaTrack or equal). A walkover type survey system is not considered equivalent and will require company approval."

The contractor should use a pilot hole survey system capable of calculating the location of the bottom hole assembly (BHA) based on the inclination and azimuth of the steering probe as well as through a secondary means. In addition, Transco's specifications require that the pilot hole survey system be capable of real-time annular pressure readings. The pilot hole survey system should be either a magnetic based system (TruTracker, ParaTrack, or equivalent) where the tool azimuth is determined using the earth's magnetic field or a gyroscopic based system (Brownline's GST, Vector Magnetics' PGM, or Sharewell's Opti-Trac) where both the inclination and azimuth of the survey tool are determined using gyroscopes. Both magnetic and gyroscopic systems available today provide for a secondary means of locating the BHA and annular pressure monitoring.

The proposed HDD alignment is located along undisturbed new pipeline ROW and generally crosses areas relatively flat, including the Banister River and adjacent floodplain, and moderately sloping, outside of the floodplain. The HDD contractor could use a secondary survey coil wire along much of the proposed HDD alignment. We understand that the Banister River floods, at times a significant amount, within the floodplain. If a secondary survey coil wire is used along the ground surface, the coil wire could be disturbed and/or displaced because of flooding conditions. We recommend the HDD contractor review the project

plans, permitting requirements, and workspace limitations to determine the most appropriate pilot hole survey system for this site.

The HDD contractor should complete the pilot hole as closely as possible to the designed HDD alignment and profile while still maintaining three-joint vertical and horizontal radii equal to or greater than the minimum allowable radius specified on the HDD Design Drawing. **We recommend that the three-joint radius be calculated for each three-joint section (for Range 2 Drill Pipe, approximately 90 feet) completed during pilot hole operations. We recommend that the contractor drill the pilot hole within the specified horizontal and vertical tolerances provided on the HDD Design Drawing. We also recommend that, upon completion of the pilot hole, GeoEngineers have the opportunity to review the pilot hole survey data prior to the start of reaming operations.**

6.5.3 Reaming

We recommend that the HDD Contractor consider the use of HDD drill rigs on both sides of the crossing to increase the flexibility of drilling operations and aid in recovering tooling in the event of a downhole tooling failure. The HDD Contractor will need to be prepared for tooling wear as mentioned above and consider the abrasivity of the bedrock anticipated along the HDD profile to estimate the amount of spare tooling that may be required to complete the installation.

6.5.4 Pullback

Based on our analysis of the installation loads (see Table 6), the pullback force during installation of the 42-inch-diameter carrier pipe may be as high as approximately 631,300 pounds, depending on the weight of the drilling fluid in the hole at the time of pullback, the buoyancy control measures employed by the contractor, and how well the hole is prepared for pullback. Because of the relatively large diameter of this pipeline installation, we anticipate that the HDD contractor will elect to use buoyancy control during pullback operations to reduce installation forces and reduce the likelihood of coating damage during installation. Because actual pull loads vary, sometimes greatly, from those estimated because of irregularities in the hole geometry, **we recommend that the selected HDD contractor drill the pilot hole within the specified tolerance using gradual steering corrections so that the pipe can more easily conform to the shape of the hole during installation.**

In our experience, the communication between the general and HDD contractor preceding and during installation of the carrier pipe can contribute, oftentimes significantly, to limiting downtime during pullback. Sheet 2 of the design drawings provides a plan and profile view of the stringing workspace with a typical HDD pullback alignment and additional pull section(s) for reference only. We recommend that the general and HDD contractor discuss the most effective layout of the fabricated pull section(s) and consider the following:

- Ability to install and repair fill lines for buoyancy control water and location of mobile storage tanks relative to the ends of the pull sections;
- Length of carrier pipe installed before temporarily suspending pullback to complete a mid-weld and associated risk;
- Type, size, spacing, and lift capabilities of pullback support equipment;
- Travel lanes for equipment and personnel during pullback operations; and

- Ground surface contours and any grading that may be required to safely support the carrier pipe without overstressing.
- Side slopes within the pipe stringing and fabrication workspace and the necessary adjustments to grades and selection of pullback support equipment that will be made.

Transco's specifications require a pullback plan be submitted as part of the HDD contractor's drill plan. We recommend that the pullback plan address the items listed above at a minimum.

6.6 HYDRAULIC FRACTURE, INADVERTENT RETURNS AND FORMATIONAL FLUID LOSS

As is typical with all HDD installations, we anticipate that there is an elevated risk of hydraulic fracture and inadvertent returns near the entry and exit points. For this crossing, we anticipate there is a high risk of hydraulic fracture and IR within approximately 100 feet of the proposed HDD entry point and within approximately 300 feet of the exit point, assuming the pilot hole is advanced solely from entry to exit. If the pilot hole were to be completed using the intersect method, we estimate the risk near exit to be high within approximately 100 feet of the exit point. We considered the higher risk of IRs near the HDD entry and exit points and proposed additional temporary workspace to include the portions of the HDD alignment where we anticipate the risk of IRs is very high. We understand that no environmentally sensitive features or settlement sensitive structures are located within these high-risk zones. If this risk is unacceptable, temporary steel casing could be installed at the HDD entry and exit points to help reduce the risk, however, it is possible that an IR may occur during installation of the temporary steel casing.

Beyond the areas near the entry and exit points, much of the HDD profile will be situated within primarily metamorphic bedrock. As mentioned above, it is our opinion that the risk of significant formational fluid loss along the proposed HDD is generally low except within the localized zones of poor rock quality observed in the borings.

As a general comment and consideration, proper management of the drilling fluid properties will assist with supporting the hole, properly removing soil and rock cuttings, and contribute to reducing the risk of hydraulic fracture and IR.

The HDD contractor should be aware that a project-specific Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan was developed as a FERC requirement and that they will be required to adhere to the protocols described within the plan. Furthermore, the HDD contractor should be aware that Transco's Horizontal Directional Drilling – Construction specification 33 05 07P requires the HDD contractor to:

- Employ a qualified third-party drilling fluid engineer/technician to develop a drilling fluid program and assist with maintaining appropriate drilling fluid properties during HDD operations.
- Monitor downhole annular pressures while drilling the pilot hole.
- Prepare a crossing-specific Inadvertent Drilling Fluid Return Contingency Plan to respond to IRs, if they should occur along the HDD alignment.
- Monitor facilities and other sensitive areas within a minimum of 500 feet (pending permit and landowner constraints) of the drill path for drilling fluid migration and release.

These procedures should be addressed within the appropriate plans described within Transco's Horizontal Directional Drilling – Construction specification 33 05 07P and be reviewed and approved by Transco prior to construction.

6.7 CUTTINGS REMOVAL

Much of the proposed HDD profile is likely to be located within fair to excellent quality metamorphic bedrock. Provided appropriate drilling fluid properties and flow rates are maintained, cuttings removal should not be problematic due to low penetration rates and higher drilling fluid rates. However, if poor drilling fluid properties are maintained, then the hole may become plugged causing drilling fluid circulation to cease and downhole annular pressures to increase, sometimes significantly. This temporary spike in downhole annular pressure can greatly increase the risk of hydraulic fracture and IRs. If drilling fluid returns begin to diminish or are lost, the HDD contractor should trip out the downhole tooling until drilling fluid returns are reestablished before proceeding forward or make other adjustments necessary to restore drilling fluid returns prior to further advancing the pilot hole or reamed hole to reduce the risk of drill pipe and downhole tooling becoming lodged downhole.

Additionally, if cuttings cannot be effectively removed from the hole during HDD operations, pullback forces could become excessively high during pullback of the carrier pipe, or the carrier pipe could become lodged in the hole. The failure to effectively remove cuttings from the hole could potentially result in failure of the HDD installation. Therefore, we recommend that the HDD contractor maintain drilling fluid returns at all times and use appropriate means and methods (appropriate penetration rates, drilling fluid management, and mechanical methods) to adequately remove cuttings from the hole during the HDD process. Furthermore, we recommend that a drilling fluid engineer be required to test the drilling fluid properties during HDD operations. In our opinion, understanding the drilling fluid rheology (plastic viscosity and yield point) throughout construction is critical to assessing the quality of the drilling fluid and the risk of a potential downhole blockage from accumulated cuttings. As such, and in accordance with Transco's specifications, the contractor should be required to test the drilling fluid rheology throughout construction.

6.8 DRILL HOLE STABILITY

The geotechnical conditions at the site are described in Section 3.3 and in the geotechnical data report in Appendix B. We consider the overall hole instability risk for the proposed HDD to be generally low because the HDD profile should largely be situated within fair to excellent quality bedrock; however, there are localized zones of poorer rock quality which will have a greater risk of hole instability. As the hole diameter increases with successive reaming passes, the risk of instability may increase in poor to very poor quality rock. In the event of localized collapse within the rock portion of the hole during the reaming process, larger rock fragments should be able to be broken down into smaller fragments by the reaming tools.

We consider the risk of hole instability within the shallow portions of the HDD profile situated in the overlying soils to be low to moderate, with the highest risk within approximately 75 feet of the entry point and approximately 100 feet of the exit point because of the soft/loose nature of the near-surface soils and the long construction duration expected to install the new pipeline.

Additionally, if extended zones of poor quality bedrock are encountered, or in transition zones from soil to rock and rock to soil, there is potential for localized hole stability problems. We judge the risk of hole

instability along these sections of the hole to be overall low. **The HDD contractor should submit a plan as part of their drill plan describing how hole instability risks will be mitigated.**

6.9 SOIL/BEDROCK TRANSITION

Based on the borings completed at the site, the subsurface conditions along the designed profile likely transition from soil to rock along the entry and exit tangents. The soil/bedrock interface along with large boulder-sized fragments of bedrock and transitions from softer to harder rock and vice versa may cause steering difficulties during pilot hole operations as the drill bit could become deflected from the designed HDD profile and follow the contour(s) of the soil/rock interface(s) or softer rock, potentially causing an excessive offset within the hole. In our opinion, the risk of steering difficulties when transitioning from soil to rock along the entry and exit tangents is moderate because of the thinner weathering profile overlying the bedrock that results in a relatively abrupt transition from medium dense to very dense decomposed rock to harder more competent bedrock with increasing depth. This risk becomes elevated if boulder-sized rock fragments are encountered through this transition zone. If steering difficulties are experienced, the contractor can reduce the drilling penetration rate to allow the drill bit additional time to penetrate through the rock versus sliding along the soil/rock interface(s).

During the reaming process, the soil/rock interface(s) within the hole can be a location where an excessive vertical offset (dogleg) in the hole profile can form as a result of the relatively heavy rock hole openers over-mining the bottom of the soil portions of the hole. Vertical offsets may also occur where significant variations in bedrock strength are observed. Decreasing the penetration rates of downhole tooling while passing the locations of the soil and rock interface will help allow for the downhole tooling to create a smoother profile and reduce the risk of a vertical offset from developing. If it is suspected that a severe hole offset exists at the soil/rock interface or along segments of the profile where the strength of the bedrock varied significantly, the hole can be reamed to a larger diameter than typically required to allow more annular space for the carrier pipe to conform to the hole and pass through the interface without becoming lodged in the hole. The HDD Contractor should submit an assessment of the potential for excessive hole offset at the soil/rock interface(s) and their proposed mitigation procedures to reduce this risk with their HDD Work Plan.

7.0 Conclusions and Recommendations

It is our opinion that there is a high probability for a qualified, prepared HDD contractor to successfully complete this crossing provided that the contractor adequately addresses the considerations outlined in this report and conducts their operations in general accordance with the HDD Best Practices presented in Appendix E.

7.1 GENERAL RECOMMENDATIONS

We recommend that a prequalification process of the candidate HDD contractors be initiated and then an agreement set in place with the selected HDD contractor so that detailed construction procedures can be agreed upon through means of a written drill plan. **We recommend that GeoEngineers be given an opportunity to review the drill plan prepared by the HDD contractor to confirm that the considerations outlined in this report were adequately addressed.**

We recommend contacting GeoEngineers. immediately if subsurface conditions are claimed to be different than presented in this report. Because the subsurface conditions can vary between widely spaced borings, we recommend GeoEngineers be on site during HDD construction to document the drilling process in real time and to characterize and quantify risks that might reduce the potential for a successful installation of this HDD.

In accordance with Transco's Horizontal Directional Drilling – Construction specification 33 05 07P, a qualified drilling fluid technician or engineer will be required to evaluate the drilling fluid properties (including rheological properties [plastic viscosity and yield point]) on a continuous basis throughout the entire HDD process. Close coordination between the HDD contractor and the drilling fluid technician is vital to maintaining proper drilling fluid properties, penetration rates and drilling fluid flow rates.

7.2 HDD DRILL PLAN REQUIREMENTS

We recommend that the HDD contractor address the items below in their HDD Drill Plan to facilitate a successful carrier pipe installation and to mitigate possible difficulties that could arise during the HDD installation. The list below is intended to provide items that should be addressed based on site-specific construction considerations but does not include all items that are provided in a typical drill plan such as size and type of equipment to be used to complete the crossing, pilot hole tracking system and drilling fluid recycling system. The contractor's drill plan should include all drill plan items required in the contract specifications and include those noted below.

- A plan that addresses how the bedrock strength and abrasivity will affect penetration rates and the estimated construction schedule, necessary drill bit and hole opener specifications, and the number of drill bits and hole openers in their estimate. Consideration of the following should be discussed:
  - Use of HDD drill rigs on both sides of the crossing.
  - Monitoring plan for downhole tooling hours/revolutions.
  - Monitoring/inspection plan for drill pipe and crossover sub wear.
- Proposed pilot hole survey system(s) and a narrative describing any limitations on the selected survey system.
- A pilot hole drill plan to reduce the risks of hydraulic fracture and inadvertent returns. The plan should include the following:
  - Drill bit type and size and drill pipe sizes with the intention of providing sufficient annular space between the drilled hole and the drill pipe such that the risk of hydraulic fracture and inadvertent returns can be reduced to the extent practical.
  - Proposed method of monitoring downhole annular pressures during pilot hole operations in accordance with Transco's specifications.
- A contingency and mitigation plan to respond to downhole annular pressure spikes, loss of drilling fluid returns and inadvertent drilling fluid returns, if they should occur along the HDD alignment. This plan should include, but not be limited to, drilling fluid returns monitoring and response, surface patrols, containment structures, drilling fluid removal, and materials to be staged at the site to contain and collect inadvertent returns. This plan should emphasize means and methods the contractor will utilize to reduce the risk of inadvertent returns occurring along the HDD alignment. This plan should be

reviewed and approved by Transco and any applicable regulatory agencies prior to the beginning of construction.

- An assessment of the potential for excessive hole offset at the soil/rock interface(s) and proposed mitigation procedures to reduce this risk as part of the drill plan.
- Documentation for all drilling fluid constituents intended for use, including manufacturer's literature and material safety data sheets (MSDS).

8.0 Failure and Contingency Planning

As a result of Transco's commitment to undertake a robust subsurface exploration program, we anticipate the Banister River HDD has a low risk of failure provided that the contractor prepares a drill plan that addresses the conditions described in this report. Transco has prepared and submitted a Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan addressing contingency planning for the proposed Banister River HDD, as required for the project. In the event difficulties are encountered during construction, Transco, the HDD contractor and general contractor will implement the contingency plan as appropriate.

9.0 Limitations

We have prepared this report for use by Transco and their authorized agents and other approved members of the design team involved with this project. The report is not intended for use by others and the information contained herein is not applicable to other sites. Our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions. The conclusions and recommendations in this report should be applied in their entirety.

Variations in subsurface conditions are possible between the borings. Subsurface conditions may also vary with time. A contingency for unanticipated conditions should be included in the project budget and schedule for such an occurrence. We recommend that sufficient monitoring and consultation be provided by GeoEngineers during construction to confirm that the conditions encountered are consistent with those indicated by the borings, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and pipeline installation activities comply with contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct The HDD contractor's methods, techniques, sequences, or procedures, except as specifically described in our report for consideration in developing a drill plan.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty or other conditions, express, written, or implied, should be understood.

Please refer to Appendix F, titled "Report Limitations and Guidelines for Use," for additional information pertaining to the use of this report.

10.0 References

American Petroleum Institute (API) Recommended Practice 2A – WSD. July 1, 1993. "Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms – Working Stress Design, API Recommended Practice 2A-WSD."

American Society of Mechanical Engineers (ASME). 2022. Gas Transmission and Distribution Piping Systems (B31.8). Parts 833.3 and 833.4.

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Code of Federal Regulations (CFR). 2017. "Design Factor for Steel Pipe," CFR Transportation, Title 49 Part 192.111.

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Pipeline Research Committee International (PRCI) of the American Gas Association "Installation of Pipelines by Horizontal Directional Drilling, An Engineering Design Guide." September 23, 2015.

Staheli, K., R.D. Bennett, H.W. O'Donnell and T.J. Hurley. 1998. Installation of Pipelines beneath levees using horizontal directional drilling, Technical Report CPAR-GL-98-1, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Staheli K., C. Price and L. Wetter. 2010. "Effectiveness of Hydrofracture Prediction for HDD Design" Proceedings of 2010 No-Dig Conference, Chicago, Illinois, May 2-7, 2010.

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Tables

Table 7

Rock Core Laboratory Test Results[1]

Banister River HDD

Pittsylvania County, Virginia

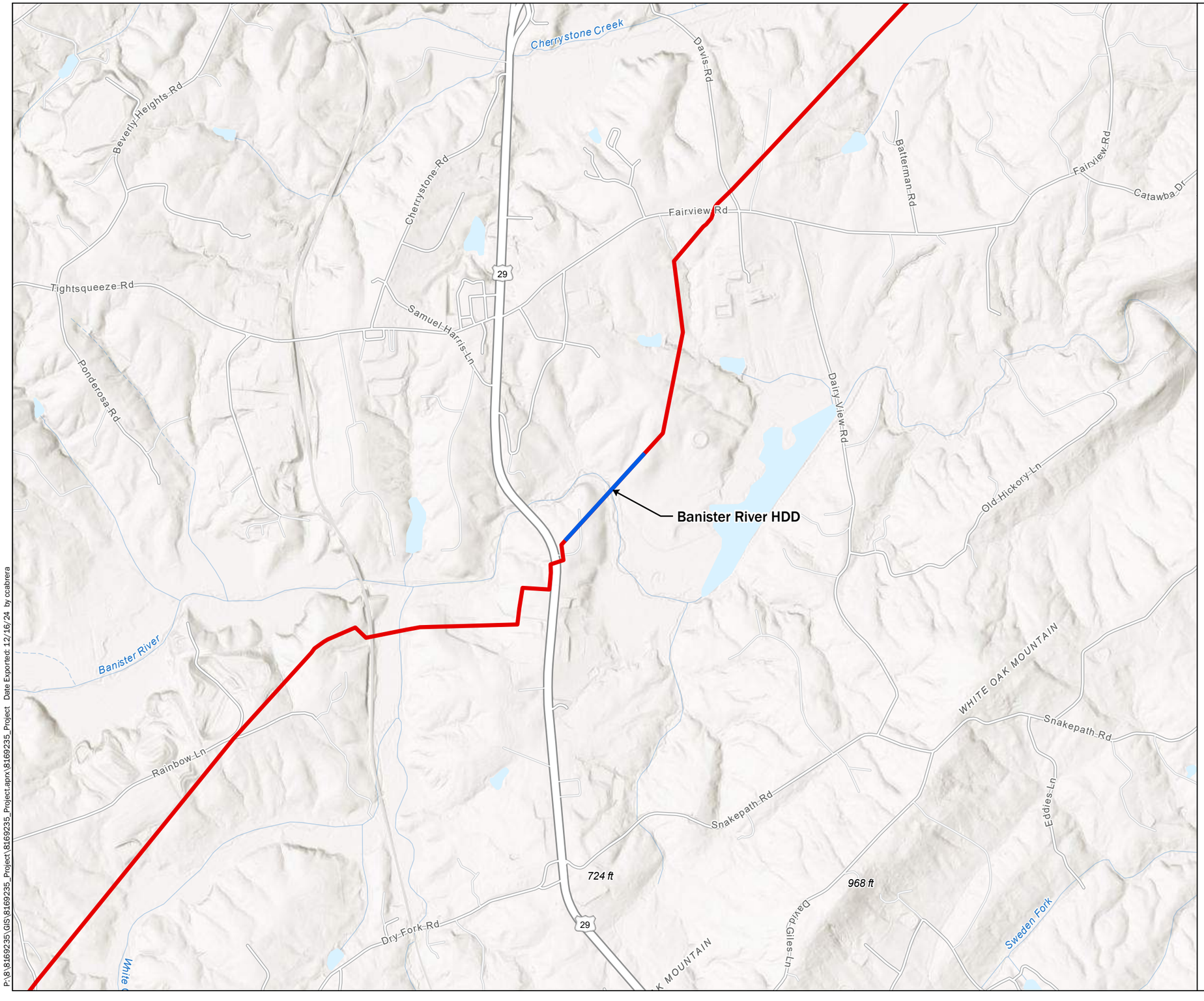
Boring	Depth (Feet)	Dry Unit Weight (pcf)	Mohs' Hardness	Cerchar Abrasivity Index	Approx. Point Load Estimated Compressive Strength (psi)	Young's Modulus (psi)	Unconfined Compressive Strength (psi)
ABR-B-1	40.8 – 45.8		6.5		5,300		
	45.8 – 50.8	170	8.5				6,950
	60.8 – 65.8	175	6.5				6,170
	70.8 – 75.8	168	5.5	3.29		7,617,000	12,439
	90.8 – 75.8	167	7.5				7,390
ABR-B-2	30.7 – 35.7		6.5		1,700		
	35.7 – 40.7	168	6.5				1,390
	50.7 – 55.7	181	6.5				8,950
	65.7 – 70.7	172	7.5				13,730
	80.7 – 85.7	172	4.5				7,320
	100.7 – 105.7	175	4.5	4.48		2,126,000	8,627
	115.7 – 120.7	163	7.5				5,370
	120.7 – 125.7			4.63			
ABR-B-3	24.6 – 29.6	173	6.5				9,090
	39.6 – 44.6	171	6.5				4,390
	54.6 – 59.6	172	6.5				5,650
	69.6 – 74.6	177	6.5	4.53		2,674,000	6,566
	84.6 – 89.6	167	6.5				1,660
	89.6 – 94.6			4.05			
	99.6 – 104.6	169	6.5				7,150
ABR-B-4	30.2 – 35.2		7.5		18,000		
	35.2 – 40.2	172	6.5				10,190
	40.2 – 45.2			5.15			
	70.2 – 75.2		6.5				
	85.2 – 90.2	171	7.5				10,080

Notes:

[1]Refer to Geotechnical Data Report for laboratory test results and rock core photographs.

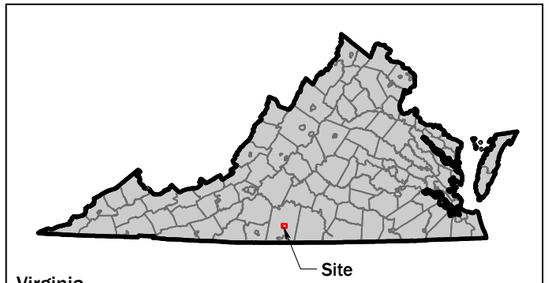
pcf = pounds per cubic foot; psi = pounds per square inch

Figures



Legend

- Proposed Centerline Alignment
- Proposed HDD Alignment



Notes:

1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Data Source: ESRI

Projection: NAD 1983 2011 StatePlane Virginia South FIPS 4502 Ft US

N

0 2,000

FEET

Transcontinental Gas Pipeline Company, LLC
Vicinity Map

Proposed 42-inch Eden Loop
Banister River HDD
Pittsylvania County, Virginia

GeoEngineers

Figure 1

P:\8 \8169235\GIS\8169235_Project\8169235_Project.aprx\8169235_Project Date Exported: 12/16/24 by ccabrera

Photograph 1: Banister River Horizontal Directional Drill (HDD) Entry (southwest side) Workspace (photograph taken in October 2024 [Facing Northwest])

Photograph 2: Banister River HDD Entry Workspace (photograph taken October 2024 [Facing Southwest])

Transcontinental Gas Pipeline Company, LLC
Banister River HDD Site Photographs

Proposed 42-inch Eden Loop
Banister River HDD
Pittsylvania County, Virginia

GeoEngineers

Figure 2

8169-235-00 Date Exported: 1/13/25

Photograph 3: Banister River HDD Exit (northeast side) Workspace (photograph taken October 2024 [Facing Southwest])

Photograph 4: Banister River HDD Exit Workspace (photograph taken October 2024 [Facing North])

Transcontinental Gas Pipeline Company, LLC
Banister River HDD Site Photographs

Proposed 42-inch Eden Loop
Banister River HDD
Pittsylvania County, Virginia

GeoEngineers

Figure 3

8169-235-00 Date Exported: 1/13/25

Photograph 5: Banister River HDD Pipe Stringing and Fabrication Workspace (photograph taken October 2024 [Facing Northeast])

Photograph 6: Banister River HDD Pipe Stringing and Fabrication Workspace (photograph taken October 2024 [Facing Northeast])

Transcontinental Gas Pipeline Company, LLC
Banister River HDD Site Photographs

Proposed 42-inch Eden Loop
Banister River HDD
Pittsylvania County, Virginia

GeoEngineers

Figure 4

8169-235-00 Date Exported: 1/13/25

Photograph 7: Banister River (photograph taken October 2024 [Facing South])

Transcontinental Gas Pipeline Company, LLC
Banister River HDD Site Photographs

Proposed 42-inch Eden Loop
Banister River HDD
Pittsylvania County, Virginia

GeoEngineers

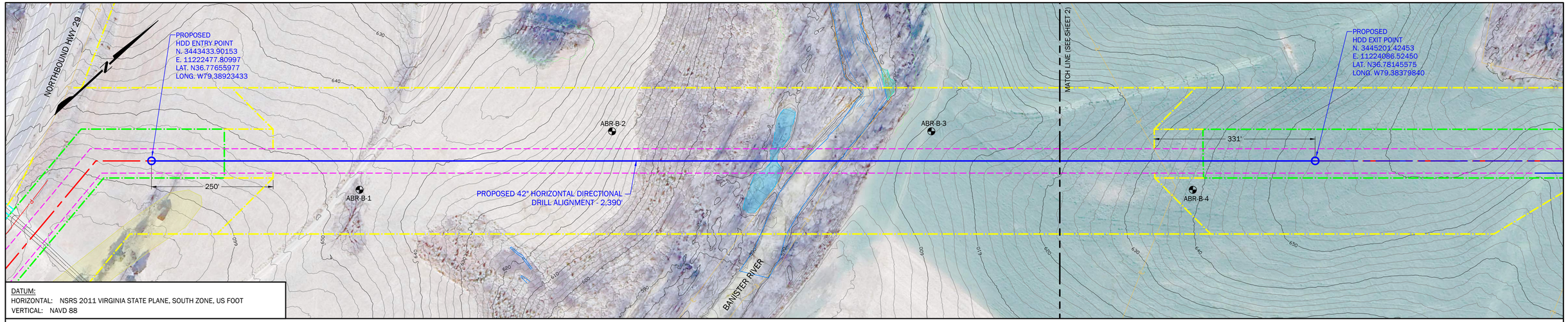
Figure 5

8169-235-00 Date Exported: 1/13/15

Appendices

Appendix A

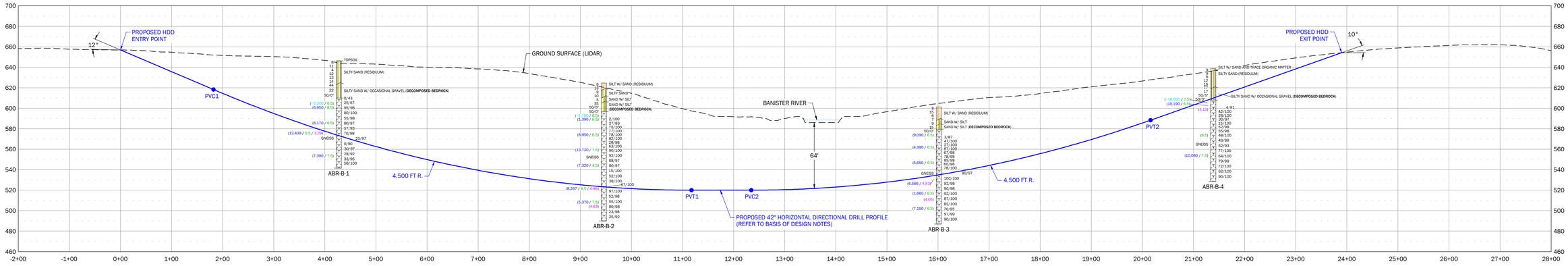
Design Drawings (Sheets 1 through 4)



DATUM:
HORIZONTAL: NSRS 2011 VIRGINIA STATE PLANE, SOUTH ZONE, US FOOT
VERTICAL: NAVD 88

PLAN

100 0 100
SCALE IN FEET



DIRECTIONAL DRILL DATA BANISTER RIVER HDD		
DESCRIPTION	STATION (FT)	ELEVATION (FT)
ENTRY @ 12°	0+00.00	657.02
PVC1 (12.00° @ 4,500 FT R.)	1+81.98	618.34
PVT1	11+17.59	520.00
PVC2 (10.00° @ 4,500 FT R.)	12+34.41	520.00
PVT2	20+15.82	588.37
EXIT @ 10°	23+90.00	654.34
HORIZONTAL DISTANCE = 2,390.00 FT		
DIRECTIONAL DRILL PIPE LENGTH = 2,410.69 FT		

PILOT HOLE TOLERANCES	
ITEM	* TOLERANCE
ENTRY ANGLE	INCREASE ANGLE UP TO 1° (STEEPER), BUT NO DECREASE IN ANGLE ALLOWED.
ENTRY LOCATION	AS PER COORDINATES PROVIDED BY COMPANY WITH NO CHANGES WITHOUT COMPANY APPROVAL.
EXIT ANGLE	INCREASE ANGLE UP TO 1° (STEEPER) OR DECREASE UP TO 2° (FLATTER).
EXIT LOCATION	UP TO 20 FEET BEYOND OR 10 FEET SHORT OF THE EXIT STAKE. BETWEEN 5 FEET LEFT AND 5 FEET RIGHT OF CENTERLINE.
DEPTH	UP TO 2 FEET ABOVE THE DESIGN DRILL PROFILE ALLOWED. UP TO 10 FEET BELOW THE DESIGN DRILL PROFILE ALLOWED.
ALIGNMENT	UP TO 5 FEET LEFT OR RIGHT OF THE HDD ALIGNMENT WILL BE ALLOWED.
MINIMUM ALLOWABLE 3-JOINT RADIUS	3,200 FEET

* TOLERANCE SHALL BE MAINTAINED UNLESS OTHERWISE APPROVED BY THE COMPANY.

BASIS OF DESIGN:

1. CARRIER PIPE WILL CONSIST OF 42" O.D. X 0.888" W.T., API-5L X-70 PIPE WITH 12 MILS BASE FUSION BONDED EPOXY (FBE), 30 MILS OF FBE-ABRASION RESISTANT OVERLAY (ARO), AND 50 MILS OF LIQUID ARO.
2. THE MAXIMUM ALLOWABLE OPERATING PRESSURE (MAOP) = 1,480 PSI.
3. DESIGN FACTOR = 0.5
4. THE ASSUMED OPERATING TEMPERATURE = 70° FAHRENHEIT
5. THE ASSUMED TIE-IN TEMPERATURE = 50° FAHRENHEIT

ISSUED FOR PERMIT

BORING LEGEND

SPT N — TYPE OF SOIL
UNCONFINED COMPRESSIVE STRENGTH (PSI)
POINT LOAD CORRELATION (PSI)
Mohs HARDNESS (#)
CERCHAR ABRASIVITY INDEX (#)
TYPE OF ROCK — RQD/REC%

BORING LOCATION

PROFILE

100 0 100
HORIZONTAL SCALE IN FEET
50 0 50
VERTICAL SCALE IN FEET

Table 1: Mohs Hardness Scale

Mineral Name	Scale Number	Common Object
Diamond	10	
Corundum	9	Masonry Drill Bit (8.5)
Topaz	8	
Quartz	7	Steel Nail (6.5)
Orthoclase	6	Knife / Glass Plate (5.5)
Apatite	5	
Fluorite	4	Copper Penny (3.5)
Calcite	3	Fingernail (2.5)
Gypsum	2	
Talc	1	

Table 2: Cerchar Abrasivity Index Classification

Classification	Average CAI (hrc=55)
Very Low Abrasiveness	0.3 – 0.5
Low Abrasiveness	0.5 – 1.0
Medium Abrasiveness	1.0 – 2.0
High Abrasiveness	2.0 – 4.0
Extreme Abrasiveness	4.0 – 6.0
Quartzitic	6.0 – 7.0

LEGEND

- PROPOSED CENTERLINE ALIGNMENT
- PROPOSED PIPELINE EASEMENT
- PROPOSED TEMPORARY WORKSPACE
- PROPOSED ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED ACCESS ROUTE
- PROPOSED FOOT TRAFFIC WORKSPACE
- EXISTING PROPERTY LINE
- EXISTING DRAINAGE CENTERLINE
- TOP OF BANK
- EDGE OF ROAD
- ROAD CENTERLINE
- TREE LINE
- PALUSTRINE FORESTED WETLANDS
- ARCHAEOLOGICAL AREA
- POND/WATER AREA
- WATERWAY LINE
- MAJOR CONTOUR - 10' INTERVAL
- MINOR CONTOUR - 2' INTERVAL

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
PROFESSIONAL ENGINEER
1/24/2025

Know what's below. Call before you dig. 811

GeoEngineers

HDD CONTRACTOR NOTES:

1. HDD CONTRACTOR SHALL ADHERE TO OWNER'S SPECIFICATIONS, CONTRACT DOCUMENTS AND SPECIAL PERMIT CONDITIONS, EXCEPT AS NOTED ON THIS DRAWING.
2. HDD CONTRACTOR SHALL FAMILIARIZE THEMSELVES WITH THE ACCOMPANYING HDD DESIGN REPORT FOR A MORE DETAILED DESCRIPTION OF THE HDD DESIGN BASIS AND ASSUMPTIONS INCLUDING SUBSURFACE CONDITIONS, SURFACE CONDITIONS, AND HDD CONSTRUCTION RISKS AND CONSIDERATIONS.
3. HDD CONTRACTOR IS RESPONSIBLE FOR CALLING VIRGINIA ONE-CALL AND PHYSICALLY LOCATING UNDERGROUND UTILITIES THAT MAY CONFLICT WITH HDD OPERATIONS PRIOR TO BEGINNING CONSTRUCTION.
4. HDD CONTRACTOR SHALL IDENTIFY AND PROTECT ANY UTILITY THAT MAY BE AFFECTED BY THE HDD OPERATIONS.
5. WATER USED FOR HDD OPERATIONS SHALL BE OBTAINED FROM A SOURCE APPROVED BY OWNER.
6. REFUELING OF ALL EQUIPMENT SHALL BE COMPLETED IN ACCORDANCE WITH THE OWNER'S CONTRACT DOCUMENTS.
7. THE HDD PILOT HOLE SHALL BE ADVANCED FROM THE ENTRY POINT TO THE EXIT POINT AS SHOWN UNLESS OTHERWISE APPROVED BY THE OWNER IN CONSULTATION WITH GEOENGINEERS.
8. THE HDD PILOT HOLE GEOMETRY SHALL BE MAINTAINED WITHIN THE TOLERANCES SHOWN ON THESE DRAWINGS.
9. DURING PILOT HOLE OPERATIONS, DOWNHOLE ANNULAR PRESSURES WILL BE RECORDED AND EVALUATED RELATIVE TO CALCULATED AND ANTICIPATED ANNULAR DRILLING FLUID PRESSURE RANGE. IF THE DOWNHOLE ANNULAR PRESSURE BEGINS TO DEVIATE OUTSIDE OF THE CALCULATED AND ANTICIPATED ANNULAR DRILLING FLUID PRESSURE RANGE, THE HDD CONTRACTOR WILL EVALUATE DRILLING CONDITIONS AND TAKE NECESSARY AND REASONABLE STEPS TO BRING THE ANNULAR DRILLING FLUID PRESSURE BACK WITHIN THE EXPECTED RANGE.
10. DRILLING FLUID PROPERTIES SHALL BE MONITORED AND TESTED BY A DRILLING FLUID ENGINEER AND BE MODIFIED AS NECESSARY TO MAINTAIN HOLE STABILITY, EFFECTIVELY REMOVE CUTTINGS, AND LIMIT ANNULAR DRILLING FLUID PRESSURES.
11. HDD CONTRACTOR SHALL TAKE NECESSARY STEPS TO MAINTAIN DRILLING FLUID RETURNS TO THE ENTRY AND/OR EXIT POINTS. IF DRILLING FLUID RETURNS DIMINISH, HDD CONTRACTOR SHALL IMPLEMENT PROCEDURES OUTLINED WITHIN HDD IR CONTINGENCY PLAN.
12. THE HDD CONTRACTOR SHALL PROVIDE PILOT HOLE SURVEY DATA TO OWNER'S REPRESENTATIVE UPON REQUEST.
13. ACCESS TO THE DRILL CAB SHALL BE PERMITTED BY APPROVED OWNER'S REPRESENTATIVE IN ORDER TO OBSERVE AND DOCUMENT GUAGE DATA AT THE DISCRETION OF THE OWNER'S REPRESENTATIVE.
14. AFTER THE PILOT HOLE IS COMPLETE, CONTRACTOR'S AS-DRILLED PROFILE SHALL BE SUBMITTED TO OWNER FOR APPROVAL PRIOR TO PROCEEDING WITH HDD ACTIVITIES IF REQUIRED BY THE CONTRACT DOCUMENTS.
15. THE DRILL STRING SHALL BE ROTATED PRIOR TO PUMPING DRILLING FLUID DOWNHOLE TO BREAK THE FLUID GEL STRENGTH AND ALLOW THE FLUID TO BECOME MORE FLOWABLE.
16. HDD CONTRACTOR SHALL CONFIRM THAT THE HOLE IS PROPERLY PREPARED FOR CARRIER PIPE PULLBACK BY CONDUCTING AT LEAST ONE SWAB PASS, AS REQUIRED BY OWNER'S SPECIFICATIONS.
17. THE CARRIER PIPE PULL SECTION(S) SHALL BE MADE UP WITHIN THE APPROVED CONSTRUCTION PIPE STRINGING AND FABRICATION WORKSPACE AS SHOWN ON THIS DRAWING.
18. HDD CONTRACTOR SHALL DISPOSE OF EXCESS DRILLING FLUID IN ACCORDANCE WITH THE APPROVED DRILL PLAN AND OWNER'S CONTRACT DOCUMENTS.
19. HDD CONTRACTOR SHALL FOLLOW THE REQUIRMENTS IN THE CONTRACT DOCUMENTS REGARDING INADVERTENT DRILLING FLUID RETURNS PREVENTION, MONITORING, CONTAINMENT AND REPORTING.

REFERENCES:

1. GEOTECHNICAL DATA: THE GEOTECHNICAL INFORMATION PROVIDED ON THIS DRAWING IS A GENERAL SUMMARY. REFER TO THE HDD DESIGN REPORT ASSOCIATED WITH THIS DRAWING FOR MORE DETAILED INFORMATION.
2. AERIAL IMAGE TAKEN FROM GOOGLE EARTH PRO © 2025, LICENSED TO GEOENGINEERS, INC., IMAGE DATED 12/01/22.
3. GROUND SURFACE AND SURVEY DATA PROVIDED BY TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC.

REFERENCE DRAWINGS								
DRAWING NO.	TITLE	NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
MAIN-E_PEX	CIVIL SURVEY	A	11/07/24	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
EDEN LAND	BOUNDARY SURVEY	B	01/14/25	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
FERC SUPPLEMENT	PROPOSED CENTERLINE, EASEMENTS & TWS	C	01/24/25	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR
SHAPE FILES	ARCHAEOLOGY & WETLANDS							

TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
PLAN AND PROFILE
BANISTER RIVER HDD
MP 14+08.56 TO 14+09.02
PITTSYLVANIA COUNTY, VIRGINIA

Williams

DRAWN BY: BTL	DATE: 08/07/24	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY: TJP	DATE: 08/07/24	ISSUED FOR CONSTRUCTION:	REVISION:
APPROVED BY:	DATE:	DRAWING NUMBER: BANISTER RIVER HDD_REV C	SHEET 1 OF 4
WO:	RID:	9:11:42 AM BLANE 1/24/2025	

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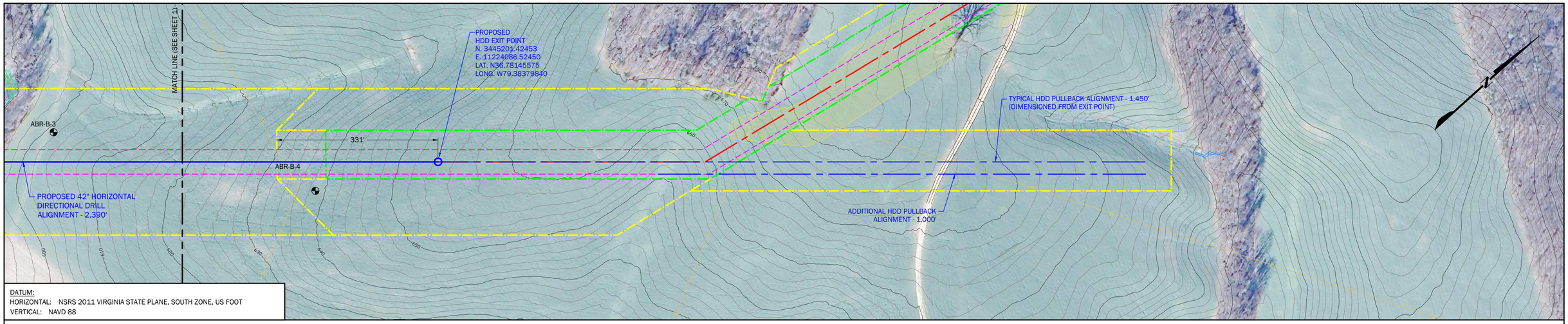

DATUM:
HORIZONTAL: NSRS 2011 VIRGINIA STATE PLANE, SOUTH ZONE, US FOOT
VERTICAL: NAVD 88

PLAN

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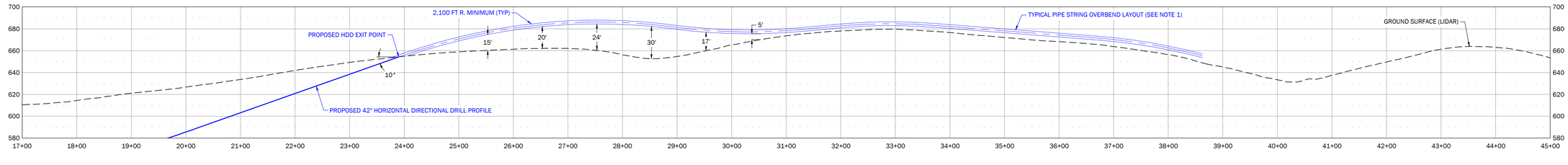
SCALE IN FEET



PROFILE

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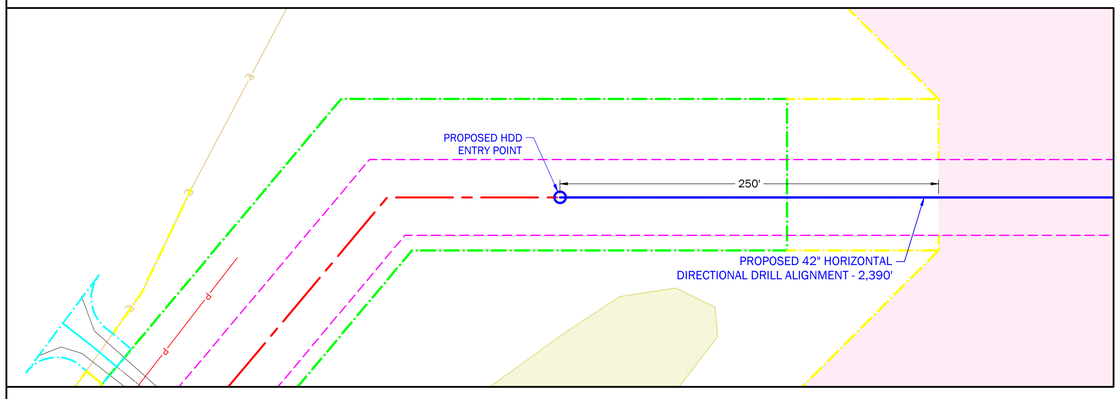
SCALE IN FEET
50 0 50
VERTICAL SCALE IN FEET



ENTRY DETAIL

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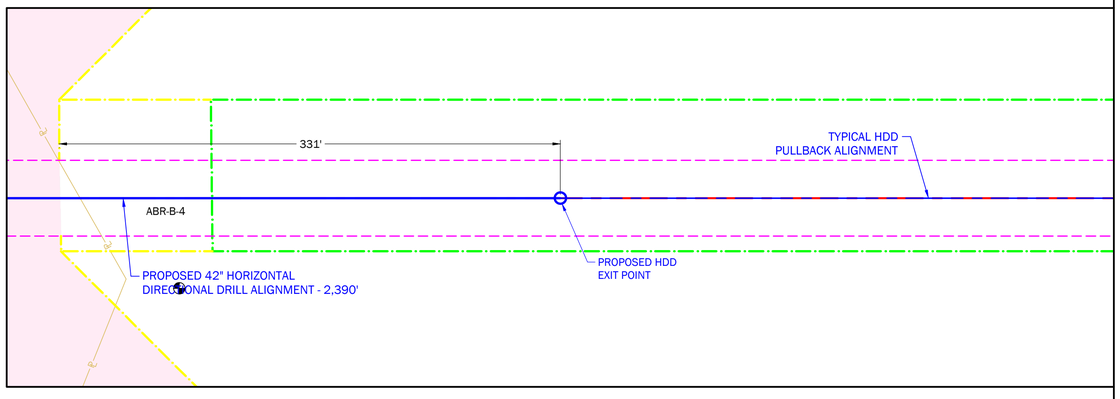
SCALE IN FEET



EXIT DETAIL

50 0 50
SCALE IN FEET

NOTES:

1. TYPICAL PIPE STRING OVERBEND LAYOUT ASSUMES A RADIUS OF CURVATURE OF 2,100 FEET. DIMENSIONS RELATIVE TO GROUND SURFACE ARE FOR REFERENCE ONLY.
2. HDD CONTRACTOR SHALL SUBMIT A PULLBACK LIFT PLAN IN ACCORDANCE WITH TRANSCO'S SPECIFICATIONS AND CONTRACT DOCUMENTS.

ISSUED FOR PERMIT

LEGEND

- BORING LOCATION
- PROPOSED CENTERLINE ALIGNMENT
- PROPOSED PIPELINE EASEMENT
- PROPOSED TEMPORARY WORKSPACE
- PROPOSED ADDITIONAL TEMPORARY WORKSPACE
- PROPOSED ACCESS ROUTE
- PROPOSED FOOT TRAFFIC WORKSPACE
- EXISTING PROPERTY LINE
- TOP OF BANK
- EDGE OF ROAD
- ROAD CENTERLINE
- TREE LINE
- PALUSTRINE FORESTED WETLANDS
- ARCHAEOLOGICAL AREAS

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
1/24/2025
PROFESSIONAL ENGINEER

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REFERENCE DRAWINGS		REVISIONS						
DRAWING NO.	TITLE	NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
MAIN-E_PEX	CIVIL SURVEY	A	12/04/24	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
EDEN LAND	BOUNDARY SURVEY	B	01/14/25	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
FERC SUPPLEMENT	PROPOSED CENTERLINE, EASEMENTS & TWS	C	01/24/25	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR
SHAPE FILES	ARCHAEOLOGY & WETLANDS							

TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
STRINGING WORKSPACE / DETAILS
BANISTER RIVER HDD
MP 14+08.56 TO 14+09.02
PITTSYLVANIA COUNTY, VIRGINIA

Williams

DRAWN BY: BTL	DATE: 11/04/24	ISSUED FOR BID:	SCALE: 1" = 100'
CHECKED BY: TJP	DATE: 11/04/24	ISSUED FOR CONSTRUCTION:	REVISION:
APPROVED BY:	DATE:	DRAWING NUMBER: BANISTER RIVER HDD_REV C	SHEET 2
WO:	RID:	9:12:01 AM BLANE 1/24/2025	OF 4

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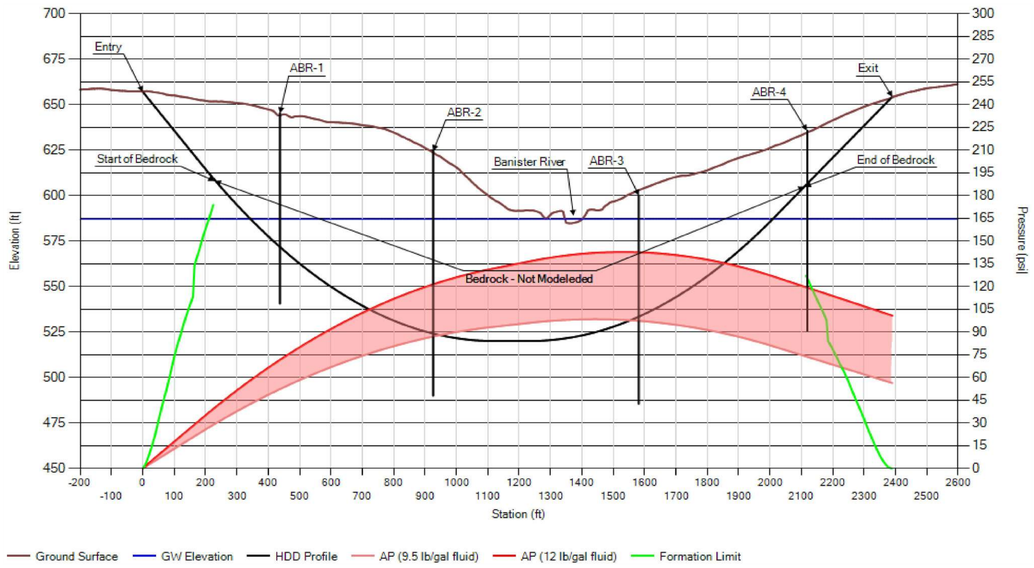
Hydraulic Fracture Analysis (HFA)



HDD Design Summary

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Design Parameters

Pipe Diameter =	42.000 in	Min. Operating Temp =	50 °F
Wall Thickness =	0.888 in	Max. Operating Temp =	70 °F
Yield Stress =	70,000 psi	Design Factor =	0.5
Pipe Material =	Steel	MAOP =	1,480 psi

Drill Data Box

Point	Station (ft)	Elevation (ft)
ENTRY @ 12°	0.00	657.02
PVC1 (12.00° @ 4,500 ft R.)	181.98	618.34
PVT1	1,117.59	520.00
PVC2 (10.00° @ 4,500 ft R.)	1,234.41	520.00
PVT2	2,015.82	588.37
EXIT @ 10°	2,390.00	654.34

Horizontal Alignment Length = 2,390.00 ft

Profile Segment Information

Segment Name	Segment Type	Segment Length (ft)
Entry Tangent	Straight	186.05
Entry Curve	Vertical Curve	942.48
Bottom Tangent	Straight	116.82
Exit Curve	Vertical Curve	785.40
Exit Tangent	Straight	379.95

Pipe Length = 2,410.69 ft

Installation Load Summary

Drilling Fluid Weight (lb/gal)	Buoyancy Condition	Buoyancy Control (lb/ft)	Effective Pipe Weight (lb/ft)	Total Installation Force* (lb)
9.50	Empty	0.00	-292.86	475,200
9.50	Full	550.66	257.80	370,800
12.00	Empty	0.00	-472.79	631,300
12.00	Full	550.66	77.87	230,400
12.00	Neutral	472.79	0.00	215,500

* Pull forces are rounded to the nearest 100 lb

ISSUED FOR PERMIT

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
1/24/2025
PROFESSIONAL ENGINEER

GeoEngineers

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REFERENCE DRAWINGS		REVISIONS						
DRAWING NO.	TITLE	NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
		A	01/14/25	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
		B	01/24/25	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR

TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
HFA AND INSTALLATION FORCE SUMMARY
BANISTER RIVER HDD
MP 14+08.56 TO 14+09.02
PITTSYLVANIA COUNTY, VIRGINIA

Williams

DRAWN BY: BTL	DATE: 12/12/24	ISSUED FOR BID:	SCALE:
CHECKED BY: TJP	DATE: 12/12/24	ISSUED FOR CONSTRUCTION:	REVISION:
APPROVED BY:	DATE:	DRAWING NUMBER: BANISTER RIVER HDD_REV C	SHEET 3 OF 4
WO:	RID:	9:12:02 AM BLANE 1/24/2025	

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Calculated Drilling Fluid Pressures

Station	Profile Elevation (feet)	Profile Measured Distance (MD) (feet)	Lower Bound Calculated Drilling Fluid Pressure (psi) (Entry to Exit)	Upper Bound Calculated Drilling Fluid Pressure (psi) (Entry to Exit)	Lower Bound Calculated Drilling Fluid Pressure (psi) (Exit to Entry)	Upper Bound Calculated Drilling Fluid Pressure (psi) (Exit to Entry)
0+00	657.02	0	0	0	53.59	97.33
0+10	654.89	10.22	1.28	1.74	54.4	98.23
0+20	652.77	20.45	2.56	3.49	55.22	99.14
0+30	650.64	30.67	3.85	5.23	56.03	100.04
0+40	648.52	40.89	5.13	6.98	56.85	100.95
0+50	646.39	51.12	6.41	8.72	57.67	101.85
0+60	644.26	61.34	7.69	10.47	58.48	102.76
0+70	642.14	71.56	8.97	12.21	59.3	103.66
0+80	640.01	81.79	10.25	13.96	60.11	104.57
0+90	637.89	92.01	11.54	15.7	60.93	105.47
1+00	635.76	102.23	12.82	17.45	61.75	106.38
1+10	633.64	112.46	14.1	19.19	62.56	107.28
1+20	631.51	122.68	15.38	20.94	63.38	108.19
1+30	629.39	132.9	16.66	22.68	64.2	109.09
1+40	627.26	143.13	17.94	24.43	65.01	110
1+50	625.13	153.35	19.23	26.17	65.83	110.9
1+60	623.01	163.57	20.51	27.92	66.64	111.81
1+70	620.88	173.8	21.79	29.66	67.46	112.72
1+80	618.76	184.02	23.07	31.41	68.28	113.62
1+90	616.64	194.24	24.35	33.15	69.09	114.52
2+00	614.54	204.46	25.62	34.87	69.89	115.41
2+10	612.47	214.68	26.87	36.58	70.68	116.28
2+20	610.42	224.89	28.11	38.28	71.46	117.14
2+30	608.4	235.09	29.35	39.96	72.22	117.98
2+40	606.4	245.29	30.57	41.62	72.98	118.81
2+50	604.42	255.48	31.77	43.28	73.72	119.62
2+60	602.47	265.67	32.97	44.91	74.45	120.42
2+70	600.54	275.86	34.15	46.53	75.17	121.2
2+80	598.63	286.04	35.33	48.14	75.88	121.97
2+90	596.75	296.22	36.49	49.73	76.58	122.73
3+00	594.89	306.39	37.64	51.31	77.27	123.47
3+10	593.06	316.56	38.77	52.87	77.94	124.2
3+20	591.24	326.72	39.9	54.42	78.6	124.91
3+30	589.45	336.88	41.01	55.95	79.25	125.61
3+40	587.69	347.04	42.12	57.47	79.89	126.29
3+50	585.95	357.19	43.21	58.97	80.52	126.96
3+60	584.23	367.34	44.29	60.46	81.14	127.62
3+70	582.53	377.48	45.35	61.93	81.75	128.26
3+80	580.86	387.62	46.41	63.39	82.34	128.88
3+90	579.21	397.76	47.46	64.84	82.92	129.5
4+00	577.58	407.89	48.49	66.27	83.5	130.09
4+10	575.98	418.02	49.51	67.68	84.06	130.68
4+20	574.4	428.15	50.52	69.08	84.61	131.25
4+30	572.84	438.27	51.52	70.47	85.14	131.8
4+40	571.3	448.39	52.51	71.84	85.67	132.34
4+50	569.79	458.5	53.49	73.2	86.19	132.87
4+60	568.3	468.61	54.45	74.54	86.69	133.38
4+70	566.84	478.72	55.4	75.87	87.18	133.88
4+80	565.39	488.82	56.35	77.18	87.67	134.37
4+90	563.97	498.93	57.28	78.48	88.14	134.84
5+00	562.58	509.02	58.2	79.77	88.6	135.29
5+10	561.2	519.12	59.1	81.04	89.04	135.73
5+20	559.85	529.21	60	82.3	89.48	136.16
5+30	558.52	539.3	60.89	83.54	89.91	136.58
5+40	557.22	549.39	61.76	84.77	90.32	136.98
5+50	555.94	559.47	62.62	85.98	90.73	137.36
5+60	554.68	569.55	63.47	87.18	91.12	137.73
5+70	553.44	579.62	64.31	88.37	91.5	138.09
5+80	552.22	589.7	65.14	89.54	91.87	138.43
5+90	551.03	599.77	65.96	90.69	92.23	138.76
6+00	549.86	609.84	66.77	91.84	92.57	139.08
6+10	548.72	619.91	67.56	92.96	92.91	139.38
6+20	547.59	629.97	68.35	94.08	93.24	139.67
6+30	546.49	640.03	69.12	95.18	93.55	139.94
6+40	545.41	650.09	69.88	96.26	93.85	140.2
6+50	544.36	660.15	70.63	97.33	94.15	140.45
6+60	543.32	670.2	71.37	98.39	94.43	140.68
6+70	542.31	680.25	72.1	99.43	94.7	140.89
6+80	541.32	690.3	72.81	100.46	94.96	141.1
6+90	540.36	700.35	73.52	101.48	95.2	141.29
7+00	539.41	710.39	74.21	102.48	95.44	141.46
7+10	538.49	720.44	74.9	103.46	95.67	141.62
7+20	537.6	730.48	75.57	104.44	95.88	141.77
7+30	536.72	740.52	76.23	105.39	96.08	141.9
7+40	535.87	750.55	76.88	106.34	96.28	142.02
7+50	535.04	760.59	77.52	107.27	96.46	142.13
7+60	534.23	770.62	78.14	108.18	96.63	142.22
7+70	533.44	780.65	78.76	109.09	96.79	142.3
7+80	532.68	790.68	79.37	109.97	96.94	142.36
7+90	531.94	800.71	79.96	110.85	97.07	142.41
8+00	531.22	810.74	80.54	111.71	97.2	142.45
8+10	530.52	820.76	81.12	112.55	97.32	142.47
8+20	529.85	830.78	81.68	113.38	97.42	142.48
8+30	529.2	840.81	82.23	114.2	97.51	142.48
8+40	528.57	850.83	82.76	115.01	97.59	142.46
8+50	527.96	860.84	83.29	115.8	97.67	142.42
8+60	527.38	870.86	83.81	116.57	97.73	142.38
8+70	526.81	880.88	84.31	117.33	97.78	142.32
8+80	526.27	890.89	84.81	118.08	97.81	142.24
8+90	525.76	900.91	85.29	118.81	97.84	142.15
9+00	525.26	910.92	85.76	119.53	97.86	142.05
9+10	524.79	920.93	86.23	120.24	97.86	141.93
9+20	524.34	930.94	86.68	120.93	97.86	141.8
9+30	523.91	940.95	87.12	121.61	97.84	141.66
9+40	523.5	950.96	87.54	122.27	97.81	141.5
9+50	523.12	960.97	87.96	122.92	97.77	141.33
9+60	522.76	970.97	88.37	123.56	97.73	141.14
9+70	522.42	980.98	88.76	124.18	97.66	140.95
9+80	522.1	990.99	89.15	124.79	97.59	140.73
9+90	521.81	1000.99	89.52	125.39	97.51	140.5
10+00	521.53	1010.99	89.88	125.97	97.42	140.26
10+10	521.28	1021	90.23	126.53	97.31	140.01
10+20	521.06	1031	90.57	127.09	97.2	139.74
10+30	520.85	1041	90.9	127.63	97.07	139.46
10+40	520.67	1051	91.22	128.15	96.93	139.16
10+50	520.5	1061.01	91.53	128.66	96.79	138.85
10+60	520.37	1071.01	91.83	129.16	96.63	138.53
10+70	520.25	1081.01	92.11	129.64	96.46	138.19
10+80	520.15	1091.01	92.39	130.11	96.28	137.84
10+90	520.08	1101.01	92.65	130.57	96.08	137.47
11+00	520.03	1111.01	92.9	131.01	95.88	137.09
11+10	520	1121.01	93.14	131.44	95.67	136.7
11+20	520	1131.01	93.37	131.85	95.44	136.29
11+30	520	1141.01	93.6	132.26	95.21	135.88
11+40	520	1151.01	93.83	132.67	94.99	135.47
11+50	520	1161.01	94.06	133.08	94.76	135.06
11+60	520	1171.01	94.28	133.49	94.53	134.65
11+70	520	1181.01	94.51	133.9	94.3	134.24
11+80	520	1191.01	94.74	134.32	94.07	133.83
11+90	520	1201.01	94.97	134.73	93.85	133.42
12+00	520	1211.01	95.2	135.14	93.62	133.01
12+10	520	1221.01	95.42	135.55	93.39	132.6
12+20	520	1231.01	95.65	135.96	93.16	132.19
12+30	520	1241.01	95.88	136.37	92.94	131.77
12+40	520	1251.01	96.11	136.78	92.71	131.36
12+50	520.03	1261.01	96.32	137.17	92.47	130.94
12+60	520.07	1271.01	96.53	137.56	92.22	130.5
12+70	520.14	1281.01	96.72	137.92	91.96	130.04
12+80	520.23	1291.01	96.9	138.28	91.68	129.58
12+90	520.34	1301.01	97.08	138.62	91.4	129.1
13+00	520.48	1311.01	97.24	138.95	91.11	128.6
13+10	520.63	1321.01	97.39	139.26	90.8	128.09
13+20	520.81	1331.01	97.53	139.56	90.48	127.57
13+30	521.02	1341.02	97.66	139.84	90.16	127.04
13+40	521.24	1351.02	97.77	140.11	89.82	126.49
13+50	521.48	1361.02	97.88	140.37	89.47	125.92
13+60	521.75	1371.02	97.98	140.61	89.11	125.34
13+70	522.04	1381.03	98.06	140.84	88.74	124.75
13+80	522.36	1391.03	98.13	141.06	88.36	124.15
13+90	522.69	1401.04	98.2	141.26	87.96	123.53
14+00	523.05	1411.05	98.25	141.45	87.56	122.89
14+10	523.43	1421.05	98.29	141.63	87.14	122.25
14+20	523.83	1431.06	98.32	141.79	86.72	121.58
14+30	524.25	1441.07	98.34	141.93	86.28	120.91
14+40	524.7	1451.08	98.34	142.07	85.83	120.22
14+50	525.17	1461.09	98.34	142.18	85.37	119.52
14+60	525.66	1471.1	98.33	142.29	84.9	118.8
14+70	526.17	1481.12	98.3	142.38	84.42	118.07
14+80	526.71	1491.13	98.27	142.46	83.93	117.32
14+90	527.26	1501.14	98.22	142.52	83.43	116.56
15+00	527.84	1511.16	98.16	142.57	82.91	115.79
15+10	528.45	1521.18	98.09	142.61	82.39	115
15+20	529.07	1531.2	98.01	142.63	81.85	114.2
15+30	529.72	1541.22	97.92	142.64	81.3	113.39
15+40	530.39	1551.24	97.82	142.63	80.74	112.56
15+50	531.08	1561.27	97.71	142.61	80.17	111.72
15+60	531.79	1571.29	97.58	142.58	79.59	110.86
15+70	532.53	1581.32	97.45	142.53	79	109.99
15+80	533.29	1591.35	97.3	142.47	78.4	109.1
15+90	534.07	1601.38	97.14	142.4	77.78	108.21
16+00	534.88	1611.41	96.97	142.31	77.16	107.29
16+10	535.7	1621.44	96.8	142.2	76.52	106.37
16+20	536.55	1631.48	96.6	142.09	75.88	105.42
16+30	537.42	1641.52	96.4	141.96	75.22	104.47
16+40	538.32	1651.56	96.19	141.81	74.55	103.5
16+50	539.23	1661.6	95.97	141.65	73.87	102.52
16+60	540.17	1671.64	95.73	141.48	73.17	101.52
16+70	541.13	1681.69	95.49	141.29	72.47	100.51
16+80	542.12	1691.74	95.23	141.09	71.76	99.48
16+90	543.12	1701.79	94.96	140.88	71.03	98.44
17+00	544.15	1711.84	94.68	140.65	70.29	97.39
17+10	545.2	1721.89	94.39	140.41	69.55	96.32
17+20	546.28	1731.95	94.09	140.15	68.79	95.24
17+30	547.37	1742.01	93.78	139.88	68.02	94.14
17+40	548.49	1752.07	93.46	139.59	67.24	93.03
17+50	549.63	1762.14	93.12	139.3	66.44	91.9
17+60	550.8	1772.21	92.78	138.98	65.64	90.76
17+70	551.99	1782.28	92.42	138.66	64.82	89.61
17+80	553.2	1792.35	92.05	138.32	64	88.44
17+90	554.43	1802.42	91.68	137.96	63.16	87.26
18+00	555.69	1812.5	91.29	137.59	62.31	86.06
18+10	556.96	1822.58	90.88	137.21	61.45	84.85
18+20	558.26	1832.67	90.47	136.81	60.58	83.63
18+30	559.59	1842.76	90.05	136.4	59.69	82.39
18+40	560.94	1852.85	89.61	135.98	58.8	81.13
18+50	562.3	1862.94	89.17	135.54	57.89	79.87
18+60	563.7	1873.04	88.71	135.08	56.98	78.58
18+70	565.11	1883.13	88.24	134.62	56.05	77.29
18+80	566.55	1893.24	87.76	134.14	55.11	75.98
18+90	568.01	1903.34	87.27	133.64	54.16	74.65
19+00	569.5	1913.45	86.77	133.13	53.2	73.31
19+10	571	1923.57	86.26	132.61	52.22	71.95
19+20	572.53	1933.68	85.73	132.07	51.24	70.59
19+30	574.09	1943.8	85.2	131.51	50.24	69.2
19+40	575.66	1953.92	84.65	130.95	49.23	67.8
19+50	577.26	1964.05	84.09	130.37	48.21	66.39
19+60	578.88	1974.18	83.52	129.77	47.18	64.96
19+70	580.53	1984.32	82.94	129.16	46.14	63.52
19+80	582.2	1994.45	82.35	128.54	45.08	62.07
19+90	583.89	2004.6	81.74	127.9	44.02	60.59
20+00	585.6	2014.74	81.13	127.25	42.94	59.11
20+10	587.34	2024.89	80.5	126.58	41.85	57.61
20+20	589.1	2035.04	79.86	125.9	40.75	56.1
20+30	590.86	2045.2	79.22	125.22	39.65	54.58
20+40	592.63	2055.35	78.59	124.54	38.55	53.06
20+50	594.39	2065.51	77.95	123.85	37.45	51.55
20+60	596.15	2075.66	77.31	123.17	36.35	50.03
20+70	597.92	2085.82	76.67	122.49	35.24	48.51
20+80	599.68	2095.97	76.03	121.81	34.14	47
20+90	601.44	2106.12	75.39	121.13	33.04	45.48
21+00	603.21	2116.28	74.75	120.44	31.94	43.97
21+10	604.97	2126.43	74.11	119.76	30.84	42.45
21+20	606.73	2136.59	73.48	119.08	29.74	40.93
21+30	608.5	2146.74	72.84	118.4	28.64	39.42
21+40	610.26	2156.9	72.2	117.72	27.53	37.9
21+50	612.02	2167.05	71.56	117.03	26.43	36.39
21+60	613.79	2177.2	70.92	116.35	25.33	34.87
21+70	615.55	2187.36	70.28	115.67	24.23	33.35
21+80	617.31	2197.51	69.64	114.99	23.13	31.84
21+90	619.08	2207.67	69	114.31	22.03	30.32
22+00	620.84	2217.82	68.36	113.62	20.93	28.81
22+10	622.6	2227.98	67.73	112.94	19.83	27.29
22+20	624.37	2238.13	67.09	112.26	18.72	25.77
22+30	626.13	2248.28	66.45	111.58	17.62	24.26
22+40	627.89	2258.44	65.81	110.89	16.52	22.74
22+50	629.66	2268.59	65.17	110.21	15.42	21.23
22+60	631.42	2278.75	64.53	109.53	14.32	19.71
22+70	633.18	2288.9	63.89	108.85	13.22	18.19
22+80	634.95	2299.06	63.25	108.17	12.12	16.68
22+90	636.71	2309.21	62.61	107.48	11.01	15.16
23+00	638.47	2319.36	61.98	106.8	9.91	13.64
23+10	640.24	2329.52	61.34	106.12	8.81	12.13
23+20	642	2339.67	60.7	105.44	7.71	10.61
23+30	643.76	2349.83	60.06	104.76	6.61	9.1
23+40	645.53	2359.98	59.42	104.07	5.51	7.58
23+50	647.29	2370.14	58.78	103.39	4.41	6.06
23+60	649.05	2380.29	58.14	102.71	3.3	4.55
23+70	650.82	2390.44	57.5	102.03	2.2	3.03
23+80	652.58	2400.6	56.86	101.34	1.1	1.52
23+90	654.34	2410.75	56.23	100.66	0	0

ISSUED FOR PERMIT

COMMONWEALTH OF VIRGINIA
JONATHAN LINDSEY ROBISON
Lic. No. 0402046798
1/24/2025
PROFESSIONAL ENGINEER

811 Know what's below. Call before you dig.

GeoEngineers

REFERENCE DRAWINGS		REVISIONS						
DRAWING NO.	TITLE	NO.	DATE	BY	DESCRIPTION	W.O. NO.	CHK.	APP.
		A	01/14/25	BTL	PRELIMINARY: NOT FOR CONSTRUCTION		TJP	
		B	01/24/25	BTL	ISSUED FOR PERMIT: NOT FOR CONSTRUCTION		TJP	JLR

TRANSCONTINENTAL GAS PIPELINE COMPANY, LLC
PROPOSED 42-INCH EDEN LOOP
CALCULATED DRILLING FLUID PRESSURES
BANISTER RIVER HDD
MP 14+08.56 TO 14+09.02
PITTSYLVANIA COUNTY, VIRGINIA

Williams

DRAWN BY: BTL	DATE: 12/12/24	ISSUED FOR BID:	SCALE:
CHECKED BY: TJP	DATE: 12/12/24	ISSUED FOR CONSTRUCTION:	REVISION:
APPROVED BY:	DATE:	DRAWING NUMBER: BANISTER RIVER HDD_REV C	SHEET 4 OF 4
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Appendix B
Geotechnical Data Report

Geotechnical Data Report

Southeast Supply Enhancement -
Banister River Crossing
Pittsylvania County, Virginia

for
Transcontinental Gas Pipeline Company, LLC

January 23, 2025

2155A West Chesterfield Boulevard
Springfield, Missouri 65807
417.831.9700

GeoEngineers

Geotechnical Data Report

Southeast Supply Enhancement -
Banister River Crossing
Pittsylvania County, Virginia

File No. 08169-235-00
January 23, 2025

Prepared for:

Transcontinental Gas Pipeline Company, LLC
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Attention: Robert Foran

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1.0 Introduction and Project Understanding

GeoEngineers, Inc. (GeoEngineers) is pleased to submit this geotechnical data report for the proposed Banister River crossing as part of the Southeast Supply Enhancement (SSE) – Eden Loop (Project). Our work was completed at the request of Transcontinental Gas Pipeline Company, LLC (Transco), and in general accordance with Transco's Request for Services (RFS) purchase order dated April 16, 2024. This report provides the results of our geotechnical exploration and laboratory testing programs and summarizes the surface and subsurface site conditions for the Banister River crossing.

We understand that the Project includes a new, approximately 30.8-mile-long 42-inch-diameter pipeline. The Project route, located in Rockingham County, North Carolina and Pittsylvania County, Virginia generally follows Transco's existing pipeline corridor, including the Banister River crossing for which this report has been prepared, which is shown on the attached Vicinity Map, Figure 1. We understand that Transco is proposing to cross the Banister River using the horizontal directional drill (HDD) method of construction.

Our geotechnical services completed at the site included drilling four (4) geotechnical borings at the locations shown on the Boring Location Map, Figure 2. Our specific geotechnical services are summarized in the following section. Our feasibility assessment of the proposed HDD crossing, detailed engineering design, and construction recommendations will be provided in a separate HDD design report.

2.0 Scope of Services

The purpose of our services was to investigate and describe the subsurface soil and groundwater conditions (where possible) at the site to support trenchless feasibility evaluation and to prepare this geotechnical data report summarizing the results. The following provides an abbreviated list of our scope of services for this phase of the project. Refer to our proposal dated January 17, 2024, for a complete list of our scope of services.

1. Reviewed geologic maps to evaluate geologic conditions at the site.
2. Reviewed and interpreted historical aerial photography available from Google Earth.
3. Completed a visual site reconnaissance at the site with members of the project team to perform the following tasks:
    a. Evaluate drill rig access.
    b. Identify boring locations.
    c. Assess water availability, and utility locations.
4. Explored the subsurface conditions at the crossing site by completing four (4) geotechnical borings to depths up to approximately 134.75 feet below ground surface (bgs). We utilized a rubber tracked drill rig for the borings. A GeoEngineers field representative logged the borings, recorded groundwater table depths where possible, and obtained samples of the soil and rock encountered at various depths. Upon completion, our subcontracted driller backfilled the borings with cement-bentonite grout. The locations were staked for identification by the project surveyors.

5. Performed general project management and daily communication with Transco during geotechnical explorations.
6. Completed a laboratory testing program on selected samples obtained from the borings to evaluate pertinent engineering properties. The tests included the following:
    a. Standard Classification of Soils in general accordance with ASTM D2488.
    b. Percent fines determinations in general accordance with ASTM D1140.
    c. Gradation of soils in general accordance with ASTM D6913.
    d. Moisture content determination in general accordance with ASTM D2216.
    e. Atterberg Limits determination in general accordance with ASTM D4318.
    f. Unconfined compressive strength tests (Methods C and D) on rock samples in general accordance with ASTM D7012.
    g. Representative Mohs hardness values for each unconfined compressive strength test.
    h. Cerchar Abrasivity Index on rock specimens in general accordance with ASTM D7625.
7. Prepared logs of the borings which included the following:
    a. Standard Penetration Test (SPT) values as an indication of in-situ soil density.
    b. Rock Quality Designation (RQD), Mohs hardness and recovery values for rock core samples.
    c. Index and classification properties of soil and rock samples, as applicable.
    d. Other properties as applicable.
8. Provided this geotechnical data report summarizing the results of our geotechnical exploration and laboratory testing programs. This report includes the following:
    a. A general description of the site geology and topography.
    b. Descriptions of the surface and subsurface conditions at the time of our exploration activities.
    c. Boring location map indicating the locations of the borings.
    d. Logs of the borings including the descriptions in item 7 above.
    e. Description of in-situ and laboratory test methods and test results performed in general accordance with ASTM specifications.
    f. Other relevant information necessary for the interpretation of the soil and rock properties for the crossing design.

3.0 Site Description

3.1 GEOLOGIC HAZARDS

We understand that Transco retained Civil & Environmental Consultants, Inc. (CEC) to complete a geologic hazard study for the Project. Please refer to CEC's full report for further details.

3.2 GEOLOGY

3.2.1 Regional Geologic Setting

The SSE Project Eden Loop is located within the eastern Piedmont Physiographic Region in north-central North Carolina and south-central Virginia. The Piedmont is a region of gently rolling hills and low ridges underlain by Proterozoic and Paleozoic Age (2,500 million to 251 million years ago) metamorphic and intrusive igneous rocks. Rocks exposed in the Piedmont experienced a complex geologic history. Some of these rocks are exotic with respect to North America. Packages of rock with distinctly different geologic histories, separated from one another by fault zones, are called geologic terranes. The oldest rocks in the Piedmont are around 1,070 million years old and occur in the enigmatic Goochland terrane west of Richmond, Virginia. Other terranes include Ordovician to Silurian igneous rocks that are the remains of ancient volcanic arcs (much like the present-day Aleutian Islands) that collided with and accreted onto the eastern edge of North America during Appalachian Mountain building. Granitic rocks of late Paleozoic age are common and form large plutons in many areas of the Piedmont. Many terranes have experienced multiple episodes of metamorphism and deformation, resulting in a complex geologic puzzle (McReynolds, 2008), (William & Mary University, 2024).

The region also includes Early Mesozoic (225 to 190 million years ago) sedimentary rocks, diabase dikes, and basalt flows that formed during the early stages of rifting associated with the opening of the Atlantic Ocean. These rocks are exposed in a number of structural basins known as half-grabens and grabens. Some Mesozoic basins preserve dinosaur, fish, and insect fossils. Coal was also deposited in swampy lowlands in some of these basins (William & Mary University, 2024).

Piedmont soils derived from Carolina Slate Belt rocks are generally quartz-, feldspar-, and mica-rich clays and loams although sandy soils can be found in some upland areas. Diagnostic heavy minerals include amphiboles (especially hornblende), epidote, and pyroxenes. Feldspars weather into kaolin group minerals, which are consequently the dominant clay minerals in the Carolina Slate Belt. Illite, chlorite, vermiculite, and hydroxy-interlayered vermiculite are also locally present, but smectite is generally absent except in the vicinity of metagabbro intrusions in the Albemarle-Asheboro region (ibid).

3.2.2 Bedrock Geology

Geologic mapping indicates the Precambrian to Early Paleozoic Age (4,600 to 251 million years ago) Fork Mountain Formation is the predominant bedrock unit at the site, as shown in the Bedrock Geology Map, Figure 3. The Fork Mountain Formation primarily consists of garnetiferous mica schist and biotite gneiss with interlayered ferruginous quartzites and quartz-epidote (Marr, 1984) and likely underlies the terrace and alluvial deposits shown on Figure 3 and described below.

3.2.3 Surficial Material

Surficial geologic mapping indicates Quaternary and Tertiary Age (65.5 million years ago to present) silty to clayey sandy saprolite is the predominant surficial material present at the site. The silty to clayey sandy saprolite typically consists of dark red, reddish brown, reddish yellow, white silty sand to slightly clayey sand. The saprolite is developed in gneissic granite, felsic schist interlayered with gneiss, foliated granitic rocks, and felsic metavolcanic rocks. In the upper part, the clay is predominantly kaolinite, but in the lower part, gibbsite may equal or exceed the amount of kaolinite. Illite and vermiculite are typically minor components. Partly weathered feldspar is the predominant weatherable mineral in the lower part. Muscovite or its

pseudomorphs predominate in the lower part. The saprolite is typically permeable and strongly acidic and grades into the underlying bedrock through an irregular zone of partly weathered, slabby fragments in a matrix of micaceous silt to clayey sand. The mapped area may include bedrock exposures, commonly as micaceous rock ribs, and slabby to boulder colluvium, especially at the base of steep slopes. The thickness of the silty to clayey sandy saprolite is typically less than 6 feet but may be up to 20 feet on well-drained uplands, overlying the bedrock described above (Howard, et al, 1991).

Geologic mapping indicates Quaternary Age (2.6 million years ago to present) alluvium is likely present at the site, within the stream valley and floodplain of Banister River. The alluvium typically consists of unconsolidated floodplain deposits of silt, sand and clay. The thickness of the alluvium is variable, overlying the silty to clayey sandy saprolite and/or the bedrock as described above (Marr, 1984).

Geologic mapping indicates Quaternary Age terrace deposits are also likely present in the terraces to the northeast and southwest of Banister River along the proposed alignment at the site. The terrace deposits typically consist of rounded pebbles and cobbles in a sandy clay matrix. The terrace deposits are variable in thickness, overlying the silty to clayey sandy saprolite and/or the bedrock as described above (ibid).

3.3 SURFACE CONDITIONS

3.3.1 General

We evaluated the surface conditions at the Banister River site during our initial site reconnaissance with Transco personnel on October 14, 2024, and again during our subsurface exploration programs conducted from October 29, 2024 through November 6, 2024.

3.3.2 Surface Description

The proposed pipeline alignment is roughly oriented southwest to northeast and deviates from Transco's existing pipeline corridor, including crossing the Banister River before converging with the existing pipeline northeast of the Banister River. Generally, the ground surface at the Banister River site slopes downward to the broader Banister River floodplain at an elevation of roughly 590 to 595 feet North American Vertical Datum (NAVD) 88. As crossed by the proposed pipeline alignment, the mud line of the Banister River is at an elevation of approximately 586 feet NAVD88. The ground surface elevations on either side of the river above the floodplain range from roughly 595 feet NAVD 88 to approximately 657 feet NAVD 88.

The project area is generally undeveloped and consists of open, grassy field on the southwest side of the river and agricultural cropland on the northeast side of the river. The alignment crosses the Banister River at an oblique angle over a distance of roughly 70 feet.

3.4 SUBSURFACE CONDITIONS

GeoEngineers and our subcontracted driller (CG2 Exploration, LLC [CG2]) explored the subsurface conditions at the site from October 29, 2024 through November 6, 2024, by completing four (4) geotechnical borings (ABR-B-1 through ABR-B-4). The borings were drilled to depths of up to approximately 134.75 feet bgs. The surveyed boring locations are shown on the attached Boring Location Map, Figure 2.

Samples collected from the borings were preserved and transported to a laboratory for testing. Testing was performed on representative samples, including index and strength testing to confirm field classifications and to determine pertinent engineering parameters. Laboratory testing on soil samples included moisture

content, Atterberg limits, particle-size distribution (gradation), and percent fines content. Laboratory testing on rock specimens included unit weight determinations, unconfined compressive strength testing (UCT), Cerchar Abrasivity Index (CAI) and Mohs hardness. A detailed description of the geotechnical exploration and laboratory testing procedures, logs of the borings, photographs of the rock cores, and laboratory test results are presented in Appendix A.

3.4.1 Subsurface Description

In general, the subsurface conditions encountered in the borings were consistent with published geology and are described within the boring descriptions below. Please note that for each boring a portion of the unconfined compressive strength test results and Mohs hardness values from selected samples had not been received at the time this report was prepared.

3.4.1.1 BORING ABR-B-1

Drilling operations were conducted at boring ABR-B-1 on October 30 and 31, 2024, utilizing a rubber-tracked drill rig. During drilling at boring ABR-B-1, we observed 22 feet of loose to medium dense silty sand residuum overlying decomposed bedrock described as medium dense to very dense silty sand with varying gravel content to a depth of about 36 feet bgs, where competent bedrock was noted to the termination depth of 104.75 feet bgs. Bedrock generally consisted of slightly weathered, poor to fair quality, gneiss below the upper approximately 10 feet of poor to very poor quality gneiss. Unconfined compressive strengths ranging from 6,170 psi to 12,439 psi and Mohs hardness values ranging from 5.5 to 8.5 were reported on selected samples. The result of a single point load test produced a Point Load Index of 238 psi which correlates to an estimated unconfined compressive strength of approximately 5,300 psi. The Cerchar abrasivity of a selected sample from the boring was 3.29 (high abrasivity). Drilling fluid returns were maintained during coring operations through the termination depth of the boring.

3.4.1.2 BORING ABR-B-2

Drilling operations were conducted at boring ABR-B-2 on October 29 and 30, 2024, utilizing a rubber-tracked drill rig. During drilling at boring ABR-B-2, we observed approximately 6 feet of medium stiff to stiff cohesive soil (silt) overlying approximately 12.5 feet of loose to medium dense sand with silt and silty sand underlain by decomposed bedrock described as dense to very dense sand with silt to a depth of about 28 feet bgs, where competent bedrock was noted to the termination depth of approximately 134.75 feet bgs. Bedrock generally consisted of slightly weathered to fresh, fair to excellent quality, gneiss below the upper approximately 8 feet of very poor to poor quality, gneiss bedrock except for isolated zones of poor and very poor quality gneiss bedrock from approximately 56 to 61 feet bgs and from approximately 86 to 91 feet bgs, respectively. Unconfined compressive strengths ranging from 1,390 psi to 13,730 psi and Mohs hardness values ranging from 4.5 to 7.5 were reported on selected samples. The result of a single point load test produced a Point Load Index of 77 psi which correlates to an estimated unconfined compressive strength of approximately 1,700 psi. The Cerchar abrasivity of selected samples from the boring ranges from 4.48 to 4.63 (extreme abrasivity). Drilling fluid returns were maintained during coring operations through the termination depth of the boring.

3.4.1.3 BORING ABR-B-3

Drilling operations were conducted at boring ABR-B-3 on November 4 and 5, 2024, utilizing a rubber-tracked drill rig. During drilling at boring ABR-B-3, we observed about 12 feet of medium stiff to stiff silt with varying sand content and approximately 5 feet of loose sand with silt underlain by approximately 5 feet of

decomposed bedrock described as medium dense sand with silt to a depth of about 22 feet bgs, where competent bedrock was noted to the termination depth of 114.5 feet bgs. Bedrock generally consisted of slightly weathered to fresh, fair to excellent quality gneiss below the upper approximately 13 feet of poor quality bedrock. Unconfined compressive strengths ranging from 1,660 psi to 9,090 psi and Mohs hardness values of 6.5 were reported on selected samples. The Cerchar abrasivity of selected samples from the boring ranges from 4.05 to 4.53 (extreme abrasivity). Drilling fluid returns were maintained during coring operations through the termination depth of the boring.

3.4.1.4 BORING ABR-B-4

Drilling operations were conducted at boring ABR-B-4 on November 5 and 6, 2024, utilizing a rubber-tracked drill rig. During drilling at boring ABR-B-4, we observed about 2 feet of stiff silt with sand and approximately 16.5 feet of loose to medium dense silty sand underlain by approximately 12.5 feet of decomposed bedrock described as medium dense to very dense silty sand with occasional gravel to a depth of about 31 feet bgs, where competent bedrock was noted to the termination depth of 110.25 feet bgs. Bedrock generally consisted of slightly weathered to fresh, poor to fair quality gneiss bedrock. Unconfined compressive strengths ranging from 10,080 psi to 10,190 psi and Mohs hardness values ranging from 6.5 to 7.5 were reported on selected samples. The result of a single point load test produced a Point Load Index of 820 psi which correlates to an estimated unconfined compressive strength of approximately 18,000 psi. The Cerchar abrasivity of a selected sample from the boring was 5.15 (extreme abrasivity). Drilling fluid returns were maintained during coring operations through the termination depth of the boring.

3.4.1.5 GROUNDWATER CONDITIONS

Groundwater was not observed at the time of drilling borings ABR-B-1 and ABR-B-2 before beginning rock coring. Groundwater was initially encountered at depths of approximately 13.5 and 28.5 feet bgs in borings ABR-B-3 and ABR-B-4, respectively. The groundwater level at the time of drilling may not be representative of present or future levels within the subsurface. The groundwater level likely fluctuates because of seasonal variation and precipitation, recharge and other factors, and may be present at different elevations during construction.

4.0 Abrasive Bedrock Conditions

To evaluate the abrasivity of the bedrock at the site, CAI tests were requested on rock samples obtained from the borings. The criteria for the CAI from ASTM D7625 is described by the data presented in Table 1 below. The testing results are presented in Table 2 below at their respective sample depths.

TABLE 1. CRITERIA FOR THE CERCHAR ABRASIVENESS INDEX

CLASSIFICATION	AVERAGE CAI (HRC=55)
Very Low Abrasiveness	0.3 – 0.5
Low Abrasiveness	0.5 – 1.0
Medium Abrasiveness	1.0 – 2.0
High Abrasiveness	2.0 – 4.0
Extreme Abrasiveness	4.0 – 6.0
Quartzitic	6.0 – 7.0

TABLE 2. CERCHAR ABRASIVITY INDEX TEST RESULTS

BORING NUMBER	SAMPLE DEPTH (FT)	CAI
ABR-B-1	70.8 – 75.8	3.29
ABR-B-2	100.7 – 105.7	4.48
ABR-B-2	120.7 – 125.7	4.63
ABR-B-3	69.6 – 74.6	4.53
ABR-B-3	89.6 – 94.6	4.05
ABR-B-4	40.2 – 45.2	5.15

As shown in Table 2 above, the CAI values for the selected samples range between 3.29 and 5.15, which indicates high to extreme abrasiveness.

5.0 Limitations

We have prepared this geotechnical data report for use by Transco and other approved members of the project team involved with this project. This report is not intended for use by others, and the information contained herein is not applicable to other sites. The data and report should be provided to prospective contractors, but our report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations. Subsurface conditions may also vary with time. A contingency for unanticipated conditions should be included in the project budget and schedule for such an occurrence. We recommend that sufficient monitoring, testing and consultation be provided by GeoEngineers during construction to evaluate that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and pipeline installation activities comply with contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, express, written or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers and will serve as the official document of record.

Please refer to Appendix B, titled "Report Limitations and Guidelines for Use," for additional information pertaining to use of this report.

6.0 References

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Figures

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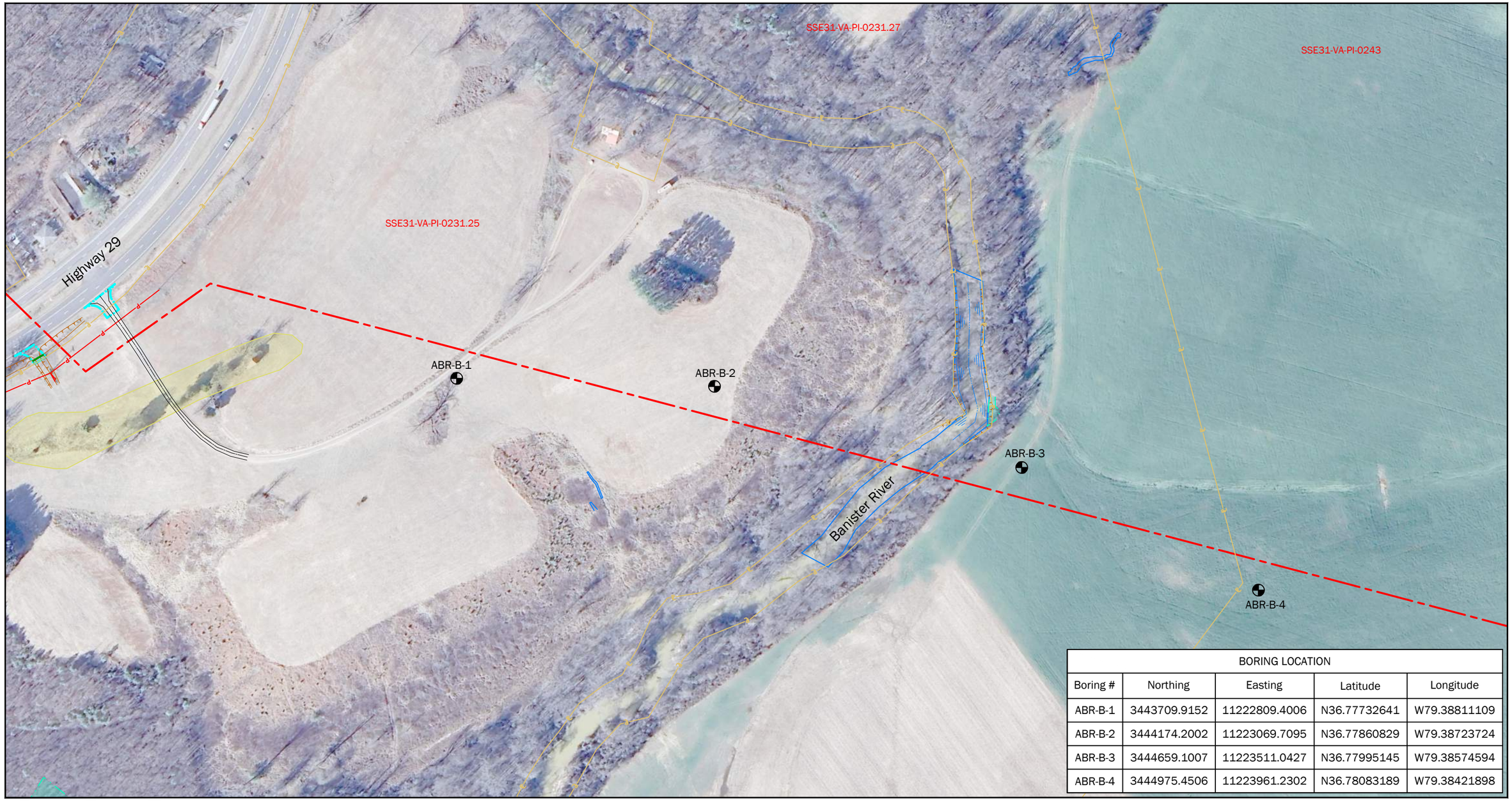

BORING LOCATION				
Boring #	Northing	Easting	Latitude	Longitude
ABR-B-1	3443709.9152	11222809.4006	N36.77732641	W79.38811109
ABR-B-2	3444174.2002	11223069.7095	N36.77860829	W79.38723724
ABR-B-3	3444659.1007	11223511.0427	N36.77995145	W79.38574594
ABR-B-4	3444975.4506	11223961.2302	N36.78083189	W79.38421898

Note(s):
1. GeoEngineers, Inc has not verified the field location of the existing utilities.

Source(s):
- Aerial from Google Earth Pro, dated 01/16/24.
- Survey provided from Williams by email on 02/05/24.

Coordinate System: NSRS2011 Virginia State Plane, South Zone, US Foot

Disclaimer: This figure was created for a specific purpose and project. Any use of this figure for any other project or purpose shall be at the user's sole risk and without liability to GeoEngineers, Inc. The locations of features shown may be approximate. GeoEngineers, Inc. makes no warranty or representation as to the accuracy, completeness, or suitability of the figure, or data contained therein. The file containing this figure is a copy of a master document, the original of which is retained by GeoEngineers, Inc. and is the official document of record.

Legend

- Boring Location
- Proposed Centerline Alignment
- Existing Property Lines
- Existing Overhead Power
- Existing Drainage Centerline
- Palustrine Forested Wetlands
- Archaeological Area
- Edge Of Road
- Road Centerline
- Top Of Bank

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NOT FOR CONSTRUCTION

Transcontinental Gas Pipeline Company, LLC
Boring Location Map

Proposed 42-inch Eden Loop
Banister River Reroute Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure 2

TJP : BTL

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al — Alluvium: *Silt, sand and gravel*

td — Terrace deposit: *Rounded pebbles and cobbles in a sandy-clay matrix*

d — Diabase dike: *fine to medium-grained, black diabase*

fm / fg / feq — Fork Mountain Formation: *fm, garnetiferous mica schist and fg, biotite gneiss with interlayered fq, ferruginous quartzites and feq, quartz-epidote fels*

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Appendices

Appendix A
Geotechnical Explorations and Laboratory Testing

Appendix A
Geotechnical Explorations and Laboratory Testing

GEOTECHNICAL EXPLORATIONS

We explored the subsurface conditions at the site from October 29, 2024 through November 6, 2024, by completing four (4) geotechnical borings (ABR-B-1 through ABR-B-4) to depths of up to approximately 134.75 feet below ground surface (bgs). Drilling operations were completed by our drilling subcontractor, CG2 Exploration, LLC (CG2), operating a rubber tracked drill rig. The locations of the borings are shown on the attached Boring Location Map, Figure 2. The Virginia State "One-Call" utility locating agency was contacted to locate utilities in the project area prior to the start of the exploratory borings.

A GeoEngineers representative observed field activities, classified the soil and rock encountered, obtained representative samples, and prepared a log of each exploration. The soils encountered were classified visually in general accordance with American Society for Testing and Materials (ASTM) D2488, which is described in Figure A-1. The rock encountered was classified visually in general accordance with the American Society of Civil Engineers (ASCE) Manual of Engineering Practice No. 56, which is described in Figure A-2.

In general, soil samples were obtained from the borings at 2½-foot depth intervals in the upper 10 feet and 5-foot-depth intervals thereafter using 1.5-inch I.D. split-spoon samplers. The split-spoon samplers were driven 18 inches during Standard Penetration Tests (SPT), using a 140-pound hammer with a 30-inch drop. The number of hammer blows required to drive the sampler the final 12-inches was recorded on field logs. Bedrock was continuously cored using NQ2 rock coring techniques. Each boring was backfilled upon completion with cement-bentonite grout.

The apparent consistency or relative density of the SPT samples recovered at each depth interval was evaluated based on correlations with lab and field observations in general accordance with the values outlined in Table A-1 below.

TABLE A-1. CORRELATION FOR BLOW COUNTS AND APPARENT CONSISTENCY OR RELATIVE DENSITY [1]

APPARENT CONSISTENCY OF COHESIVE SOIL (SILT AND CLAY) [2]						
Parameter	Very Soft	Soft	Medium Stiff	Stiff	Very Stiff	Hard
Blows (N)	0 - 1	2 – 4	5 – 8	9 – 15	16 – 30	> 30
RELATIVE DENSITY OF GRANULAR SOIL (SAND AND GRAVEL) [3]						
Parameter	Very Loose	Loose	Medium Dense	Dense	Very Dense	
Blows (N)	0 – 4	5 – 10	11 – 30	31 – 50	> 50	

Notes:

[1] After Peck R.B., Hansen W.E., and Thornburn, T.H., "Foundation Engineering," Second Edition, John Wiley & Sons, 1974.

[2] Classification also applies to cohesive soils containing additional constituents; that is, organic soil, sand, gravel, etc.

[3] Classification also applies to granular soils containing additional constituents; that is, organic soil, silt, clay, etc.

The Rock quality designation (RQD) of the rock core samples recovered from each core run was evaluated and is presented on the exploration logs, where applicable, in Figures A-3 through A-6. The rock quality descriptions are correlated to RQD (%) as outlined in Table A-2, below.

TABLE A-2. ROCK QUALITY DESIGNATION

RQD (%)	ROCK QUALITY DESCRIPTION
0-25	Very Poor
26-50	Poor
51-75	Fair
76-90	Good
91-100	Excellent

The boring logs are presented in Figures A-3 through A-6. The logs are based on our interpretation of the field data obtained from the subsurface explorations and indicate the various types of soils and rock encountered, while indicating the approximate depths at which the subsurface conditions change. Unless noted on the boring logs, the lines designating changes in classification between soil and rock types represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. Additionally, the boring logs represent conditions observed at the time of drilling and have been edited to incorporate results of the laboratory tests performed as appropriate.

LABORATORY TESTING

General

Samples collected from the borings were transported to our Cary, North Carolina office. Representative soil and rock core samples were selected for laboratory testing. Laboratory testing on samples included moisture content determinations, Atterberg limit determinations, sieve analyses, percent fines, unconfined compressive strength testing, Mohs hardness, and Cerchar Abrasivity Index testing. The laboratory testing procedures are discussed in more detail below. Laboratory test results prepared by Geo Testing Express and Geotechnics are presented at the end of Appendix A.

Moisture Content

Moisture Content tests were performed on selected soil samples obtained from the borings. The tests were completed in general accordance with ASTM D2216. The results of these tests are presented on the boring logs in Figures A-3 through A-6 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

Percent Fines

Percent Fines tests were performed on selected soil samples obtained from the borings. The tests were completed in general accordance with ASTM D1140. The results of these tests are presented on the boring logs in Figures A-3 through A-6 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

Gradation of Soils

Gradation of Soils (SA) tests were performed on selected soil samples obtained from the borings. The tests were completed in general accordance with ASTM D6913. The results of the sieve analyses were plotted and classified in general accordance with the Unified Soil Classification System (USCS) and are shown in the laboratory test results. The percentage passing the U.S. No. 200 sieve is shown on the boring logs at the respective sample depths.

Atterberg Limits

Atterberg Limits were performed on selected fine-grained soil samples in general accordance with ASTM D4318. The tests were used to classify the soils as well as to evaluate their index properties. The results of the Atterberg Limits testing are shown on the boring logs at the depth at which the samples were obtained and in the attached Laboratory Test Results.

Mohs Hardness Testing

Mohs Hardness (MOH) tests were performed on selected rock specimens obtained from the borings. The results of these tests are presented on the boring logs in Figures A-3 through A-6 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

Unconfined Compression Testing

Unconfined compression (UC) tests were performed on selected rock specimens obtained from the borings. The tests were used to evaluate compressive strength characteristics and were completed in general accordance with ASTM D7012. The results of testing are presented on the boring logs at their respective sample depths and are shown in the laboratory test results. Rock core sample photographs are presented in Figures A-7 through A-23.

Cerchar Abrasivity Index Testing

Cerchar Abrasivity Index (CAI) tests were performed on selected rock specimens obtained from the borings to provide a relative estimate of the samples abrasiveness. The tests were completed in general accordance with ASTM D7625. The results of these tests are presented on the boring logs in Figures A-3 through A-6 at the depths at which the samples were obtained and in the attached Laboratory Test Results.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE			GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% RETAINED ON NO. 200 SIEVE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS
				SP	POORLY-GRADED SANDS, GRAVELLY SAND
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

Sampler Symbol Descriptions

- Modified California Sampler (6-inch sleeve) or Dames & Moore
- Standard Penetration Test (SPT)
- Shelby tube
- Piston
- Direct-Push
- Bulk or grab
- Continuous Coring

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

"P" indicates sampler pushed using the weight of the drill rig.

"WOH" indicates sampler pushed using the weight of the hammer.

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS GRAPH	SYMBOLS LETTER	TYPICAL DESCRIPTIONS
	AC	Asphalt Concrete
	CC	Cement Concrete
	CR	Crushed Rock/ Quarry Spalls
	SOD	Sod/Forest Duff
	TS	Topsoil

Groundwater Contact

Measured groundwater level in exploration, well, or piezometer

Measured free product in well or piezometer

Graphic Log Contact

Distinct contact between soil strata

Approximate contact between soil strata

Material Description Contact

Contact between geologic units

Contact between soil of the same geologic unit

Laboratory / Field Tests

%F	Percent fines
%G	Percent gravel
AL	Atterberg limits
CA	Chemical analysis
CP	Laboratory compaction test
CS	Consolidation test
DD	Dry density
DS	Direct shear
EI	Expansion index
HA	Hydrometer analysis
MC	Moisture content
MD	Moisture content and dry density
Mohs	Mohs hardness scale
OC	Organic content
PM	Permeability or hydraulic conductivity
PI	Plasticity index
PL	Point load test
PP	Pocket penetrometer
SA	Sieve analysis
TX	Triaxial compression
UC	Unconfined compression
UU	Unconsolidated undrained triaxial compression
VS	Vane shear

Sheen Classification

NS	No Visible Sheen
SS	Slight Sheen
MS	Moderate Sheen
HS	Heavy Sheen

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

Key to Exploration Logs

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Figure A-1

Scale of Relative Rock Weathering[1]

Designation	Field Identification
Fresh	Crystals are bright. Discontinuities may show some minor surface staining. No discoloration in rock fabric.
Slightly Weathered	Rock mass is generally fresh. Discontinuities are stained and may contain clay. Some discoloration in rock fabric. Decomposition extends up to 1 inch into rock.
Moderately Weathered	Rock mass is decomposed 50% or less. Significant portions of rock show discoloration and weathering effects. Crystals are dull and show visible chemical alteration. Discontinuities are stained and may contain secondary mineral deposits.
Predominantly Decomposed	Rock mass is more than 50% decomposed. Rock can be excavated with geologist's pick. All discontinuities exhibit secondary mineralization. Complete discoloration of rock fabric. Surface of core is friable and usually pitted due to washing out of highly altered minerals by drilling water.
Decomposed	Rock mass is completely decomposed. Original rock "fabric" may be evident. May be reduced to soil with hand pressure.

Scale of Relative Rock Hardness[1]

Term	Hardness Designation	Field Identification	Approximate Unconfined Compressive Strength
Extremely Soft	R0	Can be indented with difficulty by thumbnail. May be moldable or friable with finger pressure.	< 100 psi
Very Soft	R1	Crumbles under firm blows with point of a geology pick. Can be peeled by a pocketknife. Scratched with fingernail.	100-1000 psi
Soft	R2	Can be peeled by a pocketknife with difficulty. Cannot be scratched with fingernail. Shallow indentation made by firm blow of geology pick.	1000-4000 psi
Medium Hard	R3	Can be scratched by knife or pick. Specimen can be fractured with a single firm blow of hammer/geology pick.	4000-8000 psi
Hard	R4	Can be scratched with knife or pick only with difficulty. Several hard hammer blows required to fracture specimen.	8000-16000 psi
Very Hard	R5	Cannot be scratched by knife or sharp pick. Specimen requires many blows of hammer to fracture or chip. Hammer rebounds after impact.	> 16000 psi

Discontinuity Spacing[1]

Description for Bedding, Foliation, or Flow Banding	Spacing	Description of Joints, Faults, or Other Fractures
Very Thick	>10 ft	Very Widely Spaced
Thick	3 ft – 10 ft	Widely Spaced
Medium	1 ft – 3 ft	Moderately Spaced
Thin	2 in – 1 ft	Closely Spaced
Very Thin	<2 in	Very Closely Spaced

Rock Quality Designation (RQD)[1, 2]

RQD (Percent)	Description of Rock Quality
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

NOTES: 1. Based on ASCE Manual on Engineering Practice No. 56,1976. 2. RQD is a modified core recovery measurement which expresses the number of hard and sound rock pieces of 4" or more in size as a percentage of the total length of core run.

Explanation of Bedrock Terms

GeoEngineers

Figure A-2

Drilled Start 10/30/2024 End 10/31/2024	Total Depth (ft) 104.75	Logged By AML Checked By TJP	Driller CG2 Exploration, LLC	Drilling Method Hollow-stem Auger and NQ Wireline Rock Coring	
Surface Elevation (ft) 645 Vertical Datum NAVD88	Hammer Data Autohammer 140 (lbs) / 30 (in) Drop	Drilling Equipment Diedrich D50 Rubber Tracked Drill Rig			
Easting (X) 11222809.401 Northing (Y) 3343709.915	System Datum Virginia State Plane South NSRS 2011	Groundwater not observed at time of exploration			

Notes: Upon completion, borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0								TS	Topsoil - 1-inch			
			14	8	S-1				SM	Brown to red silty sand with trace organic matter (loose, moist) (residuum)			
640	5		18	11	S-2					Becomes medium dense			
			18	4	S-3 %F					Becomes loose	22	33	
635	10		16	12	S-4					Becomes medium dense			
				12	S-5					Grades to tan-red			
630	15												
			18	14	S-6 SA						20	21	Gravel content (%) = <1
625	20								SM	Tan-gray-white silty sand with occasional gravel (dense, moist) (decomposed bedrock)			
			18	44	S-7								
620	25												
			18	22	S-8 SA					Becomes medium dense	17	19	Gravel content (%) = <1
615	30												
			0	50/0"	S-9					No recovery - becomes very dense			
610	35												

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Handheld). Vertical approximated based on GPS (Handheld).

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Log of Boring ABR-B-1

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-3
Sheet 1 of 3

Elevation (feet)	Depth (feet)	Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35												
			43		R1	0			Gneiss	White gneiss; slightly weathered, medium hard, very thinly spaced fractures Becomes tan brown with orange, predominately decomposed, very soft, very closely spaced fractures, with quartz and mica Becomes decomposed			Run 1 - 9 minute core run Full drilling fluid returns Very poor rock quality
605	40												
			67		R2 PLS MOH	25				Becomes predominately decomposed Becomes moderately weathered and closely spaced fractures Becomes dark brown to gray Becomes moderately to slightly weathered			Run 2 - 15 minute core run Full drilling fluid returns Poor rock quality Point Load Index = 238 psi; Estimated UCS =5,300 psi; Mohs Hardness = 6.5
600	45									Becomes gray with white			
			98		R3 UCS UDW MOH	95				Becomes slightly weathered to fresh, soft to medium hard, close to moderately spaced fractures			Run 3 - 18 minute core run Full drilling fluid returns Excellent rock quality UCS = 6,950 psi; UDW = 170 pcf; Mohs Hardness = 8.5
595	50												
			100		R4	80				Becomes white and fresh, medium hard, closely spaced fractures Becomes gray-white with mica (biotite)			Run 4 - 18 minute core run Full drilling fluid returns Good rock quality
590	55												
			98		R5	55							Run 5 - 18 minute core run Full drilling fluid returns Fair rock quality
585	60												
			97		R6 UCS UDW MOH	80				Becomes very soft and with muscovite layers and garnets			Run 6 - 14 minute core run Full drilling fluid returns Fair rock quality UCS = 6,170 psi; UDW = 175 pcf; Mohs Hardness = 6.5
580	65												
			93		R7	57				With muscovite layers approximately 1 to 3 inches thick Becomes white-gray gneiss, medium hard to hard, closely spaced fractures			Run 7 - 24 minute core run Full drilling fluid returns Fair rock quality
575	70												
			98		R8 CAI UCS UDW MOH YM(E)	70				Becomes white-gray, hard, with dark gray very soft layers of mica approximately ¼ to ½ inch thick			Run 8 - 27 minute core run Full drilling fluid returns Fair rock quality CAI = 3.29; UCS = 12,439 psi; UDW = 168 pcf; Mohs Hardness = 5.5; E = 7,617,000 psi
570	75												
			97		R9	25				Becomes very closely to closely spaced fractures			

FIELD DATA

Date:1/23/25 Path:P:\8\81692350000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Log of Boring ABR-B-1 (continued)

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	FIELD DATA: Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
												Run 9 - 25 minute core run Full drilling fluid returns Poor rock quality
565	80											
		90		R10	0				Becomes slightly weathered, medium hard to hard, very closely spaced fractures, with mica			Run 10 - 35 minute core run Full drilling fluid returns Very poor rock quality
									Becomes with vertical fracturing			
560	85											
		97		R11	30				Becomes fresh, very closely to closely spaced fractures, with very soft mica			Run 11 - 34 minute core run Full drilling fluid returns Poor rock quality
									Red band, fresh, medium hard, mineralization approximately 1-inch thick			
555	90											
		92		R12 UCS UDW MOH	28				Becomes gray-white with biotite			Run 12 - 30 minute core run Full drilling fluid returns Poor rock quality UCS = 7,390 psi; UDW = 167 pcf; Mohs Hardness = 7.5
550	95											
		95		R13	33							Run 13 - 28 minute core run Full drilling fluid returns Poor rock quality
545	100											
		100		R14	58				Becomes closely spaced fractures			Run 14 - 25 minute core run Full drilling fluid returns Fair rock quality

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Log of Boring ABR-B-1 (continued)

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Drilled Start 10/29/2024 End 10/30/2024	Total Depth (ft) 134.75	Logged By AML Checked By TJP	Driller CG2 Exploration, LLC	Drilling Method Hollow-stem Auger and NQ Wireline Rock Coring	
Surface Elevation (ft) 625 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment Diedrich D50 Rubber Tracked Drill Rig	
Easting (X) 11223069.71 Northing (Y) 3444174.2		System Datum Virginia State Plane South NSRS 2011		Groundwater not observed at time of exploration	

Notes: Upon completion, borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0		15	6	S-1				ML	Red-brown silt with sand (medium stiff, moist) (residuum)			
620	5		18	13	S-2					Becomes red sandy silt (stiff, moist)			
			18	9	S-3				SM	Red silty fine to medium sand (loose, moist)			
615	10		18	10	S-4					Becomes red to light red and medium dense			
610	15		16	5	S-5				SP-SM	Tan-brown medium sand with silt and mica (loose, moist)			
605	20		18	35	S-6				SP-SM	Tan-brown medium sand with silt and mica (dense, moist) (decomposed bedrock)			
600	25		10	50/5"	S-7					Becomes very dense			
595	30		0 100	50/0"	S8 R1	25			Gneiss	Gray to dark gray gneiss; slightly weathered, hard, closely spaced fractures			Run 1 - 3 minute core run Full drilling returns Very poor rock quality
			83		R2 PLS MOH	27							Run 2 - 10 minute core run Full drilling returns Poor rock quality Point Load Index = 77 psi; Estimated UCS = 1,700 psi; Mohs Hardness = 6.5
590	35												

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Handheld). Vertical approximated based on GPS (Handheld).

Log of Boring ABR-B-2

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-4
Sheet 1 of 4

Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary:Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35												
			100		R3 UCS UDW MOH	75				Gray gneiss; slightly weathered, hard, closely spaced fractures, with layers of soft biotite			Run 3 - 10 minute core run Full drilling returns Good rock quality UCS = 1,390 psi; UDW = 168 pcf; Mohs Hardness = 6.5
585	40												
			100		R4	77				Gray gneiss; slightly weathered, hard, closely spaced fractures			Run 4 - 11 minute core run Full drilling returns Good rock quality
580	45												
			100		R5	78				White to dark gray gneiss; slightly weathered, hard, closely spaced fractures with thin layers of biotite at fractures			Run 5 - 18 minute core run Full drilling returns Good rock quality
575	50												
			100		R6 UCS UDW MOH	82							Run 6 - 14 minute core run Full drilling returns Good rock quality UCS = 8,950 psi; UDW = 181 pcf; Mohs Hardness = 6.5
570	55												
			98		R7	28				White to gray gneiss; slightly weathered, hard, closely spaced fractures, muscovite and biotite			Run 7 - 12 minute core run Full drilling returns Poor rock quality
565	60												
			100		R8	63							Run 8 - 18 minute core run Full drilling returns Fair rock quality
560	65												
			100		R9 UCS UDW MOH	90				Larger pinkish band observed approximately 1½ inches thick			Run 9 - 15 minute core run Full drilling returns Excellent rock quality UCS = 13,730 psi; UDW = 172 pcf; Mohs Hardness = 7.5
555	70												
			100		R10	92				Becomes medium hard			Run 10 - 15 minute core run Full drilling returns Excellent rock quality
550	75									Becomes moderately spaced fractures			
			97		R11	88							Run 11 - 16 minute core run Full drilling returns

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Log of Boring ABR-B-2 (continued)

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-4
Sheet 2 of 4

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	FIELD DATA: Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
									Good rock quality			
545	80											
		97		R12 UCS UDW MOH	80				Gray gneiss; fresh, medium hard, closely to moderately spaced fractures			Run 12 - 13 minute core run Full drilling returns Good rock quality UCS = 7,320 psi; UDW = 172 pcf; Mohs Hardness = 4.5
540	85								2 inch vertical fracture with green mineralization			
		100		R13	15				White to gray gneiss; fresh, medium hard, very close fractures			Run 13 - 15 minute core run Full drilling returns Very poor rock quality
535	90											
		100		R14	52				Gray to dark gray gneiss; fresh, hard, closely spaced fractures			Run 14 - 13 minute core run Full drilling returns Fair rock quality
530	95											
		100		R15	38				Orange mineralized band at 2¼ inches from top of run Dark gray gneiss; fresh, medium hard to hard, closely spaced fractures			Run 15 - 14 minute core run Full drilling returns Poor rock quality
525	100											
		100		R16 CAI UCS UDW MOH YM(E)	67				White to gray gneiss; fresh, medium hard to hard, closely spaced fractures			Run 16 - 24 minute core run Full drilling returns Fair rock quality CAI = 4.48; UCS = 8,267 psi; UDW = 175 pcf; Mohs Hardness = 4.5; E = 2,126,000 psi
520	105											
		100		R17	97				White to gray gneiss; fresh, medium hard to hard, close to moderately close fractures			Run 17 - 22 minute core run Full drilling returns Excellent rock quality
515	110											
		98		R18	52							Run 18 - 27 minute core run Full drilling returns Fair rock quality
510	115											
		100		R19 UCS UDW MOH	55				White to gray gneiss; fresh, medium hard, closely spaced fractures			Run 19 - 25 minute core run Full drilling returns Fair rock quality UCS = 5,370 psi; UDW = 163 pcf; Mohs Hardness = 7.5

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Log of Boring ABR-B-2 (continued)

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	FIELD DATA: Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
505	120	98		R20	80							Run 20 - 22 minute core run Full drilling returns Good rock quality CAI = 4.63
500	125	98		R21	23				White to gray gneiss; fresh, medium hard to hard, very closely spaced fractures			Run 21 - 26 minute core run Full drilling returns Very poor rock quality
495	130	92		R22	25				White to gray gneiss; fresh, medium hard to hard, very closely spaced fractures, with biotite layers			Run 22 - 29 minute core run Full drilling returns Poor rock quality

Log of Boring ABR-B-2 (continued)

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-4
Sheet 4 of 4

Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Drilled Start 11/4/2024 End 11/5/2024	Total Depth (ft) 114.5	Logged By AML Checked By TJP	Driller CG2 Exploration, LLC	Drilling Method Hollow-stem Auger and NQ Wireline Rock Coring	
Surface Elevation (ft) 600 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment Diedrich D50 Rubber Tracked Drill Rig	
Easting (X) 11223511.043 Northing (Y) 3444659.101		System Datum Virginia State Plane South NSRS 2011		See "Remarks" section for groundwater observed	

Notes: Upon completion, borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	FIELD DATA: Interval / Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	0	15	8	S1				ML	Brown-red silt with sand (stiff, moist) (residuum)			
595	5	18	15	S2					Becomes sandy silt and very stiff			
		18	6	S3					Becomes medium stiff Grades to red-tan			
590	10	9	7	S4								
								SP-SM	Tan fine to coarse sand with silt (loose, wet)			
585	15	18	9	S5								Groundwater encountered at 13½ feet
								SP-SM	Tan fine to coarse sand with silt (medium dense, wet) (decomposed bedrock)			
580	20	13	15	S6								
		0	50/0"	S7				Gneiss	Gray with orange gneiss; moderately weathered, soft, very closely spaced			Run 1 - 11 minute core run Full drilling fluid returns Poor rock quality
575	25	87 100		R1 R2 UCS UDW MOH	30 47				Becomes gray-white, slightly weathered, medium hard, closely spaced fractures Becomes fresh			Run 2 - 14 minute core run Full drilling fluid returns Poor rock quality UCS = 9,090 psi; UDW = 173 pcf; Mohs Hardness = 6.5
570	30	100		R3	27							Run 3 - 14 minute core run Full drilling fluid returns Poor rock quality
565	35											

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Handheld). Vertical approximated based on GPS (Handheld).

Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Log of Boring ABR-B-3

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
	35												
			100		R4	87				Light gray gneiss; fresh medium hard, moderately to closely spaced fractures			Run 4 - 16 minute core run Full drilling fluid returns Good rock quality
560	40		98		R5 UCS UDW MOH	67				Light to dark gray gneiss; fresh, medium hard, closely spaced fractures			Run 5 - 13 minute core run Full drilling fluid returns Fair rock quality UCS = 4,390 psi; UDW = 171 pcf; Mohs Hardness = 6.5
555	45		98		R6	78				Becomes closely to moderately spaced fractures			Run 6 - 17 minute core run Full drilling fluid returns Good rock quality
550	50		98		R7	85				Becomes closely spaced fractures, medium hard to hard			Run 7 - 19 minute core run Full drilling fluid returns Good rock quality
545	55		98		R8 UCS UDW MOH	60				Becomes closely to moderately spaced fractures			Run 8 - 25 minute core run Full drilling fluid returns Fair rock quality UCS = 5,650 psi; UDW = 172 pcf; Mohs Hardness = 6.5
540	60		100		R9	78				Becomes closely spaced fractures			Run 9 - 22 minute core run Full drilling fluid returns Good rock quality
535	65		97		R10	90				Dark to light gray gneiss; fresh, medium hard to hard, closely to moderately spaced fractures, with mica and quartz bands			Run 10 - 25 minute core run Full drilling fluid returns Good rock quality
530	70		100		R11 CAI UCS UDW MOH YM(E)	100				Becomes moderately spaced fractures			Run 11 - 18 minute core run Full drilling fluid returns Excellent rock quality CAI = 4.53; UCS = 6,566 psi; UDW = 177 pcf; Mohs Hardness = 6.5; E = 2,674,000 psi
525	75		98		R12	92				Becomes closely to moderately spaced fractures			Run 12 - 15 minute core run Full drilling fluid returns Excellent rock quality

Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Log of Boring ABR-B-3 (continued)

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-5

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
520	80		98		R13	90				Becomes medium hard			Run 13 - 15 minute core run Full drilling fluid returns Good to excellent rock quality
515	85		100		R14 UCS UDW MOH	92							Run 14 - 11 minute core run Full drilling fluid returns Excellent rock quality UCS = 1,660 psi; UDW = 167 pcf; Mohs Hardness = 6.5
510	90		100		R15 CAI	87							Run 15 - 12 minute core run Full drilling fluid returns Good rock quality CAI = 4.05
505	95		100		R16	82				Becomes medium hard to hard, closely spaced fractures			Run 16 - 11 minute core run Full drilling fluid returns Good rock quality
500	100		95		R17 UCS UDW MOH	70				Becomes with minor green mineralization			Run 17 - 14 minute core run Full drilling fluid returns Fair rock quality UCS = 7,150 psi; UDW = 169 pcf; Mohs Hardness = 6.5
495	105		99		R18	97				Becomes closely to moderately spaced fractures			Run 18 - 16 minute core run Full drilling fluid returns Excellent rock quality
490	110		100		R19	90							Run 19 - 18 minute core run Full drilling fluid returns Good to excellent rock quality

Log of Boring ABR-B-3 (continued)

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-5
Sheet 3 of 3

Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Drilled: Start 11/5/2024 End 11/6/2024	Total Depth (ft) 110.25	Logged By AML Checked By TJP	Driller CG2 Exploration, LLC	Drilling Method Hollow-stem Auger and NQ Wireline Rock Coring	
Surface Elevation (ft) 636 Vertical Datum NAVD88		Hammer Data Autohammer 140 (lbs) / 30 (in) Drop		Drilling Equipment Diedrich D50 Rubber Tracked Drill Rig	
Easting (X) 11223961.23 Northing (Y) 344975.451		System Datum Virginia State Plane South NSRS 2011		See "Remarks" section for groundwater observed	

Notes: Upon completion, borehole backfilled with cement-bentonite grout.

Elevation (feet)	Depth (feet)	Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
635	0		15	9	S1				ML	Brown-red silt with sand and trace organic matter (stiff, moist)			
									SM	Brown-tan silty fine to medium sand with mica (loose, moist) (residuum)			
			18	9	S2								
630	5		15	8	S3 %F					Becomes with increased mica and quartz	23	30	
			18	12	S4					Becomes fine to coarse and medium dense			
625	10												
			17	16	S5					Becomes with occasional gravel and 6 inches of decomposed quartz			
620	15												
			18	77	S6 SA				SM	Brown-gray silty fine to coarse sand with occasional gravel (very dense, moist) (decomposed bedrock)	12	15	Gravel content (%) = 14
615	20												
			18	17	S7					Becomes medium dense			
610	25												
			5	50/5"	S8					Becomes very dense and with coarse gravel			Groundwater encountered at approximately 28½ feet
605	30		0	50/0"	S9				Gneiss	Dark to light gray gneiss; slightly to moderately weathered, medium hard, closely spaced fractures, with mica			Run 1 - 14 minute core run Full drilling fluid returns Poor rock quality Point Load Index = 820 psi; Estimated UCS = 18,000 psi; Mohs Hardness = 7.5
			91		R1 PLS MOH	45				5 inches of moderately weathered to predominantly decomposed quartz with mica			
	35												

Note: See Figure A-1 for explanation of symbols; Figure A-2 for explanation of bedrock terms.
Coordinates Data Source: Horizontal approximated based on GPS (Handheld). Vertical approximated based on GPS (Handheld).

Log of Boring ABR-B-4

GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-6
Sheet 1 of 3

Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered Soil (in)/Rock (%)	Blows/foot	Sample/Run Testing	RQD %	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
600	35		100		R2 UCS UDW MOH	42				Dark to light gray gneiss; slightly weathered to fresh, medium hard, closely spaced fractures, with mica Vertical fractures approximately 2 to 5 inches long with green mineralization between			Run 2 - 16 minute core run Full drilling fluid returns Poor rock quality UCS = 10,190 psi; UDW= 172 pcf; Mohs Hardness = 6.5
595	40		100		R3 CAI	28				Dark to light gray gneiss; slightly weathered to fresh, medium hard, very closely to closely spaced fractures, with mica Becomes very closely fractured with vertical fractures (1 to 2 inches long) and an 1-inch predominantly decomposed layer			Run 3 - 15 minute core run Full drilling fluid returns Poor rock quality CAI = 5.15
590	45		97		R4	30				Gray gneiss; fresh, medium hard, very closely to closely spaced fractures			Run 4 - 17 minute core run Full drilling fluid returns Poor rock quality
585	50		100		R5	15				Becomes with vertical cracks Becomes without vertical fractures			Run 5 - 22 minute core run Full drilling fluid returns Fair rock quality
580	55		98		R6	52				Becomes with vertical fractures and secondary mineralization Gray gneiss; fresh, medium hard to hard, closely spaced fractures with mica			Run 6 - 23 minute core run Full drilling fluid returns Fair rock quality
575	60		98		R7	55							Run 7 - 24 minute core run Full drilling fluid returns Fair rock quality
570	65		100		R8	48							Run 8 - 24 minute core run Full drilling fluid returns Poor rock quality
565	70		99		R9 MOH	43				Dark gray with some light gray gneiss; fresh to slightly weathered, soft to medium hard, very closely to closely spaced fractures, with vertical cracks with secondary mineralization			Run 9 - 22 minute core run Full drilling fluid returns Poor rock quality Mohs Hardness = 6.5
560	75		93		R10	52				Dark gray to light gray gneiss; fresh to slightly weathered, medium hard, very closely to			Run 10 - 13 minute core run Full drilling fluid returns Fair rock quality

Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

Log of Boring ABR-B-4 (continued)

Elevation (feet)	Depth (feet)	FIELD DATA: Interval Recovered Soil (in)/Rock (%)	FIELD DATA: Blows/foot	FIELD DATA: Sample/Run Testing	FIELD DATA: RQD %	FIELD DATA: Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Moisture Content (%)	Fines Content (%)	REMARKS
									moderately closely spaced fractures, with vertical fractures in the upper foot			
555	80	100		R11	77				Dark to light gray gneiss; fresh, medium hard, closely spaced fractures, with occasional quartz band and mica			Run 11 - 14 minute core run Full drilling fluid returns Good rock quality
550	85	100		R12 UCS UDW MOH	64				Becomes very closely to closely fractured			Run 12 - 12 minute core run Full drilling fluid returns Fair rock quality UCS = 10,080 psi; UDW= 171 pcf; Mohs Hardness = 7.5
545	90	99		R13	79				Dark gray to light gray gneiss; fresh to slightly weathered, medium hard, closely to moderately spaced fractures, with mica			Run 13 - 14 minute core run Full drilling fluid returns Fair rock quality
	95								1½-inch red band with 3½-inch quartz			
540		100		R14	72				Dark gray to light gray gneiss; fresh , medium hard, closely spaced fractures, with mica			Run 14 - 12 minute core run Full drilling fluid returns Fair rock quality
535	100	100		R15	62				Light gray with dark gray gneiss, fresh, medium hard, closely to very closely spaced fractures, with mica			Run 15 - 13 minute core run Full drilling fluid returns Fair rock quality
530	105	100		R16	90							Run 16 - 16 minute core run Full drilling fluid returns Good rock quality
	110								Light gray with dark gray gneiss, fresh, moderately hard, closely to moderately closely spaced fractures			

Log of Boring ABR-B-4 (continued)

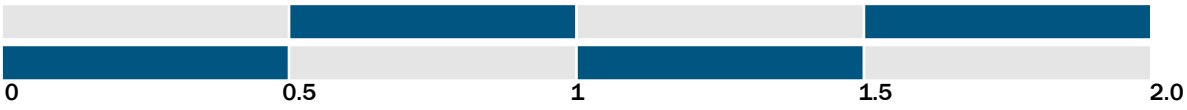
GeoEngineers

Project: SSE Project: Banister River
Project Location: Pittsylvania County, Virginia
Project Number: 08169-235-00

Figure A-6
Sheet 3 of 3

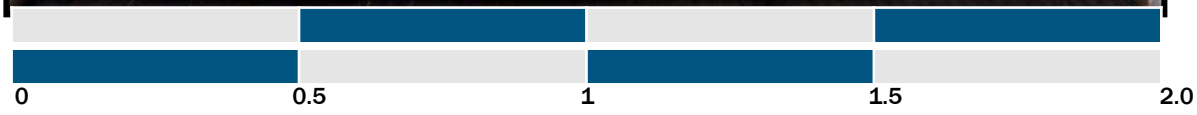
Date:1/23/25 Path:P:\8\8169235\GINT\8169235000.GPJ DBLibrary/Library:GEOENGINEERS_DF_STD_US_JUNE_2017.GLB/GEI8_GEOTECH_SOIL_ROCK_%F

ABR-B-1: 36.3' to 48.8'



Scale in Feet

ABR-B-1: 48.8' to 58.2'



Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-7

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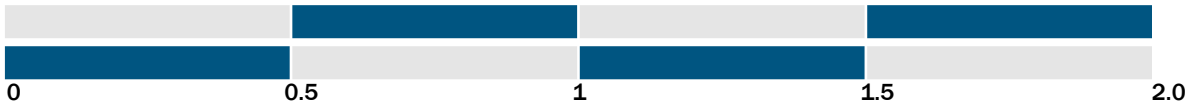
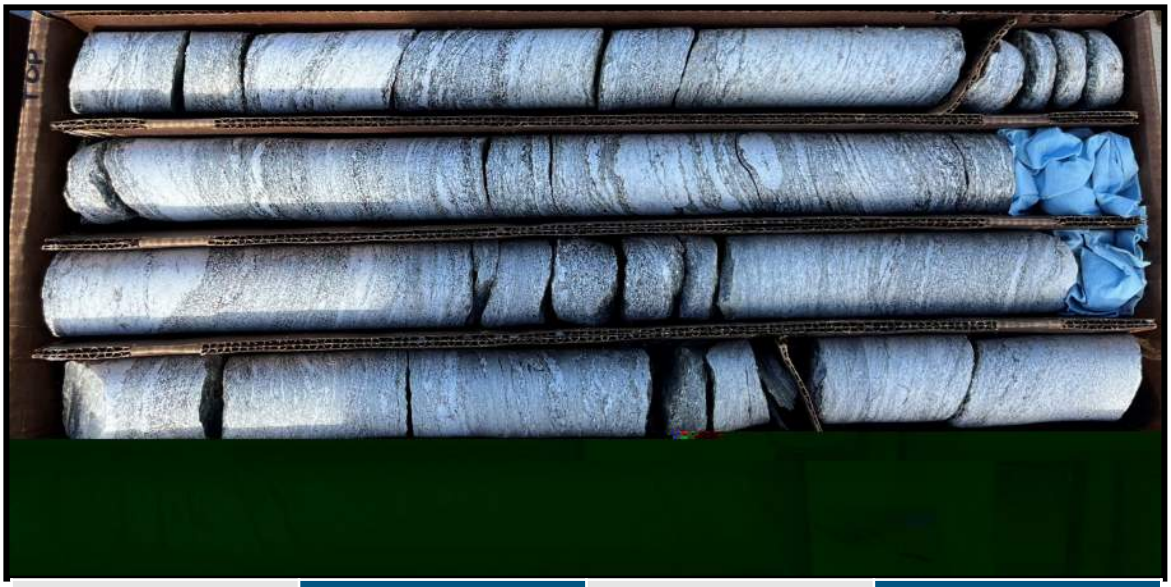
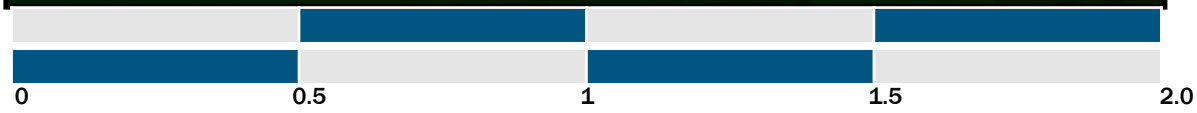
ABR-B-1: 58.2' to 68.1'



Scale in Feet

ABR-B-1: 68.1' to 78.5'





Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-8

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ABR-B-1: 77.5’ to 87.0’

0 0.5 1 1.5 2.0

Scale in Feet

ABR-B-1: 87.0’ to 96.6’

0 0.5 1 1.5 2.0

Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-9

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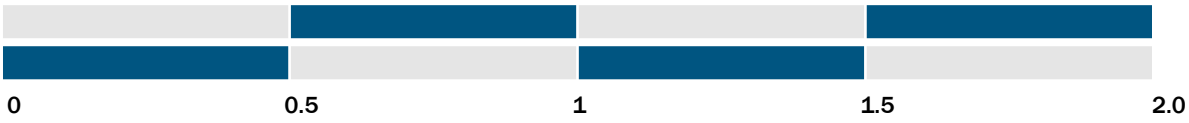
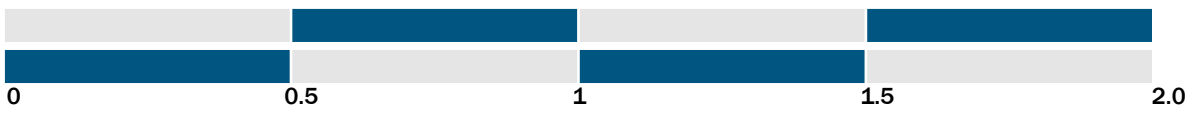
ABR-B-1: 96.6’ to 104.8’



ABR-B-2: 28.0’ to 37.7’



Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-10

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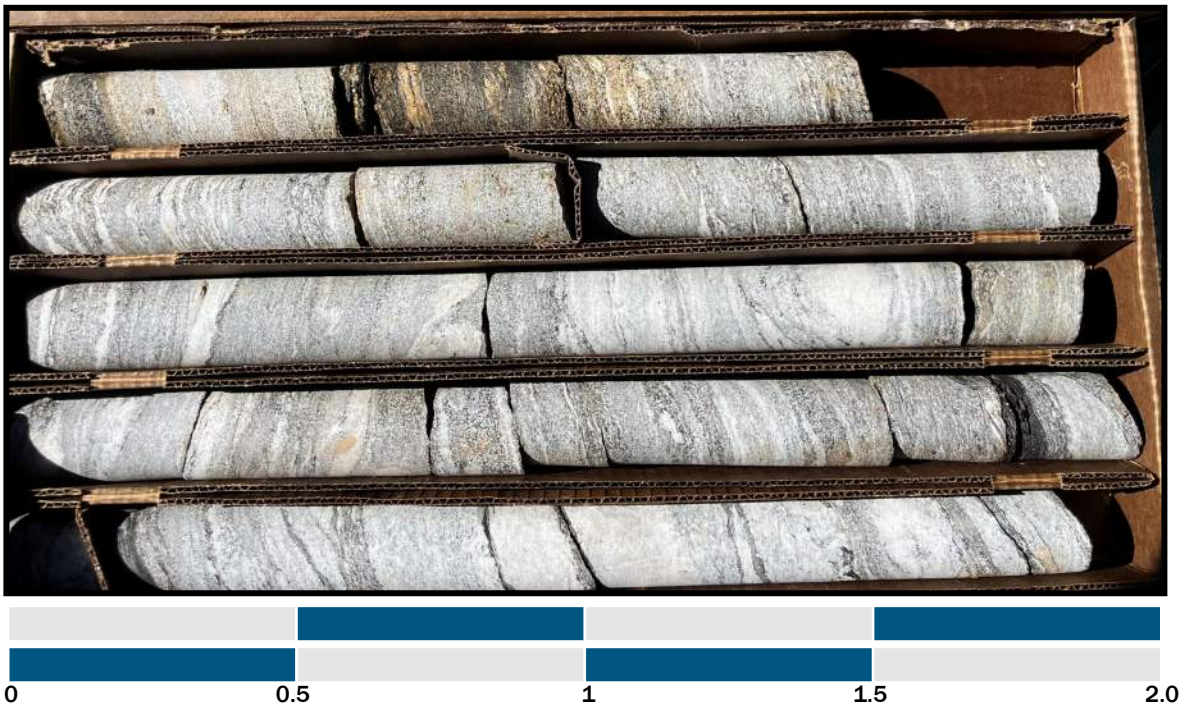
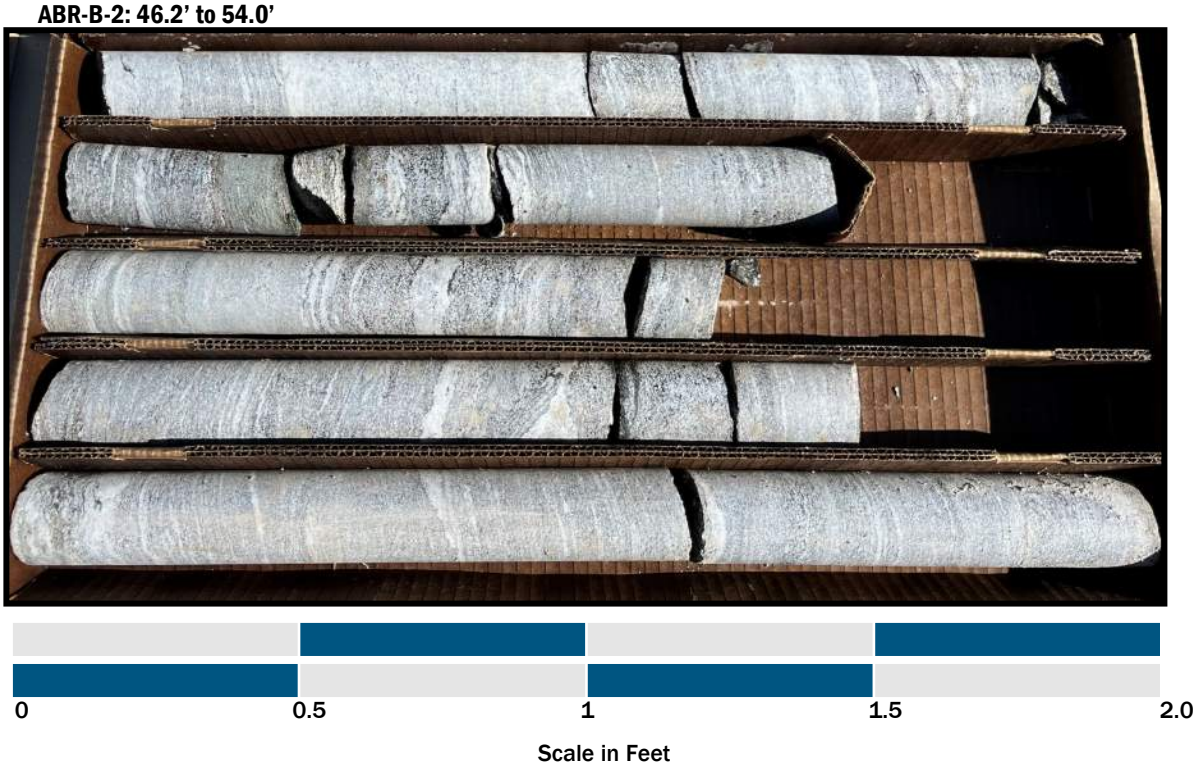
ABR-B-2: 37.7’ to 46.5’



ABR-B-2: 46.2’ to 54.0’



Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-11

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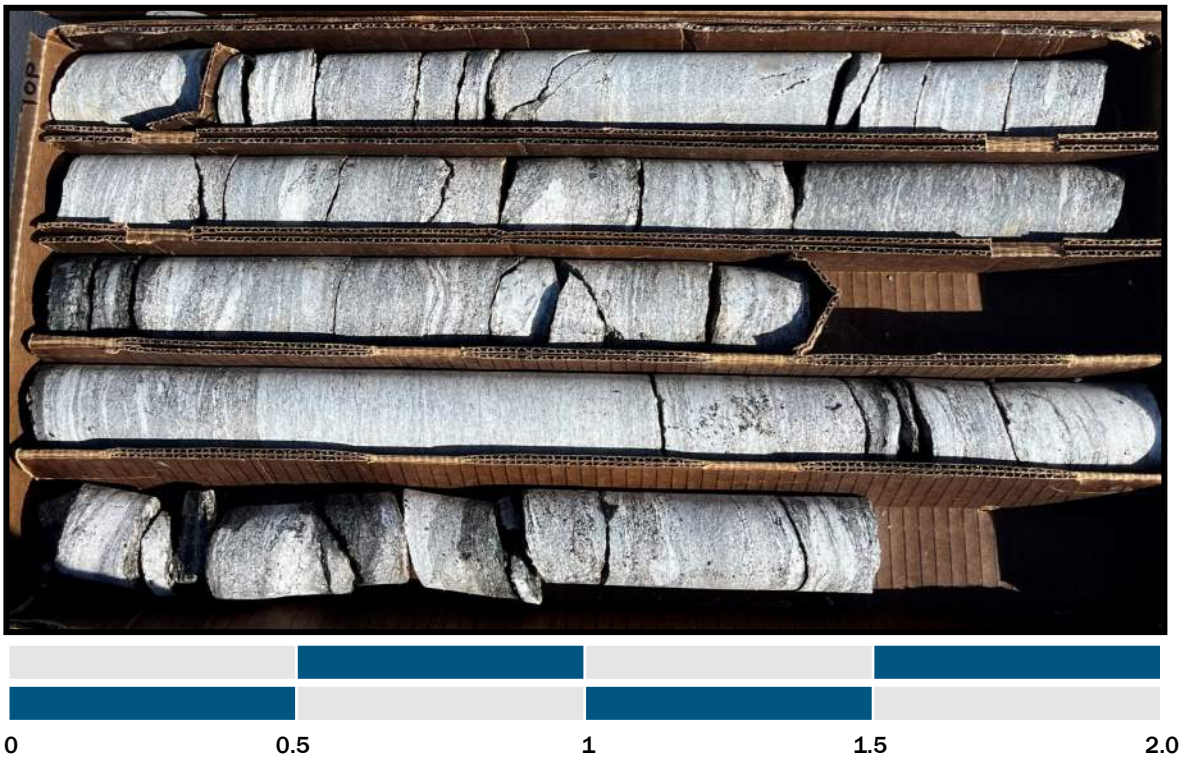
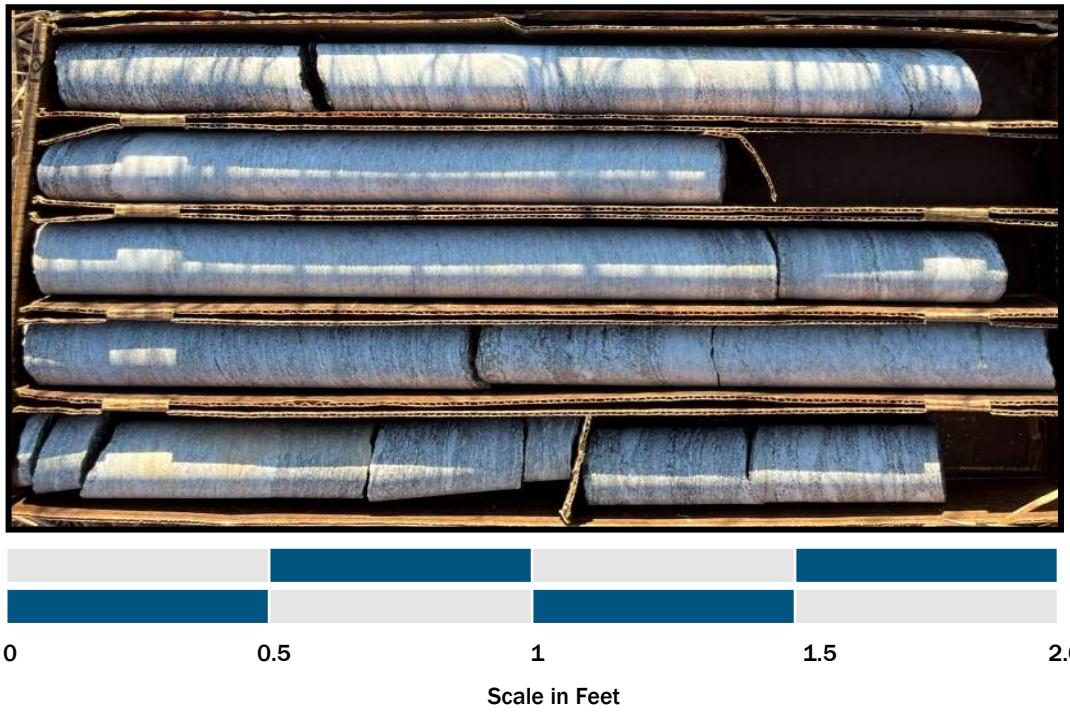
ABR-B-2: 54.0’ to 63.0’



ABR-B-2: 72.7’ to 81.0’



Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-12

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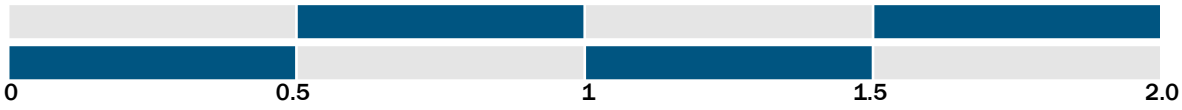
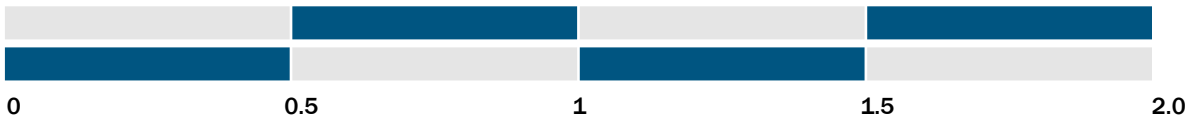
ABR-B-2: 90.7' to 99.2'



Scale in Feet

ABR-B-2: 99.2' to 108.7'



Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-13

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ABR-B-2: 108.7' to 118.0'

0 0.5 1 1.5 2.0

Scale in Feet

ABR-B-2: 118.0' to 127.0'

0 0.5 1 1.5 2.0

Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-14

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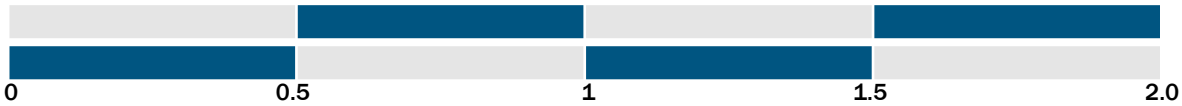
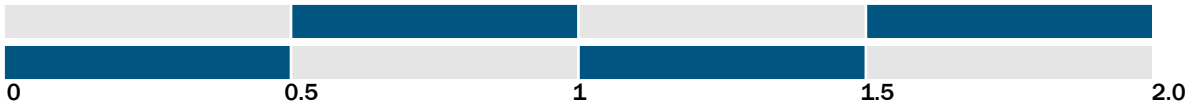
ABR-B-2: 127.0' to Termination



Scale in Feet

ABR-B-3: 22.1' to 31.3'



Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-15

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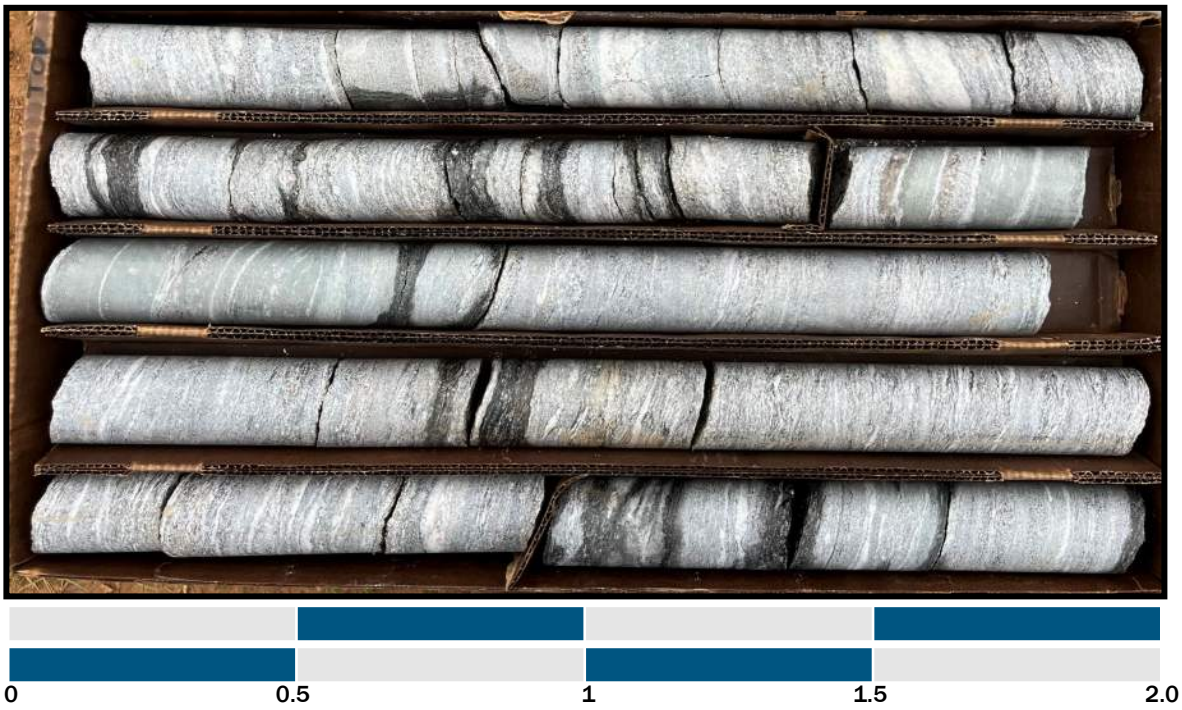
ABR-B-3: 31.3’ to 40.6’



Scale in Feet

ABR-B-3: 40.6’ to 49.6’

Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-16

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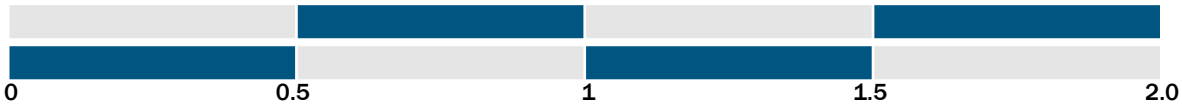
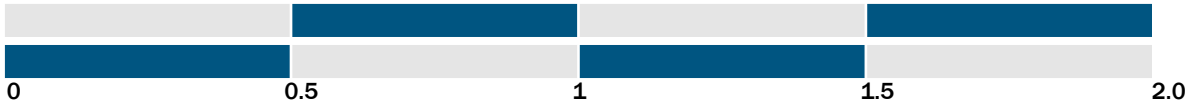
ABR-B-3: 49.6’ to 58.4’



Scale in Feet

ABR-B-3: 58.4’ to 67.1’



Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-17

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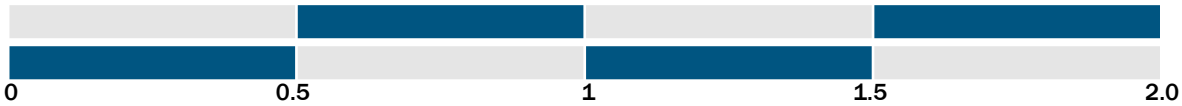
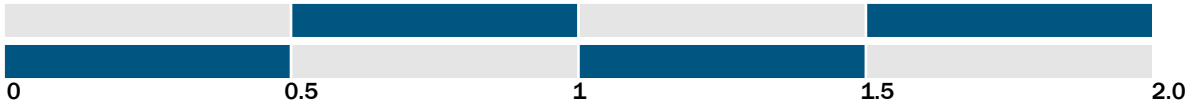
ABR-B-3: 67.1' to 76.3'



Scale in Feet

ABR-B-3: 76.3' to 85.2'



Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-18

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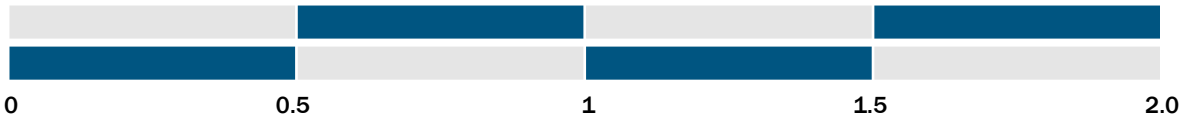
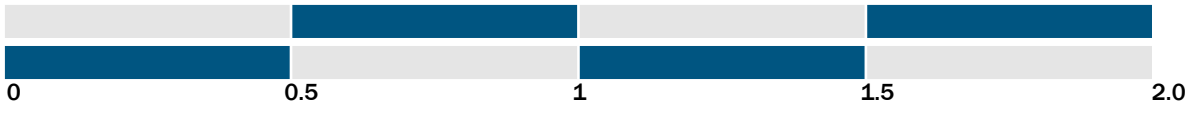
ABR-B-3: 85.2’ to 94.6’



ABR-B-3: 94.6’ to 104.6’



Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-19

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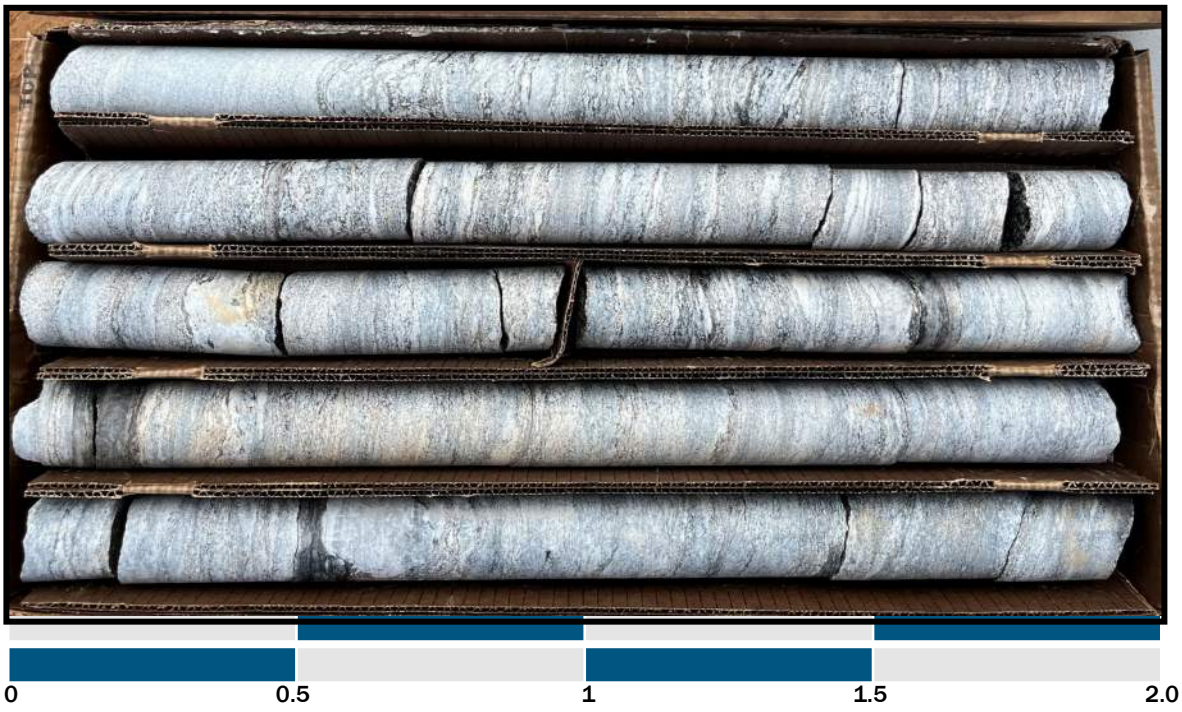
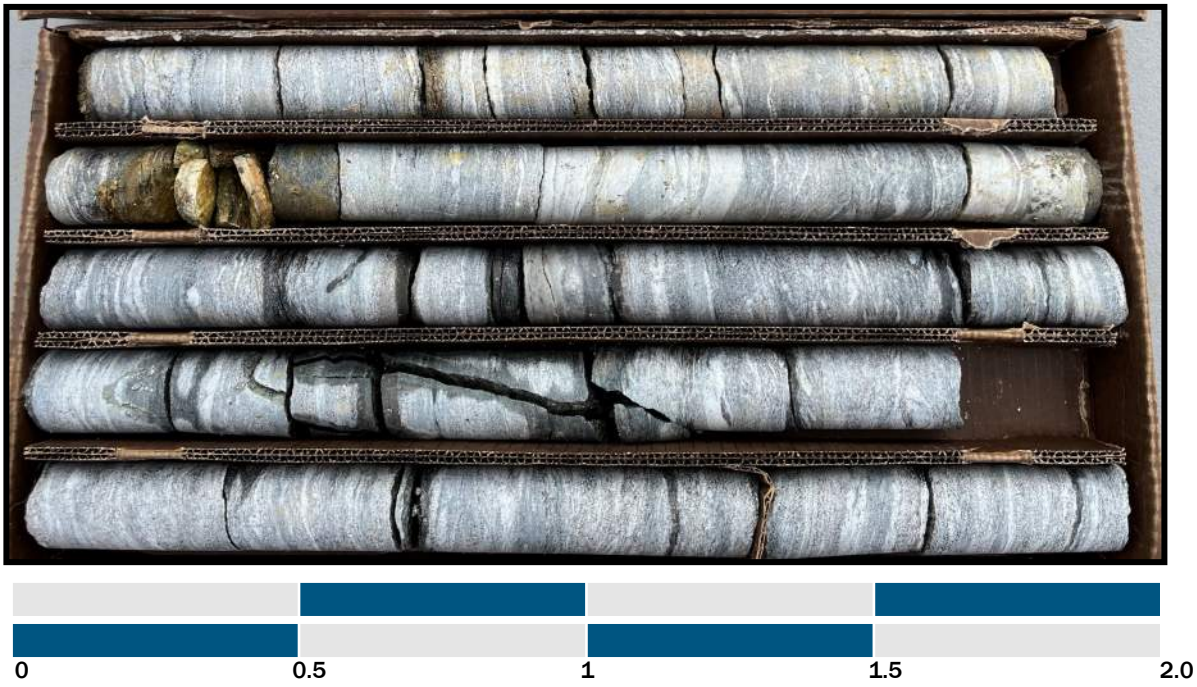
ABR-B-3: 104.6’ to 114.6’



Scale in Feet

ABR-B-4: 30.8’ to 40.9’



Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-20

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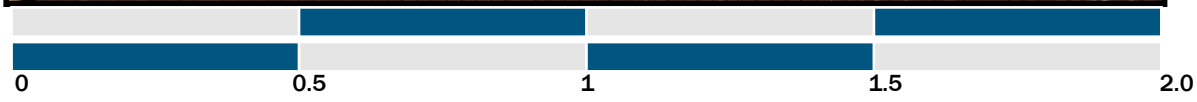
ABR-B-4:

Scale in Feet

ABR-B-4: 59.2' to 68.2'



Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-21

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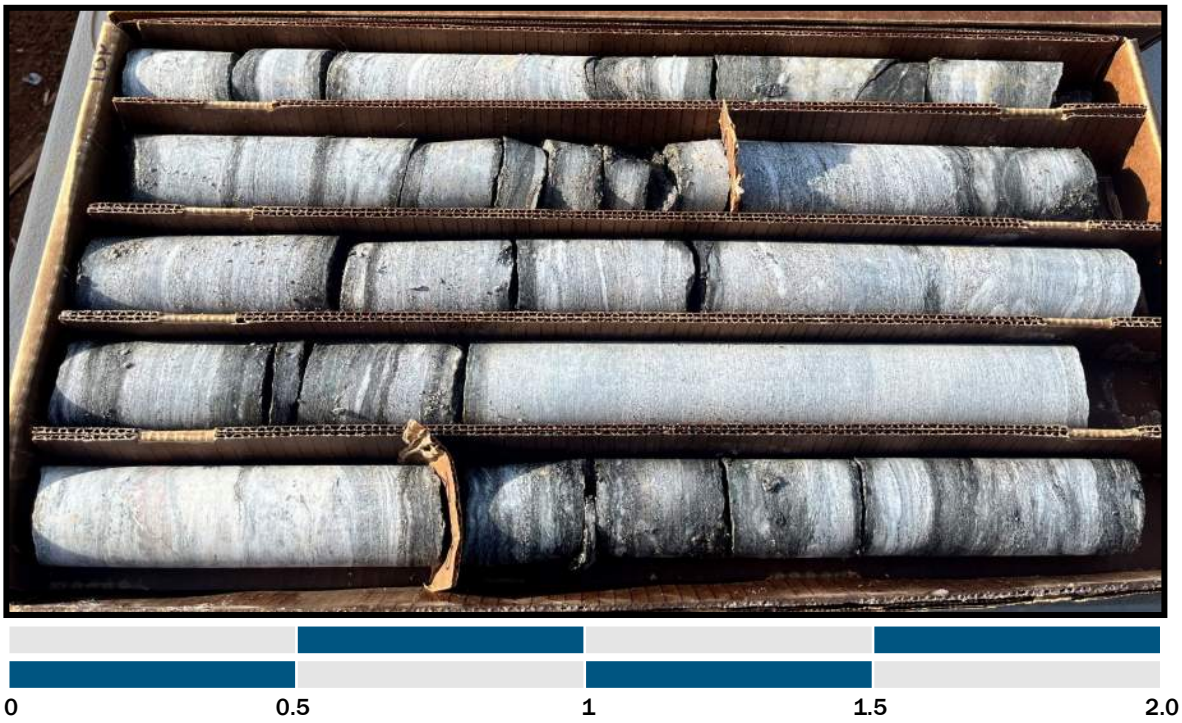
ABR-B-4: 87.4’ to 101.3’



0 0.5 1 1.5 2.0

Scale in Feet

ABR-B-4: 101.3’ to 105.2’

0 0.5 1 1.5 2.0

Scale in Feet

Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-22

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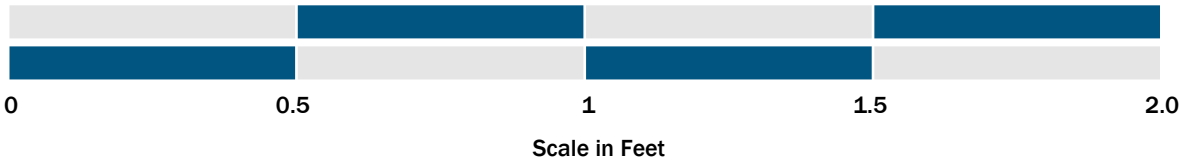
ABR-B-4: 105.2’ to 110.2’



Rock Core Photographs

Banister River Crossing
Pittsylvania County, Virginia

GeoEngineers

Figure A-23

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Geotechnic’s Laboratory Test Results

January 17, 2025

Project No. R-2024-241-003

Tim Pierce
GeoEngineers
1100 Crescent Green Drive Suite 204
Cary, NC 27518

tpierce@geoengineers.com

Transmittal
Laboratory Test Results
SSE Project: Eden Loop –Banister River

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was transmitted to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

2200 Westinghouse Blvd., Suite 103 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460 • www.geotechnics.net

Client: GeoEngineers, Inc.
Client Project: SSE Project: Eden Loop-Banister River
Project No.: 2024-241-003

Laboratory ID	Boring No.	Depth	Sample	MOH's Hardness
2024-241-003-003	ABR-B-1	40.8-45.8	R2	6.0-7.0
2024-241-003-006	ABR-B-1	7038-75.8	R8	5.0-6.0
2024-241-003-008	ABR-B-2	30.7-35.7	R2	6.0-7.0
2024-241-003-013	ABR-B-2	100.7-105.7	R16	4.0-5.0
2024-241-003-019	ABR-B-3	69.6-74.6	R11	6.0-7.0
2024-241-003-024	ABR-B-4	30.8-35.2	R1	7.0-8.0
2024-241-003-026	ABR-B-4	55.2-60.2	R6	6.0-7.0

Note: Mineralab Deluxe Hardness Picks were used for testing.

Tested by: JAC Date: 12/30/24 Checked by: NJM 1/2/25

PERCENT PASSING # 200 SIEVE

ASTM D 1140-17

Client	GeoEngineers
Client Reference	SSE Project: Eden Loop - Banister River
Project No.	R-2024-241-003

Lab Id.	001	022
Boring No.	ABR-B-1	ABR-B-4
Depth (ft)	6-7.5	6-7.5
Sample No.	SS-3	SS-3
Tare Number	725	462
Wt. of Tare & WS (gm)	460.86	461.53
Wt. of Tare & DS (gm)	403.22	402.25
Wt. of Tare (gm)	141.99	141.11
Wt. of Water (gm)	57.64	59.28
Wt. of DS (gm)	261.23	261.14
Water Content (%)	**22.1**	**22.7**
Wt. of Washed Soil & Tare	315.91	324.58
Percent Passing #200	**33.4**	**29.7**

Tested By BS *Date* 12/5/24 *Checked By* AES *Date* 12/6/24

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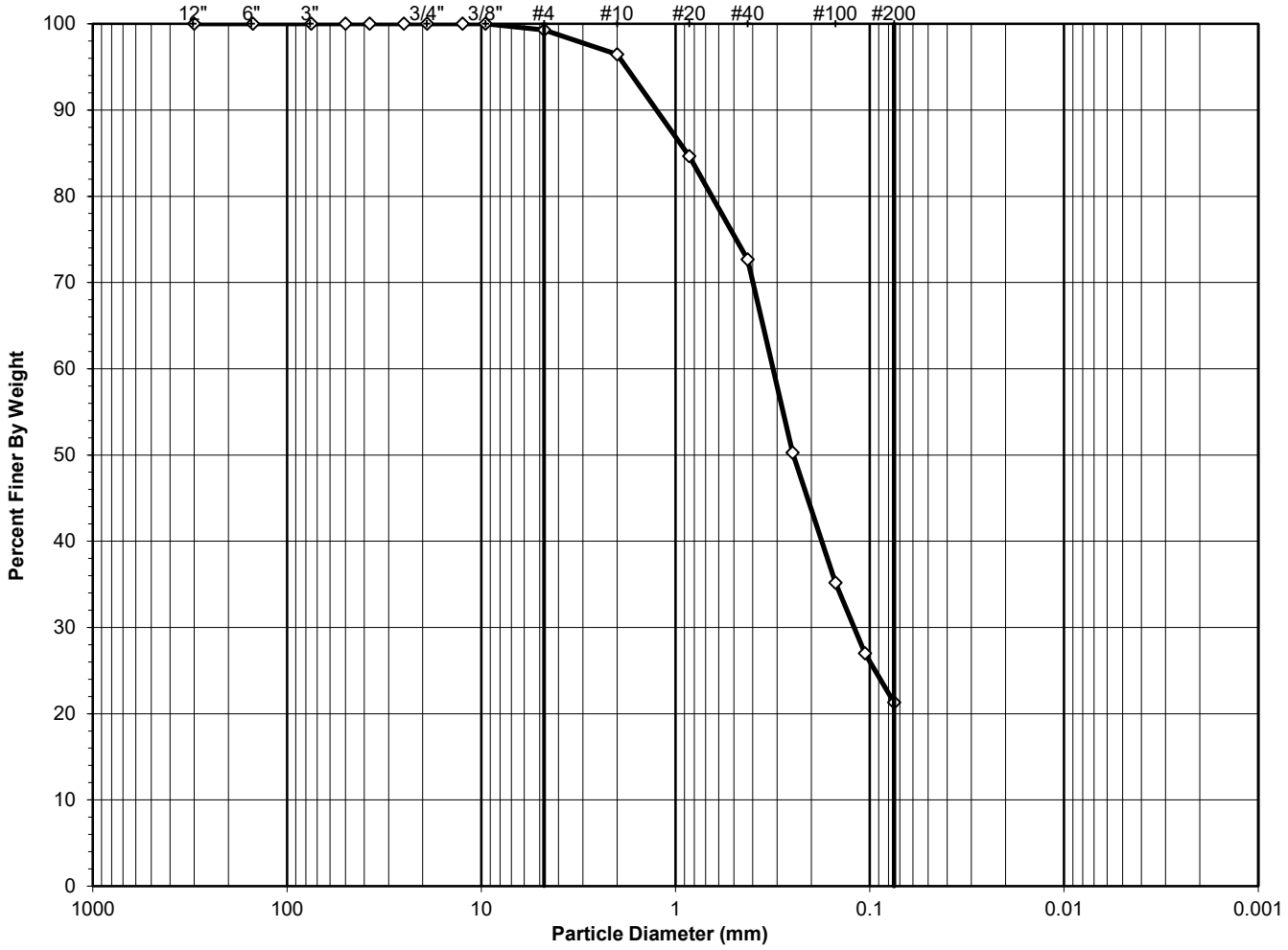
SIEVE AND HYDROMETER ANALYSIS

ASTM D6913 / D7928

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Reference:	SSE Project: Eden Loop - Banister River	Depth (ft):	18.5-20
Project No.:	R-2024-241-003	Sample No.:	SS-6
Lab ID:	R-2024-241-003-002	Soil Color:	Brown

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol:
sm, ASSUMED

D50 = 0.25

USCS Classification:
SILTY SAND

Tested By BS Date 12/6/24 Checked By AES Date 12/6/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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WASH SIEVE ANALYSIS

ASTM D6913-17

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Reference:	SSE Project: Eden Loop - Banister River	Depth (ft):	18.5-20
Project No.:	R-2024-241-003	Sample No.:	SS-6
Lab ID:	R-2024-241-003-002	Soil Color:	Brown

Moisture Content of Passing 3/4" Material		Moisture Content of Retained 3/4" Material	
Tare No.:	401	Tare No.:	NA
Wt. of Tare & Wet Sample (g):	417.31	Weight of Tare & Wet Sample (g):	NA
Wt. of Tare & Dry Sample (g):	371.45	Weight of Tare & Dry Sample (g):	NA
Weight of Tare (g):	144.56	Weight of Tare (g):	NA
Weight of Water (g):	45.86	Weight of Water (g):	NA
Weight of Dry Soil (g):	226.89	Weight of Dry Soil (g):	NA
Moisture Content (%):	**20.2**	**Moisture Content (%):**	**0.0**

Dry Weight of Sample (g):	NA	Total Dry Weight of Sample (g):	226.89
Tare No. (Sub-Specimen)	401	Wet Weight of +3/4" Sample (g):	0.00
Wt. of Tare & Wet Sub-Specimen (g):	417.31	Dry Weight of + 3/4" Sample (g):	0.00
Weight of Tare (g):	144.56	Dry Weight of - 3/4" Sample (g):	226.89
Sub-Specimen Wet Weight (g):	272.75	Dry Weight -3/4" +3/8" Sample (g):	0.00
Tare No. (-3/8" Sub-Specimen):	NA	Dry Weight of -3/8" Sample (g):	226.89
Wt. of Tare & Wet -3/8" Sub-Specimen (g):	NA	J - Factor (% Finer than 3/4"):	NA
Weight of Tare (g):	NA	J - Factor (% Finer than 3/8"):	NA
Sub-Specimen -3/8" Wet Weight (g):	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)		Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00		0.00	0.00	100.00	**100.0**
6"	150	0.00		0.00	0.00	100.00	**100.0**
3"	75	0.00		0.00	0.00	100.00	**100.0**
2"	50	0.00	(*)	0.00	0.00	100.00	**100.0**
1 1/2"	37.5	0.00		0.00	0.00	100.00	**100.0**
1"	25	0.00		0.00	0.00	100.00	**100.0**
3/4"	19	0.00		0.00	0.00	100.00	**100.0**
1/2"	12.5	0.00	(**)	0.00	0.00	100.00	**100.0**
3/8"	9.5	0.00		0.00	0.00	100.00	**100.0**
#4	4.75	1.62		0.71	0.71	99.29	**99.3**
#10	2	6.44		2.84	3.55	96.45	**96.4**
#20	0.85	26.80	(**)	11.81	15.36	84.64	**84.6**
#40	0.425	27.13		11.96	27.32	72.68	**72.7**
#60	0.25	50.90		22.43	49.76	50.24	**50.2**
#100	0.15	34.20		15.07	64.83	35.17	**35.2**
#140	0.106	18.57		8.18	73.01	26.99	**27.0**
#200	0.075	12.92		5.69	78.71	21.29	**21.3**
Pan	-	48.31		21.29	100.00	-	**-**

Notes : *(*) The + 3/4" sieve analysis is based on the Total Dry Weight of the Sample*
*(**) The - 3/4" and - 3/8" sieve analysis is based on the Weight of the Dry Specimen*

Tested By BS Date 12/6/24 Checked By AES Date 12/6/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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POINT LOAD STRENGTH OF ROCK - AXIAL

ASTM D5731-08

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Reference:	SSE Project: Eden Loop - Banister River	Depth (ft):	40.8-45.8
Project No.:	2024-241-003	Sample No.:	Run 2
Lab ID:	2024-241-003-003	Description:	Rock Core
		Moisture Condition:	As Received-Unpreserved

Sample Height Measurements, (D)

Height 1 (in):	1.559
Height 2 (in):	1.559
Height 3, Test Contact Point (in):	1.559
Test Contact Point (mm):	39.6
Average Height (in):	1.559
Equivalent Core Diam. (Axial/Block), (in):	3.694

Sample Length Measurements, (W)

Length 1 (in):	1.861
Length 2 (in):	1.861
Length 3 (in):	1.861
Average Length (in):	1.861
Length/Diameter Ratio (D/W):	0.838

Sample Length Measurements, (L)

Length 1 (in):	0.931
Length 2 (in):	0.931
Length 3 (in):	0.931
Average Length (in):	0.931
L > 0.5D (in):	0.779

Specimen Weight (g):	**171.04**
Moisture Content (%):	
Tare Number:	3243
Wt. of Tare & Wet Sample (g):	178.79
Wt. of Tare & Dry Sample (g):	177.94
Weight of Tare (g):	8.08
Weight of Wet Sample (g):	170.71
Sample Volume (cm^3):	69.49
Moisture Content (%):	0.50
Unit Wet Weight (g/cm^3):	2.461
Unit Wet Weight (pcf):	153.6
Unit Dry Weight (g/cm^3):	2.449
Unit Dry Weight (pcf):	152.8

Index & Strength Computations

I_S - Point Load Index (psi):	**237.7**
$I_{S(50)}$ - Corrected Point Load Index (psi):	**235.2**
K - Index To Strength Conversion Factor:	**22.2**
δ_{vx} - Est. Unconfined Compressive Strength (psi):	**5,269**

Test Data

Core Diameter (mm):	47.2694
P - Gauge Pressure @ Failure (lbf):	878

Mohs Hardness_6-7

SAMPLE SHOWN IN THE SAME ORIENTATION AS TESTED

Tested By JAC *Date* 1/2/25 *Checked By* NJM *Date* 1/3/25

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	45.8-50.8
Project No.:	R-2024-241-003	Sample ID:	RUN 3
Lab ID No.:	R-2024-241-003-004	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 515.28

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.21	Reading 1:	1.87
Reading 2:	4.22	Reading 2:	1.87
Reading 3:	4.21	Average:	**1.87**
Average:	**4.21**	Area (in^2):	2.73
		L/D:	2.26

MOISTURE CONTENT			
Tare Number:	711	Total Load (lb):	18,970
Wt. of Tare & Wet Sample (g):	574.18	**Uniaxial Compressive Strength (psi):**	**6,950**
Wt. of Tare & Dry Sample (g):	573.67		
Weight of Tare (g):	92.28	Fracture Type:	**Shear**
Weight of Wet Sample (g):	481.90		
Sample Volume (cm^3):	188.86	Rate of Loading (lb/sec):	213
Moisture Content (%):	0.11	Time to Break (min:sec):	01:40.30
Unit Wet Weight (g/cm^3):	2.728	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	170.2		
Unit Dry Weight (g/cm^3):	2.725	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	170.1		

Mohs Hardness: 8-9

Physical Description: Gray Sandstone Quartzite

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/9/24 *Checked By:* AES *Date:* 12/10/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	60.8-65.8
Project No.:	R-2024-241-003	Sample ID:	RUN 6
Lab ID No.:	R-2024-241-003-005	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 568.10

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.47	Reading 1:	1.88
Reading 2:	4.47	Reading 2:	1.88
Reading 3:	4.47	Average:	**1.88**
Average:	**4.47**	Area (in^2):	2.77
		L/D:	2.38

MOISTURE CONTENT			
Tare Number:	473	Total Load (lb):	17,080
Wt. of Tare & Wet Sample (g):	649.76	**Uniaxial Compressive Strength (psi):**	**6,170**
Wt. of Tare & Dry Sample (g):	649.32		
Weight of Tare (g):	97.40	Fracture Type:	**Shear**
Weight of Wet Sample (g):	552.36		
Sample Volume (cm^3):	202.49	Rate of Loading (lb/sec):	191
Moisture Content (%):	0.08	Time to Break (min:sec):	01:40.40
Unit Wet Weight (g/cm^3):	2.806	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	175.1		
Unit Dry Weight (g/cm^3):	2.803	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	174.9		

Mohs Hardness: 6-7

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/30/24 *Checked By:* AES *Date:* 12/31/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	ABR-B-1
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	70.8-75.8'
Project No.	2024-241-003	Sample No.	Run 8
Lab ID	2024-241-003-006	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.549	Top Dia. (in)	1.866
Length 2 (in)	4.549	Mid. Dia. (in)	1.866
Length 3 (in)	4.550	Bot. Dia. (in)	1.865
Avg. Length (in)	4.549	Area (in.^{2})	2.73
Gauge Length (in)	3.136		

WATER CONTENT AFTER TEST	
Tare No.	3348
Wt. Tare + WS.(gms)	557.34
Wt. Tare + DS.(gms)	557.04
Wt. of Tare (gms)	8.45
% Moisture	0.05

UNIT WEIGHT			
Wet Wt. of Core (gms.)	549.66	Sample Volume(cc.)	203.8
Diameter (in.)	1.87	Unit Wet Wt.(gms/cc)	2.70
Length (in.)	4.55	Unit Wet Wt.(pcf.)	168.30
Length (cm.)	11.56	Moisture Content, %	0.05
		Unit Dry Wt.(pcf.)	168.20

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0000160	N/A	1,248	12	0.0000051	N/A	456.7
0.0000865	N/A	2,174	25	0.0000276	N/A	795.4
0.0001677	N/A	2,705	38	0.0000535	N/A	989.3
0.0002643	N/A	3,286	50	0.0000843	N/A	1,202.1
0.0004103	N/A	4,130	63	0.0001308	N/A	1,510.9
0.0005532	N/A	4,937	76	0.0001764	N/A	1,806.0
0.0007031	N/A	5,790	89	0.0002242	N/A	2,117.9
0.0008506	N/A	6,647	101	0.0002712	N/A	2,431.6
0.0010239	N/A	7,673	114	0.0003265	N/A	2,806.9
0.0011977	N/A	8,718	127	0.0003819	N/A	3,189.2
0.0015485	N/A	10,888	152	0.0004938	N/A	3,982.9
0.0017356	N/A	12,124	165	0.0005534	N/A	4,435.1
0.0019581	N/A	13,586	178	0.0006243	N/A	4,969.8
0.0021805	N/A	15,095	191	0.0006953	N/A	5,521.7
0.0023891	N/A	16,557	203	0.0007618	N/A	6,056.4
0.0026239	N/A	18,166	216	0.0008366	N/A	6,645.0
0.0028556	N/A	19,766	229	0.0009105	N/A	7,230.4
0.0030878	N/A	21,366	242	0.0009846	N/A	7,815.6
0.0033080	N/A	22,885	254	0.0010548	N/A	8,371.4
0.0035465	N/A	24,513	267	0.0011308	N/A	8,966.7
0.0037864	N/A	26,179	280	0.0012073	N/A	9,576.2
0.0040283	N/A	27,831	293	0.0012844	N/A	10,180.4
0.0042553	N/A	29,356	305	0.0013568	N/A	10,738.3
0.0044995	N/A	31,005	318	0.0014347	N/A	11,341.5
0.0047581	N/A	32,616	331	0.0015171	N/A	11,930.9
0.0050431	N/A	34,005	343	0.0016080	N/A	12,439.1

Tested By	JAC	Date	1/7/25	Input Checked By:	NJM	Date	1/10/25

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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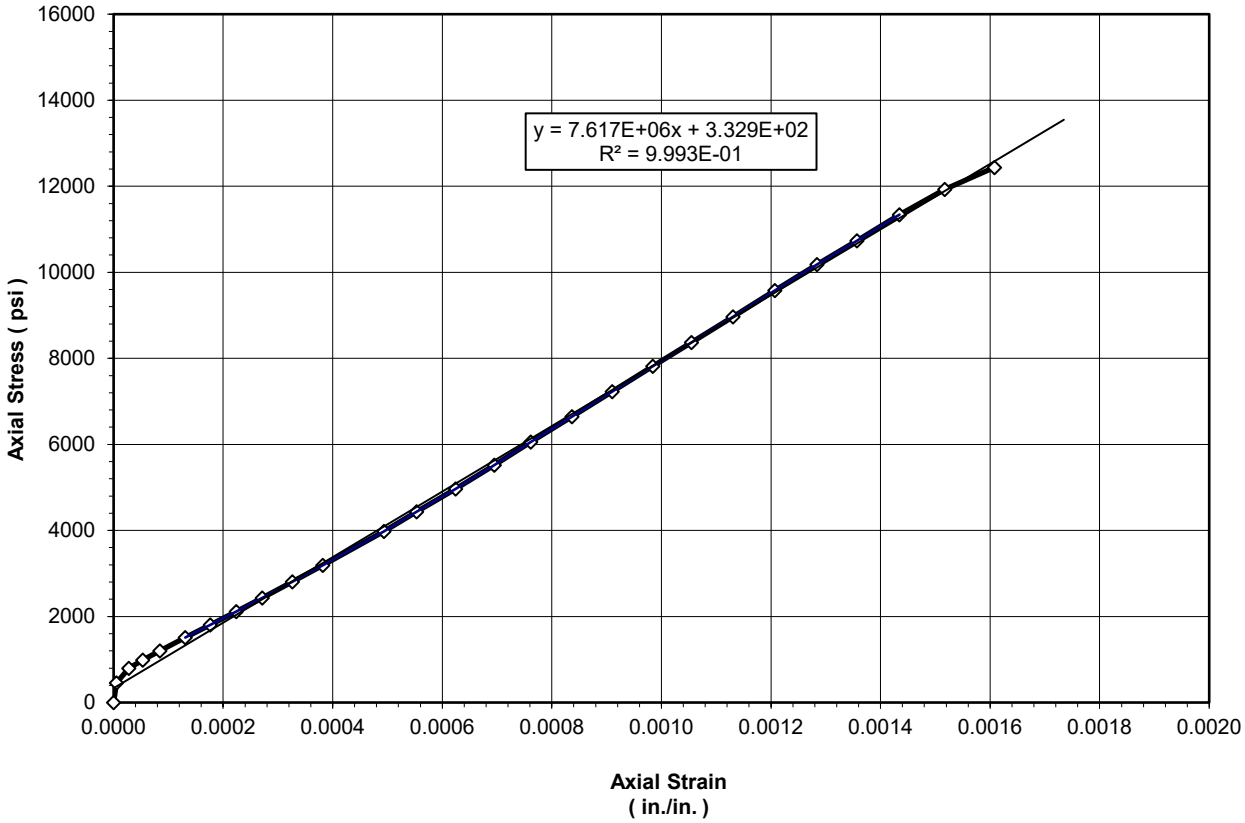
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	ABR-B-1
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	70.8-75.8'
Project No.	2024-241-003	Sample No.	Run 8
Lab ID	2024-241-003-006	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	34,005	Pounds
Peak Compressive Strength:	12,439	psi
Break Type:	Shear	
Break Time (min. : sec.):	05:43	

Stress Range (psi)	*Young's Modulus (psi)*
1,510 - 11,341	7,617,000

Tested By JAC Date 1/7/25 Approved By NJM Date 1/10/2025

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	ABR-B-1
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	70.8-75.8'
Project No.	2024-241-003	Sample No.	Run 8
Lab ID	2024-241-003-006	Visual Description:	Gray Rock Core

Tested By	JAC	Date	1/7/25	Input Checked By:	NJM	Date	1/10/2025

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	89.8-94.8
Project No.:	R-2024-241-003	Sample ID:	RUN 12
Lab ID No.:	R-2024-241-003-007	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 528.10

SPECIMEN LENGTH (in)

Reading 1:	4.45
Reading 2:	4.45
Reading 3:	4.45
Average:	**4.45**

SPECIMEN DIAMETER (in):

Reading 1:	1.86
Reading 2:	1.86
Average:	**1.86**
Area (in^2):	2.71
L/D:	2.39

MOISTURE CONTENT

Tare Number:	485
Wt. of Tare & Wet Sample (g):	625.96
Wt. of Tare & Dry Sample (g):	625.75
Weight of Tare (g):	99.76
Weight of Wet Sample (g):	526.20
Sample Volume (cm^3):	197.81
Moisture Content (%):	0.04
Unit Wet Weight (g/cm^3):	2.670
Unit Wet Weight (pcf):	166.6
Unit Dry Weight (g/cm^3):	2.669
Unit Dry Weight (pcf):	166.5

Total Load (lb):	20,020
Uniaxial Compressive Strength (psi):	**7,390**
Fracture Type:	**Shear**
Rate of Loading (lb/sec):	224
Time to Break (min:sec):	02:42.42
Deviation From Straightness[2]:	

AXIAL: *Pass* TOP: *Pass* BOTTOM: *Pass*

Mohs Hardness: 7-8

Physical Description: Light Gray Gneiss Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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POINT LOAD STRENGTH OF ROCK - AXIAL

ASTM D5731-08

Client:	GeoEngineers	Boring No.:	ABR-B-2
Client Reference:	SSE Project: Eden Loop - Banister River	Depth (ft):	30.7-35.7
Project No.:	2024-241-003	Sample No.:	Run 2
Lab ID:	2024-241-003-008	Description:	Rock Core
		Moisture Condition:	As Received-Unpreserved

Sample Height Measurements, (D)

Height 1 (in):	1.550
Height 2 (in):	1.550
Height 3, Test Contact Point (in):	1.550
Test Contact Point (mm):	39.4
Average Height (in):	1.550
Equivalent Core Diam. (Axial/Block), (in):	3.690

Sample Length Measurements, (W)

Length 1 (in):	1.869
Length 2 (in):	1.870
Length 3 (in):	1.870
Average Length (in):	1.870
Length/Diameter Ratio (D/W):	0.829

Sample Length Measurements, (L)

Length 1 (in):	0.935
Length 2 (in):	0.935
Length 3 (in):	0.935
Average Length (in):	0.935
L > 0.5D (in):	0.775

Specimen Weight (g):	**178.26**
Moisture Content (%):	
Tare Number:	4027
Wt. of Tare & Wet Sample (g):	185.45
Wt. of Tare & Dry Sample (g):	184.83
Weight of Tare (g):	8.14
Weight of Wet Sample (g):	177.31
Sample Volume (cm^3):	69.74
Moisture Content (%):	0.35
Unit Wet Weight (g/cm^3):	2.556
Unit Wet Weight (pcf):	159.5
Unit Dry Weight (g/cm^3):	2.547
Unit Dry Weight (pcf):	159.0

Index & Strength Computations

I_S - Point Load Index (psi):	**77.0**
$I_{S(50)}$ - Corrected Point Load Index (psi):	**76.2**
K - Index To Strength Conversion Factor:	**22.2**
δ_{vx} - Est. Unconfined Compressive Strength (psi):	**1,710**

Test Data

Core Diameter (mm):	47.48953
P - Gauge Pressure @ Failure (lbf):	284

Mohs Hardness_6-7

SAMPLE SHOWN IN THE SAME ORIENTATION AS TESTED

Tested By JAC *Date* 1/2/25 *Checked By* NJM *Date* 1/3/25

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-2
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	35.7-40.7
Project No.:	R-2024-241-003	Sample ID:	RUN 3
Lab ID No.:	R-2024-241-003-009	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 541.12

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.43	Reading 1:	1.88
Reading 2:	4.43	Reading 2:	1.88
Reading 3:	4.43	Average:	**1.88**
Average:	**4.43**	Area (in^2):	2.77
		L/D:	2.36

MOISTURE CONTENT			
Tare Number:	495	Total Load (lb):	3,840
Wt. of Tare & Wet Sample (g):	634.61	**Uniaxial Compressive Strength (psi):**	**1,390**
Wt. of Tare & Dry Sample (g):	633.07		
Weight of Tare (g):	99.28	Fracture Type:	**Shear**
Weight of Wet Sample (g):	535.33		
Sample Volume (cm^3):	200.68	Rate of Loading (lb/sec):	43
Moisture Content (%):	0.29	Time to Break (min:sec):	00:27.20
Unit Wet Weight (g/cm^3):	2.696	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	168.3		
Unit Dry Weight (g/cm^3):	2.689	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	167.8		

Mohs Hardness: 6-7

Physical Description: Gray Pumice/Schist Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/9/24 *Checked By:* AES *Date:* 12/10/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-2
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	50.7-55.7
Project No.:	R-2024-241-003	Sample ID:	RUN 6
Lab ID No.:	R-2024-241-003-010	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 555.10

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.42	Reading 1:	1.84
Reading 2:	4.42	Reading 2:	1.84
Reading 3:	4.42	Average:	**1.84**
Average:	**4.42**	Area (in^2):	2.65
		L/D:	2.40

MOISTURE CONTENT			
Tare Number:	447	Total Load (lb):	23,710
Wt. of Tare & Wet Sample (g):	599.61	**Uniaxial Compressive Strength (psi):**	**8,950**
Wt. of Tare & Dry Sample (g):	599.33		
Weight of Tare (g):	98.80	Fracture Type:	**Shear**
Weight of Wet Sample (g):	500.81		
Sample Volume (cm^3):	191.78	Rate of Loading (lb/sec):	266
Moisture Content (%):	0.06	Time to Break (min:sec):	01:49.37
Unit Wet Weight (g/cm^3):	2.894	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	180.6		
Unit Dry Weight (g/cm^3):	2.893	AXIAL: *Pass* TOP: *Pass* BOTTOM: *Pass*	
Unit Dry Weight (pcf):	180.5		

Mohs Hardness: 6-7

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/30/24 *Checked By:* AES *Date:* 12/31/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-2
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	65.7-70.7
Project No.:	R-2024-241-003	Sample ID:	RUN 9
Lab ID No.:	R-2024-241-003-011	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 546.90

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.47	Reading 1:	1.86
Reading 2:	4.47	Reading 2:	1.86
Reading 3:	4.47	Average:	**1.86**
Average:	**4.47**	Area (in^2):	2.70
		L/D:	2.41

MOISTURE CONTENT			
Tare Number:	474	Total Load (lb):	37,070
Wt. of Tare & Wet Sample (g):	642.42	**Uniaxial Compressive Strength (psi):**	**13,730**
Wt. of Tare & Dry Sample (g):	642.26		
Weight of Tare (g):	98.30	Fracture Type:	**Shear**
Weight of Wet Sample (g):	544.12		
Sample Volume (cm^3):	197.88	Rate of Loading (lb/sec):	415
Moisture Content (%):	0.03	Time to Break (min:sec):	02:49.51
Unit Wet Weight (g/cm^3):	2.764	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	172.5		
Unit Dry Weight (g/cm^3):	2.763	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	172.4		

Mohs Hardness: 7-8

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/30/24 *Checked By:* AES *Date:* 12/31/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-2
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	80.7-85.7
Project No.:	R-2024-241-003	Sample ID:	RUN 12
Lab ID No.:	R-2024-241-003-012	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 537.03

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.41	Reading 1:	1.85
Reading 2:	4.41	Reading 2:	1.85
Reading 3:	4.41	Average:	**1.85**
Average:	**4.41**	Area (in^2):	2.69
		L/D:	2.38

MOISTURE CONTENT			
Tare Number:	702	Total Load (lb):	19,700
Wt. of Tare & Wet Sample (g):	628.52	**Uniaxial Compressive Strength (psi):**	**7,320**
Wt. of Tare & Dry Sample (g):	628.22		
Weight of Tare (g):	91.59	Fracture Type:	**Shear**
Weight of Wet Sample (g):	536.93		
Sample Volume (cm^3):	194.60	Rate of Loading (lb/sec):	221
Moisture Content (%):	0.06	Time to Break (min:sec):	02:19.01
Unit Wet Weight (g/cm^3):	2.760	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	172.2		
Unit Dry Weight (g/cm^3):	2.758	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	172.1		

Mohs Hardness: 4-5

Physical Description: Gray Gneiss Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	ABR-B-2
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	100.7-105.7'
Project No.	2024-241-003	Sample No.	Run 16
Lab ID	2024-241-003-013	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.649	Top Dia. (in)	1.864
Length 2 (in)	4.649	Mid. Dia. (in)	1.863
Length 3 (in)	4.650	Bot. Dia. (in)	1.865
Avg. Length (in)	4.649	Area (in.^{2})	2.73
Gauge Length (in)	3.266		

WATER CONTENT AFTER TEST	
Tare No.	4015
Wt. Tare + WS.(gms)	592.16
Wt. Tare + DS.(gms)	591.95
Wt. of Tare (gms)	8.05
% Moisture	0.04

UNIT WEIGHT			
Wet Wt. of Core (gms.)	584.41	Sample Volume(cc.)	207.9
Diameter (in.)	1.86	Unit Wet Wt.(gms/cc)	2.81
Length (in.)	4.65	Unit Wet Wt.(pcf.)	175.40
Length (cm.)	11.81	Moisture Content, %	0.04
		Unit Dry Wt.(pcf.)	175.34

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0012572	N/A	768	12	0.0003850	N/A	281.4
0.0018166	N/A	1,274	25	0.0005563	N/A	466.9
0.0023069	N/A	1,853	38	0.0007065	N/A	678.9
0.0027013	N/A	2,469	51	0.0008272	N/A	904.6
0.0029909	N/A	3,017	64	0.0009159	N/A	1,105.7
0.0032659	N/A	3,559	76	0.0010001	N/A	1,304.1
0.0035957	N/A	4,209	89	0.0011011	N/A	1,542.3
0.0039872	N/A	4,899	102	0.0012210	N/A	1,795.4
0.0044002	N/A	5,646	115	0.0013475	N/A	2,068.9
0.0048231	N/A	6,458	128	0.0014770	N/A	2,366.4
0.0057410	N/A	7,743	153	0.0017581	N/A	2,837.4
0.0060563	N/A	8,328	166	0.0018546	N/A	3,052.0
0.0064154	N/A	8,932	179	0.0019646	N/A	3,273.3
0.0067528	N/A	9,614	192	0.0020679	N/A	3,523.1
0.0071974	N/A	10,594	205	0.0022041	N/A	3,882.3
0.0076556	N/A	11,544	217	0.0023444	N/A	4,230.4
0.0083346	N/A	12,606	230	0.0025523	N/A	4,619.3
0.0097775	N/A	13,572	243	0.0029942	N/A	4,973.4
0.0190790	N/A	14,539	256	0.0058426	N/A	5,327.8
0.0197229	N/A	15,655	269	0.0060398	N/A	5,736.8
0.0048819	N/A	16,541	281	0.0014950	N/A	6,061.6
0.0048774	N/A	17,513	294	0.0014936	N/A	6,417.8
0.0048613	N/A	18,691	307	0.0014887	N/A	6,849.3
0.0048505	N/A	20,146	320	0.0014854	N/A	7,382.6
0.0048188	N/A	22,182	333	0.0014757	N/A	8,128.8
0.0035049	N/A	23,541	345	0.0010733	N/A	8,626.7

Tested By	JAC	Date	1/7/25	Input Checked By:	NJM	Date	1/10/25

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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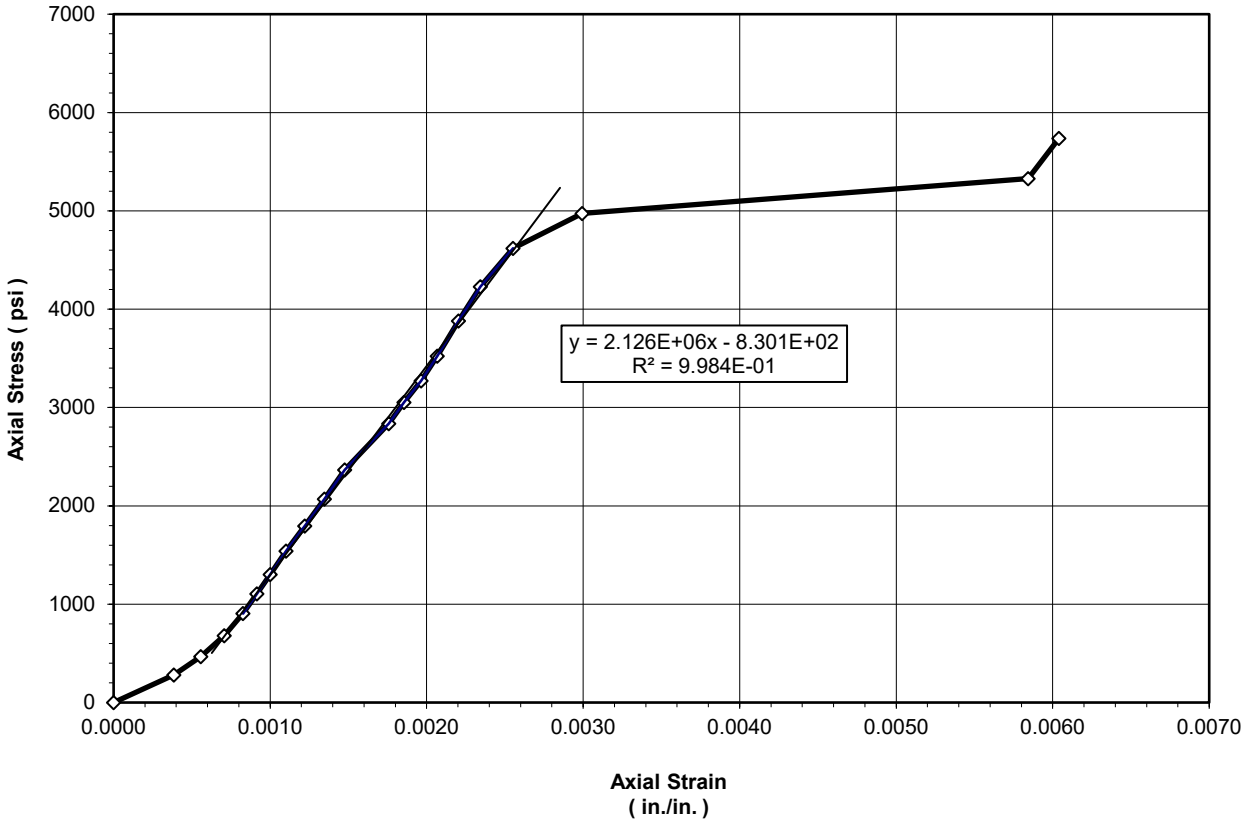
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	ABR-B-2
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	100.7-105.7'
Project No.	2024-241-003	Sample No.	Run 16
Lab ID	2024-241-003-013	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	23,541	Pounds
Peak Compressive Strength:	8,627	psi
Break Type:	Cone & Shear	
Break Time (min. : sec.):	05:45	

Stress Range (psi)	*Young's Modulus (psi)*
904 - 4,619	2,126,000

Tested By JAC Date 1/7/25 Approved By NJM Date 1/10/2025

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	ABR-B-2
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	100.7-105.7'
Project No.	2024-241-003	Sample No.	Run 16
Lab ID	2024-241-003-013	Visual Description:	Gray Rock Core

Tested By	JAC	Date	1/7/25	Input Checked By:	NJM	Date	1/10/2025

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-2
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	115.7-120.7
Project No.:	R-2024-241-003	Sample ID:	RUN 19
Lab ID No.:	R-2024-241-003-014	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): **524.23**

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.49	Reading 1:	1.87
Reading 2:	4.49	Reading 2:	1.87
Reading 3:	4.48	Average:	**1.87**
Average:	**4.48**	Area (in^2):	2.73
		L/D:	2.40

MOISTURE CONTENT			
Tare Number:	474	Total Load (lb):	14,660
Wt. of Tare & Wet Sample (g):	578.42	**Uniaxial Compressive Strength (psi):**	**5,370**
Wt. of Tare & Dry Sample (g):	578.17		
Weight of Tare (g):	98.48	Fracture Type:	**Shear**
Weight of Wet Sample (g):	479.94		
Sample Volume (cm^3):	200.98	Rate of Loading (lb/sec):	164
Moisture Content (%):	0.05	Time to Break (min:sec):	01:50.39
Unit Wet Weight (g/cm^3):	2.608	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	162.8		
Unit Dry Weight (g/cm^3):	2.607	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	162.7		

Mohs Hardness: 7-8

Physical Description: White Marble Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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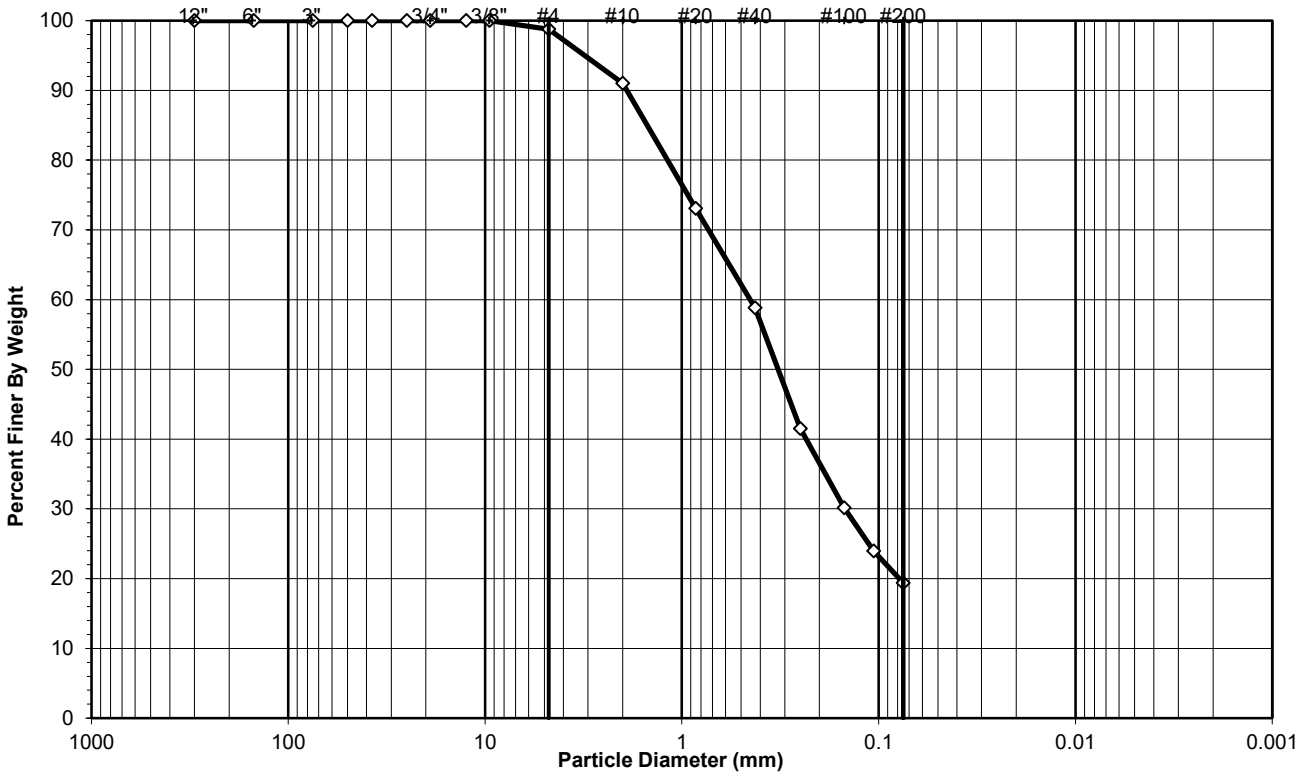
SIEVE AND HYDROMETER ANALYSIS

ASTM D6913 / D7928

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Reference:	SSE Project: Eden Loop - Banister River	Depth (ft):	30.0
Project No.:	R-2024-241-003	Sample No.:	SS-8
Lab ID:	R-2024-241-003-015	Soil Color:	Brown

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



Sieve Size		Percentage (%)
Greater than #4	***Gravel***	**1.24**
#4 to #200	***Sand***	**79.37**
Finer than #200	***Silt & Clay***	**19.39**

USCS Symbol:
sm, ASSUMED

D50 = 0.32

USCS Classification:
SILTY SAND

Tested By BS Date 12/9/24 Checked By AES Date 12/9/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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WASH SIEVE ANALYSIS

ASTM D6913-17

Client:	GeoEngineers	Boring No.:	ABR-B-1
Client Reference:	SSE Project: Eden Loop - Banister River	Depth (ft):	30.0
Project No.:	R-2024-241-003	Sample No.:	SS-8
Lab ID:	R-2024-241-003-015	Soil Color:	Brown

Moisture Content of Passing 3/4" Material		Moisture Content of Retained 3/4" Material	
Tare No.:	455	Tare No.:	NA
Wt. of Tare & Wet Sample (g):	536.37	Weight of Tare & Wet Sample (g):	NA
Wt. of Tare & Dry Sample (g):	480.54	Weight of Tare & Dry Sample (g):	NA
Weight of Tare (g):	141.45	Weight of Tare (g):	NA
Weight of Water (g):	55.83	Weight of Water (g):	NA
Weight of Dry Soil (g):	339.09	Weight of Dry Soil (g):	NA
Moisture Content (%):	**16.5**	**Moisture Content (%):**	**0.0**

Dry Weight of Sample (g):	NA	Total Dry Weight of Sample (g):	339.09
Tare No. (Sub-Specimen)	455	Wet Weight of +3/4" Sample (g):	0.00
Wt. of Tare & Wet Sub-Specimen (g):	536.37	Dry Weight of + 3/4" Sample (g):	0.00
Weight of Tare (g):	141.45	Dry Weight of - 3/4" Sample (g):	339.09
Sub-Specimen Wet Weight (g):	394.92	Dry Weight -3/4" +3/8" Sample (g):	0.00
Tare No. (-3/8" Sub-Specimen):	NA	Dry Weight of -3/8" Sample (g):	339.09
Wt. of Tare & Wet -3/8" Sub-Specimen (g):	NA	J - Factor (% Finer than 3/4"):	NA
Weight of Tare (g):	NA	J - Factor (% Finer than 3/8"):	NA
Sub-Specimen -3/8" Wet Weight (g):	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)		Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00		0.00	0.00	100.00	**100**
6"	150	0.00		0.00	0.00	100.00	**100**
3"	75	0.00		0.00	0.00	100.00	**100**
2"	50	0.00	(*)	0.00	0.00	100.00	**100**
1 1/2"	37.5	0.00		0.00	0.00	100.00	**100**
1"	25	0.00		0.00	0.00	100.00	**100**
3/4"	19	0.00		0.00	0.00	100.00	**100**
1/2"	12.5	0.00	(**)	0.00	0.00	100.00	**100**
3/8"	9.5	0.00		0.00	0.00	100.00	**100**
#4	4.75	4.20		1.24	1.24	98.76	**99**
#10	2	26.22		7.73	8.97	91.03	**91**
#20	0.85	60.87	(**)	17.95	26.92	73.08	**73**
#40	0.425	48.34		14.26	41.18	58.82	**59**
#60	0.25	58.78		17.33	58.51	41.49	**41**
#100	0.15	38.44		11.34	69.85	30.15	**30**
#140	0.106	20.90		6.16	76.01	23.99	**24**
#200	0.075	15.60		4.60	80.61	19.39	**19**
Pan	-	65.74		19.39	100.00	-	**-**

Notes : *(*) The + 3/4" sieve analysis is based on the Total Dry Weight of the Sample*
*(**) The - 3/4" and - 3/8" sieve analysis is based on the Weight of the Dry Specimen*

Tested By BS Date 12/9/24 Checked By AES Date 12/9/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-3
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	24.6-29.6
Project No.:	R-2024-241-003	Sample ID:	RUN 2
Lab ID No.:	R-2024-241-003-016	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): **523.24**

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.19	Reading 1:	1.87
Reading 2:	4.19	Reading 2:	1.87
Reading 3:	4.19	Average:	**1.87**
Average:	**4.19**	Area (in^2):	2.76
		L/D:	2.24

MOISTURE CONTENT			
Tare Number:	709	Total Load (lb):	25,090
Wt. of Tare & Wet Sample (g):	608.88	**Uniaxial Compressive Strength (psi):**	**9,090**
Wt. of Tare & Dry Sample (g):	608.56		
Weight of Tare (g):	90.80	Fracture Type:	**Shear**
Weight of Wet Sample (g):	518.08		
Sample Volume (cm^3):	189.08	Rate of Loading (lb/sec):	281
Moisture Content (%):	0.06	Time to Break (min:sec):	02:49.31
Unit Wet Weight (g/cm^3):	2.767	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	172.7		
Unit Dry Weight (g/cm^3):	2.766	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	172.6		

Mohs Hardness: 6-7

Physical Description: Gray Gneiss Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-3
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	39.6-44.6
Project No.:	R-2024-241-003	Sample ID:	RUN 5
Lab ID No.:	R-2024-241-003-017	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 552.59

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.46	Reading 1:	1.88
Reading 2:	4.46	Reading 2:	1.88
Reading 3:	4.46	Average:	**1.88**
Average:	**4.46**	Area (in^2):	2.76
		L/D:	2.37

MOISTURE CONTENT			
Tare Number:	13-a	Total Load (lb):	12,110
Wt. of Tare & Wet Sample (g):	633.67	**Uniaxial Compressive Strength (psi):**	**4,390**
Wt. of Tare & Dry Sample (g):	633.41		
Weight of Tare (g):	87.72	Fracture Type:	**Shear**
Weight of Wet Sample (g):	545.95		
Sample Volume (cm^3):	201.81	Rate of Loading (lb/sec):	136
Moisture Content (%):	0.05	Time to Break (min:sec):	02:10.08
Unit Wet Weight (g/cm^3):	2.738	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	170.9		
Unit Dry Weight (g/cm^3):	2.737	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	170.8		

Mohs Hardness: 6-7

Physical Description: Gray Gneiss Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-3
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	54.6-59.6
Project No.:	R-2024-241-003	Sample ID:	RUN 8
Lab ID No.:	R-2024-241-003-018	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 569.83

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.52	Reading 1:	1.88
Reading 2:	4.52	Reading 2:	1.88
Reading 3:	4.53	Average:	**1.88**
Average:	**4.52**	Area (in^2):	2.78
		L/D:	2.40

MOISTURE CONTENT			
Tare Number:	425	Total Load (lb):	15,710
Wt. of Tare & Wet Sample (g):	668.81	**Uniaxial Compressive Strength (psi):**	**5,650**
Wt. of Tare & Dry Sample (g):	668.06		
Weight of Tare (g):	99.37	Fracture Type:	**Shear**
Weight of Wet Sample (g):	569.44		
Sample Volume (cm^3):	206.25	Rate of Loading (lb/sec):	176
Moisture Content (%):	0.13	Time to Break (min:sec):	01:13.01
Unit Wet Weight (g/cm^3):	2.763	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	172.4		
Unit Dry Weight (g/cm^3):	2.759	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	172.2		

Mohs Hardness: 6-7

Physical Description: Gray Mica Schist Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/9/24 *Checked By:* AES *Date:* 12/10/24

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	ABR-B-3
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	69.6-74.6'
Project No.	2024-241-003	Sample No.	Run 11
Lab ID	2024-241-003-019	Visual Description:	Gray Rock Core

INITIAL SAMPLE DIMENSIONS			
Length 1 (in)	4.537	Top Dia. (in)	1.874
Length 2 (in)	4.536	Mid. Dia. (in)	1.872
Length 3 (in)	4.535	Bot. Dia. (in)	1.871
Avg. Length (in)	4.536	Area (in.^{2})	2.75
Gauge Length (in)	3.151		

WATER CONTENT AFTER TEST	
Tare No.	5138
Wt. Tare + WS.(gms)	590.51
Wt. Tare + DS.(gms)	590.04
Wt. of Tare (gms)	8.16
% Moisture	0.08

UNIT WEIGHT			
Wet Wt. of Core (gms.)	582.40	Sample Volume(cc.)	204.7
Diameter (in.)	1.87	Unit Wet Wt.(gms/cc)	2.85
Length (in.)	4.54	Unit Wet Wt.(pcf.)	177.57
Length (cm.)	11.52	Moisture Content, %	0.08
		Unit Dry Wt.(pcf.)	177.43

Deformation (in.)		*Load*	*Time*	*Axial Strain (+)*	*Lateral Strain (-)*	*Stress*
Vertical (+)	*Lateral (-)*	*(lbs)*	*(sec)*	*(in./in.)*	*(in./in.)*	*(psi)*
0.0000000	N/A	0	0	0.0000000	N/A	0.0
0.0001803	N/A	330	8	0.0000572	N/A	119.7
0.0006897	N/A	593	17	0.0002189	N/A	215.3
0.0017972	N/A	1,249	26	0.0005704	N/A	453.5
0.0023359	N/A	1,653	35	0.0007414	N/A	600.4
0.0028090	N/A	2,116	44	0.0008916	N/A	768.7
0.0032863	N/A	2,701	53	0.0010431	N/A	981.1
0.0037013	N/A	3,281	62	0.0011748	N/A	1,191.7
0.0040922	N/A	3,922	71	0.0012989	N/A	1,424.4
0.0044626	N/A	4,572	80	0.0014165	N/A	1,660.4
0.0047823	N/A	5,175	89	0.0015179	N/A	1,879.7
0.0054134	N/A	6,514	107	0.0017183	N/A	2,365.9
0.0057127	N/A	7,214	116	0.0018133	N/A	2,620.0
0.0060274	N/A	7,940	125	0.0019131	N/A	2,884.0
0.0063166	N/A	8,645	134	0.0020050	N/A	3,139.7
0.0066056	N/A	9,336	143	0.0020967	N/A	3,391.0
0.0069391	N/A	10,195	152	0.0022025	N/A	3,703.0
0.0073292	N/A	11,214	161	0.0023264	N/A	4,072.8
0.0077272	N/A	12,239	170	0.0024527	N/A	4,445.3
0.0080851	N/A	13,109	179	0.0025663	N/A	4,761.3
0.0084169	N/A	13,937	188	0.0026716	N/A	5,062.0
0.0087719	N/A	14,745	197	0.0027843	N/A	5,355.4
0.0091530	N/A	15,558	206	0.0029052	N/A	5,650.7
0.0095576	N/A	16,347	215	0.0030337	N/A	5,937.0
0.0099945	N/A	17,071	224	0.0031723	N/A	6,200.1
0.0104833	N/A	17,699	233	0.0033275	N/A	6,428.4
0.0111232	N/A	18,080	242	0.0035306	N/A	6,566.5

Tested By	JAC	Date	1/7/25	Input Checked By:	NJM	Date	1/10/25

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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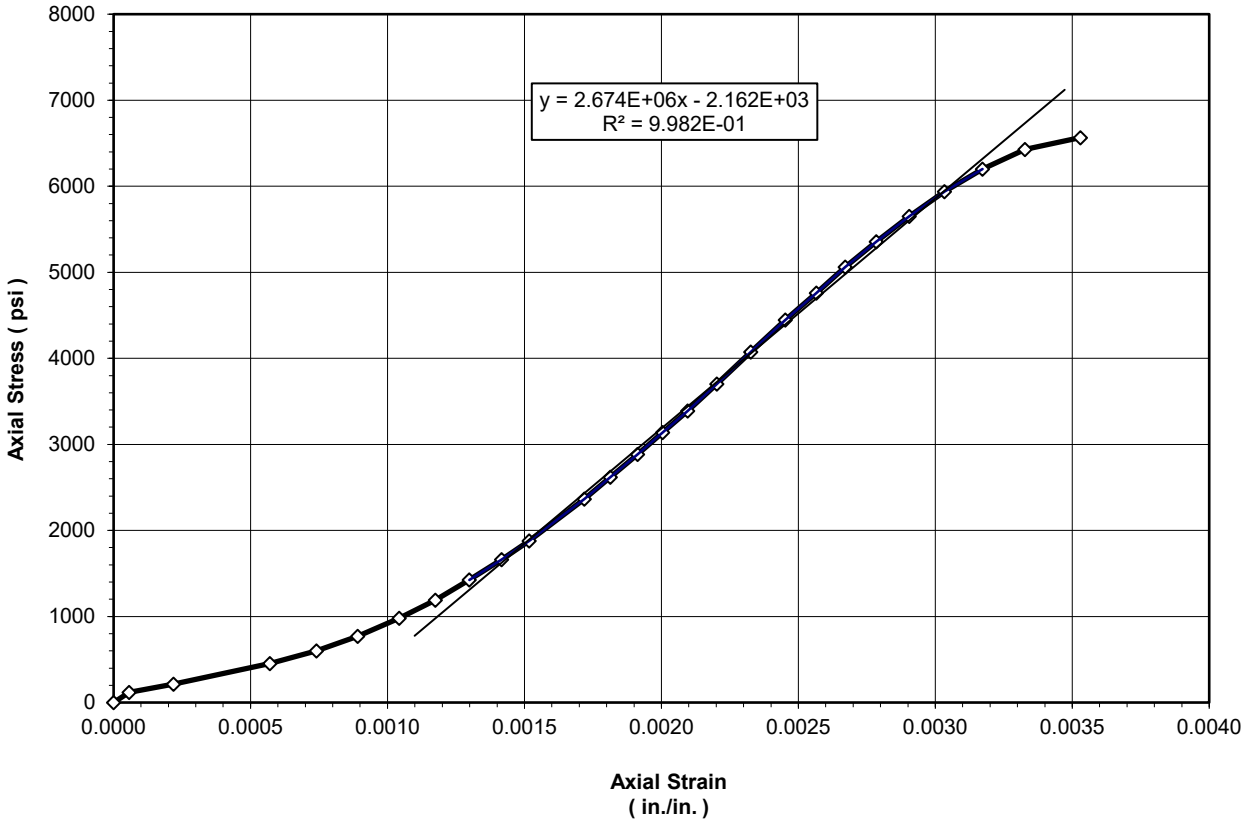
COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D

Client	GeoEngineers	Boring No.	ABR-B-3
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	69.6-74.6'
Project No.	2024-241-003	Sample No.	Run 11
Lab ID	2024-241-003-019	Visual Description:	Gray Rock Core

Axial Stress vs Axial Strain



Total Load:	18,080	Pounds
Peak Compressive Strength:	6,566	psi
Break Type:	Shear	
Break Time (min. : sec.):	04:02	

Stress Range (psi)	*Young's Modulus (psi)*
1,424 - 6,200	2,674,000

Tested By JAC Date 1/7/25 Approved By NJM Date 1/10/2025

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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COMPRESSIVE STRENGTH AND ELASTIC MODULI OF ROCK

ASTM D7012-10 METHOD D (MODIFIED)

Client	GeoEngineers	Boring No.	ABR-B-3
Client Reference	SSE Project: Eden Loop-Banister River	Depth (ft)	69.6-74.6'
Project No.	2024-241-003	Sample No.	Run 11
Lab ID	2024-241-003-019	Visual Description:	Gray Rock Core

Tested By	JAC	Date	1/7/25	Input Checked By:	NJM	Date	1/10/2025

DCN: CT45B; Revision No.:Orig; Revision Date :06/24/10

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-3
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	84.6-89.6
Project No.:	R-2024-241-003	Sample ID:	RUN 14
Lab ID No.:	R-2024-241-003-020	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 480.22

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	3.94	Reading 1:	1.88
Reading 2:	3.94	Reading 2:	1.88
Reading 3:	3.94	Average:	**1.88**
Average:	**3.94**	Area (in^2):	2.78
		L/D:	2.09

MOISTURE CONTENT

Tare Number:	708	Total Load (lb):	4,610
Wt. of Tare & Wet Sample (g):	570.58	**Uniaxial Compressive Strength (psi):**	**1,660**
Wt. of Tare & Dry Sample (g):	569.69		
Weight of Tare (g):	90.81	Fracture Type:	**Shear**
Weight of Wet Sample (g):	479.77		
Sample Volume (cm^3):	179.65	Rate of Loading (lb/sec):	52
Moisture Content (%):	0.19	Time to Break (min:sec):	00:40.19
Unit Wet Weight (g/cm^3):	2.673	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	166.8		
Unit Dry Weight (g/cm^3):	2.668	AXIAL: *Pass*	TOP: *Pass* BOTTOM: *Pass*
Unit Dry Weight (pcf):	166.5		

Mohs Hardness: 6-7

Physical Description: Gray Mica Schist Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/9/24 *Checked By:* AES *Date:* 12/10/24

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-3
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	99.6-104.6
Project No.:	R-2024-241-003	Sample ID:	RUN 17
Lab ID No.:	R-2024-241-003-021	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 546.95

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.45	Reading 1:	1.88
Reading 2:	4.45	Reading 2:	1.88
Reading 3:	4.45	Average:	**1.88**
Average:	**4.45**	Area (in^2):	2.76
		L/D:	2.37

MOISTURE CONTENT			
Tare Number:	19-a	Total Load (lb):	19,740
Wt. of Tare & Wet Sample (g):	597.39	**Uniaxial Compressive Strength (psi):**	**7,150**
Wt. of Tare & Dry Sample (g):	596.94		
Weight of Tare (g):	87.71	Fracture Type:	**Shear**
Weight of Wet Sample (g):	509.68		
Sample Volume (cm^3):	201.69	Rate of Loading (lb/sec):	221
Moisture Content (%):	0.09	Time to Break (min:sec):	02:10.93
Unit Wet Weight (g/cm^3):	2.712	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	169.2		
Unit Dry Weight (g/cm^3):	2.709	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	169.1		

Mohs Hardness: 6-7

Physical Description: Gray Slate Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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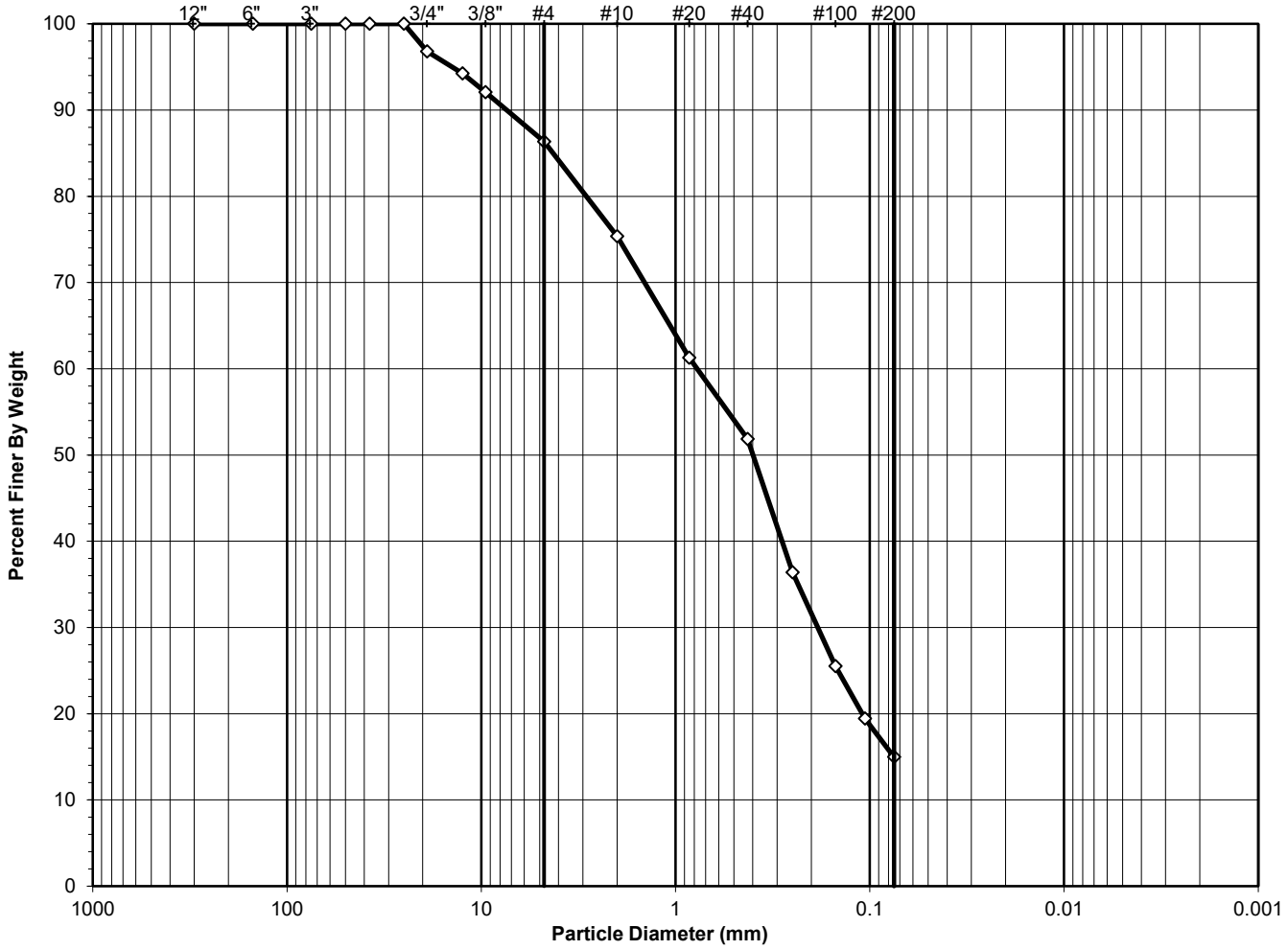
SIEVE AND HYDROMETER ANALYSIS

ASTM D6913 / D7928

Client:	GeoEngineers	Boring No.:	ABR-B-4
Client Reference:	SSE Project: Eden Loop - Banister Creek	Depth (ft):	18.5-20
Project No.:	R-2024-241-003	Sample No.:	SS-6
Lab ID:	R-2024-241-003-023	Soil Color:	Brown

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol:
sm, ASSUMED

D50 = 0.40

USCS Classification:
SILTY SAND

Tested By BS Date 12/10/24 Checked By AES Date 12/10/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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WASH SIEVE ANALYSIS

ASTM D6913-17

Client:	GeoEngineers	Boring No.:	ABR-B-4
Client Reference:	SSE Project: Eden Loop - Banister Creek	Depth (ft):	18.5-20
Project No.:	R-2024-241-003	Sample No.:	SS-6
Lab ID:	R-2024-241-003-023	Soil Color:	Brown

Moisture Content of Passing 3/4" Material		Moisture Content of Retained 3/4" Material	
Tare No.:	448	Tare No.:	NA
Wt. of Tare & Wet Sample (g):	514.49	Weight of Tare & Wet Sample (g):	NA
Wt. of Tare & Dry Sample (g):	475.05	Weight of Tare & Dry Sample (g):	NA
Weight of Tare (g):	137.88	Weight of Tare (g):	NA
Weight of Water (g):	39.44	Weight of Water (g):	NA
Weight of Dry Soil (g):	337.17	Weight of Dry Soil (g):	NA
Moisture Content (%):	**11.7**	**Moisture Content (%):**	**0.0**

Dry Weight of Sample (g):	NA	Total Dry Weight of Sample (g):	337.17
Tare No. (Sub-Specimen)	448	Wet Weight of +3/4" Sample (g):	12.07
Wt. of Tare & Wet Sub-Specimen (g):	514.49	Dry Weight of + 3/4" Sample (g):	10.81
Weight of Tare (g):	137.88	Dry Weight of - 3/4" Sample (g):	326.36
Sub-Specimen Wet Weight (g):	376.61	Dry Weight -3/4" +3/8" Sample (g):	15.98
Tare No. (-3/8" Sub-Specimen):	NA	Dry Weight of -3/8" Sample (g):	310.38
Wt. of Tare & Wet -3/8" Sub-Specimen (g):	NA	J - Factor (% Finer than 3/4"):	NA
Weight of Tare (g):	NA	J - Factor (% Finer than 3/8"):	NA
Sub-Specimen -3/8" Wet Weight (g):	NA		

Sieve Size	Sieve Opening (mm)	Weight of Soil Retained (g)		Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00		0.00	0.00	100.00	**100**
6"	150	0.00		0.00	0.00	100.00	**100**
3"	75	0.00		0.00	0.00	100.00	**100**
2"	50	0.00	(*)	0.00	0.00	100.00	**100**
1 1/2"	37.5	0.00		0.00	0.00	100.00	**100**
1"	25	0.00		0.00	0.00	100.00	**100**
3/4"	19	10.81		3.21	3.21	96.79	**97**
1/2"	12.5	8.64	(**)	2.56	5.77	94.23	**94**
3/8"	9.5	7.34		2.18	7.95	92.05	**92**
#4	4.75	19.30		5.72	13.67	86.33	**86**
#10	2	37.05		10.99	24.66	75.34	**75**
#20	0.85	47.49	(**)	14.08	38.74	61.26	**61**
#40	0.425	31.71		9.40	48.15	51.85	**52**
#60	0.25	52.21		15.48	63.63	36.37	**36**
#100	0.15	36.63		10.86	74.50	25.50	**26**
#140	0.106	20.44		6.06	80.56	19.44	**19**
#200	0.075	15.08		4.47	85.03	14.97	**15**
Pan	-	50.47		14.97	100.00	-	**-**

Notes : *(*) The + 3/4" sieve analysis is based on the Total Dry Weight of the Sample*
*(**) The - 3/4" and - 3/8" sieve analysis is based on the Weight of the Dry Specimen*

Tested By BS Date 12/10/24 Checked By AES Date 12/10/24

DCN: CT-S73T, DATE 2/25/22, REV. 1

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POINT LOAD STRENGTH OF ROCK - AXIAL

ASTM D5731-08

Client:	GeoEngineers	Boring No.:	ABR-B-4
Client Reference:	SSE Project: Eden Loop - Banister River	Depth (ft):	30.8-35.2
Project No.:	2024-241-003	Sample No.:	Run 1
Lab ID:	2024-241-003-024	Description:	Rock Core
		Moisture Condition:	As Received-Unpreserved

Sample Height Measurements, (D)

Height 1 (in):	1.462
Height 2 (in):	1.462
Height 3, Test Contact Point (in):	1.462
Test Contact Point (mm):	37.1
Average Height (in):	1.462
Equivalent Core Diam. (Axial/Block), (in):	3.472

Sample Length Measurements, (W)

Length 1 (in):	1.865
Length 2 (in):	1.865
Length 3 (in):	1.865
Average Length (in):	1.865
Length/Diameter Ratio (D/W):	0.784

Sample Length Measurements, (L)

Length 1 (in):	0.933
Length 2 (in):	0.933
Length 3 (in):	0.933
Average Length (in):	0.933
L > 0.5D (in):	0.731

Specimen Weight (g):	**179.90**
Moisture Content (%):	
Tare Number:	3399
Wt. of Tare & Wet Sample (g):	187.69
Wt. of Tare & Dry Sample (g):	187.55
Weight of Tare (g):	8.24
Weight of Wet Sample (g):	179.45
Sample Volume (cm^3):	65.45
Moisture Content (%):	0.08
Unit Wet Weight (g/cm^3):	2.749
Unit Wet Weight (pcf):	171.5
Unit Dry Weight (g/cm^3):	2.747
Unit Dry Weight (pcf):	171.4

Test Data

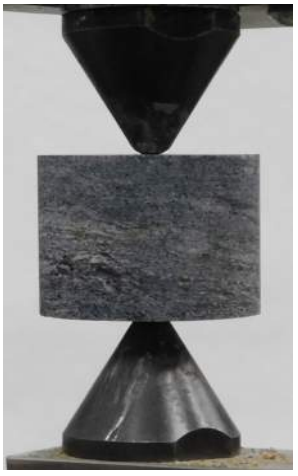
Core Diameter (mm):	47.371
P - Gauge Pressure @ Failure (lbf):	2847

Index & Strength Computations

I_S - Point Load Index (psi):	**820.0**
$I_{S(50)}$ - Corrected Point Load Index (psi):	**800.0**
K - Index To Strength Conversion Factor:	**22.2**
δ_{vx} - Est. Unconfined Compressive Strength (psi):	**18,191**

Mohs Hardness_7-8

SAMPLE SHOWN IN THE SAME ORIENTATION AS TESTED



Tested By JAC *Date* 1/2/25 *Checked By* NJM *Date* 1/3/25

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-4
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	35.2-40.2
Project No.:	R-2024-241-003	Sample ID:	RUN 2
Lab ID No.:	R-2024-241-003-025	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 518.62

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.18	Reading 1:	1.87
Reading 2:	4.18	Reading 2:	1.87
Reading 3:	4.18	Average:	**1.87**
Average:	**4.18**	Area (in^2):	2.74
		L/D:	2.24

MOISTURE CONTENT			
Tare Number:	473	Total Load (lb):	27,910
Wt. of Tare & Wet Sample (g):	615.98	**Uniaxial Compressive Strength (psi):**	**10,190**
Wt. of Tare & Dry Sample (g):	615.73		
Weight of Tare (g):	97.77	Fracture Type:	**Shear**
Weight of Wet Sample (g):	518.21		
Sample Volume (cm^3):	187.84	Rate of Loading (lb/sec):	313
Moisture Content (%):	0.05	Time to Break (min:sec):	03:00.09
Unit Wet Weight (g/cm^3):	2.761	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	172.3		
Unit Dry Weight (g/cm^3):	2.760	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	172.2		

Mohs Hardness: 6-7

Physical Description: Gray Gneiss Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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Client:	GeoEngineers
Client Reference:	SSE Project: Eden Loop - Banister River
Project No.:	R-2024-241-003

Lab ID:	027
Boring No.:	ABR-B-4
Depth (ft):	70.2-75.2
Sample No.:	RUN 9
Mohs Hardness:	6-7

Notes :

Tested By NS *Date* 1/2/25 *Checked By* AES *Date* 1/3/25

DCN: CT-S1 DATE: 3/18/13 REVISION: 4

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UNCONFINED COMPRESSIVE STRENGTH of INTACT ROCK CORE SPECIMENS

ASTM D 7012-14e1 Method C

This method does not report strain rate or deformation

Client:	GeoEngineers	Boring No.:	ABR-B-4
Client Project:	SSE Project: Eden Loop - Banister River	Depth (ft):	85.2-90.2
Project No.:	R-2024-241-003	Sample ID:	RUN 12
Lab ID No.:	R-2024-241-003-028	Moisture Condition:	As Received-Unpreserved

Specimen Weight (g): 536.97

SPECIMEN LENGTH (in)		SPECIMEN DIAMETER (in):	
Reading 1:	4.34	Reading 1:	1.87
Reading 2:	4.34	Reading 2:	1.87
Reading 3:	4.34	Average:	**1.87**
Average:	**4.34**	Area (in^2):	2.75
		L/D:	2.32

MOISTURE CONTENT			
Tare Number:	705	Total Load (lb):	27,710
Wt. of Tare & Wet Sample (g):	577.87	**Uniaxial Compressive Strength (psi):**	**10,080**
Wt. of Tare & Dry Sample (g):	577.65		
Weight of Tare (g):	91.05	Fracture Type:	**Shear**
Weight of Wet Sample (g):	486.82		
Sample Volume (cm^3):	195.97	Rate of Loading (lb/sec):	310
Moisture Content (%):	0.05	Time to Break (min:sec):	02:50.50
Unit Wet Weight (g/cm^3):	2.740	Deviation From Straightness[2]:	
Unit Wet Weight (pcf):	171.0		
Unit Dry Weight (g/cm^3):	2.739	AXIAL: *Pass* TOP: *Pass*	BOTTOM: *Pass*
Unit Dry Weight (pcf):	170.9		

Mohs Hardness: 7-8

Physical Description: Gray Gneiss Rock

Notes:

1) Moisture conditions at time of the test are: As Received-Unpreserved
2) Sample prep conforms to ASTM D4543-08 "best effort" if applicable
3) Deviation from straightness, Procedure A of ASTM D 4543-08
   Pass/Fail criteria: gap < 0.02 = Pass, gap > 0.02 = Fail
4) Temperature is laboratory room temperature.

Tested By: NS Date: 12/19/24 *Checked By:* AES *Date:* 12/20/24

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Geo Testing Express Test Results

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Banister River
Project Location:	VA
GTX #:	319565
Test Date:	12/4/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

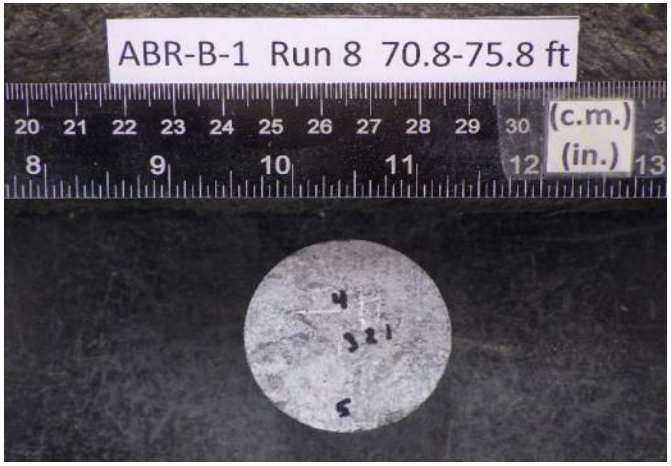
Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
ABR-B-1	Run 8	70.8-75.8	1	0.1	0.1	0.10	
			2	3.2	3.0	3.10	
			3	3.6	3.6	3.60	
			4	3.2	3.5	3.35	
			5	4.2	4.4	4.30	
			Average CAIs			2.89	
			Average CAI *			3.29	
CERCHAR Abrasiveness Index Classification						High Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Banister River
Project Location:	VA
GTX #:	319565
Test Date:	12/4/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

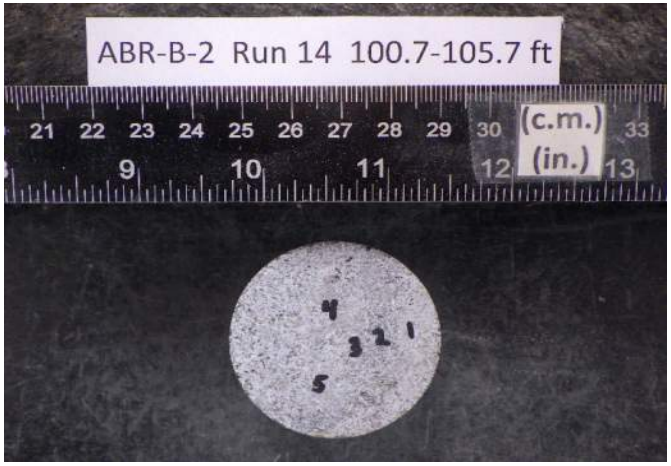
Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
ABR-B-2	Run 14	100.7-105.7	1	3.8	4.0	3.90	
			2	3.5	3.4	3.45	
			3	3.7	4.0	3.85	
			4	4.5	4.8	4.65	
			5	3.7	3.9	3.80	
			Average CAIs			3.93	
			Average CAI *			4.48	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Banister River
Project Location:	VA
GTX #:	319565
Test Date:	12/4/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
ABR-B-2	Run 18	120.7-125.7	1	3.5	3.8	3.65	
			2	4.0	4.7	4.35	
			3	4.5	4.3	4.40	
			4	4.2	4.0	4.10	
			5	4.5	4.4	4.45	
			Average CAIs			4.19	
			Average CAI *			4.63	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

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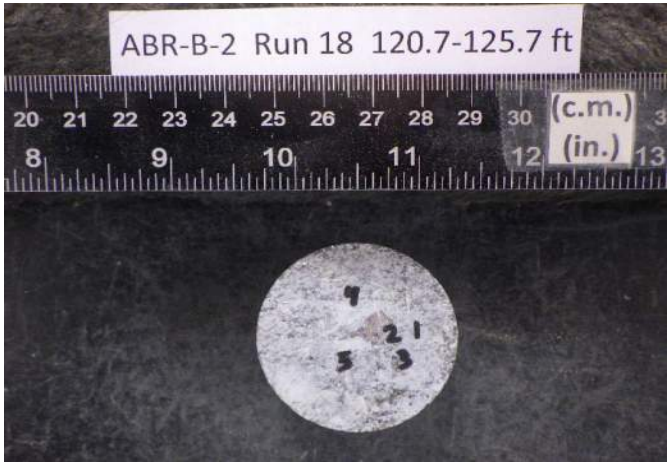
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Banister River
Project Location:	VA
GTX #:	319565
Test Date:	12/4/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
ABR-B-3	Run 11	69.6-74.6	1	4.1	3.4	3.75	
			2	3.0	2.5	2.75	
			3	5.2	4.9	5.05	
			4	3.0	2.9	2.95	
			5	5.7	5.0	5.35	
			Average CAIs			3.97	
			Average CAI *			4.53	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

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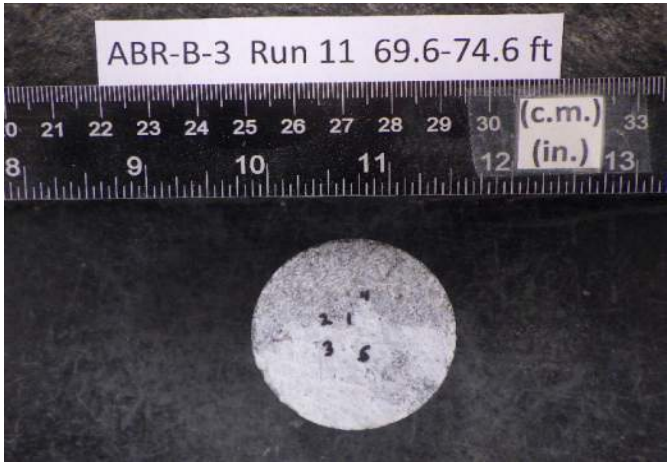
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48

CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Banister River
Project Location:	VA
GTX #:	319565
Test Date:	12/4/2024
Tested By:	jss
Checked By:	smd

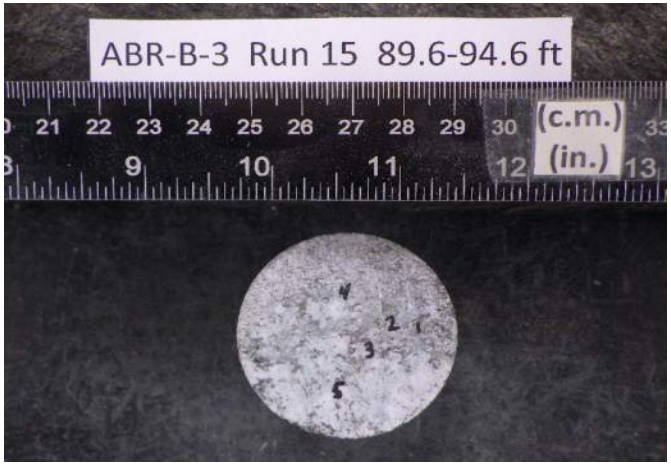
Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
ABR-B-3	Run 15	89.6-94.6	1	4.3	4.4	4.35	
			2	4.2	3.8	4.00	
			3	2.7	2.5	2.60	
			4	3.2	3.2	3.20	
			5	3.4	3.8	3.60	
			Average CAIs			3.55	
			Average CAI *			4.05	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
* If CAIs $\geq$ 4.0, CAI = (0.99 x CAI_S) + 0.48
CAIs = CERCHAR index for smooth (saw cut) surface
CAI = CERCHAR index for natural surface



After Test

Client:	GeoEngineers, Inc.
Project Name:	Eden Loop - Banister River
Project Location:	VA
GTX #:	319565
Test Date:	12/4/2024
Tested By:	jss
Checked By:	smd

Abrasiveness of Rock Using the CERCHAR Method by ASTM D7625-22

Boring ID	Sample ID	Depth, ft.	Stylus No.	Reading 1	Reading 2	Average	Comments
ABR-B-4	Run 3	40.2-45.2	1	4.6	4.7	4.65	
			2	5.8	5.0	5.40	
			3	4.0	4.0	4.00	
			4	4.0	4.9	4.45	
			5	5.2	5.0	5.10	
			Average CAIs			4.72	
			Average CAI *			5.15	
CERCHAR Abrasiveness Index Classification						Extreme Abrasiveness	

Notes:

Test Surface: Saw Cut
Moisture Condition: As Received
Apparatus Type: Original CERCHAR
Stylus Hardness: Rockwell Hardness 54/56 HRC
Stylus Displacement Relative to Rock Fabric:
Styli 1-3: Normal; Styli 4-5: Parallel

* If CAIs $\leq$ 3.9, CAI = 1.14 X CAI_S
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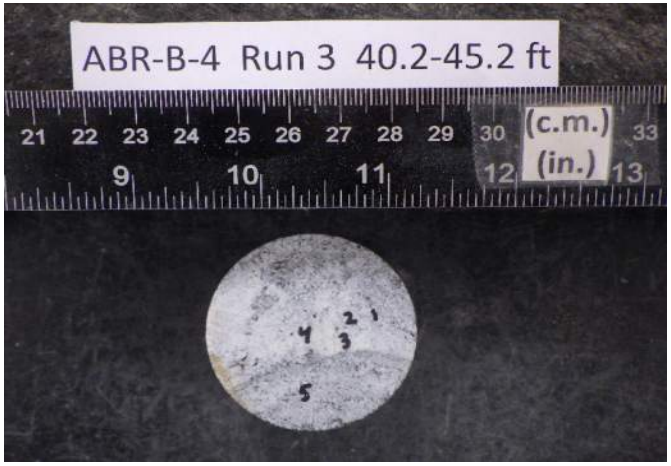


After Test

Appendix B

Report Limitations and Guidelines for Use

Appendix B
Report Limitations and Guidelines for Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers, Inc. (GeoEngineers) includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for Transcontinental Gas Pipeline Company, LLC and the project team for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with terms and conditions in our Request for Services (RFS) purchase order dated April 16, 2024, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the Southeast Supply Enhancement Project – Banister River crossing located in Pittsylvania County, Virginia. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- not prepared for you,
- not prepared for your project,

[1] Developed based on material provided by ASFE/The Best People on Earth, Professional Firms Practicing in the Geosciences; www.asfe.org.

- not prepared for the specific site explored, or
- completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- the function of the proposed structure;
- elevation, configuration, location, orientation or weight of the proposed structure;
- composition of the design team; or
- project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Bedrock classification shown in our boring logs is based on visual inspection and field observation with the unaided eye. While effort has been made to strive for accuracy, visual rock classification is inherently subjective. This method does not substitute for detailed laboratory testing and may not fully capture the variability and complexity of the subsurface conditions. GeoEngineers laboratory testing program typically

focuses on the physical/mechanical rock properties such as compressive strength, hardness and abrasivity. To classify rock type with near certainty, additional mineralogical and chemical laboratory testing may be required including petrographic analysis (thin section microscopy), xray diffraction, and scanning electron microscopy.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by contractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable but separating logs from the report can create a risk of misinterpretation.

GIVE CONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving contractors the complete geotechnical engineering or geologic report, including these

"Report Limitations and Guidelines for Use." When providing the report, you should preface it with a clearly written letter of transmittal that:

- advises contractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- encourages contractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

CONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the contractor's procedures, methods, schedule or management of the work site. The contractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers' Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings or conclusions regarding the detecting, assessing, preventing or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term "Biological Pollutants" includes, but is not limited to, molds, fungi, spores, bacteria and viruses, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Appendix C

Hydraulic Fracture Analysis and Results

Appendix C
Hydraulic Fracture Analysis and Results

GENERAL

Drilling fluid surface releases, commonly referred to as "inadvertent returns" (IR) or "Frac Outs," occur when drilling fluid emerges at the ground surface or in any other undesired location such as waterbodies, or other environmentally sensitive features or utilities. Hydraulic fracture is a term typically used to describe the condition in which the annular drilling fluid pressure exceeds the capacity of the surrounding soil to resist that pressure (formation limit pressure). Once the formation limit pressure is exceeded, drilling fluid is lost either through crack propagation (fracture) or by uncontrolled cavity expansion (blowout).

Hydraulic fracture typically occurs when the drill path passes through relatively weak cohesive soils or loose granular soils with low shear strength. Very loose to loose sands and silty sands, and soft to medium stiff silts and clays typically have a higher hydraulic fracture potential. Medium dense to very dense sands, and very stiff to hard silts and clays have a low to moderate hydraulic fracture potential. However, the HDD contractor's construction procedures are an important factor influencing the risk of hydraulic fracture and inadvertent drilling fluid releases. If the contractor operates with insufficient drilling fluid flow rates, inadequate drilling fluid properties or excessive rates of penetration, the annulus may become blocked through an accumulation of drill cuttings falling out of suspension. This can occur within formations that typically have a low potential for hydraulic fracture. If the accumulation of cuttings creates a blockage downhole, the annulus may become over-pressurized, leading to hydraulic fracturing and potentially, drilling fluid surface releases. The hydraulic fracture analysis does not account for this over-pressurized condition.

Bedrock, because of its high shear strength, has a relatively low potential for hydraulic fracture. Hydraulic fracture of soil is defined by and can be quantitatively analyzed by cavity expansion theory. However, cavity expansion theory cannot be applied to bedrock conditions. The annular drilling fluid pressures associated with the HDD construction method are typically not capable of hydraulically fracturing competent bedrock.

However, inadvertent returns of drilling fluid to the ground surface can occur during HDD operations in bedrock by following existing fractures and planes of weakness. Currently, there are no widely accepted methods for calculating the safety factor against inadvertent returns occurring from within bedrock during HDD operations. However, the risk can be qualitatively characterized based on the type and quality of the bedrock.

Our analysis computes the factors of safety against hydraulic fracture by dividing the calculated formation limit pressure by the estimated annular drilling fluid pressure along the profile. The formation limit pressure varies depending on the soil properties anticipated along the HDD profile. The estimated drilling fluid pressure also varies along the HDD profile and is a function of the drilling fluid properties, size and condition of annulus, and groundwater conditions.

METHODOLOGY

Cavity expansion behavior in a soil mass has been considered and evaluated for a number of geotechnical problems including bearing capacity of deep foundations, interpretation of pressuremeter testing, breakout resistance of anchors, and most recently for drilling fluid loss during HDD operations. Specifically, Luger and Hergarden (1988) of Delft Geotechnics developed a method largely based on cavity expansion theory

(Vesic, 1972) to estimate the maximum allowable annular drilling fluid pressures before hydrofracture or blowout will occur during HDD operations. Subsequently, the United States Army Corps of Engineers (USACE) worked with Delft Geotechnics to develop formal guidelines as discussed in Appendix B of the U.S. Army Corps of Engineers (USACE) Report CPAR-98-1 (Staheli, et al. 1998).

The Delft method is based on equations specifically developed for use in analyzing cavity expansion in granular (sandy) soils in a drained loading condition, although this was not clearly stated in the original USACE CPAR-98-1 guidelines. The USACE published updated guidelines (USACE, 2020) which attempt to improve the methodology from USACE CPAR-98-1. The clarifications include but are not limited to 1) accounting for anisotropic stress conditions in calculating the formation limit pressure by multiplying the vertical effective stress by the lateral earth pressure coefficient (K_0) and 2) providing a simplified equation for calculating the formation limit pressure for undrained (phi=0) conditions in low permeability soils. The simplified equation conservatively neglects soil stiffness and plastic deformation by assuming the formation limit pressure is equal to the effective confining pressure plus the soil cohesion (undrained shear strength or "C").

For projects that are not regulated by the USACE, alternative methods, including the method developed by Queen's university (Xia and Moore, 2006) are available to estimate the formation limit pressure of clay soils in undrained conditions that consider soil stiffness and plastic deformation.

Formation Limit Pressure

Estimating the formation limit pressure requires the selection and input of a number of geotechnical soil parameters that are estimated based on a site-specific geotechnical evaluation including in-situ and laboratory soil testing. The required parameters include the unit weight, shear strength (phi and/or C), coefficient of lateral earth pressure (K0), Poisson's ratio, and the modulus of elasticity.

We estimate the formation limit pressure for each unique soil strata at least 10 feet thick observed in the geotechnical borings. Because the formation limit pressure varies along the HDD profile with depth and as it passes through variable soil strata, our model generates a plot depicting the variable formation limit pressure along the length of the HDD.

For all HDD design projects that are under the jurisdiction of the USACE or by client request, GeoEngineers performs a hydraulic fracture analysis in accordance with the updated USACE guidelines (USACE, 2020).

For projects that are not regulated by the USACE, GeoEngineers estimates the formation limit pressures in general accordance with cavity expansion theory using equations proposed by Queen's University (Xia and Moore, 2006) for clay soils and the Delft equation as proposed by Luger and Hergarden (1988) for granular soils.

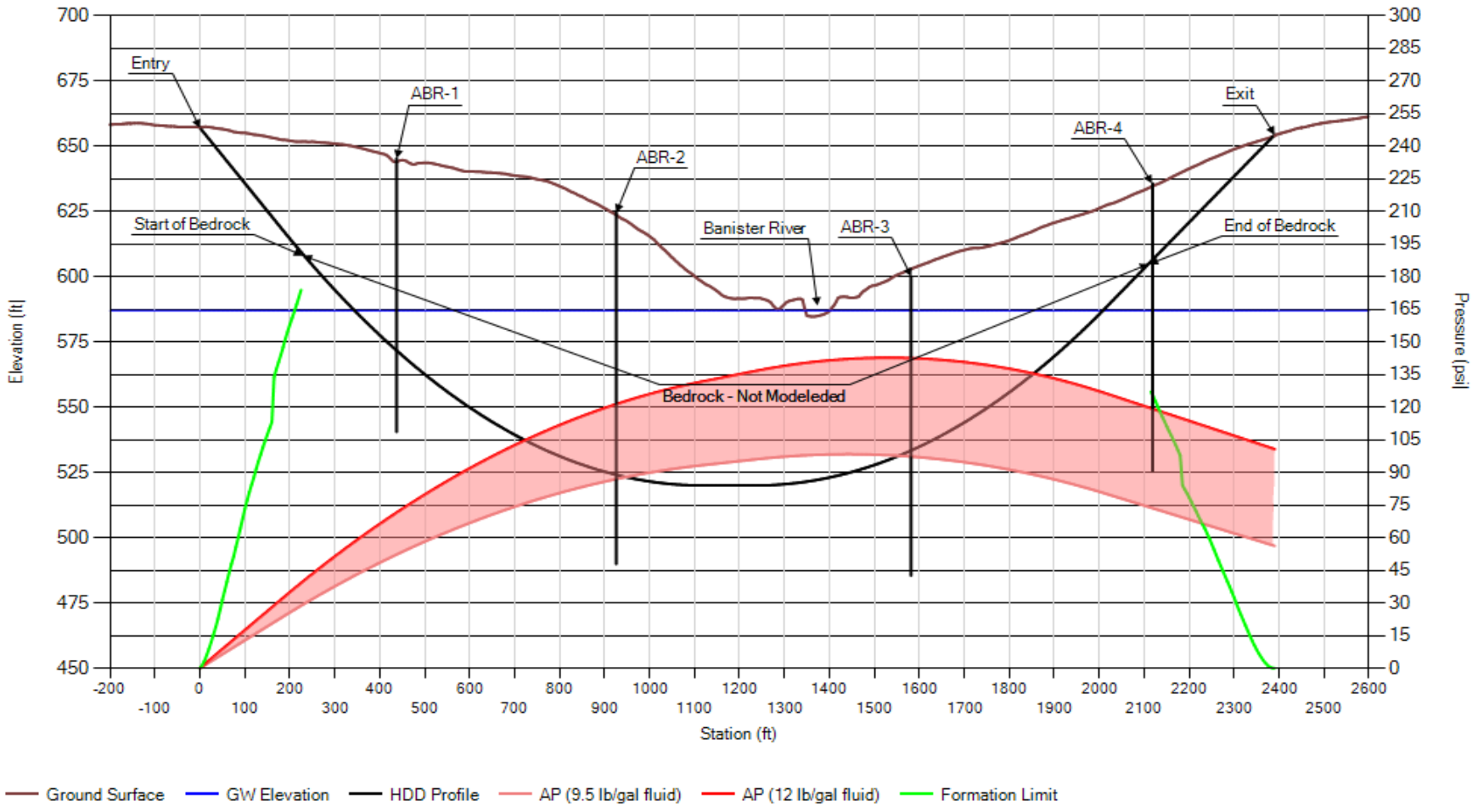
Annular Drilling Fluid Pressure

We estimate the anticipated annular drilling fluid pressure along the length of the pilot hole based on the Bingham plastic model as presented by Bourgoyne, A.T., et al. (1991). Calculating the anticipated annular drilling fluid pressure along the HDD profile requires selection and input of the drilling fluid rheological properties, anticipated tool dimensions and pump rates which are estimated based on our experience and generally accepted best practices of the HDD industry. Our model assumes that no obstructions are present within the drilled hole, drilling fluid returns are maintained at all times and the drilled hole is completely

cylindrical. Because these parameters are subject to change depending on the HDD contractor's means and methods, the hydraulic fracture analysis can be refined once the HDD contractor is selected, and the input parameters are known.

Safety Factor and Graphical Results of Analysis

Once the formation limit pressures and annular drilling fluid pressures are estimated along the HDD profile, the referenced pressures are plotted relative to each other and the HDD alignment in profile view as shown in this appendix. A second plot is prepared showing the safety factor against hydraulic fracture along the HDD alignment. The safety factor is calculated by dividing the formation limit pressure by the anticipated annular drilling fluid pressure. The target minimum safety factor against hydraulic fracture beneath critical infrastructure or environmental resources varies according to project and client requirements as well as the analysis method but typically ranges from 1.5 to 2.0. The evaluation considers only the hydraulic fracture potential during pilot hole operations assuming that drilling fluid returns are continuously maintained to the entry point.



Crossing Length: 2,390.00 ft

Hole Diameter: 12.25 Inches

Drill Pipe Diameter: 6.625 Inches

Drilling Fluid Weight: 9.5 lbs/gallon

Plastic Viscosity: 13 CP

Yield Point: 25 lbs/100 ft^2

Estimated Formation Limit and Drilling Fluid Pressures (Entry to Exit) (Delft Eqn.)

SSE Project: Eden Loop - Banister River HDD

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Figure C-1

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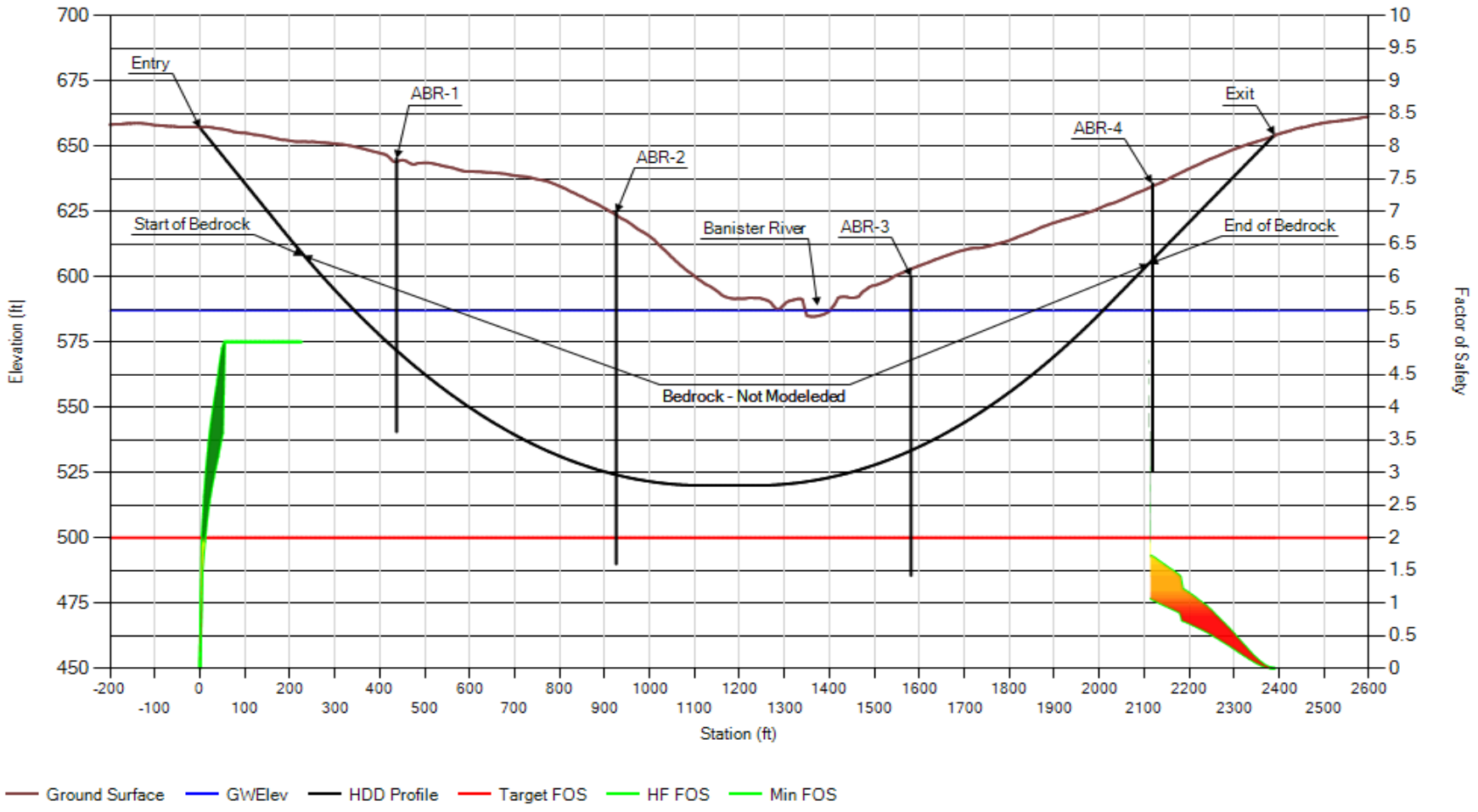

Crossing Length: 2,390.00 ft

Hole Diameter: 12.25 Inches

Drill Pipe Diameter: 6.625 Inches

Drilling Fluid Weight: 9.5 lbs/gallon

Plastic Viscosity: 13 CP

Yield Point: 25 lbs/100 ft^2

Hydraulic Fracture and Inadvertent Fluid Release Factors of Safety (Entry to Exit)

SSE Project: Eden Loop - Banister River HDD

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Figure C-2

Appendix D

HDD Operating Stress and Pullback Force Calculations

HDD Design Summary

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Design Parameters

Pipe Diameter = 42.000 in
Wall Thickness = 0.888 in
Yield Stress = 70,000 psi
Pipe Material = Steel
Min. Operating Temp = 50 °F
Max. Operating Temp = 70 °F
Design Factor = 0.5
MAOP = 1,480 psi

Drill Data Box

Point	Station (ft)	Elevation (ft)
ENTRY @ 12°	0.00	657.02
PVC1 (12.00° @ 4,500 ft R.)	181.98	618.34
PVT1	1,117.59	520.00
PVC2 (10.00° @ 4,500 ft R.)	1,234.41	520.00
PVT2	2,015.82	588.37
EXIT @ 10°	2,390.00	654.34

Horizontal Alignment Length = 2,390.00 ft

Profile Segment Information

Segment Name	Segment Type	Segment Length (ft)
Entry Tangent	Straight	186.05
Entry Curve	Vertical Curve	942.48
Bottom Tangent	Straight	116.82
Exit Curve	Vertical Curve	785.40
Exit Tangent	Straight	379.95

Pipe Length = 2,410.69 ft

Installation Load Summary

Drilling Fluid Weight (lb/gal)	Buoyancy Condition	Buoyancy Control (lb/ft)	Effective Pipe Weight (lb/ft)	Total Installation Force* (lb)
9.50	Empty	0.00	-292.86	475,200
9.50	Full	550.66	257.80	370,800
12.00	Empty	0.00	-472.79	631,300
12.00	Full	550.66	77.87	230,400
12.00	Neutral	472.79	0.00	215,500

* Pull forces are rounded to the nearest 100 lb

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Minimum Radius Calculations

Project:	SSE Project: Eden Loop	**HDD Name:**	Banister River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** JLR	**Location:**	Pittsylvania County, Virginia	**Date:**	Monday, January 13, 2025

Design Parameters:

Pipe Diameter =	42.000 in	**MAOP =**	1,480 psi	**Factor of Safety =**	2.10
Wall Thickness =	0.888 in	**SMYS =**	70,000 psi	**Min. Operating Temp. =**	50 °F
D/t Ratio =	47.30	**Modulus (E) =**	2.96E+007 psi	**Max. Operating Temp. =**	70 °F
Thermal Coeff. =	6.50E-006 in/in/°F	**Poisson Ratio =**	0.30		

Hoop Stress:

Calculated Hoop Stress = (MAOP * Pipe Diameter) / (2 * Wall Thickness) = 35,000 psi

Longitudinal Stress from Hoop:

Longitudinal Stress from Hoop = Hoop Stress * Poisson Ratio = 10,500 psi

Thermal Stress:

Thermal Stress = E * Thermal Coeff * (Min. Operating Temp - Max. Operating Temp) = -3,849 psi

Bending Stress Capacity:

Bending Stress Capacity = 0.9 * SMYS - Hoop + Long. from Hoop +/- Thermal = 34,651 psi

Allowable Bending Stress:

Allowable Bending Stress = Bending Stress Capacity / FOS = 16,501 psi

Minimum Allowable Radius:

Calculated Minimum Radius = (E * Pipe Diameter) / (2 * Allowable Bending Stress) = 3,140 ft

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Operating Stress Summary

Project Name:	SSE Project: Eden Loop	**HDD Name:**	Banister River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** JLR	**Location:**	Pittsylvania County, Virginia	**Date:**	Monday, January 13, 2025

Design Parameters

Pipe diameter =	42.000 in	**Minimum Allowable Radius =**	3,200 ft
Wall Thickness =	0.888 in	**Coefficient of Thermal Expansion =**	6.5E-06 in/in/°F
SMYS =	70,000 psi	**Min. Operating Temperature =**	50 °F
MAOP =	1,480 psi	**Max. Operating Temperature =**	70 °F
Poissons's Ratio =	0.30	**Temperature Derating Factor =**	1.00
Young's Modulus (E) =	2.96E+007 psi	**Groundwater Table Head =**	0.00 ft
Design Factor =	0.5	**MAOP From Barlow's Equation**	1,480 psi

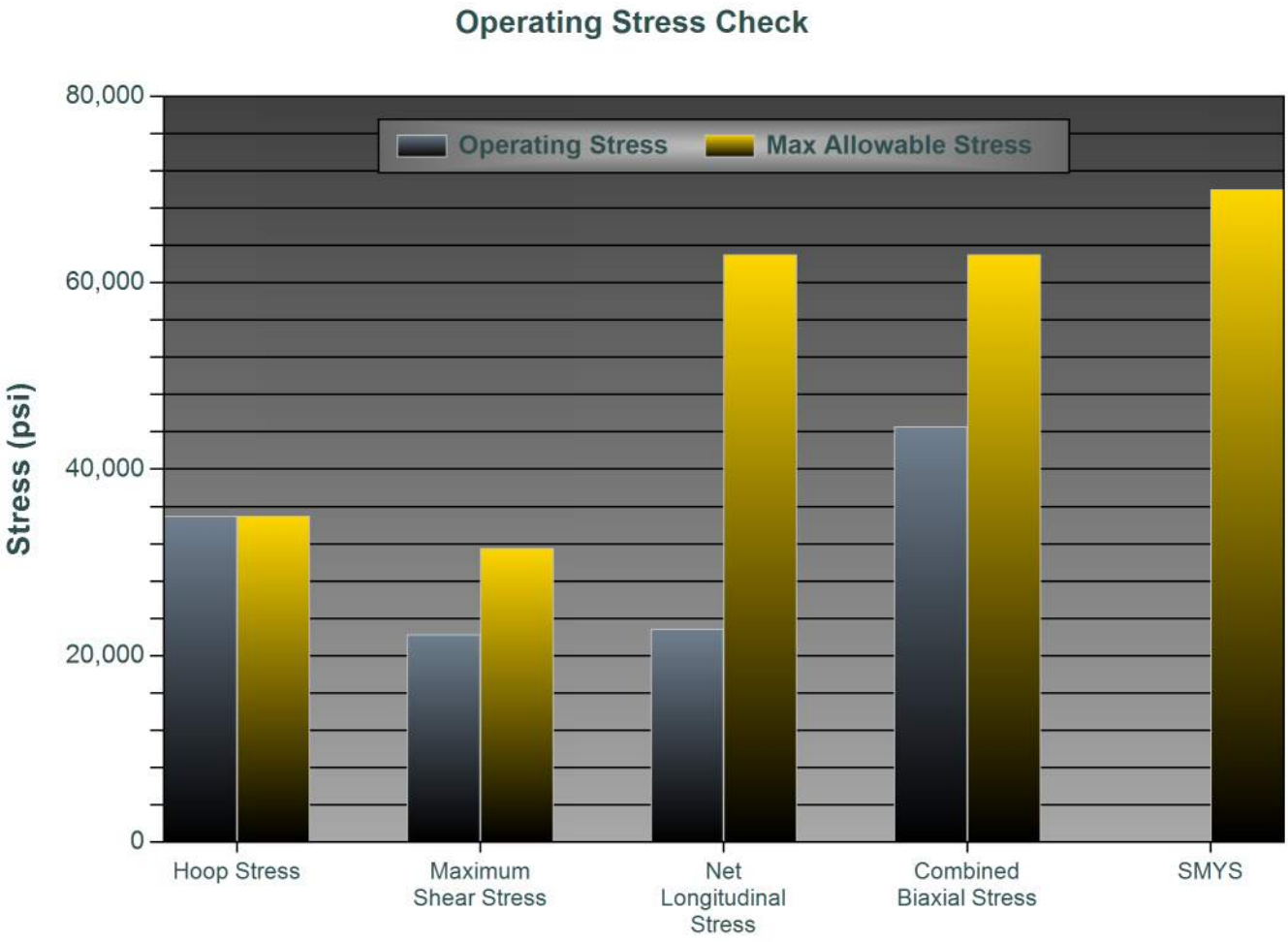
Stress Analyses

Longitudinal Stress from Bending =	16,190 psi	
Percent SMYS =	23.13 %	
Hoop Stress =	35,000 psi	
Percent SMYS =	50.00 %	Limited by Design Factor according to 49 CFR 192.111
Longitudinal Tensile Stress from Hoop Stress =	10,500 psi	
Percent SMYS =	15.00 %	
Longitudinal Stress from Thermal Expansion =	-3,849 psi	
Percent SMYS =	5.50 %	Limited to 90% SMYS by ASME/ANSI B31.4 Table 403.3.1-1
Net Longitudinal Stress (Comp. side of Curve) =	-9,538 psi	
Percent SMYS =	13.63 %	Limited to 90% SMYS by ASME/ANSI B31.8 section 833.3
Net Longitudinal Stress (Tension side of Curve) =	22,841 psi	
Percent SMYS =	32.63 %	Limited to 90% SMYS by ASME/ANSI B31.8 section 833.3
Maximum Shear Stress =	22,269 psi	
Percent SMYS =	31.81 %	Limited to 45% SMYS by ASME/ANSI B31.4 section 403.12
Combined Biaxial Stress Check =	44,538 psi	
Percent SMYS =	63.63 %	Limited to 90% SMYS by ASME/ANSI B31.8 section 833.4

Operating Stress Summary

Project Name: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025



Installation Load Calculations

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Installation Case: 9.50 lb/gal Drilling Fluid With the Pipe Empty

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	2,411 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	683.72 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	-292.86 lb/ft

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	379.95 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	30,080 lb
Friction Force =	32,874 lb
Segment Weight =	19,322 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	82,276 lb
Cumulative Force =	**82,276 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	717 psi	
Cumulative Axial Stress =	717 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	801 psi	7,605 psi
Combined Stress =	0.0128	< 1.0
Total Stress =	0.0115	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 2 of 5**

Segment Parameters			
Segment Name =	Exit Curve	Radius of Curvature =	4,500 ft
Segment Type =	Vertical Curve	Angle Turned =	10.00 deg
Segment Length =	785.40 ft	Center Displacement =	17.12 ft

Segment Force Components	
Normal Force =	165,021 lb
Drag Force =	62,179 lb
Friction Force =	49,506 lb
Segment Weight =	20,047 lb
Tension =	263,514 lb
Average Tension =	172,895 lb
Segment Force =	181,238 lb
Cumulative Force =	**263,514 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	1,580 psi	
Cumulative Axial Stress =	2,298 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	1,599 psi	7,605 psi
Combined Stress =	0.3876	< 1.0
Total Stress =	0.1794	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 3 of 5**

Segment Parameters			
Segment Name =	Bottom Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	116.82 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	9,249 lb
Friction Force =	10,264 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	19,512 lb
Cumulative Force =	**283,026 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	170 psi	
Cumulative Axial Stress =	2,468 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,599 psi	7,605 psi
Combined Stress =	0.0441	< 1.0
Total Stress =	0.0489	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,500 ft
Segment Type =	Vertical Curve	Angle Turned =	12.00 deg
Segment Length =	942.48 ft	Center Displacement =	24.65 ft

Segment Force Components	
Normal Force =	211,705 lb
Drag Force =	74,614 lb
Friction Force =	63,512 lb
Segment Weight =	-28,851 lb
Tension =	455,812 lb
Average Tension =	369,419 lb
Segment Force =	172,786 lb
Cumulative Force =	**455,812 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	1,507 psi	
Cumulative Axial Stress =	3,974 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	1,599 psi	7,605 psi
Combined Stress =	0.4175	< 1.0
Total Stress =	0.2026	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Empty — **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	186.05 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	14,729 lb
Friction Force =	15,988 lb
Segment Weight =	-11,328 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	19,389 lb
Cumulative Force =	**475,201 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	169 psi	
Cumulative Axial Stress =	4,143 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	451 psi	7,605 psi
Combined Stress =	0.0740	< 1.0
Total Stress =	0.0109	< 1.0

Installation Load Calculations

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Installation Case: 9.50 lb/gal Drilling Fluid With the Pipe Full

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	2,411 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	683.72 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	257.80 lb/ft

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full

Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	379.95 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	30,080 lb
Friction Force =	28,939 lb
Segment Weight =	-17,009 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	42,010 lb
Cumulative Force =	**42,010 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	366 psi	
Cumulative Axial Stress =	366 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	801 psi	7,605 psi
Combined Stress =	0.0065	< 1.0
Total Stress =	0.0111	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 2 of 5**

Segment Parameters

Segment Name =	Exit Curve	**Radius of Curvature =**	4,500 ft
Segment Type =	Vertical Curve	**Angle Turned =**	10.00 deg
Segment Length =	785.40 ft	**Center Displacement =**	17.12 ft

Segment Force Components

Normal Force =	-105,590 lb
Drag Force =	62,179 lb
Friction Force =	31,677 lb
Segment Weight =	-17,647 lb
Tension =	149,895 lb
Average Tension =	95,953 lb
Segment Force =	107,886 lb
Cumulative Force =	**149,895 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	941 psi	
Cumulative Axial Stress =	1,307 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	1,599 psi	7,605 psi
Combined Stress =	0.3699	< 1.0
Total Stress =	0.1665	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 3 of 5**

Segment Parameters

Segment Name =	Bottom Tangent	**Radius of Curvature =**	0 ft
Segment Type =	Straight	**Angle Turned =**	0.00 deg
Segment Length =	116.82 ft	**Center Displacement =**	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	9,249 lb
Friction Force =	9,035 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	18,284 lb
Cumulative Force =	**168,179 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	159 psi	
Cumulative Axial Stress =	1,466 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,599 psi	7,605 psi
Combined Stress =	0.0262	< 1.0
Total Stress =	0.0459	< 1.0

Installation Load Calculations

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 4 of 5**

Segment Parameters

Segment Name =	Entry Curve	**Radius of Curvature =**	4,500 ft
Segment Type =	Vertical Curve	**Angle Turned =**	12.00 deg
Segment Length =	942.48 ft	**Center Displacement =**	24.65 ft

Segment Force Components

Normal Force =	-106,350 lb
Drag Force =	74,614 lb
Friction Force =	31,905 lb
Segment Weight =	25,397 lb
Tension =	332,000 lb
Average Tension =	250,090 lb
Segment Force =	163,821 lb
Cumulative Force =	**332,000 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	1,428 psi	
Cumulative Axial Stress =	2,895 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	1,599 psi	7,605 psi
Combined Stress =	0.3982	< 1.0
Total Stress =	0.1875	< 1.0

Installation: 9.50 lb/gal Drilling Fluid With the Pipe Full — **Segment 5 of 5**

Segment Parameters

Segment Name =	Entry Tangent	**Radius of Curvature =**	0 ft
Segment Type =	Straight	**Angle Turned =**	0.00 deg
Segment Length =	186.05 ft	**Center Displacement =**	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	14,729 lb
Friction Force =	14,075 lb
Segment Weight =	9,972 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	38,776 lb
Cumulative Force =	**370,776 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	338 psi	
Cumulative Axial Stress =	3,233 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	451 psi	7,605 psi
Combined Stress =	0.0577	< 1.0
Total Stress =	0.0083	< 1.0

Installation Load Calculations

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Installation Case: 12.00 lb/gal Drilling Fluid With the Pipe Empty

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	2,411 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	863.65 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	-472.79 lb/ft

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	379.95 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	30,080 lb
Friction Force =	53,072 lb
Segment Weight =	31,193 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	114,345 lb
Cumulative Force =	**114,345 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	997 psi	
Cumulative Axial Stress =	997 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,012 psi	7,605 psi
Combined Stress =	0.0178	< 1.0
Total Stress =	0.0185	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 2 of 5**

Segment Parameters

Segment Name =	Exit Curve	**Radius of Curvature =**	4,500 ft
Segment Type =	Vertical Curve	**Angle Turned =**	10.00 deg
Segment Length =	785.40 ft	**Center Displacement =**	17.12 ft

Segment Force Components

Normal Force =	255,054 lb
Drag Force =	62,179 lb
Friction Force =	76,516 lb
Segment Weight =	32,363 lb
Tension =	361,919 lb
Average Tension =	238,132 lb
Segment Force =	247,574 lb
Cumulative Force =	**361,919 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	2,159 psi	
Cumulative Axial Stress =	3,156 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.4029	< 1.0
Total Stress =	0.2251	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 3 of 5**

Segment Parameters

Segment Name =	Bottom Tangent	**Radius of Curvature =**	0 ft
Segment Type =	Straight	**Angle Turned =**	0.00 deg
Segment Length =	116.82 ft	**Center Displacement =**	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	9,249 lb
Friction Force =	16,569 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	25,818 lb
Cumulative Force =	**387,736 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	225 psi	
Cumulative Axial Stress =	3,381 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.0604	< 1.0
Total Stress =	0.0791	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,500 ft
Segment Type =	Vertical Curve	Angle Turned =	12.00 deg
Segment Length =	942.48 ft	Center Displacement =	24.65 ft

Segment Force Components	
Normal Force =	322,130 lb
Drag Force =	74,614 lb
Friction Force =	96,639 lb
Segment Weight =	-46,577 lb
Tension =	609,052 lb
Average Tension =	498,394 lb
Segment Force =	221,315 lb
Cumulative Force =	**609,052 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	1,930 psi	
Cumulative Axial Stress =	5,310 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.4414	< 1.0
Total Stress =	0.2575	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Empty — **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	186.05 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	14,729 lb
Friction Force =	25,812 lb
Segment Weight =	-18,288 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	22,253 lb
Cumulative Force =	**631,304 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	194 psi	
Cumulative Axial Stress =	5,504 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	570 psi	7,605 psi
Combined Stress =	0.0983	< 1.0
Total Stress =	0.0185	< 1.0

Installation Load Calculations

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Installation Case: 12.00 lb/gal Drilling Fluid With the Pipe Full

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	2,411 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	863.65 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	77.87 lb/ft

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full

Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	379.95 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	30,080 lb
Friction Force =	8,742 lb
Segment Weight =	-5,138 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	33,684 lb
Cumulative Force =	**33,684 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	294 psi	
Cumulative Axial Stress =	294 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,012 psi	7,605 psi
Combined Stress =	0.0052	< 1.0
Total Stress =	0.0180	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 2 of 5**

Segment Parameters

Segment Name =	Exit Curve	**Radius of Curvature =**	4,500 ft
Segment Type =	Vertical Curve	**Angle Turned =**	10.00 deg
Segment Length =	785.40 ft	**Center Displacement =**	17.12 ft

Segment Force Components

Normal Force =	-22,166 lb
Drag Force =	62,179 lb
Friction Force =	6,650 lb
Segment Weight =	-5,331 lb
Tension =	103,831 lb
Average Tension =	68,757 lb
Segment Force =	70,148 lb
Cumulative Force =	**103,831 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	612 psi	
Cumulative Axial Stress =	905 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.3627	< 1.0
Total Stress =	0.1945	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 3 of 5**

Segment Parameters

Segment Name =	Bottom Tangent	**Radius of Curvature =**	0 ft
Segment Type =	Straight	**Angle Turned =**	0.00 deg
Segment Length =	116.82 ft	**Center Displacement =**	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	9,249 lb
Friction Force =	2,729 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	11,978 lb
Cumulative Force =	**115,809 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	104 psi	
Cumulative Axial Stress =	1,010 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.0180	< 1.0
Total Stress =	0.0705	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,500 ft
Segment Type =	Vertical Curve	Angle Turned =	12.00 deg
Segment Length =	942.48 ft	Center Displacement =	24.65 ft

Segment Force Components	
Normal Force =	-17,242 lb
Drag Force =	74,614 lb
Friction Force =	5,173 lb
Segment Weight =	7,672 lb
Tension =	208,440 lb
Average Tension =	162,124 lb
Segment Force =	92,631 lb
Cumulative Force =	**208,440 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	808 psi	
Cumulative Axial Stress =	1,817 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.3790	< 1.0
Total Stress =	0.2065	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With the Pipe Full — **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	186.05 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	14,729 lb
Friction Force =	4,251 lb
Segment Weight =	3,012 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	21,993 lb
Cumulative Force =	**230,433 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	192 psi	
Cumulative Axial Stress =	2,009 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	570 psi	7,605 psi
Combined Stress =	0.0359	< 1.0
Total Stress =	0.0080	< 1.0

Installation Load Calculations

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Installation Case: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy

Product Pipe Parameters

Pipe Diameter =	42.000 in
Wall Thickness =	0.888 in
SMYS =	70,000 psi
Young's Modulus =	2.90E+007 psi
Total Pipe Length =	2,411 ft
Moment of Inertia =	24,243 in⁴
Pipe Face Area =	114.69 in²
D/t Ratio =	47.30
Poisson Ratio =	0.30
Coefficient of Soil Friction =	0.30
Fluid Drag Shear Stress =	0.05 psi

Effective Weight Calculations

Total Empty Pipe Weight In Air=	390.87 lb/ft
Pipe Interior Volume =	8.82 ft³
Coating Thickness =	0.00 in
Coating Density =	0.00 lb/ft³
Pipe Exterior Volume =	9.62 ft³/ft
Displaced Fluid Weight =	863.65 lb/ft
B.C. Line(s) Weight =	0.00 lb/ft
B.C. Line(s) Volume =	0.00 ft³/ft
Unit Weight of B.C. Fluid =	62.40 lb/ft³
Effective Weight of Pipe =	0.00 lb/ft

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy — Segment 1 of 5

Segment Parameters

Segment Name =	Exit Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	379.95 ft	Center Displacement =	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	30,080 lb
Friction Force =	0 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	30,080 lb
Cumulative Force =	**30,080 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	262 psi	
Cumulative Axial Stress =	262 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	1,012 psi	7,605 psi
Combined Stress =	0.0047	< 1.0
Total Stress =	0.0181	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 2 of 5**

Segment Parameters

Segment Name =	Exit Curve	**Radius of Curvature =**	4,500 ft
Segment Type =	Vertical Curve	**Angle Turned =**	10.00 deg
Segment Length =	785.40 ft	**Center Displacement =**	17.12 ft

Segment Force Components

Normal Force =	15,099 lb
Drag Force =	62,179 lb
Friction Force =	4,530 lb
Segment Weight =	0 lb
Tension =	101,318 lb
Average Tension =	65,699 lb
Segment Force =	71,238 lb
Cumulative Force =	**101,318 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	621 psi	
Cumulative Axial Stress =	883 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.3623	< 1.0
Total Stress =	0.1942	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 3 of 5**

Segment Parameters

Segment Name =	Bottom Tangent	**Radius of Curvature =**	0 ft
Segment Type =	Straight	**Angle Turned =**	0.00 deg
Segment Length =	116.82 ft	**Center Displacement =**	0.00 ft

Segment Force Components

Normal Force =	0 lb
Drag Force =	9,249 lb
Friction Force =	0 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	9,249 lb
Cumulative Force =	**110,566 lb**

Segment Installation Stress Checks

Stress Component	Calculated	Allowable
Segment Axial Stress =	81 psi	
Cumulative Axial Stress =	964 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.0172	< 1.0
Total Stress =	0.0707	< 1.0

Installation Load Calculations

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 4 of 5**

Segment Parameters			
Segment Name =	Entry Curve	Radius of Curvature =	4,500 ft
Segment Type =	Vertical Curve	Angle Turned =	12.00 deg
Segment Length =	942.48 ft	Center Displacement =	24.65 ft

Segment Force Components	
Normal Force =	25,928 lb
Drag Force =	74,614 lb
Friction Force =	7,778 lb
Segment Weight =	0 lb
Tension =	200,737 lb
Average Tension =	155,652 lb
Segment Force =	90,171 lb
Cumulative Force =	**200,737 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	786 psi	
Cumulative Axial Stress =	1,750 psi	56,000 psi
Bending Stress =	15,859 psi	45,765 psi
Hoop Stress =	2,020 psi	7,605 psi
Combined Stress =	0.3778	< 1.0
Total Stress =	0.2056	< 1.0

Installation: 12.00 lb/gal Drilling Fluid With Neutral Pipe Buoyancy **Segment 5 of 5**

Segment Parameters			
Segment Name =	Entry Tangent	Radius of Curvature =	0 ft
Segment Type =	Straight	Angle Turned =	0.00 deg
Segment Length =	186.05 ft	Center Displacement =	0.00 ft

Segment Force Components	
Normal Force =	0 lb
Drag Force =	14,729 lb
Friction Force =	0 lb
Segment Weight =	0 lb
Tension =	0 lb
Average Tension =	0 lb
Segment Force =	14,729 lb
Cumulative Force =	**215,466 lb**

Segment Installation Stress Checks		
Stress Component	Calculated	Allowable
Segment Axial Stress =	128 psi	
Cumulative Axial Stress =	1,879 psi	56,000 psi
Bending Stress =	0 psi	45,765 psi
Hoop Stress =	570 psi	7,605 psi
Combined Stress =	0.0335	< 1.0
Total Stress =	0.0077	< 1.0

Overbend Radius Calculations

Project: SSE Project: Eden Loop **HDD Name:** Banister River HDD **Owner:** Transcontinental Gas Pipeline Company, LLC

Project No: 8169-235-00 **By:** TJP **Ck'd By:** JLR **Location:** Pittsylvania County, Virginia **Date:** Monday, January 13, 2025

Design Parameters:

Pipe Diameter =	42.000 in	**MAOP =**	0 psi	**Factor of Safety =**	2.85
Wall Thickness =	0.888 in	**SMYS =**	70,000 psi		
D/t Ratio =	47.30	**Modulus (E) =**	2.96E+007 psi		

Hoop Stress:

Calculated Hoop Stress = **(MAOP * Pipe Diameter) / (2 * Wall Thickness) =** **0 psi**

Longitudinal Stress:

Calculated Longitudinal Stress = **Hoop Stress / 2 =** **0 psi**

Allowable Stress:

Calculated Allowable Stress = **SMYS / Factor of Safety =** 24,561 psi

Bending Stress:

Calculated Bending Stress = **Allowable Stress - Longitudinal Stress =** 24,561 psi

Minimum Radius:

Calculated Minimum Radius = **(E * Pipe Diameter) / (2 * Bending Stress) =** 2,066 ft

GeoEngineers

Overbend Stress Summary

Project:	SSE Project: Eden Loop	**HDD Name:**	Banister River HDD	**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No:	8169-235-00	**By:** TJP	**Ck'd By:** JLR	**Location:**	Pittsylvania County, Virginia	**Date:**	Monday, January 13, 2025

Design Parameters

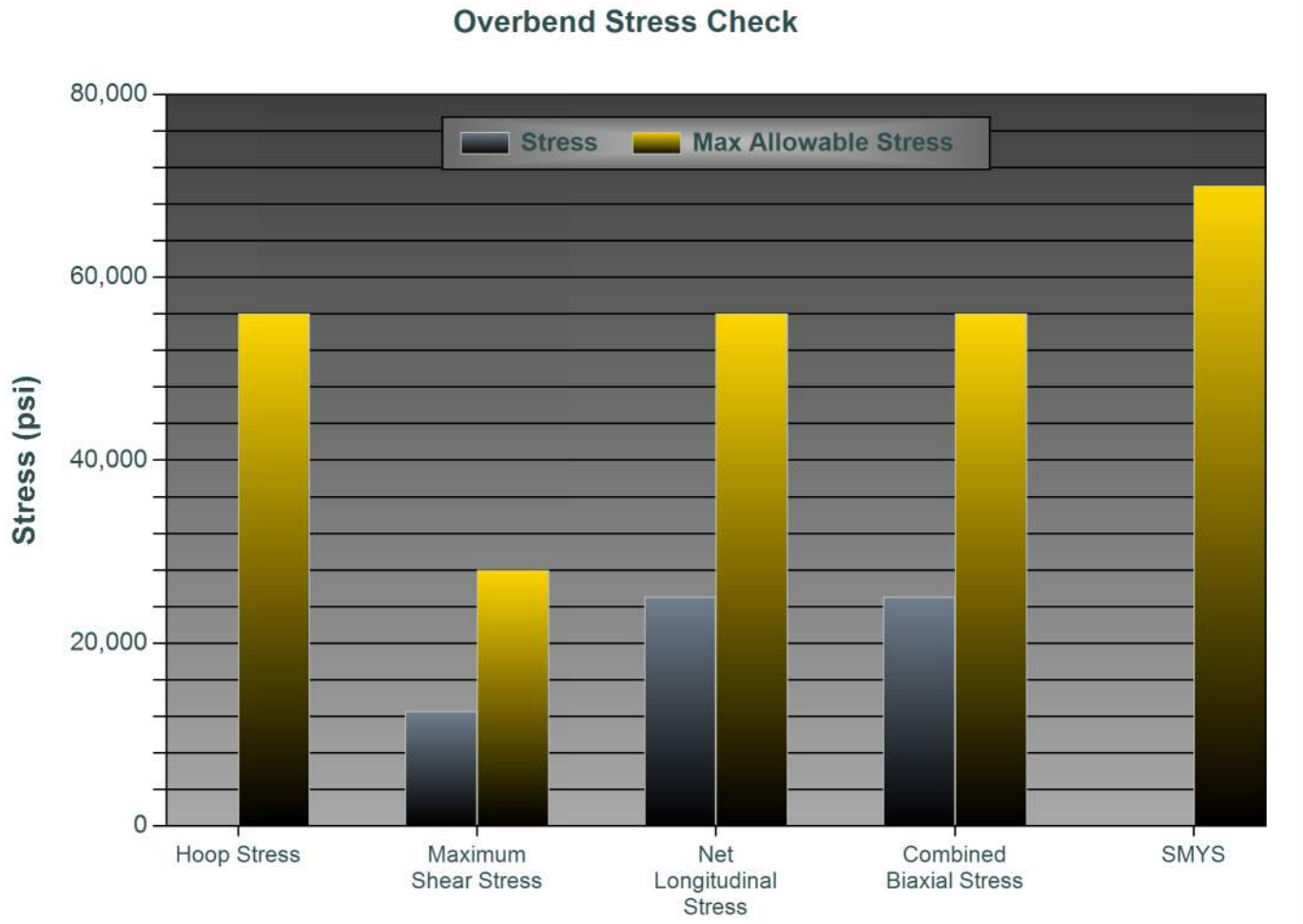
Pipe diameter =	42.000 in	**Factor of Safety =**	2.85
Wall Thickness =	0.888 in	**Overbend Radius of Curvature =**	2.066 ft
SMYS =	70,000 psi	**Assumed Installation Temperature =**	50 °F
Internal Pressure =	0 psi		
Poissons's Ratio =	0.30		
Young's Modulus (E) =	2.96E+007 psi		

Stress Analyses

Longitudinal Stress from Bending =	25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS
Hoop Stress =	0 psi	
Percent SMYS =	0 %	
Longitudinal Tensile Stress from Hoop Stress =	0 psi	
Percent SMYS =	0 %	
Longitudinal Stress from Thermal Expansion =	0 psi	
Percent SMYS =	0 %	
Net Longitudinal Stress (Comp. side of Curve) =	-25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS
Net Longitudinal Stress (Tension side of Curve) =	25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS
Maximum Shear Stress =	12,536 psi	
Percent SMYS =	17.91 %	Limited to 40% SMYS
Combined Biaxial Stress Check =	25,073 psi	
Percent SMYS =	35.82 %	Limited to 80% SMYS

Overbend Stress Summary

Project Name: SSE Project: Eden Loop		**HDD Name:** Banister River HDD		**Owner:**	Transcontinental Gas Pipeline Company, LLC
Project No: 8169-235-00	**By:** TJP	**Ck'd By:** JLR	**Location:** Pittsylvania County, Virginia	**Date:**	Monday, January 13, 2025



Appendix E
HDD Best Practices

Appendix E
HDD Best Practices

GENERAL

The chosen HDD contractor should follow industry standard HDD construction best practices. The purpose of this appendix is to provide HDD construction best practices that are recommended by GeoEngineers and are in addition to industry standard HDD construction best practices. The following best practices do not constitute all HDD construction best practices that are the standard of practice in the HDD industry.

PILOT HOLE CONSIDERATIONS

Under the generally accepted industry standard, the design radius in feet for the entry and exit vertical curves is typically 100 times the carrier pipe diameter in inches (for example, 42-inch-nominal-diameter pipe 42 x 100 = 4,200-foot design radius). Depending on the proposed operating conditions, pipe specification and geometric considerations, the design radii for the horizontal and vertical curves may vary from normal industry design standards and pipe materials.

The minimum allowable three-joint radius over any consecutive three-joint drill pipe section is established to reduce the risk of overstressing the carrier pipe during installation. The HDD contractor's means and methods during construction are critical to the successful completion of the HDD. Specifically, while completing the pilot hole, only small deviations from the design for horizontal and vertical curvature should be allowed so that pull load forces and operational stresses similar to those estimated by the calculations can be maintained.

The HDD contractor should complete the pilot hole as closely as possible to the designed HDD alignment and profile while still maintaining three-joint vertical and horizontal radii equal to or greater than the minimum allowable radius specified on the HDD Design Drawing . We recommend that the three-joint radius be calculated for each three-joint section (for Range 2 Drill Pipe, approximately 90 feet) completed during pilot hole operations. We recommend that the contractor drill the pilot hole within the specified horizontal and vertical tolerances. We also recommend that, upon completion of the pilot hole, GeoEngineers have the opportunity to review the pilot hole survey data prior to the start of reaming operations.

We recommend that a secondary survey system (TruTracker, ParaTrack or equivalent) be used along the entire length of the HDD. If a secondary surface survey coil is required for the secondary survey system, we recommend that the wire grids be placed at least as wide as the survey probe is deep plus 20 feet. The placement of the coils is typically limited to areas where ground surface conditions, permit requirements and landowner permissions allow.

The HDD contractor should be responsible for producing and submitting an as-built drawing of the pilot hole survey data within 2 weeks of the completion of the pilot hole. The HDD contractor's as-built drawing should be reviewed by GeoEngineers prior to storing the data in the project file.

During pilot hole operations, hydraulic fracture of the formation and drilling fluid surface releases may occur as a result of high annular pressures in the hole. Causes of high annular pressures include insufficient removal of cuttings, hole collapse and excessive penetration rates. The annular pressures should be closely monitored during the pilot hole process to help identify when the potential for drilling fluid surface releases

may be possible. Annular pressures can be monitored through the use of a downhole annular pressure tool as part of the bottom hole assembly and compared with the anticipated drilling fluid pressures.

REAMING/SWABBING CONSIDERATIONS

During reaming operations, the HDD contractor will likely ream the hole by conducting one or more successive ream passes to enlarge the hole to a minimum final hole diameter that is typically 12 inches larger than the carrier pipe for diameters equal to or greater than 24 inches or 1.5 times larger than the carrier pipe for diameters less than 24 inches. While conducting a pull ream pass (from exit to entry), a drilling fluid recycling system and high-pressure drilling fluid pump may be positioned on the exit side of the crossing to facilitate the pumping and recycling of the drilling fluid at exit. Conversely, the drilling fluid recycling system could remain at the entry side of the crossing, and drilling fluid returns could be collected with vacuum tankers and hauled to the entry side of the crossing.

In some instances, the contactor may elect to conduct forward reaming passes to promote drilling fluid returns to the entry side of the crossing while enlarging the pilot hole. The process involves keeping the drill rig on the entry side of the crossing and advancing the reamer from entry (away from the drill rig) towards the exit side of the crossing. If the contractor elects to conduct forward reaming passes, we recommend utilizing a large excavator or bulldozer positioned on the exit side of the HDD alignment to apply most of the pull force required to advance the reamer toward the exit point. Additionally, we recommend that the HDD contractor maintain a continuous string of drill pipe in the hole at all times during reaming and swabbing operations. Maintaining a drill pipe string in the hole at all times will reduce the risk of the reamer not following the pilot hole and could eliminate the need for to conduct operations to recover lost tooling in the event that the drill pipe string breaks and the reamer is lost downhole.

During the reaming operations, the rate of penetration and drilling fluid flow rates should be evaluated to reduce potential problems with inadequate removal of cuttings, hydraulic fracturing and drilling fluid surface releases. Generally accepted best practices within the HDD industry recommend an annular solids percentage of 30 percent or less, which requires pumping drilling fluid at a flow rate such that the volume of drilling fluid is more than three times the volume of soil cuttings being generated. The annular solids percentage can be adjusted by varying either penetration or pumping rates. If cuttings begin to build up in the hole because of high annular solids content, high drill string torque, stuck tooling or hydraulic fracture and drilling fluid surface release could occur.

When the reaming process is completed, and prior to pullback operations, we recommend conducting at least one swab pass to (1) check the stability of the hole; (2) help remove any excess cuttings remaining in the hole; (3) provide fresh drilling fluid immediately prior to pullback; and (4) help confirm that the hole is in a condition to receive the carrier pipe. The pullback process typically begins after completing one or more acceptable swab passes.

PULLBACK CONSIDERATIONS

Our analysis of the installation loads assumes that cuttings are removed from the hole prior to attempting pullback. Improper conditioning of the hole prior to pullback could result in higher installation forces.

We recommend that the HDD contractor utilize a drill rig with a capacity of at least 1.5 times the anticipated pull loads. In addition, the HDD contractor should install a deadman anchor of sufficient capacity to

withstand the anticipated pull loads; these aspects are generally left to the HDD contractor's discretion as approved by the owner. We also recommend that during pullback, the minimum allowable carrier pipe over bend radius be assessed to reduce the risk of damaging the carrier pipe during installation.

For carrier pipes less than 24 inches in diameter, it is uncommon for the contractor to use buoyancy control (typically water) during pullback. However, If the diameter of the carrier pipe is greater than 24 inches, the HDD contractor should consider using buoyancy control in the carrier pipe during pullback to reduce the positive buoyancy. In some instances, if buoyancy control measures are not utilized during the pullback process, the carrier pipe(s) may float in the drilling fluid and exert pressure against the top of the hole, increasing the risk for the following problems:

- Increased skin friction between the carrier pipe(s) and formation could lead to an increase in the drill rig pull load. The carrier pipe(s) and/or the protective coatings could be damaged if excessive pull force is applied to them.
- The leading edge of the pullhead could dislodge a cobble or rock fragment, in formations where such subsurface materials are present, binding the carrier pipe(s) and making it impossible to move it in either direction.
- The external coatings could be damaged by sharp and/or protruding material and highly abrasive material (like coarse sands) if such subsurface materials are present.

During pullback, the pull section(s) is/are typically supported with a combination of roller stands and/or carrier pipe handling equipment (cranes, side booms and/or excavators) to direct the carrier pipe(s) into the hole at the correct angle, to help prevent excessive bending of the carrier pipe(s), to reduce tension during pullback and to help protect the carrier pipe(s) from being damaged.

USE OF CASING IN HDD OPERATIONS

When hole stability or drilling fluid surface releases are a concern within the entry or exit tangents, the HDD contractor may choose to install a casing to mitigate these risks. In addition to providing hole stability and reducing the potential for drilling fluid surface releases, the casing can provide a reaction mass for allowing a greater transfer of axial loads through the downhole drill pipe string to the drill bit.

Casing is typically pushed and/or rotated over the drill pipe string in 15- to 40-foot sections. These sections are typically welded together during installation. However, if hydraulic fracture and drilling fluid surface release is a concern near the entry or exit points where casing will be installed, the casing should be advanced prior to initiating pilot hole operations. As sections are added, the casing will continue to be advanced to a depth necessary to maintain hole stability or reduce the risk of hydraulic fracture and drilling fluid surface release. The casing is then typically extracted before or during the hole opening process but may remain in place until pullback operations are complete if necessary. This methodology is most commonly used in soft or loose soil where the drill path is shallow and where gravel or cobbles are anticipated.

UTILITIES

We recommend that the HDD contractor physically locate (pothole) all utilities that are within the entry and exit workspaces, or crossed by the proposed HDD alignment, prior to initiating pilot hole operations to verify the location and depth of each utility and confirm that HDD operations will not conflict with the utilities.

DRILLING FLUID CONTAINMENT PITS AND TEMPORARY EXCAVATIONS

Drilling fluid containment pits will be required at the drill entry and exit work areas. Depending on the practices of the HDD contractor, drilling fluid containment pit excavations are typically constructed adjacent to the centerline near the entry and exit point locations and are approximately 10 feet long by 10 feet wide and up to 8 feet deep.

Maintenance of safe working conditions, including temporary excavation stability, is the responsibility of the HDD contractor. All temporary cuts in excess of 4 feet in height should be shored or sloped in accordance with Occupational Safety and Health Administration (OSHA) regulation 1926 Subpart P, Appendix B – Sloping and Benching. For planning purposes, soils in the vicinity of the excavation areas are often assumed to be classified as Type C. Temporary excavations in Type C soil should be inclined no steeper than 1.5H:1V (horizontal to vertical). These allowable cut slope inclinations are applicable to excavations above the groundwater table only. Steeper temporary slope inclinations may be allowed if soil conditions are determined to be suitable by the field geotechnical engineer. For open cuts, we recommend that:

- No traffic, construction equipment, stockpiles or supplies should be allowed within a distance of at least 5 feet from the top of the cut.
- Construction activities should be scheduled to reduce the length of time the cuts are left open.
- Erosion control measures should be implemented as appropriate to limit runoff from the site.
- Surface water should be diverted away from the excavations.

DRILLING FLUID CONSIDERATIONS

The HDD contractor's ability to maintain proper drilling fluid properties with appropriate penetration and drilling fluid flow rates will be important factors to consider during drilling, because hole conditions and risk of drilling fluid surface releases will be directly affected by these operations. The contractor's means and methods will be instrumental in maintaining a clean pilot hole and reamed hole and in maintaining drilling fluid returns to the entry point throughout the drilling process so that the risk of hydraulic fracture and drilling fluid releases is not increased during the pilot hole and reaming operations.

Maintaining appropriate drilling fluid properties during HDD operations will be vital for effective cuttings removal and maintaining hole stability during all aspects of HDD operations. We recommend that the HDD contractor employ the use of a qualified drilling fluid engineer/technician to develop a drilling fluid program and assist with maintaining appropriate drilling fluid properties during HDD operations.

CUTTINGS REMOVAL AND ANNULAR SOLIDS

Based on our experience, cuttings removal in clays is typically more challenging than in other non-cohesive soils. In some cases, relatively dry clays or high plasticity silts may swell and block the drill hole.

Alternatively, the clay cuttings may “ball up” forming large diameter particles that fall out of suspension and are more difficult to remove than smaller clay particles that remain in suspension. Cuttings removal can also be difficult when drilling through gravel because the relatively heavy gravels tend to fall out of suspension and accumulate within the bore hole. Therefore, the potential for the hole to become plugged with cuttings is elevated along proposed HDD crossings where the drill path is within clay, high plasticity silt and gravel. In the event that the hole becomes plugged, and drilling fluid circulation ceases, downhole annular pressures can increase dramatically. This temporary spike in downhole annular pressure can dramatically increase the risk of hydraulic fracture and drilling fluid surface release.

If cuttings are not effectively removed from the hole during HDD operations, pullback forces could be excessively high during pipe pullback, the pipe could become lodged in the hole, or the pipe could become damaged. The failure to effectively remove cuttings from the hole could potentially result in failure of the HDD installations.

We recommend that the HDD contractor maintain drilling fluid returns at all times and use appropriate means and methods (appropriate penetration rates, drilling fluid management, mechanical methods) to adequately remove the cuttings from the hole during the HDD process.

Appendix F

Report Limitations and Guidelines for Use

Appendix F
Report Limitations and Guidelines for Use[1]

This appendix provides information to help you manage your risks with respect to the use of this report.

READ THESE PROVISIONS CLOSELY

It is important to recognize that the geoscience practices (geotechnical engineering, geology, and environmental science) rely on professional judgment and opinion to a greater extent than other engineering and natural science disciplines, where more precise and/or readily observable data may exist. To help clients better understand how this difference pertains to our services, GeoEngineers, Inc. (GeoEngineers) includes the following explanatory "limitations" provisions in its reports. Please confer with GeoEngineers if you need to know more how these "Report Limitations and Guidelines for Use" apply to your project or site.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES, PERSONS AND PROJECTS

This report has been prepared for Transcontinental Gas Pipeline Company, LLC and the design team for the Project specifically identified in the report. The information contained herein is not applicable to other sites or projects.

GeoEngineers structures its services to meet the specific needs of its clients. No party other than the party to whom this report is addressed may rely on the product of our services unless we agree to such reliance in advance and in writing. Within the limitations of the agreed scope of services for the Project, and its schedule and budget, our services have been executed in accordance with the existing blanket Professional Services Terms and Conditions negotiated as referenced in Purchase Order No. WPO159056 dated April 16, 2024, and generally accepted geotechnical practices in this area at the time this report was prepared. We do not authorize, and will not be responsible for, the use of this report for any purposes or projects other than those identified in the report.

A GEOTECHNICAL ENGINEERING OR ENVIRONMENTAL REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

This report has been prepared for the Banister River horizontal directional drill, located in Pittsylvania County, Virginia. GeoEngineers considered a number of unique, project-specific factors when establishing the scope of services for this project and report. Unless GeoEngineers specifically indicates otherwise, it is important not to rely on this report if it was:

- Not prepared for you,
- Not prepared for your project,

[1] Developed based on material provided by ASFE/The Best People on Earth, Professional Firms Practicing in the Geosciences; www.asfe.org.

- Not prepared for the specific site explored, or
- Completed before important project changes were made.

For example, changes that can affect the applicability of this report include those that affect:

- The function of the proposed structure;
- Elevation, configuration, location, orientation or weight of the proposed structure;
- Composition of the design team; or
- Project ownership.

If changes occur after the date of this report, GeoEngineers cannot be responsible for any consequences of such changes in relation to this report unless we have been given the opportunity to review our interpretations and recommendations. Based on that review, we can provide written modifications or confirmation, as appropriate.

ENVIRONMENTAL CONCERNS ARE NOT COVERED

Unless environmental services were specifically included in our scope of services, this report does not provide any environmental findings, conclusions, or recommendations, including but not limited to, the likelihood of encountering underground storage tanks or regulated contaminants.

SUBSURFACE CONDITIONS CAN CHANGE

This geotechnical or geologic report is based on conditions that existed at the time the study was performed. The findings and conclusions of this report may be affected by the passage of time, by man-made events such as construction on or adjacent to the site, new information or technology that becomes available subsequent to the report date, or by natural events such as floods, earthquakes, slope instability or groundwater fluctuations. If more than a few months have passed since issuance of our report or work product, or if any of the described events may have occurred, please contact GeoEngineers before applying this report for its intended purpose so that we may evaluate whether changed conditions affect the continued reliability or applicability of our conclusions and recommendations.

GEOTECHNICAL AND GEOLOGIC FINDINGS ARE PROFESSIONAL OPINIONS

Our interpretations of subsurface conditions are based on field observations from widely spaced sampling locations at the site. Site exploration identifies the specific subsurface conditions only at those points where subsurface tests are conducted or samples are taken. GeoEngineers reviewed field and laboratory data and then applied its professional judgment to render an informed opinion about subsurface conditions at other locations. Actual subsurface conditions may differ, sometimes significantly, from the opinions presented in this report. Our report, conclusions and interpretations are not a warranty of the actual subsurface conditions.

Bedrock classification shown in our boring logs is based on visual inspection and field observation with the unaided eye. While effort has been made to strive for accuracy, visual rock classification is inherently subjective. This method does not substitute for detailed laboratory testing and may not fully capture the variability and complexity of the subsurface conditions. GeoEngineers laboratory testing program typically

focuses on the physical/mechanical rock properties such as compressive strength, hardness and abrasivity. To classify rock type with near certainty, additional mineralogical and chemical laboratory testing may be required including petrographic analysis (thin section microscopy), xray diffraction, and scanning electron microscopy.

GEOTECHNICAL ENGINEERING REPORT RECOMMENDATIONS ARE NOT FINAL

We have developed the following recommendations based on data gathered from subsurface investigation(s). These investigations sample just a small percentage of a site to create a snapshot of the subsurface conditions elsewhere on the site. Such sampling on its own cannot provide a complete and accurate view of subsurface conditions for the entire site. Therefore, the recommendations included in this report are preliminary and should not be considered final. GeoEngineers' recommendations can be finalized only by observing actual subsurface conditions revealed during construction. GeoEngineers cannot assume responsibility or liability for the recommendations in this report if we do not perform construction observation.

We recommend that you allow sufficient monitoring, testing and consultation during construction by GeoEngineers to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes if the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork activities are completed in accordance with our recommendations. Retaining GeoEngineers for construction observation for this project is the most effective means of managing the risks associated with unanticipated conditions. If another party performs field observation and confirms our expectations, the other party must take full responsibility for both the observations and recommendations. Please note, however, that another party would lack our project-specific knowledge and resources.

A GEOTECHNICAL ENGINEERING OR GEOLOGIC REPORT COULD BE SUBJECT TO MISINTERPRETATION

Misinterpretation of this report by members of the design team or by subcontractors can result in costly problems. GeoEngineers can help reduce the risks of misinterpretation by conferring with appropriate members of the design team after submitting the report, reviewing pertinent elements of the design team's plans and specifications, participating in pre-bid and preconstruction conferences, and providing construction observation.

DO NOT REDRAW THE EXPLORATION LOGS

Geotechnical engineers and geologists prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. The logs included in a geotechnical engineering or geologic report should never be redrawn for inclusion in architectural or other design drawings. Photographic or electronic reproduction is acceptable but separating logs from the report can create a risk of misinterpretation.

GIVE SUBCONTRACTORS A COMPLETE REPORT AND GUIDANCE

To help reduce the risk of problems associated with unanticipated subsurface conditions, GeoEngineers recommends giving subcontractors the complete geotechnical engineering or geologic report, including

these “Report Limitations and Guidelines for Use.” When providing the report, you should preface it with a clearly written letter of transmittal that:

- Advises subcontractors that the report was not prepared for purposes of bid development and that its accuracy is limited; and
- Encourages subcontractors to confer with GeoEngineers and/or to conduct additional study to obtain the specific types of information they need or prefer.

SUBCONTRACTORS ARE RESPONSIBLE FOR SITE SAFETY ON THEIR OWN CONSTRUCTION PROJECTS

Our geotechnical recommendations are not intended to direct the subcontractor’s procedures, methods, schedule, or management of the work site. The subcontractor is solely responsible for job site safety and for managing construction operations to minimize risks to on-site personnel and adjacent properties.

BIOLOGICAL POLLUTANTS

GeoEngineers’ Scope of Work specifically excludes the investigation, detection, prevention or assessment of the presence of Biological Pollutants. Accordingly, this report does not include any interpretations, recommendations, findings, or conclusions regarding the detecting, assessing, preventing, or abating of Biological Pollutants, and no conclusions or inferences should be drawn regarding Biological Pollutants as they may relate to this project. The term “Biological Pollutants” includes, but is not limited to, molds, fungi, spores, bacteria, and/or any of their byproducts.

A Client that desires these specialized services is advised to obtain them from a consultant who offers services in this specialized field.

INFORMATION PROVIDED BY OTHERS

GeoEngineers has relied upon certain data or information provided or compiled by others in the performance of our services. Although we use sources that we reasonably believe to be trustworthy, GeoEngineers cannot warrant or guarantee the accuracy or completeness of information provided or compiled by others.

Transcontinental Gas Pipeline Company, LLC

Horizontal Directional Drill Monitoring, Inadvertent Return Response, and Contingency Plan

Appendix D – Disposal Tracking Log

Southeast Supply Enhancement – Eden Loop VA
Pittsylvania County, Virginia

January 2025

Disposal Tracking Log *(to be managed and updated during construction)*