Inadvertent Release Contingency Plan For Horizontal Directional Drilling in Segment 6 – Package 4A

Ballston Spa to Glenville
Saratoga & Schenectady County, New York

CHA Project Number: 066076

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1.0 INTRODUCTION

CHA Consulting, Inc. (CHA) and the Kiewit Team, with the support of Boscardin Consulting Engineers (BCE), proposes to design and construct approximately 85 horizontal directional drilling (HDD) crossings for a pair of HVDC electrical transmission cables (two crossings at 85 locations) plus a telecommunications line located in upland areas of the Hudson River Valley of New York for Segments 1 through 7 from Putnam Station to Schenectady, NY. Horizontal directional drilling (HDD) methods will be used to route the crossings below congested areas, railroads, under/around obstructions (e.g., existing infrastructure or utilities), and below wetlands and bodies of water. The portions of the cable between HDD bores will be installed in PVC conduits via trenching methods. The trenching construction is addressed in a separate report.

The underground construction of the two HVDC electrical transmission cables is proposed to be housed in individual 10-inch-diameter DR 9 HDPE conduits spaced a distance dependent on depth and soil Thermal Resistivity (TR) values provided by NKT and as shown on drawing plans. A third, typically 2-inch-diameter DR 9 conduit will be bundled with one of the 10-inch-diameter conduits for a telecommunications line. The conduits are to be installed in 16-inch to 22-inch final reamed diameter bore holes. Final conduit diameter and DR values will depend on length and depth of the HDD bores. Longer and deeper bores may require an 8-inch-diameter conduit composed of the stronger, fusible PVC (FPVC) with an appropriate wall thickness (typically DR 14 or DR 17) to resist tensile stresses during installation and collapse-related long-term. The 8-inch conduit would typically be bundled with a 3-inch diameter HDPE for the telecommunications line.. This is checked and determined on a case-by-case basis and design sizes are shown on the design drawings. (See Appendix B)

This Inadvertent Release Contingency Plan (IRCP) is for Segment 6 – Package 4A which includes nine HDD crossings labeled HDD 51 through HDD 61.

HDD is a widely used trenchless construction method to install conduits with limited disturbance to the ground around the bore alignment and minimal ground surface impacts above the alignment. The goal for using HDD methods is to install the conduits while controlling and minimizing the amount of impact on water bodies, congested areas, existing underground obstructions, and to the wetlands, to the extent possible.

A primary potential environmental concern associated with HDD involves the inadvertent release of drilling fluids, also referred to as drilling mud, during the drilling process, which is addressed in this plan. The purpose of this plan is to establish general procedures to prevent a fluid release (sometimes referred to as a frac-out) during HDD construction and to present steps to manage, control and minimize the impacts in the event that an inadvertent release of drilling fluid occurs. The objectives of this plan are to:

- Provide an overview of the HDD process with a specific focus on the composition, management and use of drilling fluids;
- Identify controls to be implemented during construction to minimize the potential of an inadvertent release;
- Identify the planned means of monitoring to permit early detection of inadvertent releases;
- Identify planned means to protect areas that are considered environmentally sensitive (rivers, wetlands, other biological resources or cultural resources);
- Establish site-specific environmental protection measures to be utilized prior to, during, and following drilling and conduit installation activities to minimize and control erosion and sediment releases to adjoining wetlands or watercourses;
- Have site specific preplanned general response programs in place at the start of construction that is understood and can be implemented immediately by all field crews in the event of an inadvertent release of drilling fluid occurs; and
- Establish a chain of command for reporting and notifying, in a timely manner, the construction management team, the Certificate Holders, and the proper authorities in the event of an inadvertent release of drilling fluid and of the preplanned actions that are to be implemented.

It is important to note that the plan in this document serves as the guiding framework for confirming that the HDD Construction Subcontractor (HDD Subcontractor) is adhering to the specifications and provisions to be protective of the environment. Since there are a variety of potential measures listed in this document available for preventing inadvertent releases and mitigating the effects of a release should one occur, the specifications require that each HDD Subcontractor submit to the project design team, for its review and acceptance, a supplemental site and HDD Subcontractor specific means and methods plan for each HDD crossing reaffirming and detailing how the HDD Subcontractor will conform with the requirements of this plan and the project specifications to prevent inadvertent releases and to mitigate any effects of a release

should one occur. The supplemental plan by the HDD Subcontractor shall be consistent with the site conditions and constraints, and the Subcontractor's selected means, methods and equipment. The selected HDD Subcontractor will be responsible for incorporating specific permit conditions, applicable regulatory requirements, site specific environmental features and geotechnical information not available at this time into its submittal. The submittal shall be reviewed and approved by the design team and the Environmental Inspector prior to the start of construction of a specific HDD location.

2.0 DESCRIPTION OF THE HDD PROCESS

The Horizontal Directional Drilling process begins by mechanically excavating shallow (approximately 5 feet wide by 10 feet long by 4 to 5 feet deep entry and exit pits at either end of the directional bore alignment within a designated work area. Typical work areas and equipment layouts are discussed in the Design Summary Report. However, final individual work areas and equipment layouts will be site specific and depend on the length of bore, size of drill rig to be used, and site constraints. A small diameter (on the order of 5 to 9 inches in diameter) pilot bore is then drilled from the entry pit using directional boring methods. During the pilot bore, a drilling fluid (typically bentonite and water based with selected NSF certified additives to improve and modify fluid stability, carrying capacity, and drilling properties to address site-specific ground characteristics and HDD Subcontractor preferences) is pumped through nozzles in the drill head to support the hole and to hydraulically transport drill cuttings from the drill bit back to the entry pit. Environmentally acceptable (formally National Sanitations Foundation) NSF certified, additives are required by specification for use on this project and those planned for use by the HDD Subcontractor will be checked for compliance by the design team prior to their use.

A guidance system is mounted immediately behind the drilling head to allow the crew to track and steer the path of the drilling so that it follows the preplanned alignment within the specification's permitted tolerances. The drilling fluid holds the cuttings in suspension and carries the drill cuttings back through the annular space between the drill rods and the bore hole wall to the entry pit where it is collected and processed for re-used by a recycling system. The cuttings are separated from the bentonite, using screens, centrifuges, and desanding units which prepares the bentonite for re-use. Once the pilot bore reaches the exit pit, a larger diameter back-reaming head is

then attached to the drill string and pulled back through the pilot hole to enlarge the hole. Depending on the size of the conduit to be installed and the ground conditions, several successively larger reaming passes may be needed. Again, a bentonite and water slurry is pumped into the bore hole during reaming to remove cuttings and to stabilize the bore hole. Lastly, the drill string is pulled back through the bore hole with the new, preassembled conduit attached to it in one continuous process until the lead end of the conduit emerges at the entry pit. Final reaming or swabbing and conduit pull back may be combined.

Specific to this plan, it is important to have an awareness of the function and composition of the HDD drilling fluids. The drilling fluid composition and drilling fluid management are integral components of the HDD process with the following primary purposes:

- Support and stabilize the drill hole,
- Suspend and transport the cuttings from drill bit through the drill hole annulus,
- Control fluid loss through the bore's side walls by forming a filter cake on the bore hole walls,
- Managing and modifying the drilling fluid mix to improve its cutting carrying characteristics, its pumpability, and its hole stabilization and support characteristics,
- Power the downhole cutting tools (e.g., via mud motors if required); and,
- Serve as a coolant and lubricant to the drill bit during the drilling process, and serve as a lubricant during the conduit insertion process.

The drilling fluids are composed primarily of potable water, which will likely be obtained from nearby sources selected and permitted by the HDD Subcontractor. As mentioned above, the drilling fluid also contains bentonite clay as a viscosifier. Bentonite is a naturally occurring, nontoxic, inert substance that meets NSF/ANSI 60 NSF Drinking Water Additives Standards and is frequently used for drilling potable water wells. While bentonite is non-toxic and commonly used in farming practices, it has the potential to impact plants, fish and their eggs if discharged to waterways in significant quantities. Frequently, additives are used to: amend the drilling fluid, improve its compatibility with the ground and groundwater chemical characteristics, improve its cutting suspension and carrying characteristics, improve its hole stabilization ability, and reduce seepage loss through the ground characteristics. Environmentally acceptable (i.e. NSF certified) additives are required by specification for this project and before the start of work at a specific HDD, the HDD Subcontractor is required to submit crossing data environmental and toxicity data

including Safety Data Sheets (SDSs) for review and acceptance by the design team.

During the HDD process and subsequent conduit insertion, the drilling fluid pumped downhole will tend to flow along the path of least resistance. Generally, this will be though the annulus between the drill string and the drill hole side wall. However, the bore alignment may encounter ground conditions where the path of least resistance is an existing fracture, fissure, hole of anthropogenic origin, areas with low overburden confinement, areas of hole collapse, or coarse gravel zones in the soil or rock substrate. When this occurs, circulation can be lost or reduced. This is a common occurrence in the HDD process but does not necessarily prevent completion of the bore or result in a release to the environment. However, the environment may be impacted if the fluid inadvertently releases to the surface at a location on a waterway's banks or within a waterway or wetland. Again, additives to amend the properties of the drilling fluid may be used as necessary to prevent and limit releases and losses through such paths of lower flow resistance.

3.0 ORGANIZATION AND STAFFING RESPONSIBILITIES

The organizational chart shown below list the contact information of the principal organizations involved in this project. The remainder of Section 3 discusses the roles and responsibilities of these principal organizations.

Organizational Chart

Entity	Contact Information
Certificate Holders	Name, Title Phone Email
Construction Manager	TBD
HDD Design /Engineer Team	TBD
HDD Construction Subcontractor	
	TBD
Environmental Inspector	TBD
U.S. Army Corps of Engineers, New York District Office	**USACE** New York District Upstate Regulatory Field Office ATTN; CENAN-OP-UR, Bldg. 10, 3rd Floor North 1 Buffington Street

	Watervliet, NY 12189-4000 518-266-6350 cenan.rfo@usace.army.mil
New York State Department of Public Service	Matthew Smith Department of Public Service Empire State Plz 3 Albany, NY 12223 (518) 402-5141 matthew.smith@dps.ny.gov
New York State Department of Environmental Conservation	Regional Office(s) Information **NYSDEC** REGION 5 Sub-Office Regional Permit Administrator 232 Golf Course Rd Warrensburg, NY 12885-1172 518-623-1281 dep.r5@dec.ny.gov
New York State Department of Environmental Conservation (Spills)	NYS Spill Hotline: 1-800-457-7362

3.1 RESPONSIBILITIES OF VARIOUS ORGANIZATIONS

The principal organizations involved in this project include the Regulatory Agencies, Certificate Holders, Design Engineer, HDD Construction Subcontractor, Construction Manager, and Environmental Inspector. The roles and responsibilities of the principal organizations are discussed in the following subsections and are shown in the organizational chart included above.

3.2 REGULATORY AGENCIES

The Certificate of Conditions issued by the NY Public Service Commission is the primary regulatory agency for the requirements associated with the project. The Champlain Hudson Power Express (CHPE) Route Project also has permits from the Department of Energy, and the US Army Corps of Engineers, and the New York Water Quality Certification. Various HDDs within this package take place within or adjacent to wetlands, underneath or adjacent to bodies of water, and underneath or adjacent to DOT roads. Measures are discussed throughout this report to control/mitigate any potential releases before environmentally sensitive boundaries are reached or impacted.

3.3 CERTIFICATE HOLDERS

The project Certificate Holders are TDI. TDI's Project Manager will have the overall responsibility to coordinate this project for TDI. The Project Manager, will be responsible for correspondence and coordination among all parties and will have the authority to stop work as necessary.

3.4 DESIGN ENGINEER

The Front-End Engineering and Design (FEED) Design Engineer for the HDD Design is CHA and Kiewit in collaboration with BCE. During construction, the yet to be confirmed Design Engineer during construction will be responsible for reviewing and approving required Subcontractor submittals, shop drawings, and material certificates. Transmission Developers Inc. will also take responsibility for review and acceptance of submittals, and documenting the materials and methods used in performance of the construction work to document that the construction complies with the contract documents.

3.5 THIRD-PARTY ENGINEER

The Third-Party Engineer for the HDD inadvertent return analysis has yet to be confirmed. During construction the chosen Third-Party Engineer will be assisting Transmission Developers Inc. with the review of the HDD Subcontractors Inadvertent Release Plan and providing technical assistance as needed with the HDD installation.

3.6 CONSTRUCTION MANAGER

The Construction Manager for this project has yet to be selected. The Construction Manager will be responsible for on-site management of the project for the Certificate Holders to ensure overall Subcontractor compliance with the EM&CP documents, environmental permits, local and federal regulations.

3.7 HDD CONSTRUCTION SUBCONTRACTOR

The HDD Subcontractors for the various HDD crossing of this project have yet to be selected. The Subcontractor will be responsible for completion of the conduit installation by HDD methods

in accordance with the design criteria, contract documents, environmental compliance permits and federal regulations. The Subcontractor will be expected to use the appropriate construction procedures and techniques to complete the project, including supplemental site specific and means and methods specific HDD Subcontractor-prepared Inadvertent Release Prevention and Contingency Plans reviewed and accepted by the design team for each crossing in accordance with the contract documents.

The HDD Drill Operator (Drill Operator) will be responsible for operating the HDD drill rig and observing and managing changes in annular fluid pressure or loss of circulation. The Drill Operator will communicate with other members of the drill crew as needed when issues arise. The Subcontractor will be responsible for developing the specific lines of communication within their organization and shall dedicate a responsible person(s) for monitoring and communicating inadvertent releases to the Construction Management team and Environmental Inspector.

3.8 ENVIRONMENTAL INSPECTOR

The Environmental Inspector for this project has not yet been determined. In general, the Environmental Inspector will perform full-time observation and documentation during the HDD activities at a specific site. The Environmental Inspector will be responsible for coordination with all county, state and federal resource agencies, compliance with and changes to any environmental permits.

The Environmental Inspector shall have the authority to stop work when the environmental permit conditions are not being followed or when appropriate environmental precautions are being disregarded by the Subcontractor.

3.9 LINES OF COMMUNICATION AND AUTHORITY

Formal lines of communication will generally follow the established lines of authority. However, open communications between all parties will be encouraged to facilitate more efficient communication and coordination.

3.10 TRAINING

The Subcontractor will verify and document that all construction personnel have appropriate

environmental training before they begin work. The Environmental Inspector will also conduct a project orientation meeting for staff assigned with specific roles during the HDD installation and will review the site-specific environmental concerns and permit conditions. The Certificate Holders and Design Engineer will also attend the orientation meeting to review the procedures that will be used to document inadvertent releases in accordance with the HDD specifications.

4.0 FLUID RELEASE MINIMIZATION MEASURES

4.1 GEOTECHNICAL INVESTIGATION

The first steps taken to minimize the potential risk of an inadvertent release included conducting a geotechnical investigation at the site to develop an understanding of the ground around the planned HDD bores. Test borings were conducted near the proposed cable alignment within or immediately adjacent to the HDD sites. We understand that each boring has been backfilled and sealed with a cement or cement/bentonite grout, and located off the planned bore path, to limit the risk of a release through an abandoned bore hole during the HDD construction.

4.2 HDD DESIGN

The HDD crossing is being designed to reduce the potential risk of an inadvertent fluid release during construction. General design considerations for HDD include:

- Depth of cover during profile design (based on test borings) to limit the potential inadvertent break through to the water body, road, wetlands, or ground surface;
- Typically, potential exists for releases near the entry and exit pits of a bore. The distance where there is a potential for releases at the ends depends on the soil conditions, the slope of the ground surface and the length of the bore. Generally, the longer and deeper the bore the greater the slurry pressures required to hold the borehole open and to carry the cuttings back to the entry or exit pit;
- Specific provisions regarding exit pit design for underwater cable installation (i.e. via the use of temporary dredged cofferdams or steel conduit riser pipes for pressure relief);
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest and therefore requires large slurry pressures to overcome flow resistance to carry cuttings back to the entry pit;
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, pile foundations, and other obstacles;
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up and limit pull back stresses and bending stresses in the conduit, as well as being compatible with the bending capacity of the drill steel.
- Requiring drilling fluid composition, flow rates, and drilling procedures that minimize drilling fluid pressures;

- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment;
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling, and;
- Requiring that, during the performance of any HDD waterbody crossing, contractors monitor the use of the drilling solution containing NSF certified amendments (Article VII: General Condition No. 114 [m]) and, in the event of a detected release of fluid, implement the procedures specified in the approved EM&CP. For any release occurring in a waterbody, the Certificate Holders shall immediately notify DPS Staff and NYSDEC Region 5 Staff of details of the release and the course of action they recommend taking.

4.3 CONTINGENCY PLAN

As mentioned above, prior to construction the selected Subcontractor will be required to submit a supplemental site-and Subcontractor-Specific Inadvertent Release Contingency Plan for review and approval by design team. The project specifications require that the following major elements be addressed in detail in the Subcontractor's Plan:

- Work plan and detailed description of the drilling program (details for executing pilot hole, reaming, pull-back operations, and schedule), this plan shall include necessary procedures for addressing problems that are typically encountered during HDD installations through the anticipated subsurface for each drill location;
- Drilling fluid composition design and on-hand amendments to alter fluid properties to reduce pressures, potential for plugging, and seepage losses;
- Description of the planned drilling equipment and drill site layout;
- SDS information for all drilling fluid products proposed for use;
- Procedures for drilling fluid pressure control, and fluid and pressure loss monitoring and management to aid in the detection of an inadvertent release (i.e., metering of makeup water, recording of drilling fluid product quantities utilized, fluid return volumes, fluid and cuttings disposal quantities, turbidity of river water, etc.);
- Contingency plans for addressing inadvertent releases into wetlands, or other sensitive areas, which includes the specific procedures used to halt the release and then contain, clean-up, and remove materials from the release site;
- Notification procedures and chain-of-command in the event of a release;
- Criteria for evaluating the need for a drill hole abandonment and the associated plan

for sealing the drill hole if abandoned;

- Drilling fluid management and disposal procedures;

- The work plan and detailed drilling program description should include documentation regarding site restoration, vegetation management, sedimentation and erosion control, and hazardous material usage (if applicable). The intended approach will be in compliance with those measures presented in the Project EM&CP.

- Notice shall be provided to residents, businesses, and building, structure, and facility (including underground, aboveground and underwater facilities) owners and operators within one hundred (100) feet of any HDD staging area or trenching activity with an offer to inspect foundations before, during, and after construction. Additional detail regarding this notice, associated inspections, intended benefits, proof of notice, cost reimbursements and associated construction initiation schedule is included in General Condition 154.

In addition to providing a site-specific Inadvertent Release Contingency Plan, the specifications require that the Subcontractor implement the additional necessary safeguards to minimize the likelihood of a fluid release and management/control should a release occur. This includes having a readily available supply of spill response devices (containment booms, pumps, straw bales, silt fence, sediment logs, sandbags, vacuum trucks, and storage tanks) and any other materials or equipment necessary to contain and clean up inadvertent releases. To maximize protection to sensitive environmental areas these measures shall be pre-positioned at the site, readily available and operational prior to the start of any drilling. If needed, additional spill response measures shall be employed immediately, as secondary measures, in the event of a fluid release.

The workspace layout for HDD materials and equipment will be configured to reduce the likelihood of a release. Final dimensions and equipment layout are to be adjusted based on actual space available and shown on the drawings for each HDD crossing.

4.4 DRILLING FLUIDS MANAGEMENT

As described in the Project EM&CP document, drilling fluid (typically bentonite and water based with selected additives) will be NSF certified and all recycling and reuse regulations will be followed where applicable. The drilling fluid management system and subsequent disposal is the responsibility of the HDD subcontractor performing the HDD. However, the drilling fluid

management system and subsequent disposal will adhere to the following requirements:

- Drilling fluid will be processed through an initial cleaning that separates the solid materials from the fluid;
- Solids will be sifted out by a screening apparatus/system and the solids deposited into a dump truck and periodically transported off-site and disposed of at an approved disposal facility determined by the HDD construction subcontractor;
- Drilling fluid that is deemed unacceptable to be reused during construction or left over at the end of drilling will be collected and transferred into a tanker truck for disposal at an approved disposal facility determined by the HDD construction subcontractor;
- Petroleum-based fluids and other potentially hazardous materials associated with drilling operations that are spilled during HDD construction will be contained following the mitigation measures described in the SPCC (Appendix K of the EM&CP) and disposed of at an approved disposal facility as determined by the HDD construction subcontractor and included in the EM&CP; and,
- Supply of spill containment equipment and measures shall be maintained and readily available around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system, if used, to prevent spills into the surrounding environment. Pumps, vacuum trucks, and/or storage of sufficient size will be in place to contain excess drilling fluid.

An overview of the drilling fluid system will be submitted to the Environmental Inspector for approval once determined and prior to any HDD installation activities. The role of the Environmental Inspector is discussed in Chapter 3 of the EM&CP.

4.5 EARLY FLUID RELEASE DETECTION

The HDD method has the potential for seepage or fluid loss into pervious geologic formations that the bore path crosses. This may occur due to the presence of fractures in the rock, low overburden confinement, or from seepage through porous soils such as coarse gravels or via prior exploratory boreholes. It is important to note that inadvertent releases of drilling fluid can occur even if the down-hole pressures are minimal. Subsurface conditions that could be conducive and lead to inadvertent releases or drill difficulties include:

- Highly permeable soil such as cobbles and gravel;
- Presence of rock joints, solution features, or other subsurface fractures;
- Considerable differences in the elevations of HDD entry and exit points

(typically greater than 50 feet);

- Disturbed soil, such unconsolidated fill;
- Soft/weak soils with low overburden confining capacity;
- Low density soils in areas where the HDD bore is relatively shallow;
- Longer bore alignments; and
- The presence of archeological features such as, existing wells, piles and culverts, in close proximity to the HDD bore that may provide a preferential path for the drilling slurry to escape from the bore path.

The risks associated with the above conditions at specific crossings are discussed in Section 9 of this report.

An experienced drill crew is the most effective approach to detecting reaction to drilling fluid seepage prior to a surface release. They can promptly stop the drilling, modify the drilling fluid composition, fluid properties, and pressures to address indications of loss of drill fluid. The HDD Subcontractor is required to utilize experienced drill crews particularly in and adjacent to environmentally sensitive areas. The following factors can be used for identifying the potential for drill fluid release:

- The loss of pressure within the drill hole utilizing a downhole pressure monitoring system;
- A large rapid build-up of pressure within the drill hole utilizing a downhole pressure monitoring system or at the drill rig;
- A substantial reduction in the volume of return fluid (loss of circulation); and
- The lack of drill cuttings returning in the drill fluid

In addition to an experienced drill crew, the HDD Subcontractor will be required to perform periodic (at least twice a day) visual inspection and monitoring of the stream channel bottom and wetlands in the vicinity of the drill bit or reaming bit for signs of an inadvertent release. The Environmental Inspector will monitor the status of each HDD waterbody crossing while construction activities are underway until the crossing has been completed and the stream and stream banks have been restored. In the event of any potential or actual failure of the crossing, the Certificate Holders shall have engaged adequate staff, materials, and equipment to take the necessary steps to prevent or avoid adverse environmental impacts. If visual monitoring

indicates a potential release, additional measures such as turbidity measurements and bentonite accumulation measurements both upstream and downstream of the current active location of the drill bit are required.

5.0 INADVERTENT RELEASE MONITORING AND NOTIFICATIONS

The HDD Subcontractor is responsible for monitoring of the drilling operation to detect a potential inadvertent release by observing and documenting the flow characteristics of drilling fluid returns to the HDD entry/exit pits and by visual inspection along the drill path. If drilling fluid to the HDD entry/exit pits are lost, the Subcontractor shall implement the following steps:

- The Drill Operator will monitor and document pertinent drilling parameters and conditions and observe and monitor the drill path for evidence of an inadvertent release, if there is evidence (typically visual) of a release, the Subcontractor will be required to stop the drilling immediately;
- The Subcontractor shall notify the lead Environmental Inspector of any significant loss of drilling fluid returns at the drill rig; and, in the event of a detected release of drilling fluid during the performance of any HDD waterbody crossing, implement the procedures specified in the approved EM&CP. The Certificate Holders shall immediately notify New York State Department of Public Service (NYSDPS) Staff and New York State Department of Environmental Conservation of details of the release and the course of action they recommend taking.
- The subcontractor will take steps to modify the drill fluid properties and pressures to reduce the potential of drill fluid loss or release; and
- The Drill Operator will take steps to restore drilling fluid circulation in accordance with the requirements of the HDD technical specifications.

If a fluid release is identified, an immediate response is necessary and the Subcontractor is required to take proper corrective actions to minimize impacts, particularly to environmentally sensitive resources (e.g. watercourse, waterbodies, and wetlands).

6.0 INADVERTENT RELEASE RESPONSE (UPLAND AND ROAD AREAS)

A common reason for upward movement and release of drill fluid is from borehole collapse or blockage and a resulting increase in the pressure exerted by drill pumps. Lowering drill fluid pressure is a first step to limiting the extent of a release and can be accomplished by stopping drill rig pumps and allowing pressure to bleed off. With no pumping pressure in the hole, surface seepage will generally stop immediately, then the Subcontractor can trip the drill steel back a selected distance and attempt to clear cuttings from the annulus to re-establish circulation.

The Subcontractor will be required to contain/isolate and remove any fluid that has escaped to the ground or mudline surface. On land this can be done through use of berms, straw bales, shovels as needed, or silt fence to contain the release in conjunction with excavating a small sump pit and/or use of vacuum collection equipment, if needed. Sufficient spill-absorbent material will also be required on-site.

If a release is identified in an upland area, the Subcontractor will be required to respond immediately as described above to limit the extents of the release. After containment is established, cleanup and removal can be conducted by hand, with vacuum trucks, or other equipment. The Environmental Inspector will be present during clean up and removal activities, as they may need to be conducted outside of the pre-authorized temporary workspace areas. The Environmental Inspector, Construction Manager, and the Subcontractor will work together closely to determine the best course of action for inadvertent releases occurring within upland areas.

Upon containment of the release, the Subcontractor will be required to evaluate the cause of the seepage and develop mitigation strategies to limit the likelihood of recurrence. The location of the seepage and the area around the seep will be monitored upon the re-start of the HDD operations for changes in conditions. The segments of borehole nearest the entry and exit points and other areas of low overburden cover tend to be the most susceptible to surface seepage as they have the least amount of soil confinement. These locations will generally be in areas of dry land where seepage detection is easily identified and contained. If areas of high risk for inadvertent releases are identified during the HDD design phase, they can be protected from an uncontrolled release through use of strategically placed confinement/filter beds, straw bales, silt

fence, or earth berms placed prior to the start of drilling or the use of conductor conduits if at entry and exit areas.

7.0 INADVERTENT RELEASE RESPONSE (WETLAND, RAILROAD, AND OPEN WATER BODY AREAS)

For any release occurring in a waterbody, the Certificate Holders shall immediately notify DPS Staff and NYSDEC of details of the release and the course of action they recommend taking. During the performance of any HDD waterbody crossing, contractors monitor the use of an approved drilling solution and, in the event of a detected release of fluid, implement the procedures specified in the approved EM&CP. If an inadvertent release occurs when working beneath the waterway, wetland, or railroad the HDD Subcontractor will be required to cease drilling operations and reduce pressures in borehole immediately, and notify the Environmental Inspector, the Railroad (if within railroad property), the construction management team and the Certificate Holders. The Environmental Inspector, with input from the Drill Operator, will evaluate the potential impact of the release on a site-specific basis and will determine the appropriate course of action. Prior to construction, the Subcontractor is required to develop a detailed, site-specific submittal for general in-stream or in-rail response methods and pre-place necessary materials and equipment at or near the site prior to construction. Specific response actions will be determined in consultation with the Environmental Inspector and HDD Subcontractor and could include the following:

- Shutting down or slowing the drill fluid pumps;
- Modifying the drill fluid properties, add agents to reduce drilling fluid pressures and/or to plug/seal release path;
- Tripping the drill steel back a selected distance and attempt to clear cuttings from the annulus to re-establish circulation
- Stopping drilling activities for 24 hours to allow the bentonite in the subsurface pathways to gel and seal the pathways;
- Evaluate the current drill methods to identify site specific improvements to lower the risk of additional inadvertent releases and,
- Implementation of proper in-wetlands and in upland, road and railroad, hand-placed sedimentation control measures including, but not limited to straw bales, vacuum trucks, silt curtains, containment cells, turbidity curtains, or if suitable, sand bags and confinement/filter beds. These activities will require that qualified construction personnel and other support equipment, and supplies be prepositioned and readily available at or near the site.

- Use of a relief well installed at the location of the release. A well or pit equipped with a subsurface pump to control slurry pressures and future releases at that location by evacuating drilling fluid as it accumulates can also be used. The relief well can be utilized to immediately lower the borehole pressures in the event of an inadvertent release and later to control and manage the release as the drilling continues.

8.0 DRILL HOLE ABANDONMENT PLAN

In the event the HDD Subcontractor must abandon the drilled hole, a plan to fill the abandoned hole will be implemented as detailed in the HDD Subcontractor's supplemental Inadvertent Release Contingency Plan and an alternative plan/alignment for crossing shall be evaluated. If it becomes necessary to abandon a partially completed hole, the abandoned hole will be filled with a mixture of high-yield bentonite, water, and drill spoil. The first ten feet of the bore path will be compacted and filled with soil or a cement-bentonite mix to prevent future settlement. The Subcontractor submitted site-specific abandonment plan shall be approved by the Design Engineer and the Construction Manager prior to being performed in the field.

After the abandoned hole has been filled, an alternative entry and exit hole and bore path alignment will be evaluated by the HDD Subcontractor, Construction Manager, and the Design Engineer. The new alignment shall be offset from the abandoned hole by at least 10 feet (except at the ends where a 5- foot offset may be used) to help limit the risk steering difficulties due to the presence of or hydraulic connection causing drill fluid loss to the abandoned hole.

9.0 CROSSING SPECIFIC DISCUSSION

9.1 HDD CROSSING #51

HDD #51 consist of two HDD bores located underneath CP Railway, south of Saratoga Lake. The HDD bores are approximately 1907 feet and 2018 feet long as shown in Appendix B. The HDD bores will pass approximately 30-33 feet below multiple culverts, and approximately 38 feet below CP Rail railroad tracks. The ground surface elevations along the path of HDD#51 gently undulates between El. 284 and El. 293 (reference datum NAVD 1988).

The bores will have both horizontal and vertical curves. The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks, and the horizontal curves are used to keep the alignment within the corridor, work zone, and associated easements. Portions of the work zones on southern end are proposed to minorly impact wetlands. The bores also are briefly intersecting, over and under design., due to limited clearance between the RR bridge structure over E. High Street and the adjacent home. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #51: Based on the borings drilled for this project, the soil profile for the HDD #51 BoreAid analysis will be divided into three (3) layers: medium dense poorly graded sand (SP), very dense poorly graded gravels (GP) and shale bedrock. The soil profiles used for BoreAid analyses for the HDD in this segment are presented in Appendix A.

Specific design considerations for HDD #51 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, or ground surface. General depth of cover under multiple culverts is approximately 30-33 feet and 54 feet below railway tracks. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 1940 psi (Conduit 1) and 2234 psi (Conduit 2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 46 psi (Conduit 1) and 50 psi (Conduit 2) assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 2344 (Conduit 1) psi and 0

to 2364 (Conduit 2) psi and the approximate applied slurry pressure during drilling ranges from 0 to 65 psi (Conduit 1) and 0 to 72 psi (Conduit 2). A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.

- It appears that a potential for releases in approximately the last 30-55 feet, approximately, as each bore approaches the exit pit exist. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- It appears that a potential for releases in the approximately 4 feet of clayey gravel capped by clay just above the shale bedrock, el. 283, exist at the exit. This is too short for conductor casing and vacuum truck should be readily available with erosion control measures. Over excavation of the pit to communicate slurry from the clayey gravel to the pit may also be considered.
- Due to work zones being located within wetlands, measures to mitigate the potential inadvertent release are required:
    - Barriers to contain the releases tot the ground surface, railroad surface and provisions to clean it up (such as use of a vacuum truck).
    - In addition, down the hole slurry pressure monitoring and/or conductor casings may be implemented to limit the potential for releases depending on the details of the HDD Subcontractor's selected means and methods.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up,
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,

- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling,
- The use of conductor casing, temporary steel casing at exit end of each bore to contain drilling fluids during drilling reaming and pullback.

9.2 HDD CROSSING #52

HDD #52 consists of two, straight, HDD bores located west of the CP Railroad Canadian Mainline, south of the Saratoga Lake. The bores are approximately 2701 feet long as shown in Appendix B. The HDD bores will pass approximately 35 feet below the existing ground surface in Ballston, NY and cross underneath wetlands. The ground surface elevations along the HDD path gently undulates between El. 294 and El. 297 (reference datum NAVD 1988).

Portions of the work zones on both side of the bores are proposed to majorly impact wetlands. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #52: Based on the borings drilled for this project, the soil profile for the HDD #52 BoreAid analysis will be divided into three (3) layers: loose silty sand (SM), very dense well graded sand (SW), and shale bedrock. The soil profiles used for BoreAid analyses for the HDD in this segment are presented in Appendix A.

Specific design considerations for HDD #52 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, or ground surface. General depth of cover under wetlands is approximately 35 feet near the center of the bores. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 1490 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 46 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 1766 psi and the approximate applied slurry pressure during drilling ranges from 0 to 67 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the

summary BoreAid analyses in the attached Appendix A.

- It appears that a potential for releases in approximately the last 70 feet, approximately, as each bore approaches the exit pit exist. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- Due to work zones being located within wetlands, measures to mitigate the potential inadvertent release are required:
    - Barriers to contain the releases tot the ground surface, railroad surface and provisions to clean it up (such as use of a vacuum truck).
    - In addition, down the hole slurry pressure monitoring and/or conductor casings may be implemented to limit the potential for releases depending on the details of the HDD Subcontractor's selected means and methods.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up,
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling,
- The use of conductor casings, temporary steel casing at exit end of each bore to contain drilling fluids during drilling reaming and pullback.

9.3 HDD CROSSING #53

HDD #53 consists of two, straight, HDD bores located west of the CP Railroad Canadian Mainline, north of the Ballston Lake. The bores are approximately 815 feet long as shown in Appendix B. The HDD bores will pass approximately 20 feet below the estimated mudline (assuming a 5' water depth) and 37 feet below the Route 67. The ground surface elevations along the path of HDD #53 gently undulates from approximately El. 295 to El. 296 aside from the dip to the water level which is at approximately El. 266 (reference datum NAVD 1988).

Portions of the work zones on both side of the bores are proposed to minorly impact wetlands. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #53: Based on the borings drilled for this project, the soil profile for the HDD #53 BoreAid analysis will be divided into four (4) layers: loose silt (ML), medium dense silty sand (SM), and dense weathered rock (ML), and shale bedrock. The soil profiles used for BoreAid analyses for the HDD in this segment are presented in Appendix A.

Specific design considerations for HDD #53 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, or ground surface. General depth of cover under the estimated mudline (assuming a 5' water depth) is 20 feet and 37 feet or more below the Route 67. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 1400 psi (conduit 1) & 1420 psi (conduit 2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 35 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 2000 psi and the approximate applied slurry pressure during drilling ranges from 0 to 39 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.
- It appears that a potential for releases in approximately the last 15 feet as each bore

approaches the exit pit exist. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.

- Due to work zones being located within wetlands, measures to mitigate the potential inadvertent release are required:
    - Barriers to contain the releases tot the ground surface, railroad surface and provisions to clean it up (such as use of a vacuum truck).
    - In addition, down the hole slurry pressure monitoring and/or conductor casings may be implemented to limit the potential for releases depending on the details of the HDD Subcontractor's selected means and methods.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up,
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

9.4 HDD CROSSING #53A

HDD #53A consists of two, straight, HDD bores located west of the CP Railroad Canadian Mainline, north of the Ballston Lake. The bores are approximately 625 feet and 627 feet long as shown in Appendix B. The HDD bores will pass approximately 17 feet below the estimated mudline (assuming a 5' water depth. The ground surface elevation at entry and exit of bore alignment is approximately El. 276, while at the center it dips down to the water level at El. 271 (reference datum NAVD 1988).

Portions of the work zones on both side of the bores are proposed to impact wetlands. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #53A: Based on the layering observed in the three borings conducted along the alignment, the soil profile for the HDD #53A BoreAid analysis will be divided int four (4) layers: medium dense fill (SP), medium dense silty sand (SM), dense weathered rock (GP) and shale bedrock. The soil profiles used for BoreAid analyses for the HDD in this segment are presented in Appendix A.

Specific design considerations for HDD #53A include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, or ground surface. General depth of cover under the estimated mudline (assuming a 5' water depth) is 17 feet. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 745psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 19 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 1030 psi and the approximate applied slurry pressure during drilling ranges from 0 to 23 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.
- It appears that there is a potential for inadvertent releases in the starting 15 ft of each bore near entry pit exist. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize

pressure build-up,

- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

9.5 HDD CROSSING #59

HDD #59 consists of two, straight, HDD bores located west of the CP Railroad Canadian Mainline, north of the Ballston Lake. The bores are approximately 1124 feet and 1159 feet long as shown in Appendix B. The HDD bores will pass approximately 20-22 feet below the existing ground surface. The ground surface elevations along the HDD path gently undulates between El. 260 and El. 270 (reference datum NAVD 1988).

No work is to be proposed within wetlands and/or waterbodies. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #59: Based on the borings drilled for this project, the soil profile for the HDD #59 BoreAid analysis will consist of four (4) layers: medium dense poorly graded sand (SP), stiff low plasticity clay (CL), very dense weathered rock (GP) and shale bedrock. The soil profiles used for BoreAid analyses for the HDD in this segment are presented in Appendix A.

Specific design considerations for HDD #59 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, waterbody, or ground surface. General depth of cover under the unnamed tributary is approximately 24 feet. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 1780 psi and the total circulating pressure estimated to occur in the middle portion of the bore is

approximately 31 psi assumed standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 1960 psi and the approximate applied slurry pressure during drilling ranges from 0 to 38 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.

- It appears that a potential for releases in approximately the first 15-30 feet from the entry pit and the last 45 feet as each bore approaches the exit pit exists. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up,
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

9.6 HDD CROSSING #59A

HDD #59A consists of two, horizontal curved HDD bores located west of CP Railroad Canadian Mainline and starts north of US-Route 110 in Ballston, NY. The bores are approximately 1826 feet long as shown in Appendix B. HDD bores start on the west side of CP Railroad railway tracks and crosses to the east side. The conduits will pass below an 18" RCP culvert and cross underneath US Route-110 & a gas transmission line in Ballston. The ground surface elevations along the HDD path gently undulates between El. 269 and El. 259 (reference datum NAVD 1988).

The bores will have both horizontal and vertical curves. The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks, and the horizontal curves are used to keep the alignment within the work zone easements. No work is to be proposed within wetlands and/or waterbodies. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #59A: Based on the borings drilled for this project, the soil profile for the HDD #59A BoreAid analysis will be divided into four (4) layers: medium dense fill (SP), medium stiff low plasticity clay (CL), dense weathered rock (GM) and shale bedrock. The soil profiles used for BoreAid analyses for the HDD in this segment are presented Appendix A.

Specific design considerations for HDD #59A include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, or ground surface. General depth of cover under an 18" RCP culvert is approximately 27 feet and approximately 30 feet below US Route-110. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 1245 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 30 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 2000 psi and the approximate applied slurry pressure during drilling ranges from 0 to 42 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.
- It appears that a potential for release in approximately the last 30 feet, as each bore approaches the exit pit exist. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize

pressure build-up,

- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.
- The use of conductor casing, temporary steel casing at exit end of each bore to contain drilling fluids during drilling reaming and pullback.

9.7 HDD CROSSING #59B

HDD #59B consist of two, straight, HDD bores located approximately 3,200 feet west of Blue Barns Road and 2,700 feet east of Hetcheltown Road in Ballston, NY. The bores are approximately 829 feet long as shown in Appendix B. HDD bores start on the east side of CP Railroad railway tracks and crosses to the west side. The bores run approximately 8 degrees skewed to the rails. The ground surface elevations along the HDD path gently undulates between El. 252 and El. 241 (reference datum NAVD 1988).

Portions of the work zones on the southern end may minorly impact NYS designated wetlands. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #59B:

Based on the borings drilled for this project, the soil profile for the HDD #59B BoreAid analysis will be divided into five (5) layers: loose fill (SP), medium dense poorly graded sand (SP), medium dense silty sand (SM), very dense weathered rock (GP), and shale bedrock. The soil profiles used for BoreAid analyses for the HDD in this segment are presented Appendix A.

Specific design considerations for HDD #59B include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the railroad or ground surface. General depth of cover under the rial is approximately 30 feet. Preliminary analysis of the bore, assuming typical

drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 1330 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 33 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 1420 psi and the approximate applied slurry pressure during drilling ranges from 0 to 40 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.

- It appears that a potential for release in approximately the last 28 feet of Conduit 1 and the last 49 feet or Conduit 2, as each bore approaches the exit pit exist. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up,
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.
- The use of conductor casing, temporary steel casing at exit end of each bore to contain drilling fluids during drilling reaming and pullback

9.8 HDD CROSSING #60

HDD #60 consist of two, straight (in plan view) HDD bores located underneath an open river in Ballston, NY. The bores are approximately 1332 feet and 1335 feet long as shown in Appendix B.

Both conduits cross a gas transmission line and later pass underneath the river at an approximate depth of 25 feet. The ground surface elevations along the HDD path gently undulates between El. 233 and El. 236, aside from dipping to a water level at approximately El. 221 (reference datum NAVD 1988).

The bores will have both horizontal and vertical curves. The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks, and the horizontal curves are used to keep the alignment within the work zone easements. No work is to be proposed within wetlands and/or waterbodies. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #60: Based on the borings drilled for this project, the soil profile for the HDD #60 BoreAid analysis will be divided into three (3) layers: loose silty sand (SM), medium stiff high plasticity clay (CH), and dense glacial till (SM). The soil profiles used for BoreAid analyses for the HDD in this segment are presented in Appendix A.

Specific design considerations for HDD #60 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, or ground surface. General depth of cover under the estimated mudline (assuming a 5' water depth) is 20 feet. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 121 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 34 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 188 psi and the approximate applied slurry pressure during drilling ranges from 0 to 41 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.
- It appears that a potential for releases in approximately the first 15 feet from the entry pit and the last 30 feet, approximately, as each bore approaches the exit pit exists. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD

process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.

- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up,
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

9.9 HDD CROSSING #61

HDD #61 consist of two, straight (in plan view) HDD bores located underneath a DOT Road (Glenridge Road) in Ballston, NY. The bores are approximately 684 feet and 689 feet long as shown in Appendix B. The HDD bores will cross underneath an existing storm and gas line, pass approximately 25 feet below the pavement. The ground surface elevations gently slope down started at approximately El. 230 and reaching El. 240 at the exit (reference datum NAVD 1988). The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Portions of the work zones on southern end of the bores are proposed to impact wetlands. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #61: Based on the borings drilled for this project, the soil profile for the HDD #61 BoreAid analysis will be divided into four (4) layers: medium dense poorly graded sand (SP), medium dense silty sand (SM), soft low plasticity clay (CL) and medium dense silty sand (SM). The soil profiles used for BoreAid analyses for the HDD in this segment are presented in Appendix A.

Specific design considerations for HDD #61 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, waterbody, or ground surface. General depth of cover under 28 to 32 feet and approximately 26 feet below edge of pavement. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 74 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 20 psi assumed standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 92 psi and the approximate applied slurry pressure during drilling ranges from 0 to 24 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.
- It appears that a potential for releases in approximately the last 15 feet, approximately, as each bore approaches the exit pit exist. These should be relatively easy to control through the use of conductive conduits, straw bales, silt fences, erosion control measures and vacuum trucks.
- Due to work zones being located within wetlands, measures to mitigate the potential inadvertent release are required:
    - Barriers to contain the releases tot the ground surface, railroad surface and provisions to clean it up (such as use of a vacuum truck).
    - In addition, down the hole slurry pressure monitoring and/or conductor casings may be implemented to limit the potential for releases depending on the details of the HDD Subcontractor's selected means and methods.
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest.
- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up,
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,

- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment,
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

Appendix A

BoreAid HDD Simulation Output

Generated Output

WARNING: The accuracy of the data obtained by the BoreAid® system is highly dependent upon accurate data gathering, data input and proper use of the software. Vermeer is not responsible for that information. BoreAid® data is not intended to replace the need for future on-site utility locating, measuring and verification procedures, which are essential for accurate placement of new underground installations and avoidance of existing utilities.

CALL YOUR ONE-CALL SYSTEM FIRST

WARNING: Always contact your local One-Call system before the start of your digging project. The BoreAid® system is intended to be used with other utility locating methods, such as the use of the One-Call system and the exposing of existing utilities by potholing.

Locate utilities before drilling. Call 811 (U.S. only) or 1-888-258-0808 (U.S. or Canada) or local utility companies or national regulating authority.

Before you start any digging project, do not forget to call the local One-Call system in your area and any utility company that does not subscribe to the One-Call system. For areas not represented by One-Call Systems International, contact the appropriate utility companies or national regulating authority to locate and mark the underground installations. If you do not call, you may have an accident or suffer injuries; cause interruption of services; damage the environment; or experience job delays.

OSHA CFR 29 1926.651 requires that the estimated location of underground utilities be determined before beginning the excavation or underground drilling operation. When the actual excavation or bore approaches an estimated utility location, the exact location of the underground installation must be determined by a safe, acceptable and dependable method. If the utility cannot be precisely located, it must be shut off by the utility company.

Project Summary

General:	CHPE HDD 51 P4A Start Date: 04-25-2023 End Date: 04-25-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 51 Conduit 1 10-inch DR9 reversed

Input Summary

Start Coordinate	(0.00, 0.00, 293.00) ft
End Coordinate	(1907.00, 0.00, 283.00) ft
Project Length	1907.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

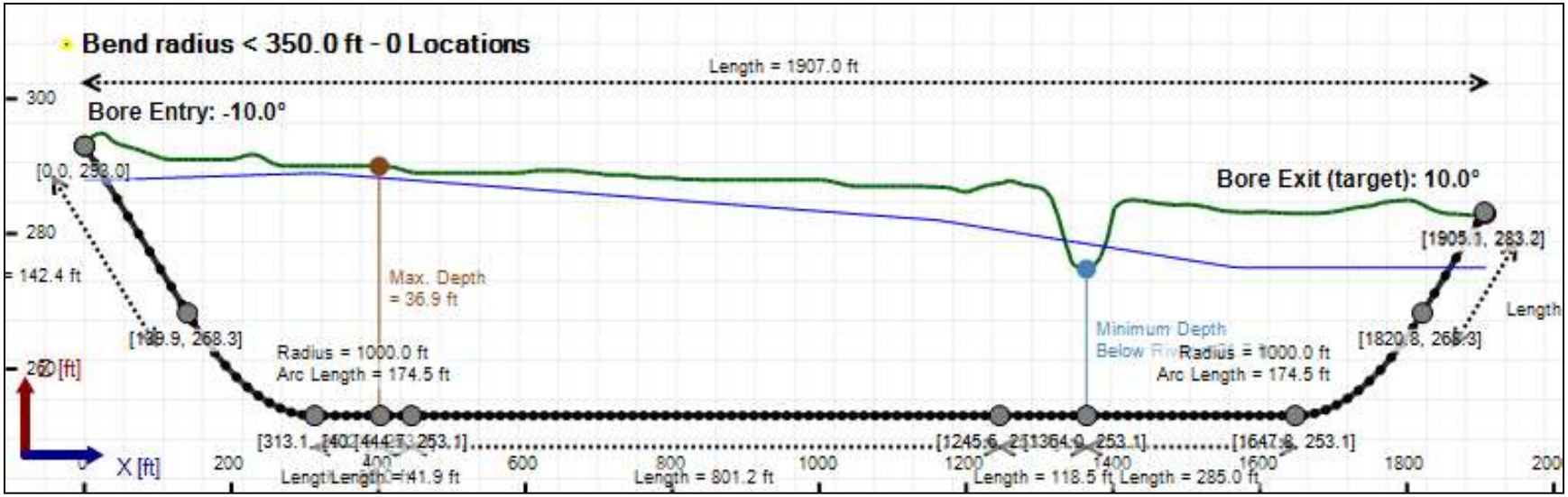
Number of Layers: 3

Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 120.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 300.00, Coh: 0.00 [psi]

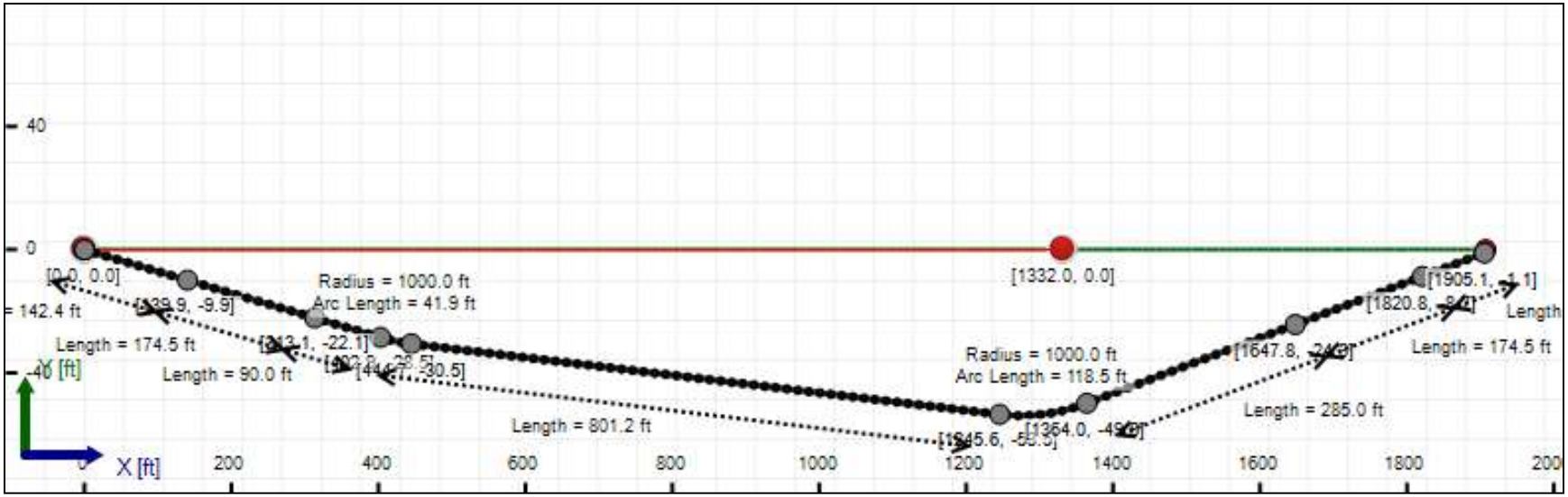
Soil Layer #2 USCS, Gravel (G), GP
From Assistant
Unit Weight: 125.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 35.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #3 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 3000.00, Coh: 2000.80 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 1920.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.2	24.5
Water Pressure	15.6	15.6
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	20.8	40.0
Deflection		
Earth Load Deflection	1.596	6.697
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.728	6.829
Compressive Stress [psi]		
Compressive Wall Stress	93.6	180.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	31170.4	31170.4
Pullback Stress [psi]	869.3	869.3
Pullback Strain	1.512E-2	1.512E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	869.3	889.9
Tensile Strain	1.512E-2	1.592E-2

Net External Pressure = 25.2 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.728	7.5	4.3	OK
Unconstrained Collapse [psi]	26.0	118.3	4.6	OK
Compressive Wall Stress [psi]	93.6	1150.0	12.3	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	36.0	200.9	5.6	OK
Tensile Stress [psi]	889.9	1200.0	1.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	6.50 in	2340.302 psi	2779.576 psi
1	6.50 in	12.00 in	2337.514 psi	2778.472 psi
2	12.00 in	16.13 in	2334.339 psi	2777.214 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

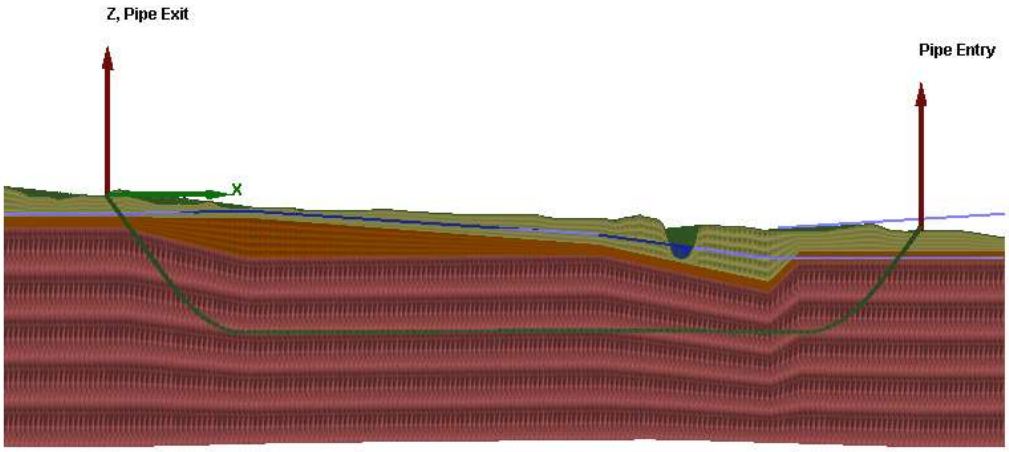
Rheological model: Power-Law

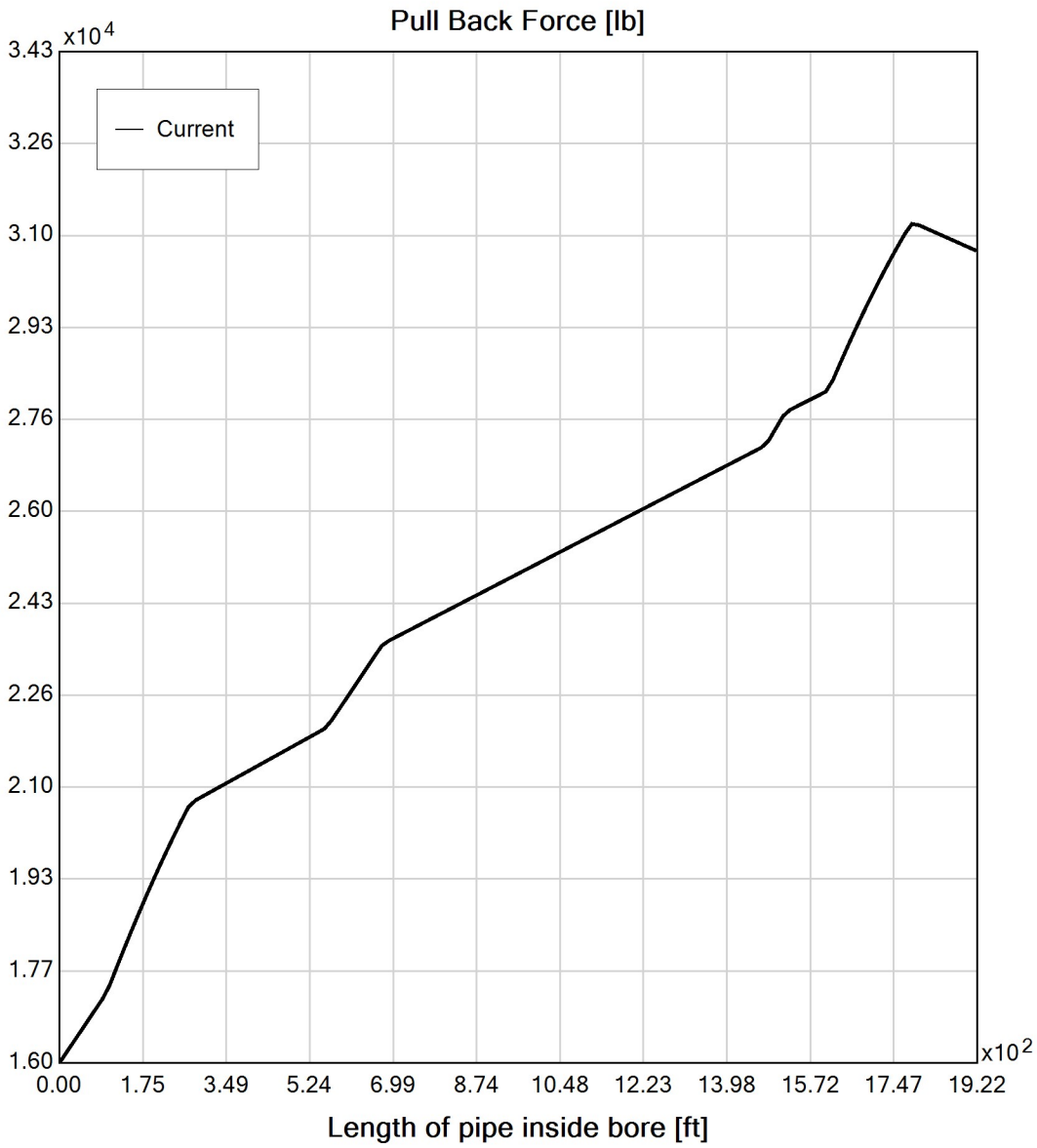
Fluid Consistency Index (K): 63.17

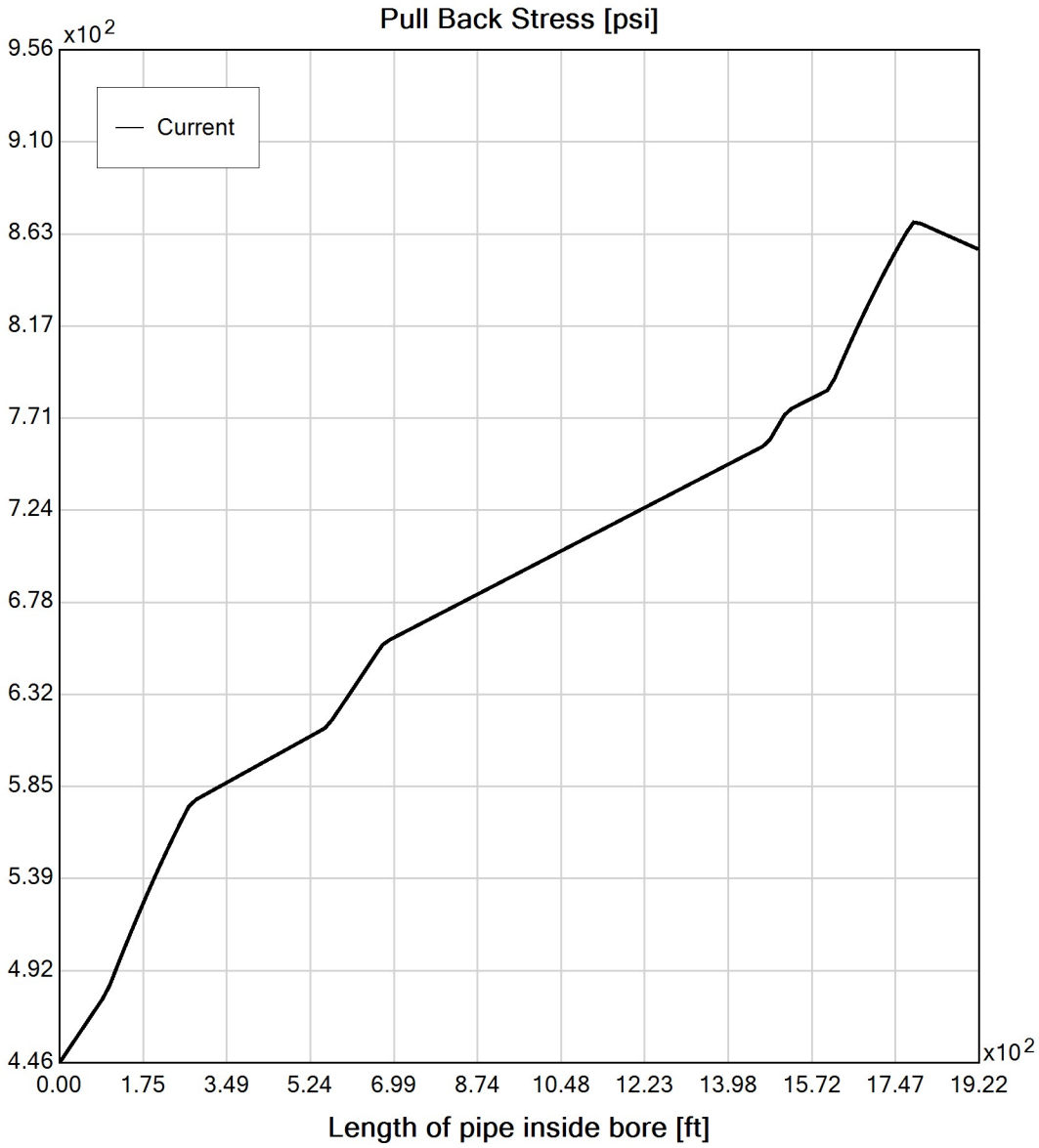
Power Law Exponent (n): 0.14

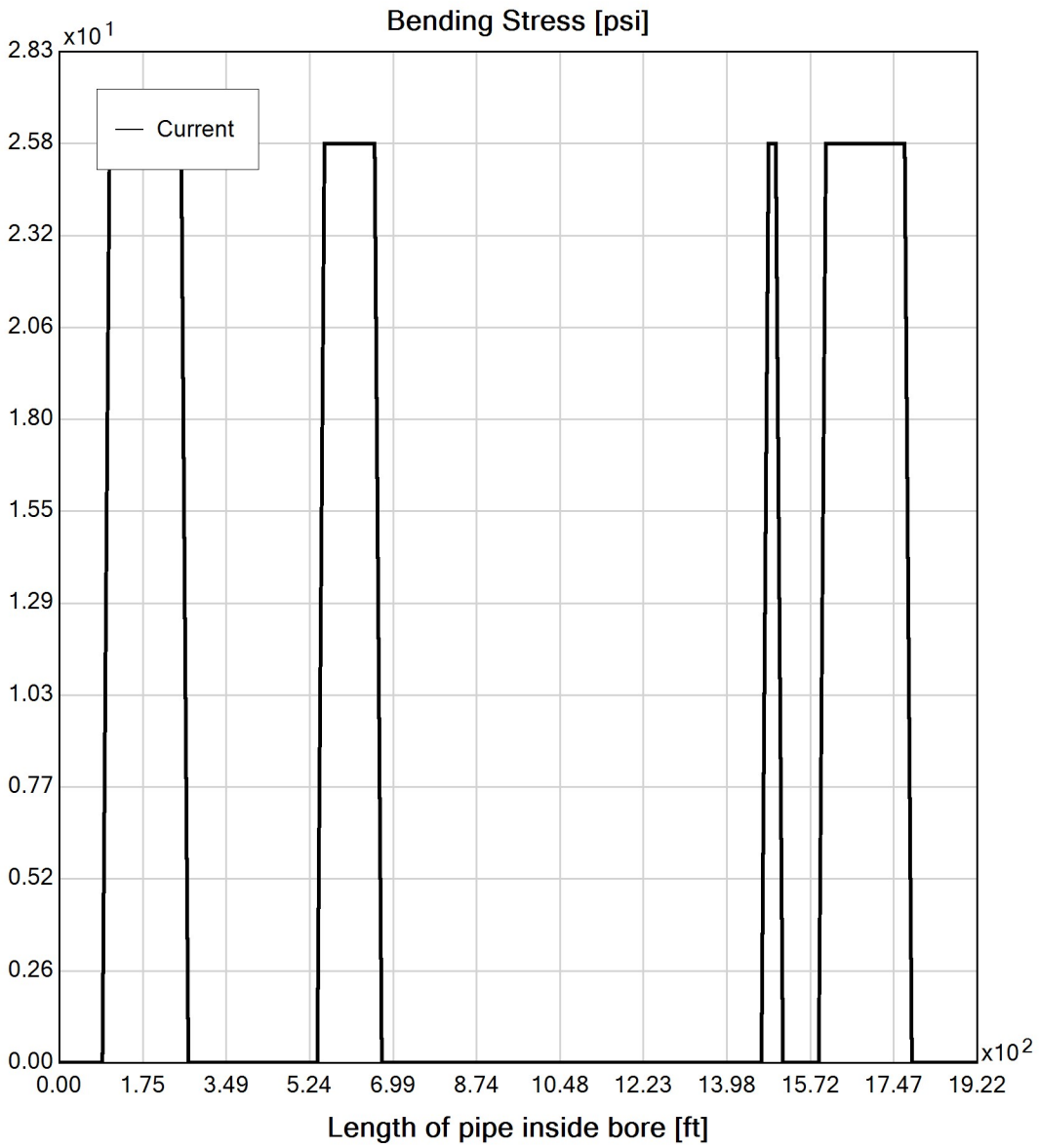
Effective Viscosity (cP): 378.3

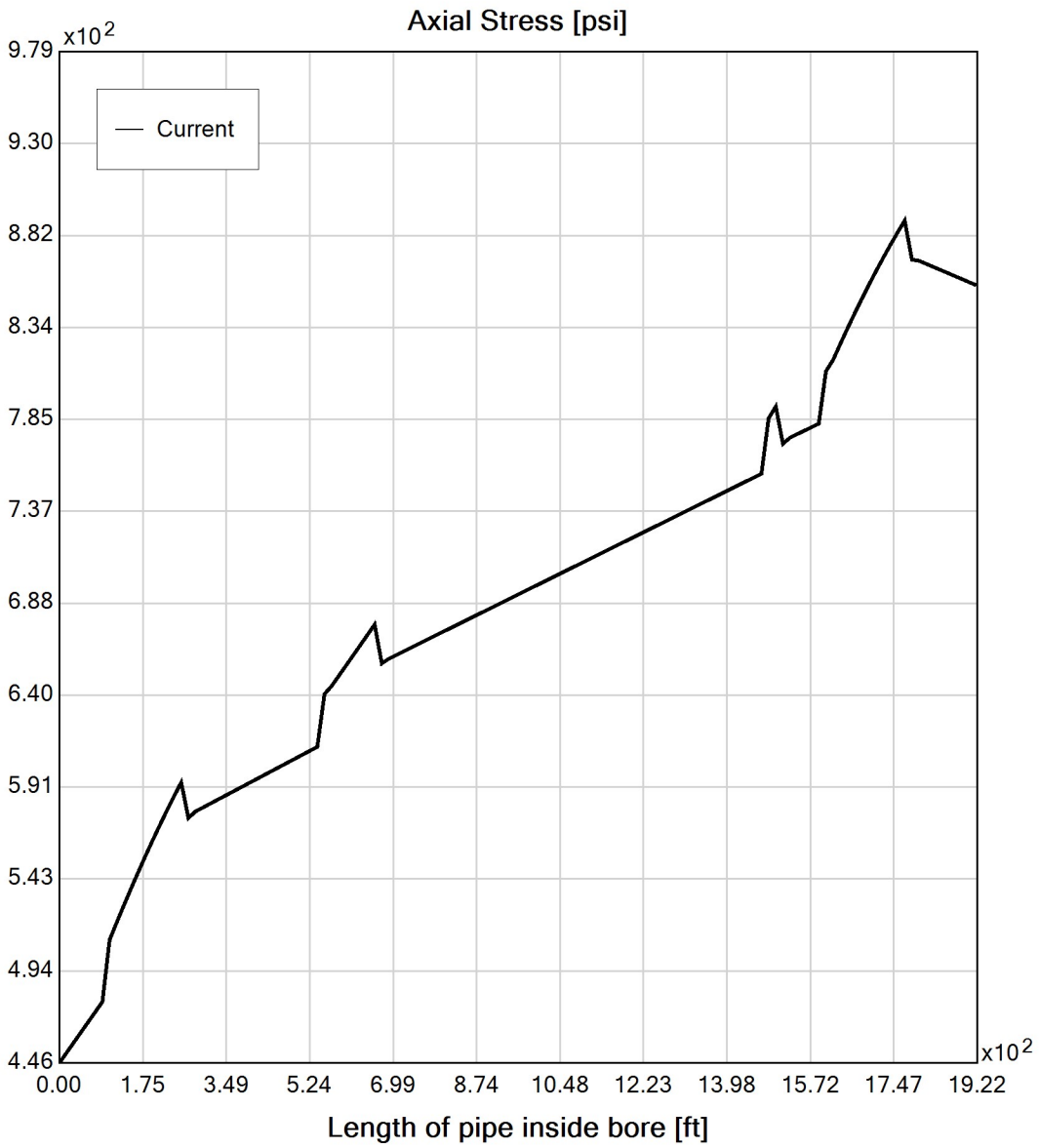
Virtual Site

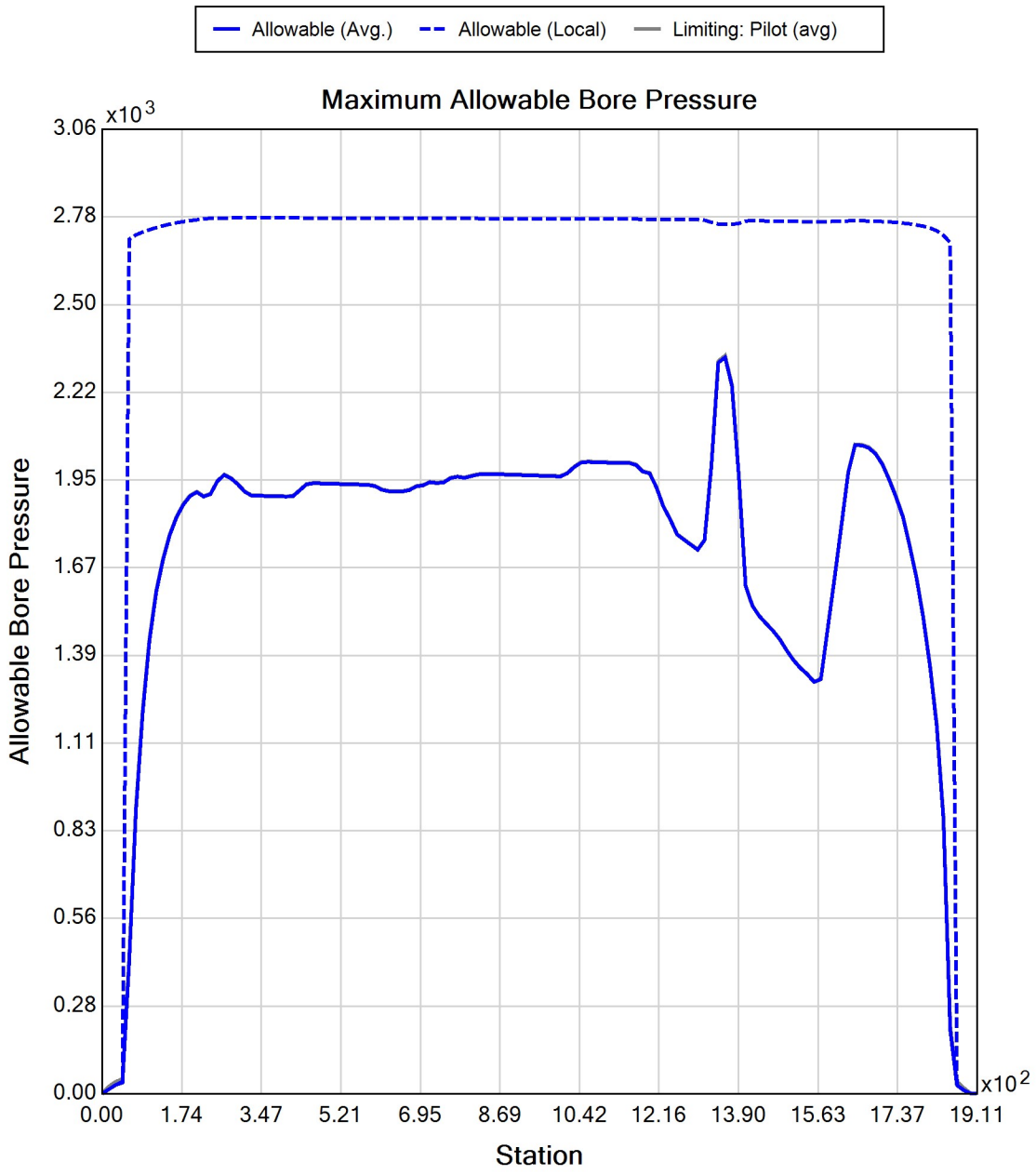


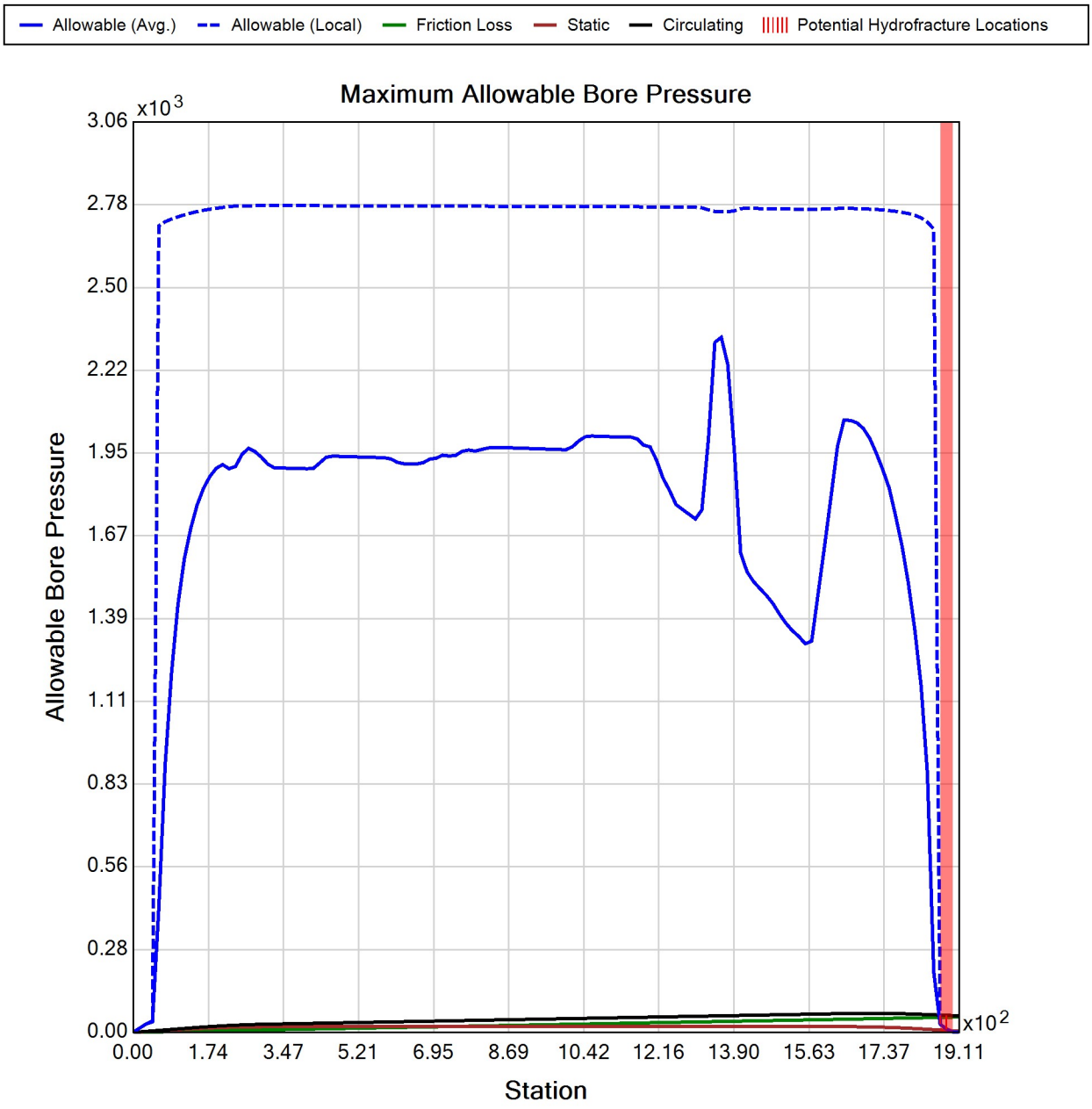












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Project Summary

General:	CHPE HDD 51 P4A Start Date: 04-25-2023 End Date: 04-25-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 51 Conduit 1 2-inch DR9 reversed

Input Summary

Start Coordinate	(0.00, 0.00, 293.00) ft
End Coordinate	(1907.00, 0.00, 283.00) ft
Project Length	1907.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 1920.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.1	24.5
Water Pressure	15.6	15.6
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	17.6	40.0
Deflection		
Earth Load Deflection	0.646	6.697
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.675	6.726
Compressive Stress [psi]		
Compressive Wall Stress	79.4	180.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1631.0	1631.0
Pullback Stress [psi]	931.9	931.9
Pullback Strain	1.621E-2	1.621E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	931.9	932.4
Tensile Strain	1.621E-2	1.632E-2

Net External Pressure = 25.2 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.675	7.5	11.1	OK
Unconstrained Collapse [psi]	26.0	130.0	5.0	OK
Compressive Wall Stress [psi]	79.4	1150.0	14.5	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	36.0	198.3	5.5	OK
Tensile Stress [psi]	932.4	1200.0	1.3	OK

Generated Output

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Project Summary

General:	CHPE HDD 51 P4A Start Date: 04-25-2023 End Date: 04-25-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 51 Conduit 2 10-inch DR9 reversed

Input Summary

Start Coordinate	(0.00, 0.00, 293.00) ft
End Coordinate	(2018.00, 0.00, 283.00) ft
Project Length	2018.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

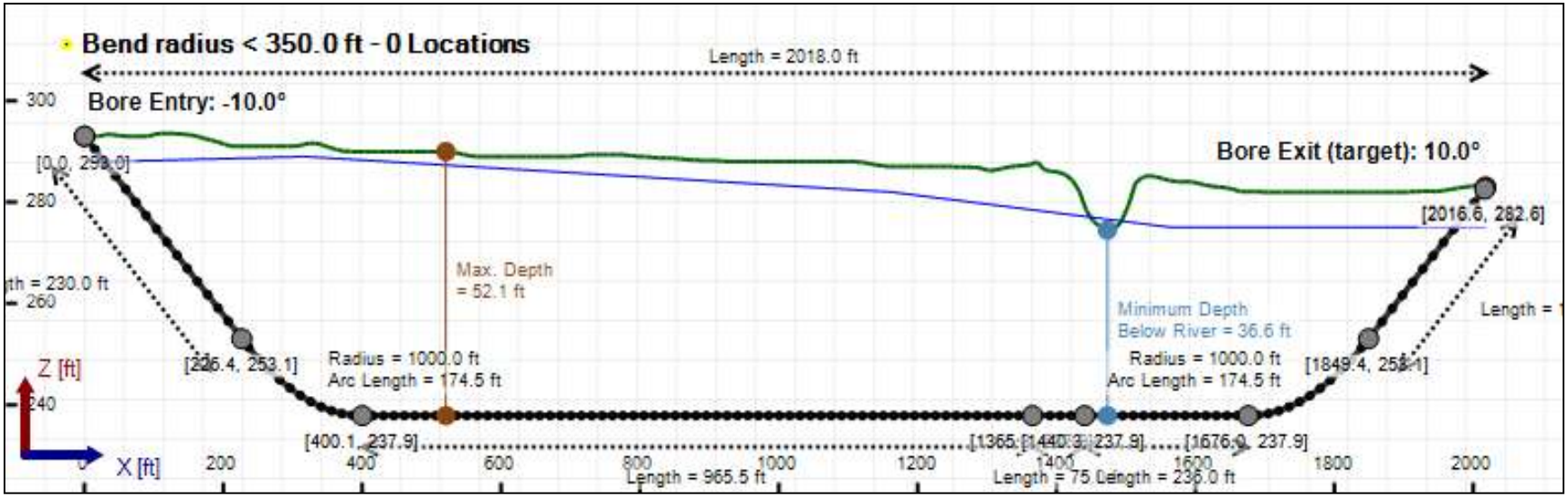
Number of Layers: 3

Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 300.00, Coh: 0.00 [psi]

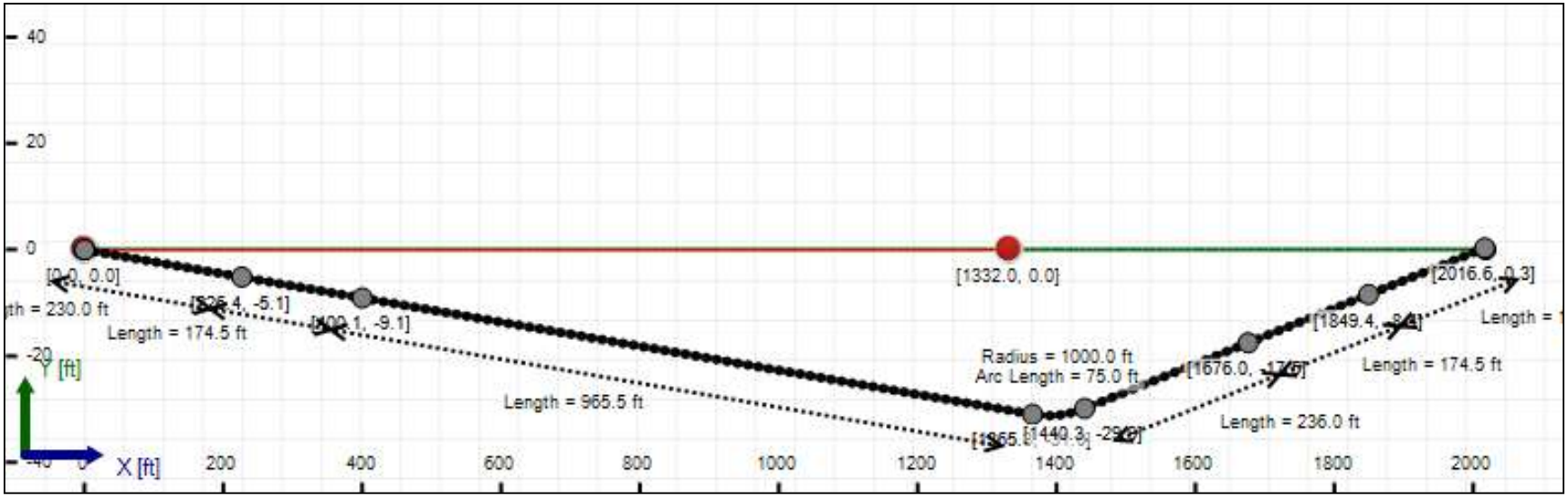
Soil Layer #2 USCS, Gravel (G), GP
From Assistant
Unit Weight: 125.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 35.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #3 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 3000.00, Coh: 2000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 2040.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.5	36.0
Water Pressure	21.9	21.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	27.4	57.9
Deflection		
Earth Load Deflection	1.632	9.875
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.764	10.007
Compressive Stress [psi]		
Compressive Wall Stress	123.3	260.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	32850.6	32850.6
Pullback Stress [psi]	916.2	916.2
Pullback Strain	1.593E-2	1.593E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	916.2	935.4
Tensile Strain	1.593E-2	1.672E-2

Net External Pressure = 33.7 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.764	7.5	4.3	OK
Unconstrained Collapse [psi]	35.9	117.9	3.3	OK
Compressive Wall Stress [psi]	123.3	1150.0	9.3	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	45.8	197.1	4.3	OK
Tensile Stress [psi]	935.4	1200.0	1.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	6.50 in	2363.910 psi	2800.405 psi
1	6.50 in	12.00 in	2363.244 psi	2799.852 psi
2	12.00 in	16.13 in	2362.485 psi	2799.221 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

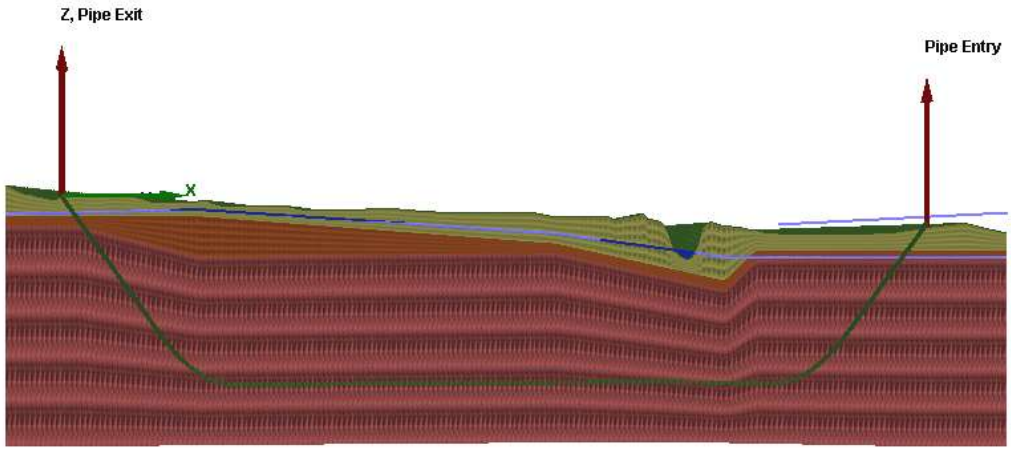
Rheological model: Power-Law

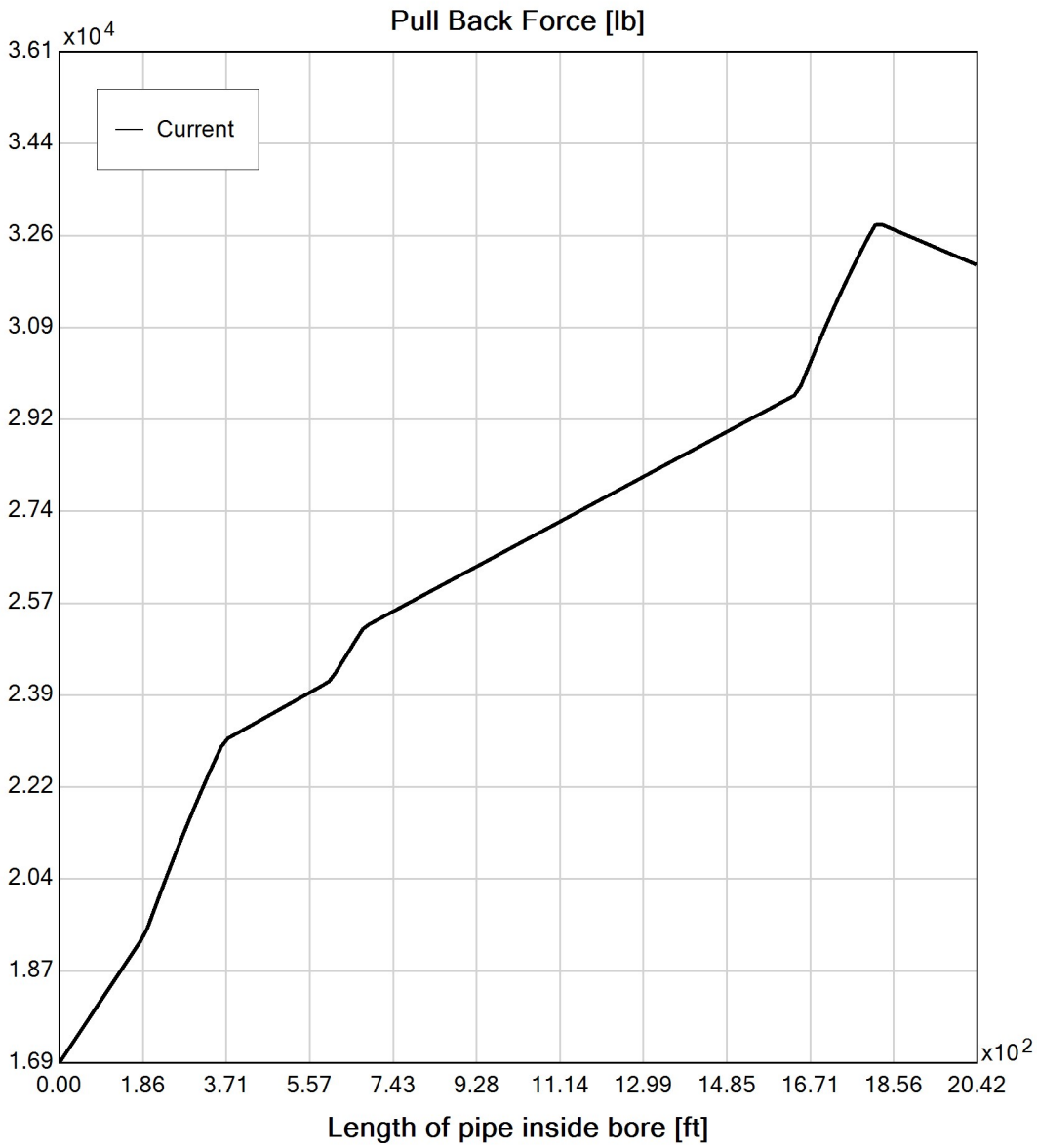
Fluid Consistency Index (K): 63.17

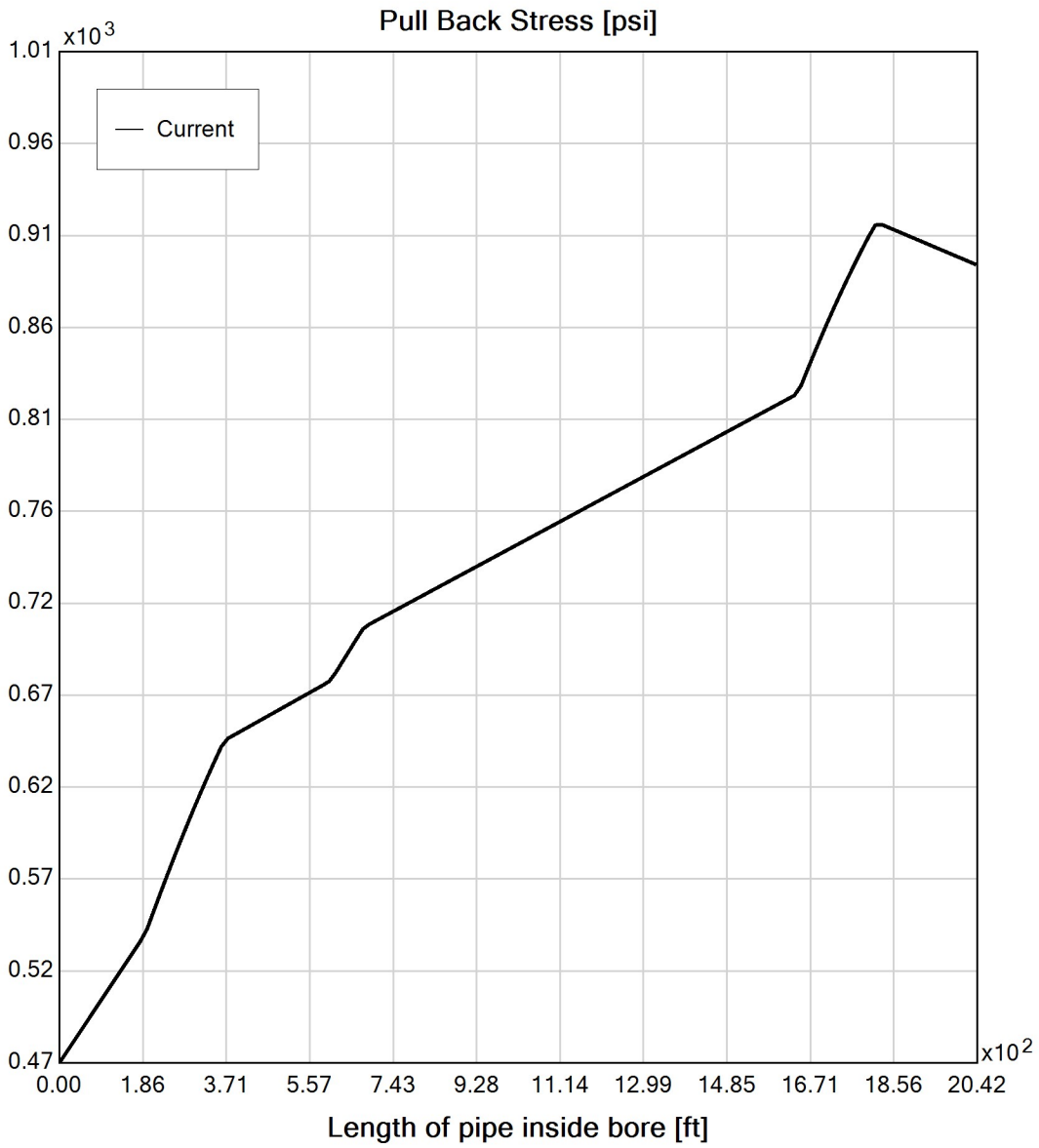
Power Law Exponent (n): 0.14

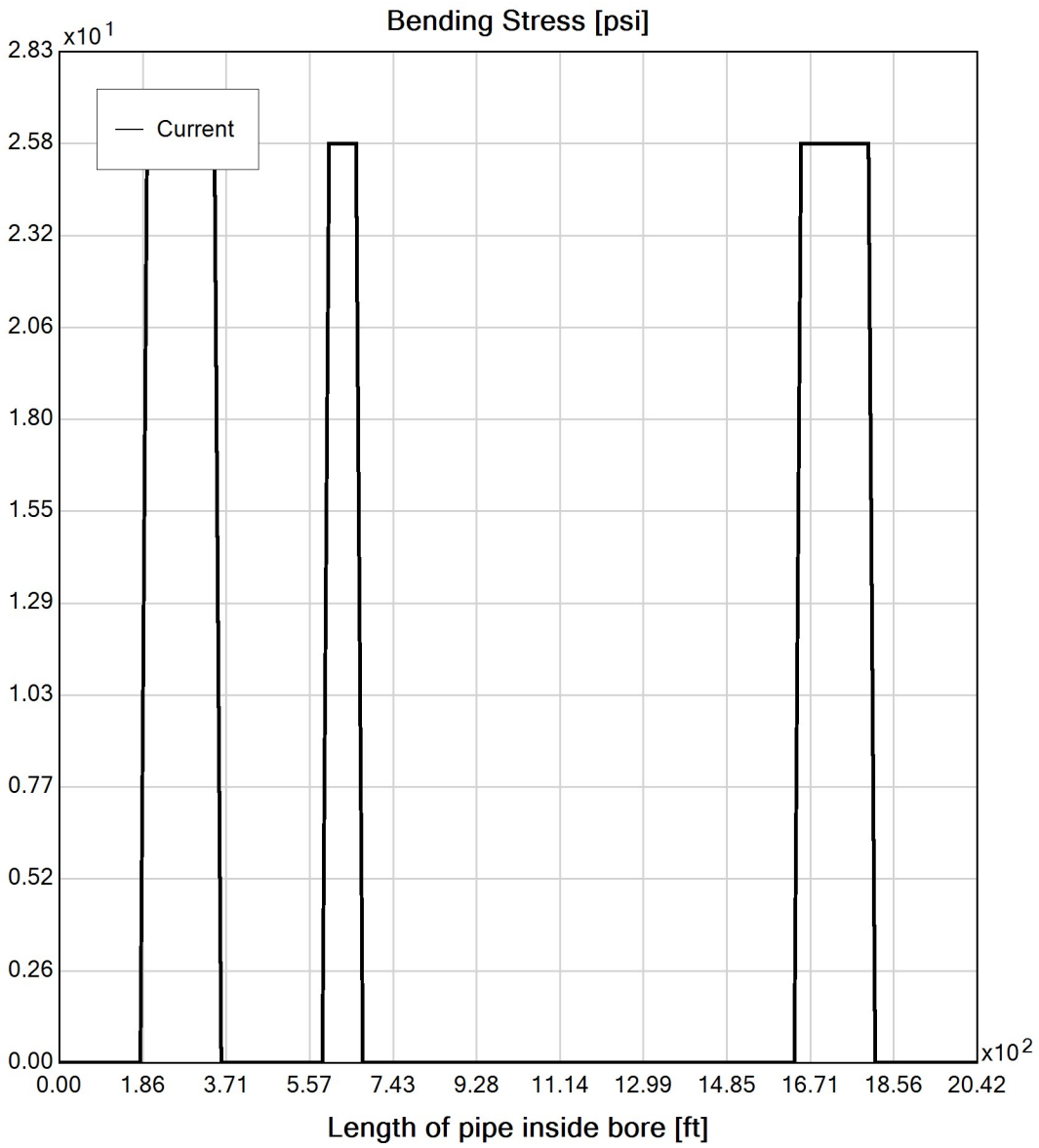
Effective Viscosity (cP): 378.3

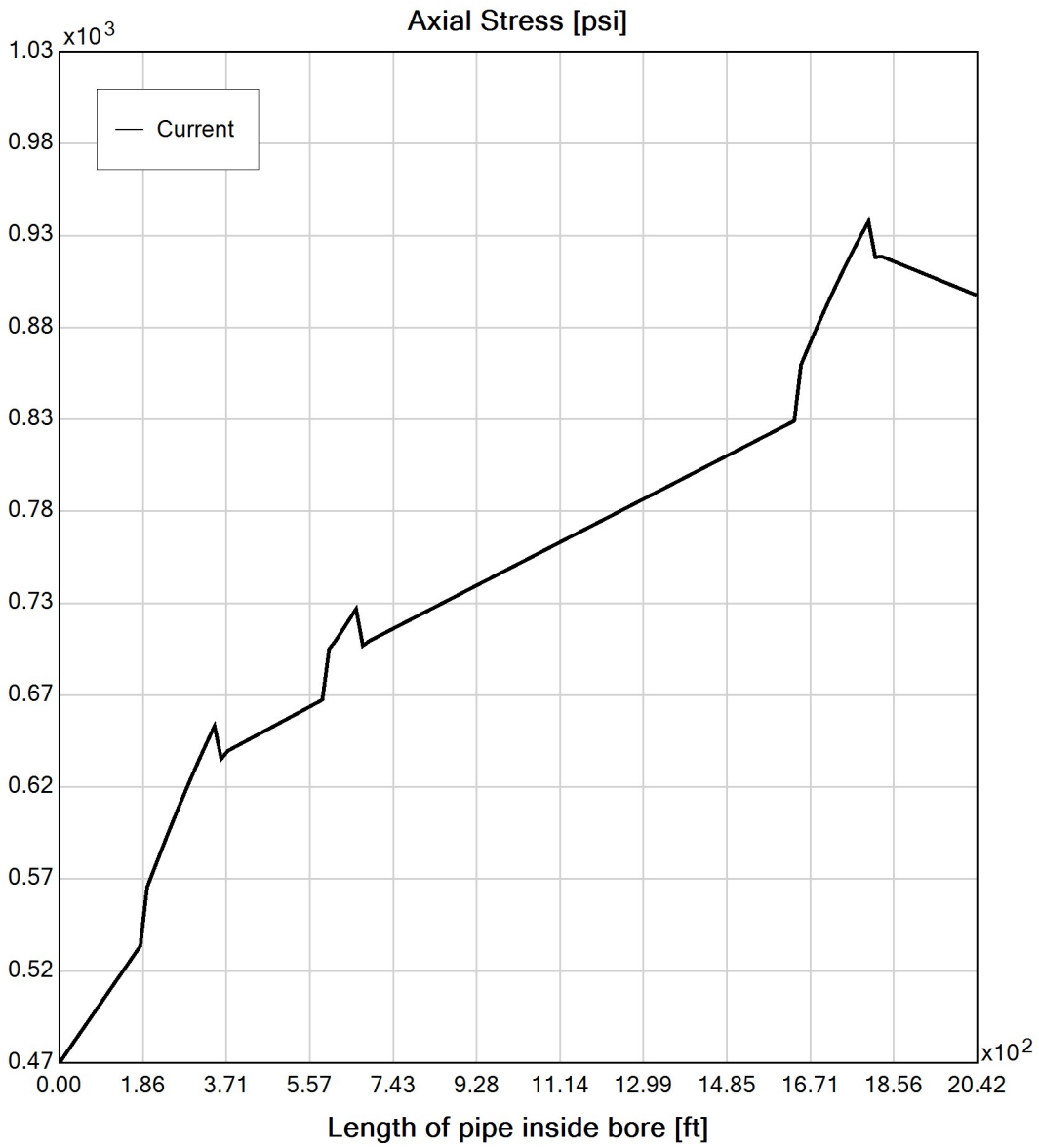
Virtual Site

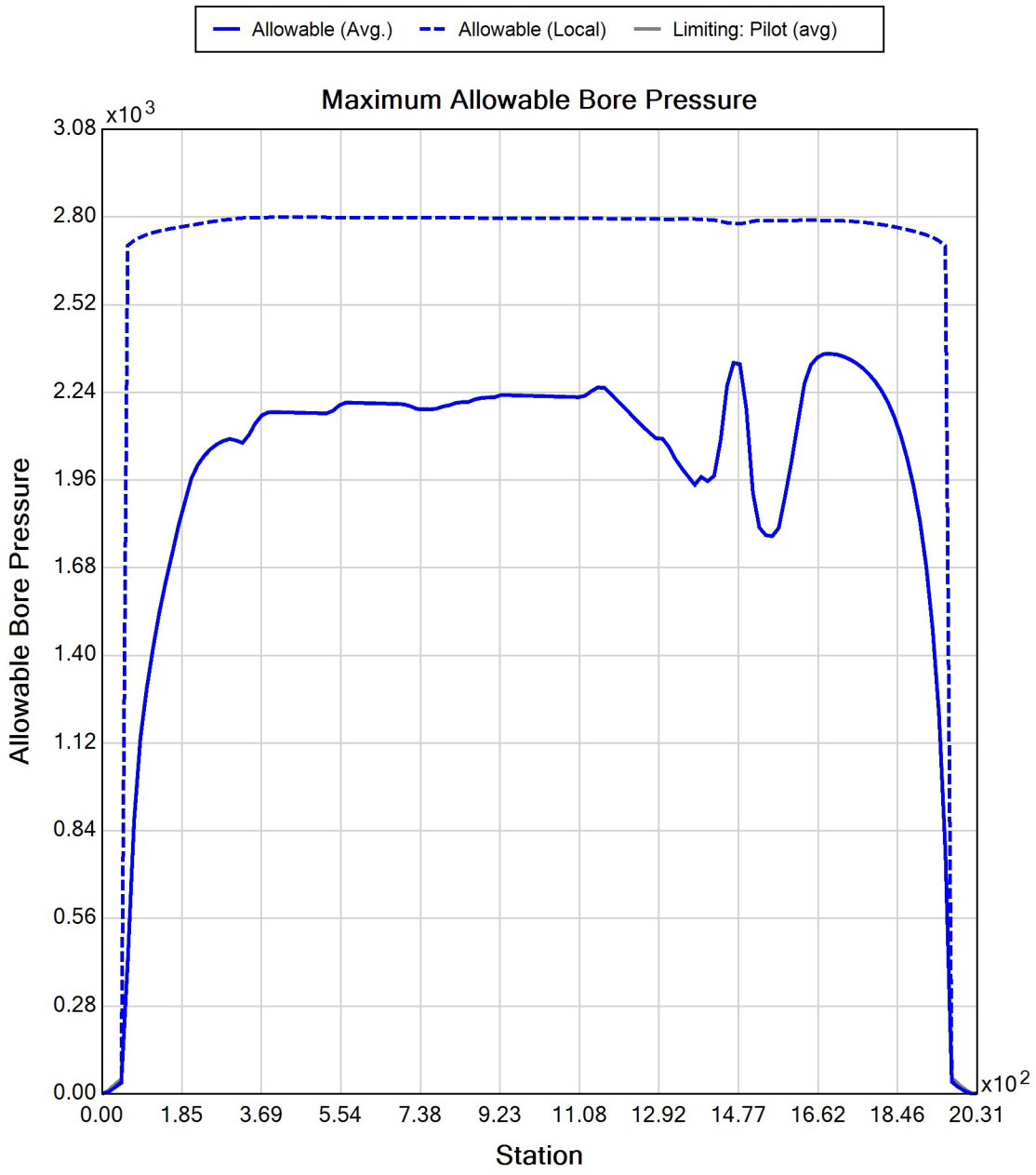


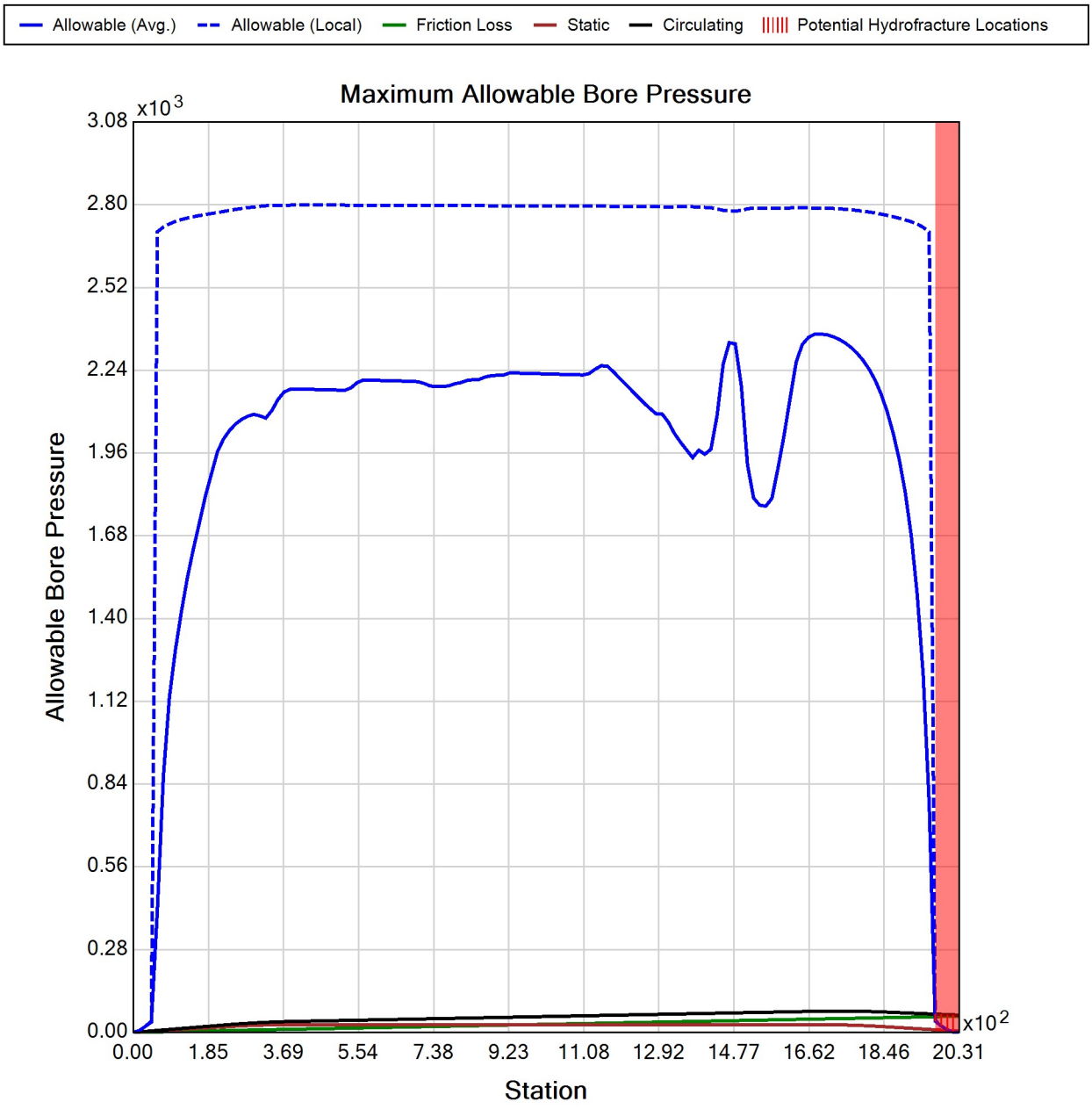












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Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 51 Conduit 2 2-inch DR9 reversed

Input Summary

Start Coordinate	(0.00, 0.00, 293.00) ft
End Coordinate	(2018.00, 0.00, 283.00) ft
Project Length	2018.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 2040.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.2	36.0
Water Pressure	21.9	21.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	24.1	57.9
Deflection		
Earth Load Deflection	0.647	9.875
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.676	9.904
Compressive Stress [psi]		
Compressive Wall Stress	108.3	260.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1713.0	1713.0
Pullback Stress [psi]	978.8	978.8
Pullback Strain	1.702E-2	1.702E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	978.8	978.8
Tensile Strain	1.702E-2	1.711E-2

Net External Pressure = 33.7 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.676	7.5	11.1	OK
Unconstrained Collapse [psi]	35.9	130.0	3.6	OK
Compressive Wall Stress [psi]	108.3	1150.0	10.6	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	45.8	194.4	4.2	OK
Tensile Stress [psi]	978.8	1200.0	1.2	OK

Generated Output

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Project Summary

General:	CHPE HDD 52 P4A Start Date: 06-07-2023 End Date: 06-07-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 52 Reverse Conduit 10-inch DR9

Input Summary

Start Coordinate	(0.00, 0.00, 297.00) ft
End Coordinate	(2701.00, 0.00, 294.00) ft
Project Length	2701.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

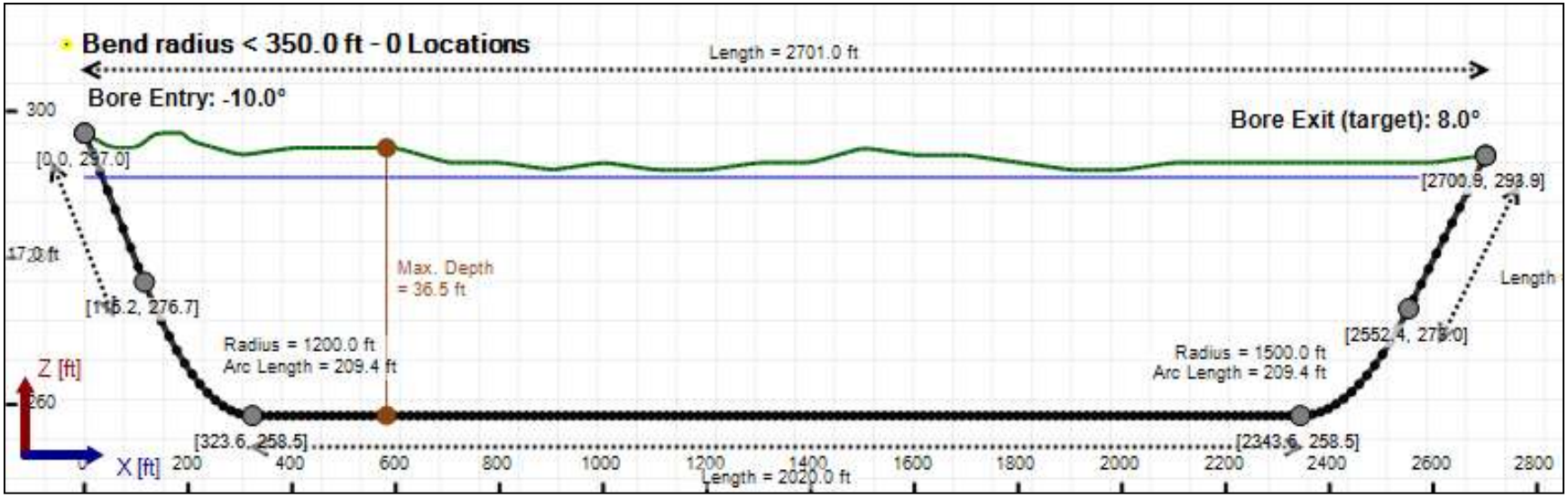
Number of Layers: 3

Soil Layer #1 USCS, Sand (S), SM
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 200.00, Coh: 0.00 [psi]

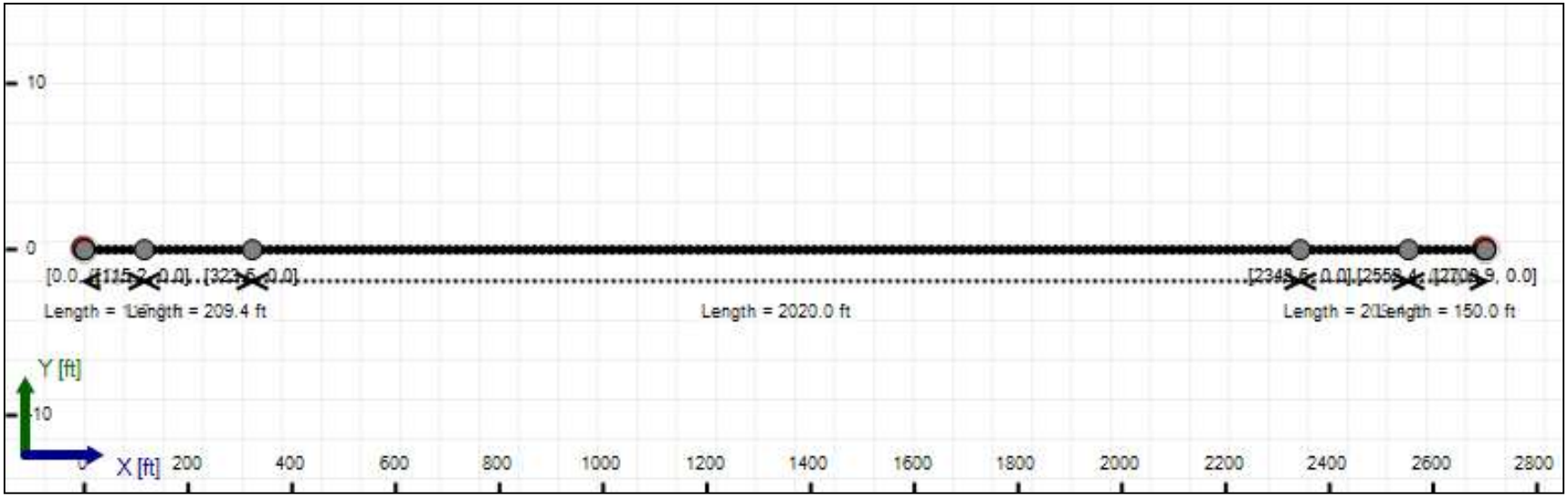
Soil Layer #2 USCS, Sand (S), SW
From Assistant
Unit Weight: 130.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #3 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 2000.00, Coh: 3000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 2715.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.7	25.8
Water Pressure	14.1	14.1
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	19.8	39.9
Deflection		
Earth Load Deflection	1.545	7.033
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.678	7.165
Compressive Stress [psi]		
Compressive Wall Stress	89.0	179.7

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	42140.2	42140.2
Pullback Stress [psi]	1175.2	1175.2
Pullback Strain	2.044E-2	2.044E-2
Bending Stress [psi]	0.0	21.5
Bending Strain	0	3.733E-4
Tensile Stress [psi]	1175.2	1192.1
Tensile Strain	2.044E-2	2.111E-2

Net External Pressure = 21.9 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.678	7.5	4.5	OK
Unconstrained Collapse [psi]	25.1	118.8	4.7	OK
Compressive Wall Stress [psi]	89.0	1150.0	12.9	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	34.9	176.8	5.1	OK
Tensile Stress [psi]	1192.1	1200.0	1.0	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	1766.759 psi	2015.390 psi
1	8.00 in	14.00 in	1766.030 psi	2014.671 psi
2	14.00 in	16.13 in	1765.677 psi	2014.322 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 280.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

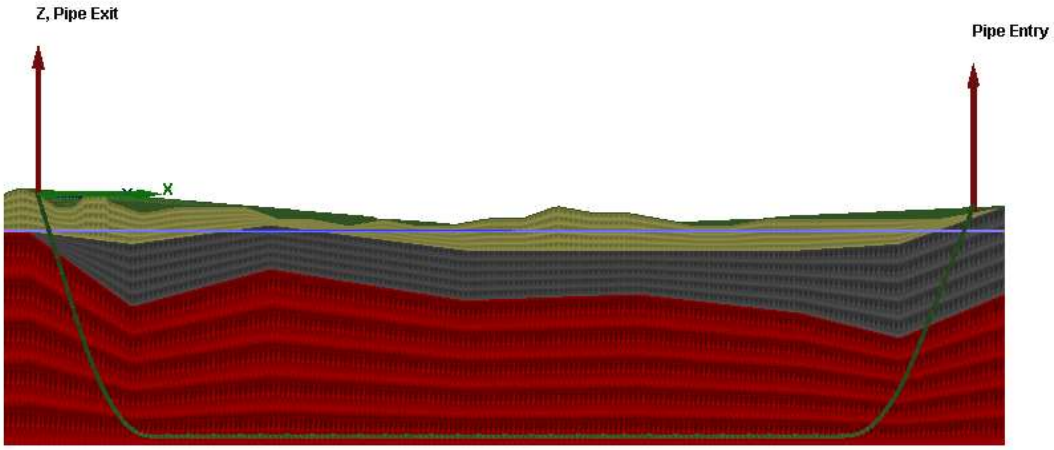
Rheological model: Bingham-Plastic

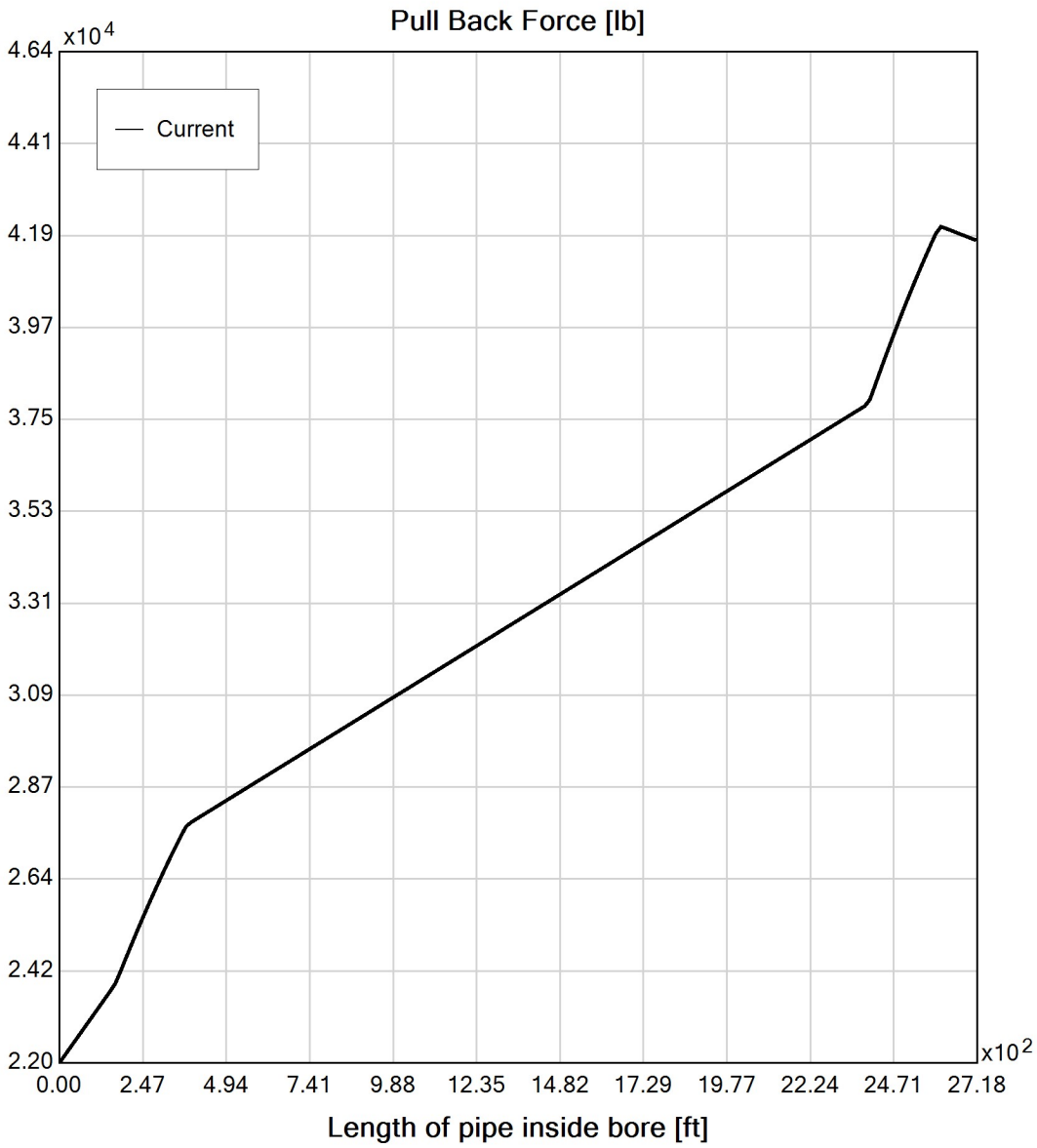
Plastic Viscosity (PV): 25.53

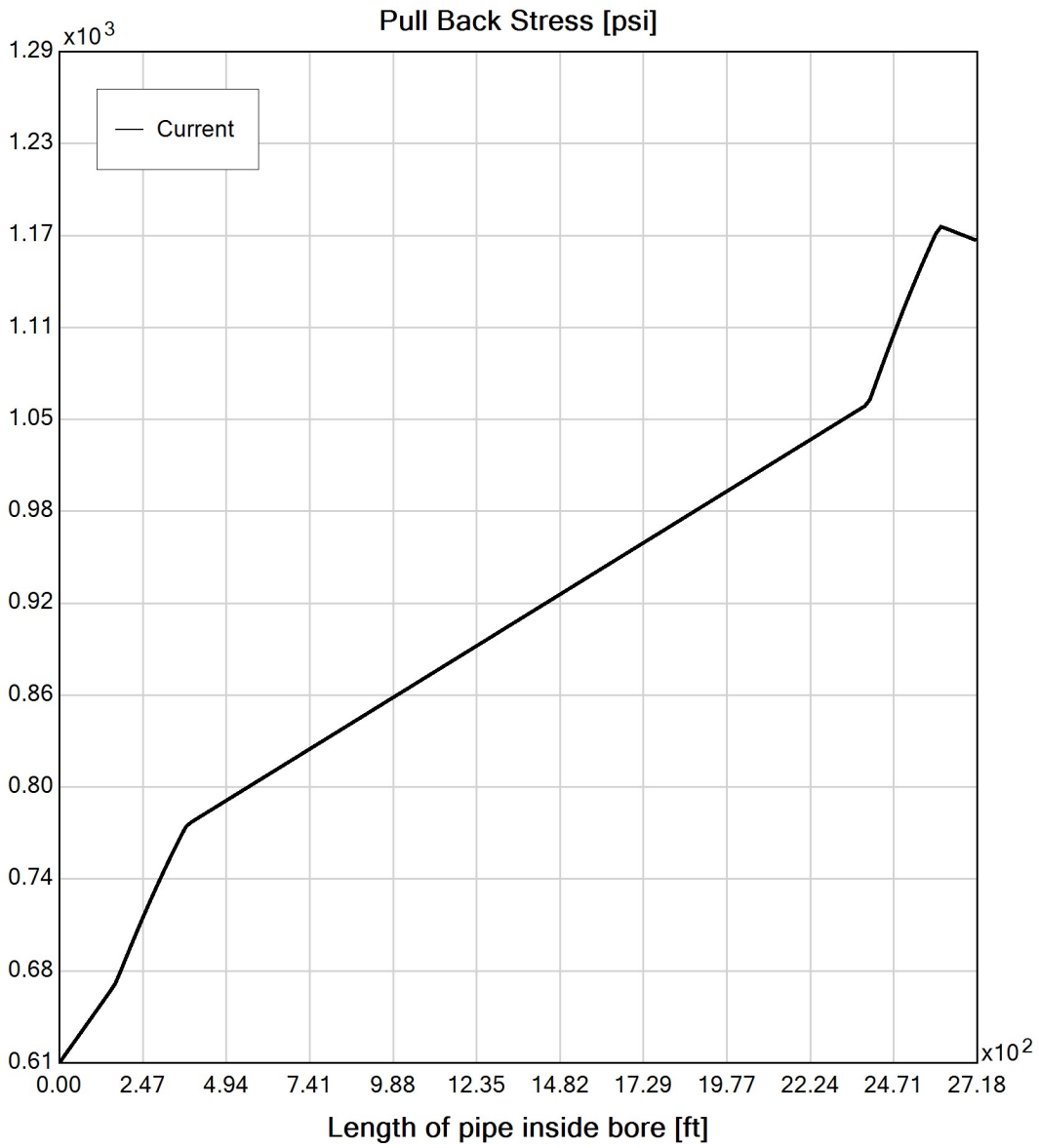
Yield Point (YP): 16.49

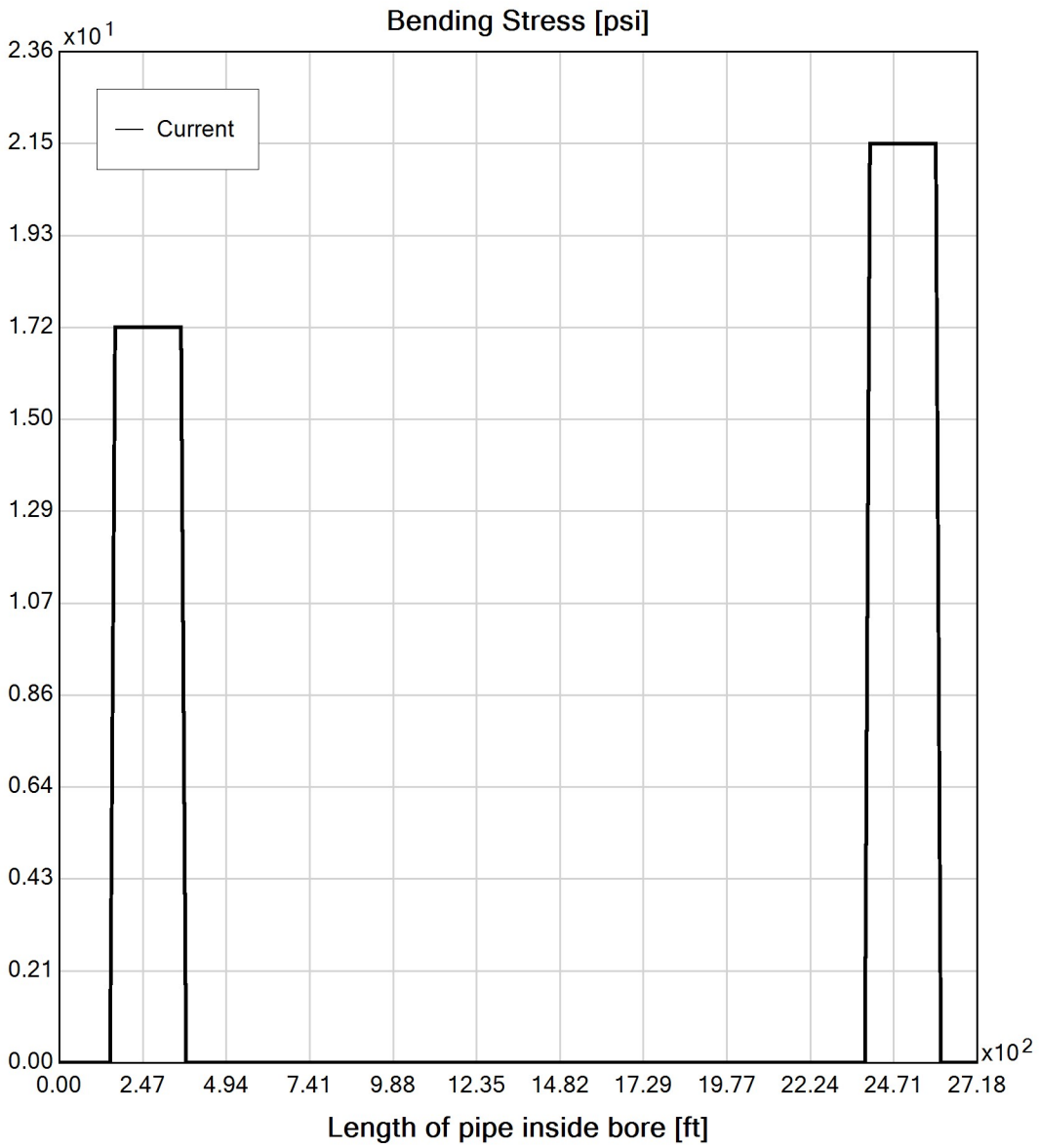
Effective Viscosity (cP): 193.6

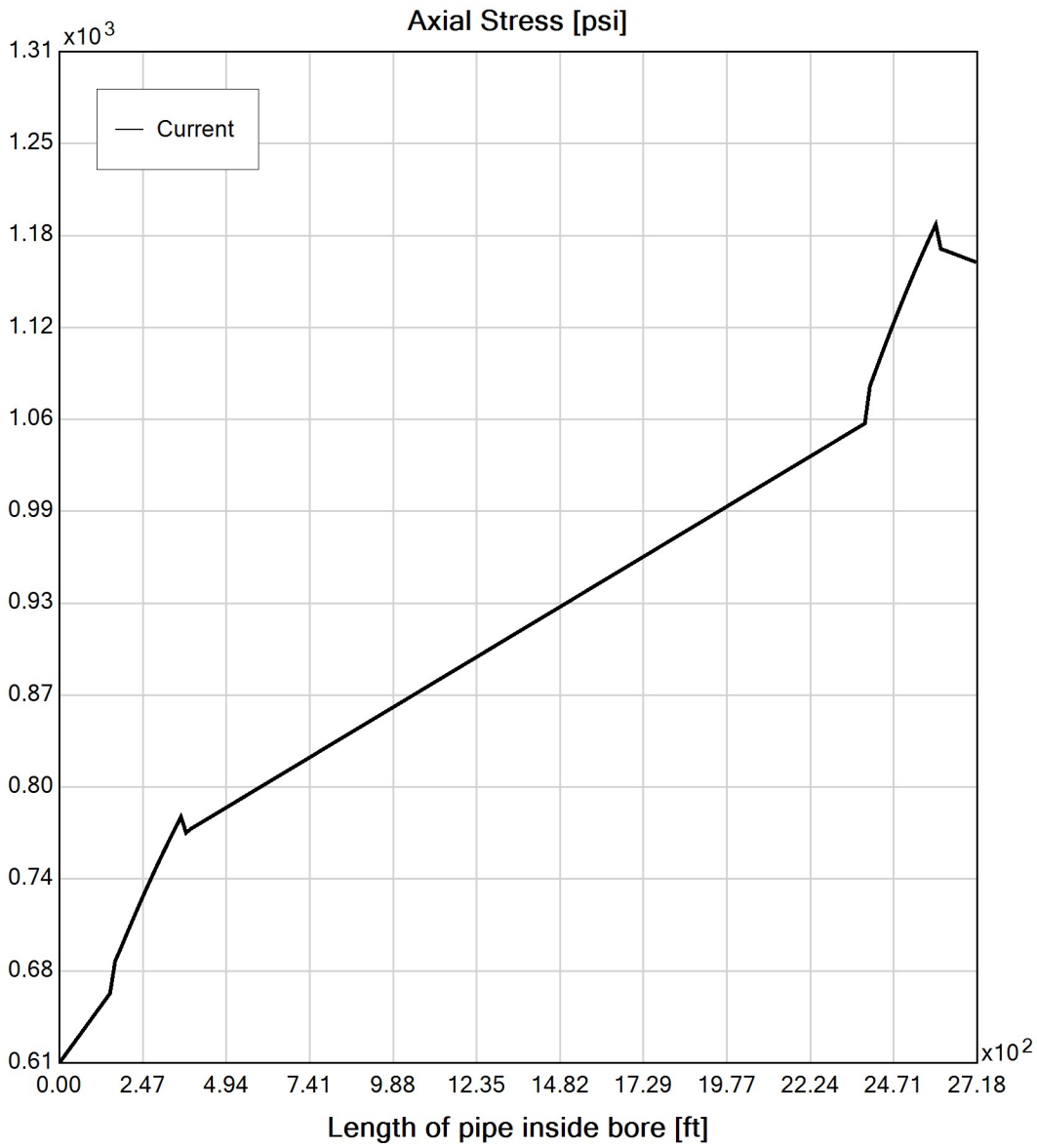
Virtual Site

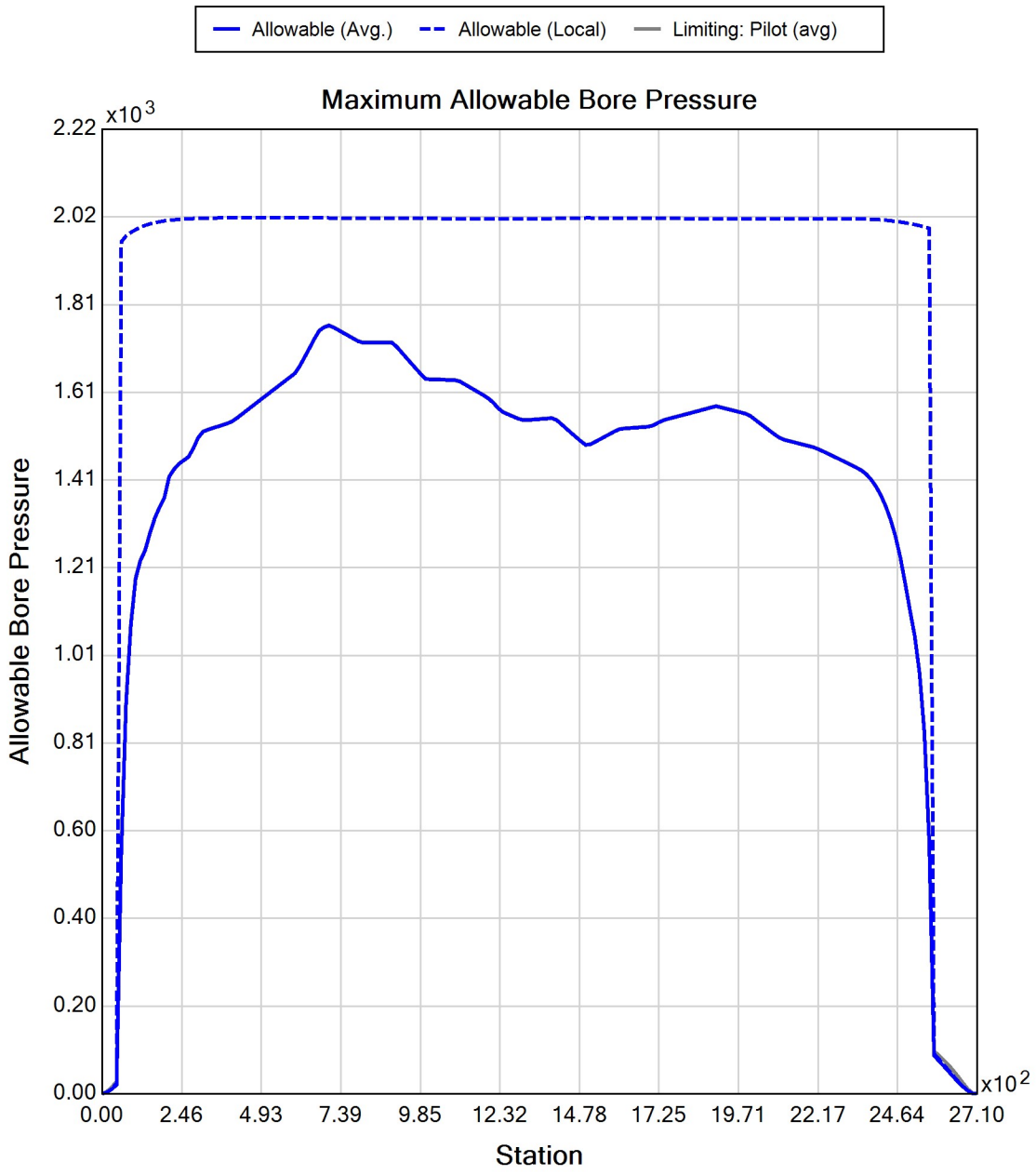


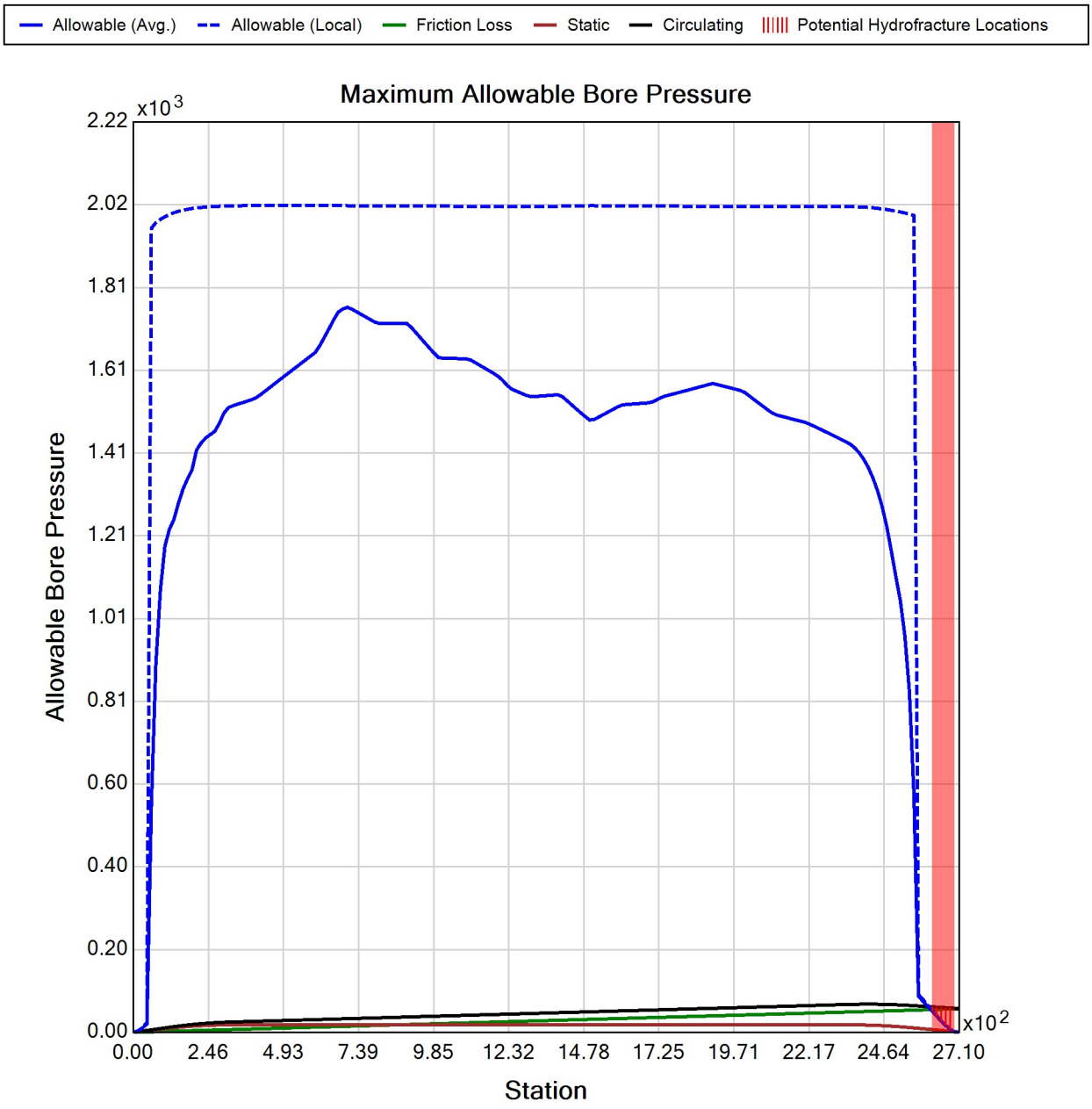












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Project Summary

General:	CHPE HDD 52
	P4A
	Start Date: 06-07-2023
	End Date: 06-07-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB
	BCE
	Amherst, MA
Description:	HDD 52 Reverse Conduit 2-inch DR9

Input Summary

Start Coordinate	(0.00, 0.00, 297.00) ft
End Coordinate	(2701.00, 0.00, 294.00) ft
Project Length	2701.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 2715.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.3	25.8
Water Pressure	14.1	14.1
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	16.4	39.9
Deflection		
Earth Load Deflection	0.618	7.033
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.648	7.063
Compressive Stress [psi]		
Compressive Wall Stress	73.7	179.7

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	2166.5	2166.5
Pullback Stress [psi]	1237.8	1237.8
Pullback Strain	2.153E-2	2.153E-2
Bending Stress [psi]	0.0	4.7
Bending Strain	0	8.247E-5
Tensile Stress [psi]	1237.8	1238.0
Tensile Strain	2.153E-2	2.161E-2

Net External Pressure = 21.9 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.648	7.5	11.6	OK
Unconstrained Collapse [psi]	25.1	130.3	5.2	OK
Compressive Wall Stress [psi]	73.7	1150.0	15.6	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	34.9	173.3	5.0	OK
Tensile Stress [psi]	1238.0	1200.0	1.0	OK

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Project Summary

General:	HDD 53 P4A Start Date: 12-10-2021 End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AB CHA
Description:	HDD 53 10-Inch DR 9 Conduit 1

Input Summary

Start Coordinate	(0.00, 0.00, 296.00) ft
End Coordinate	(815.00, 0.00, 295.00) ft
Project Length	815.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 4

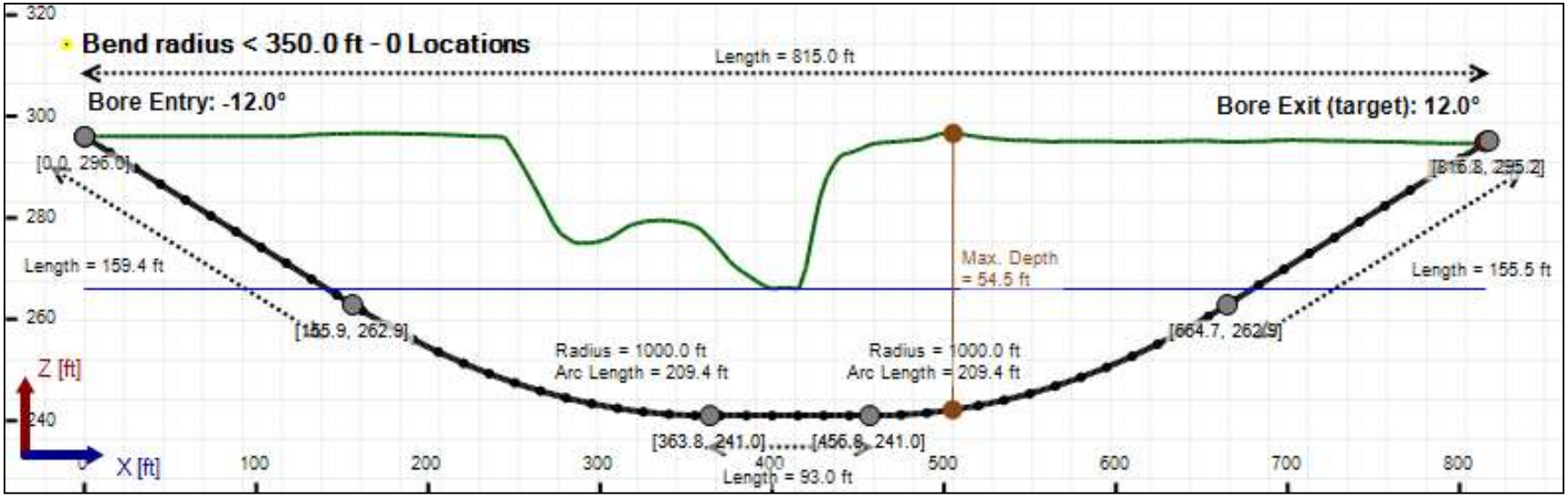
Soil Layer #1 USCS, Silt (M), ML
Depth: 5.00 ft
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 28.00, S.M.: 50.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Sand (S), SM
Depth: 9.50 ft
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 145.00, Coh: 0.00 [psi]

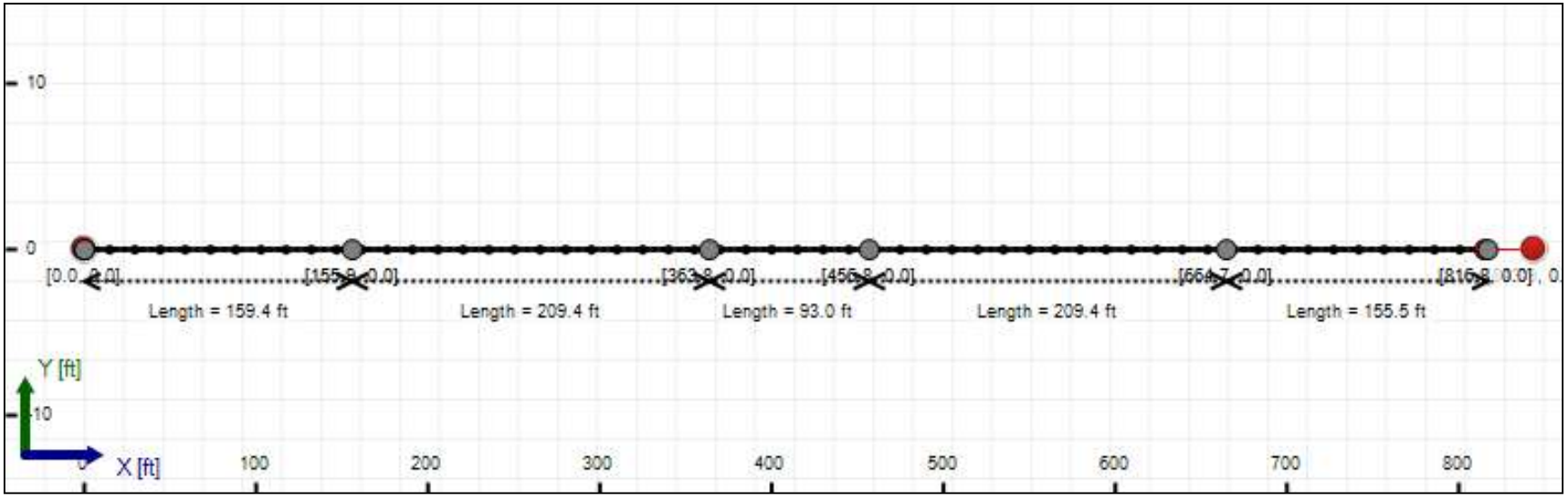
Soil Layer #3 USCS, Silt (M), ML
Depth: 1.50 ft
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #4 Rock, Geological Classification, Sedimentary Rocks
Depth: 50.00 ft
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 2000.00, Coh: 3000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 840.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.9	44.9
Water Pressure	10.8	10.8
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	17.8	55.6
Deflection		
Earth Load Deflection	1.926	12.254
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	2.058	12.386
Compressive Stress [psi]		
Compressive Wall Stress	79.9	250.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	15173.5	15173.5
Pullback Stress [psi]	423.2	423.2
Pullback Strain	7.359E-3	7.359E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	423.2	448.2
Tensile Strain	7.359E-3	8.242E-3

Net External Pressure = 31.5 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	2.058	7.5	3.6	OK
Unconstrained Collapse [psi]	37.0	115.3	3.1	OK
Compressive Wall Stress [psi]	79.9	1150.0	14.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	47.0	230.6	4.9	OK
Tensile Stress [psi]	448.2	1200.0	2.7	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	2019.045 psi	2029.982 psi
1	8.00 in	12.00 in	2018.644 psi	2029.782 psi
2	12.00 in	16.13 in	2018.063 psi	2029.492 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

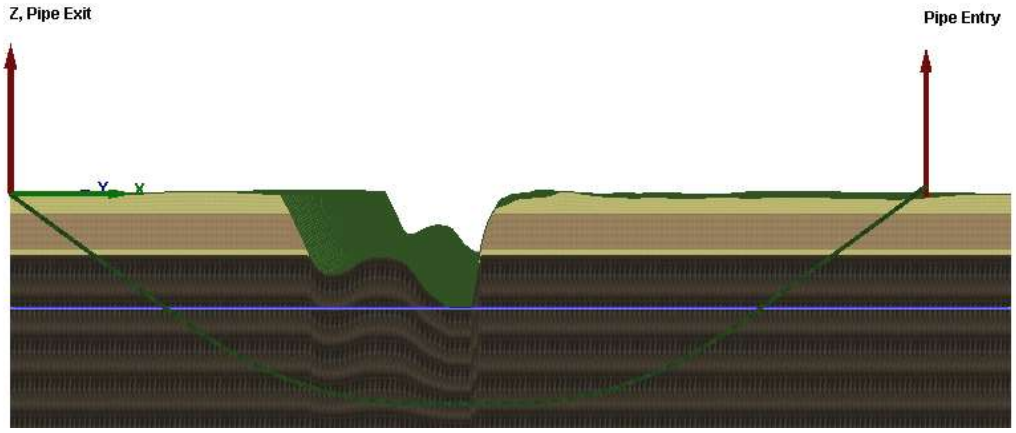
Rheological model: Bingham-Plastic

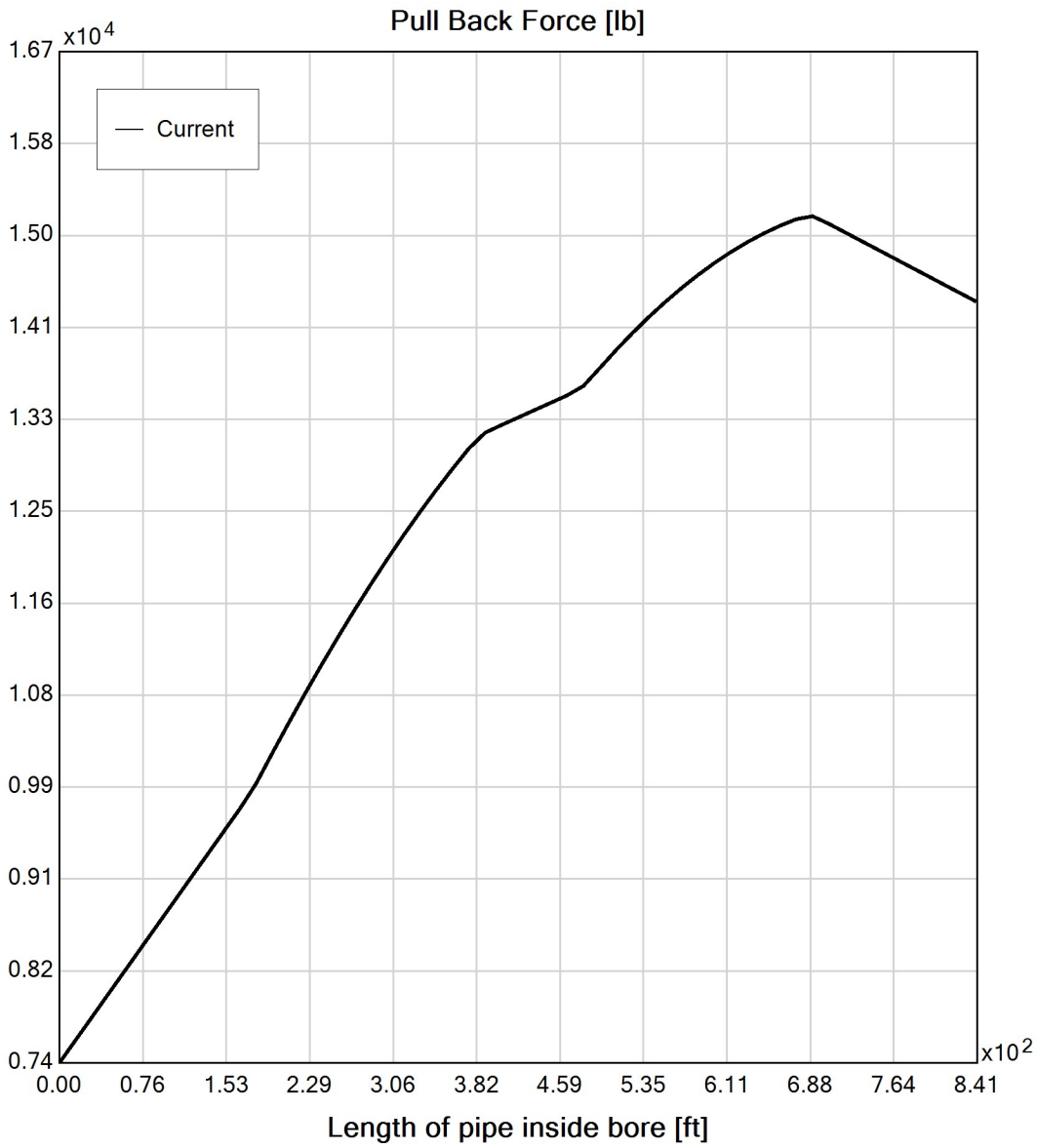
Plastic Viscosity (PV): 25.53

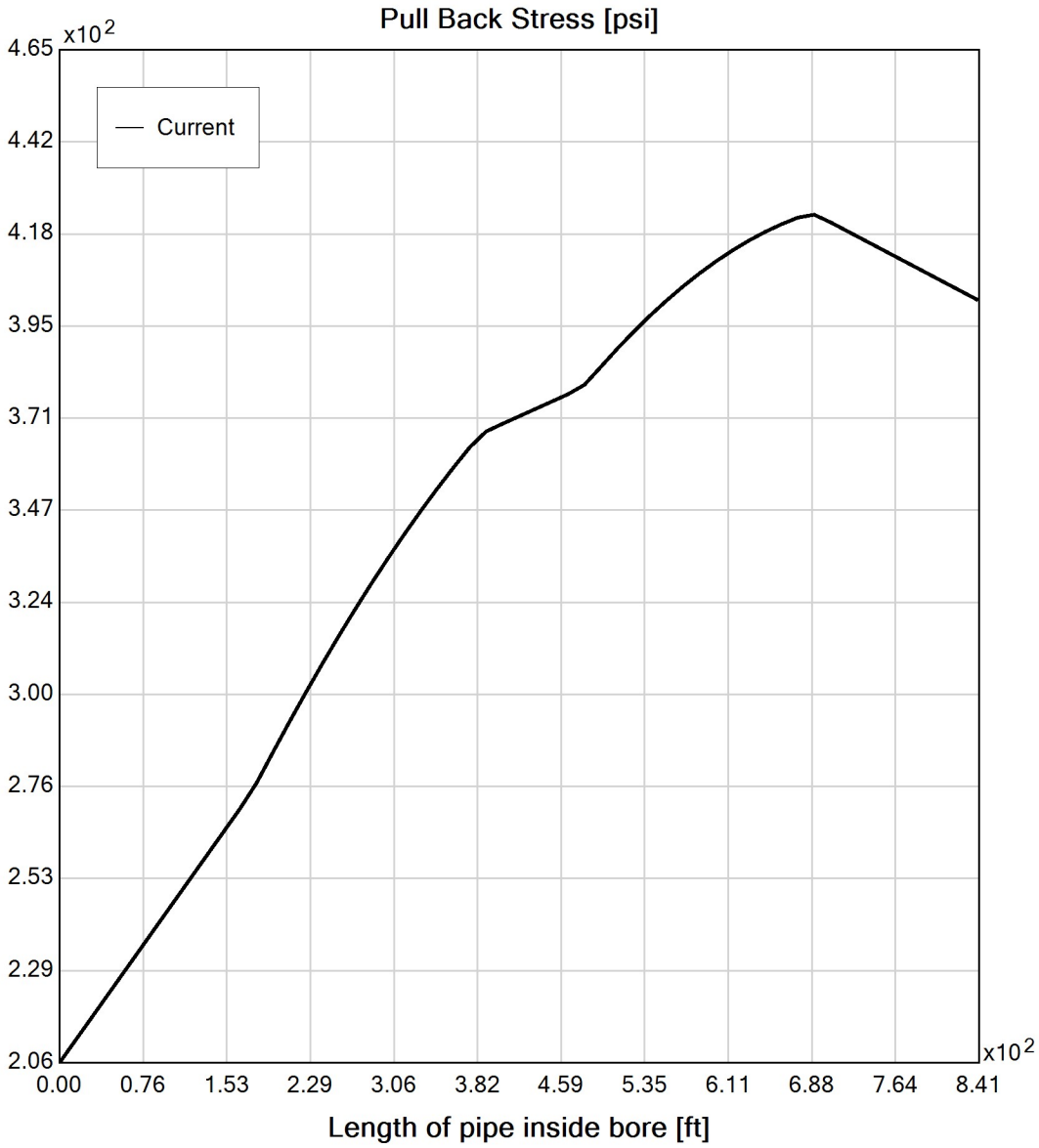
Yield Point (YP): 16.49

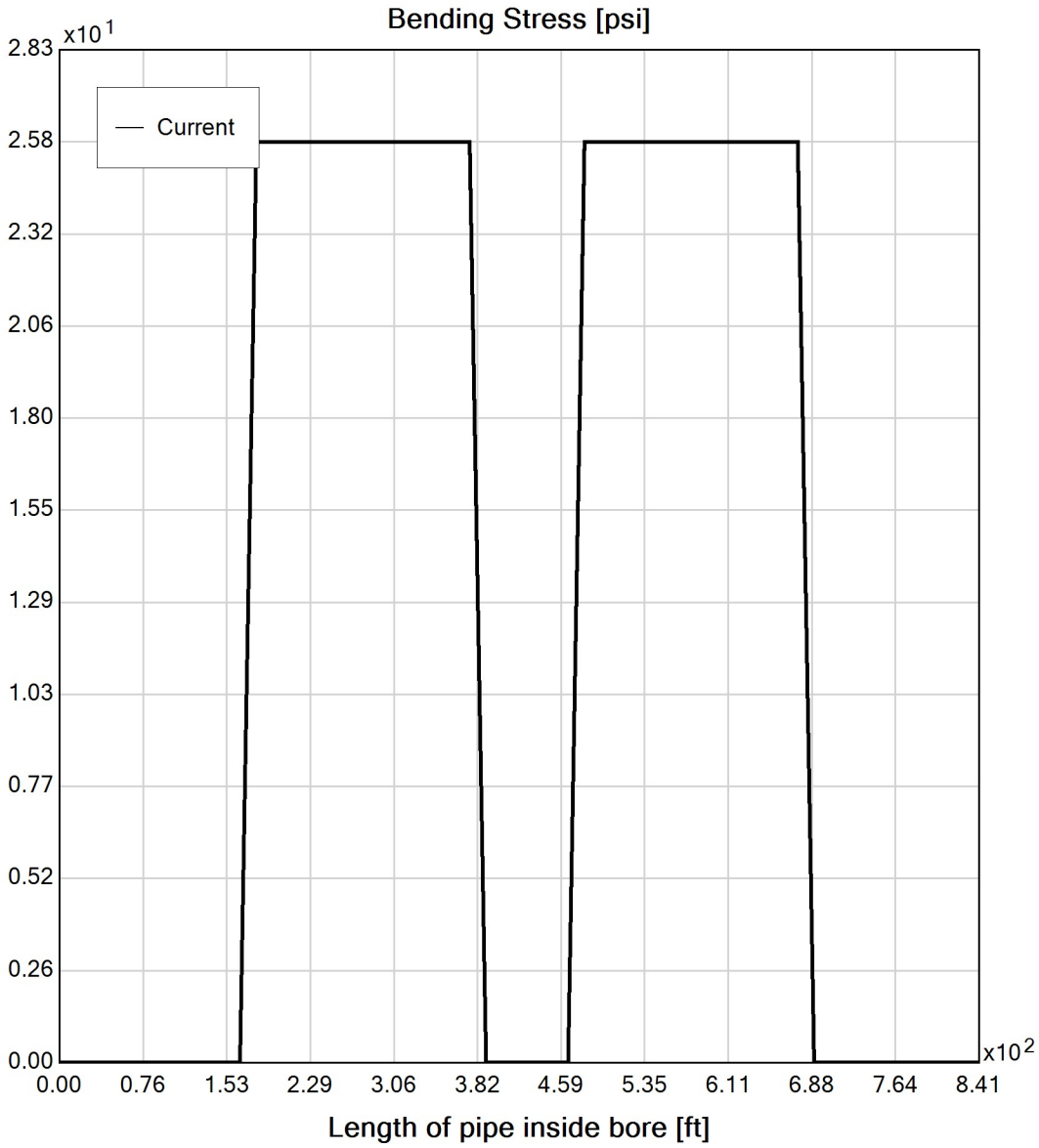
Effective Viscosity (cP): 1202.0

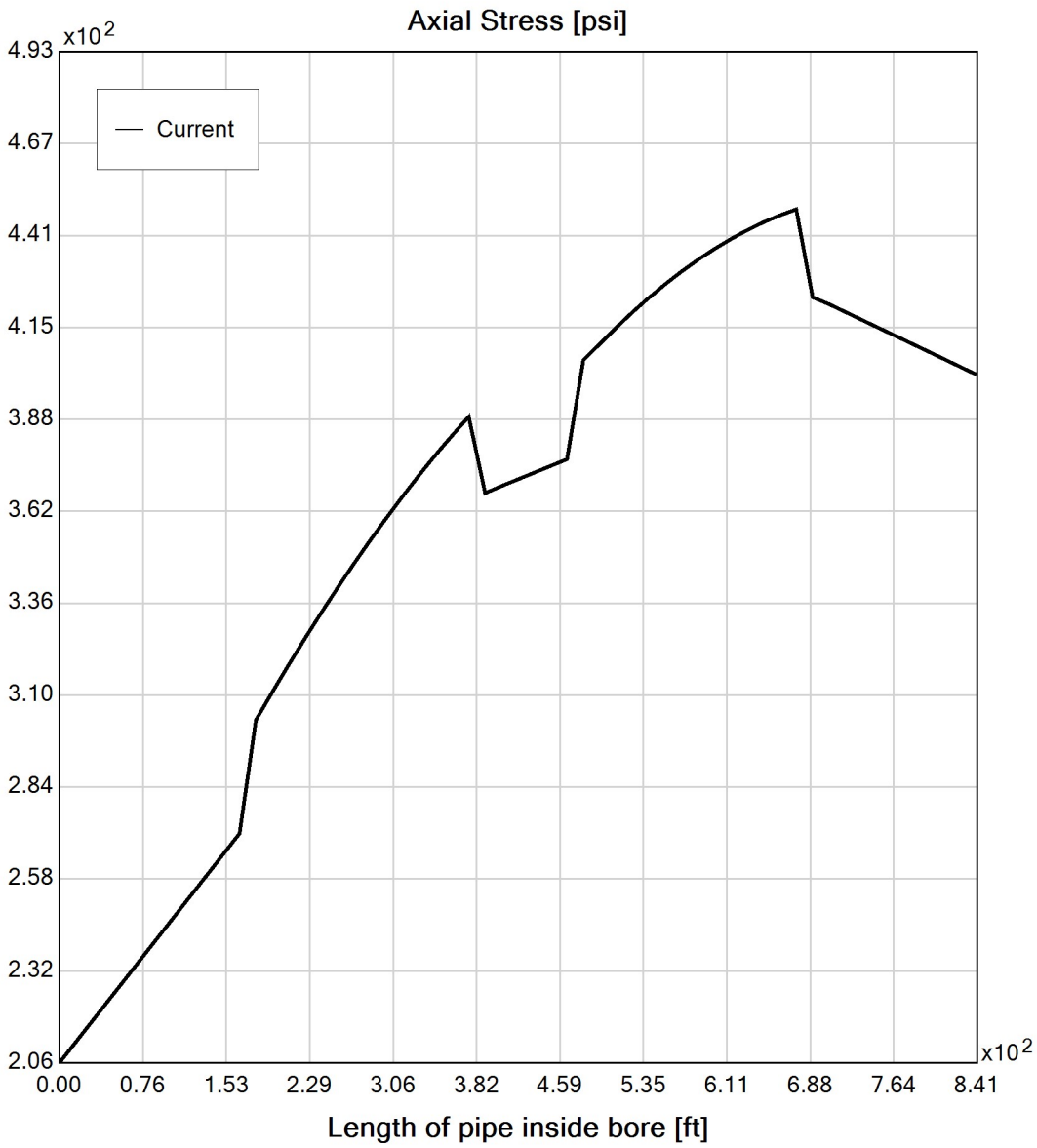
Virtual Site

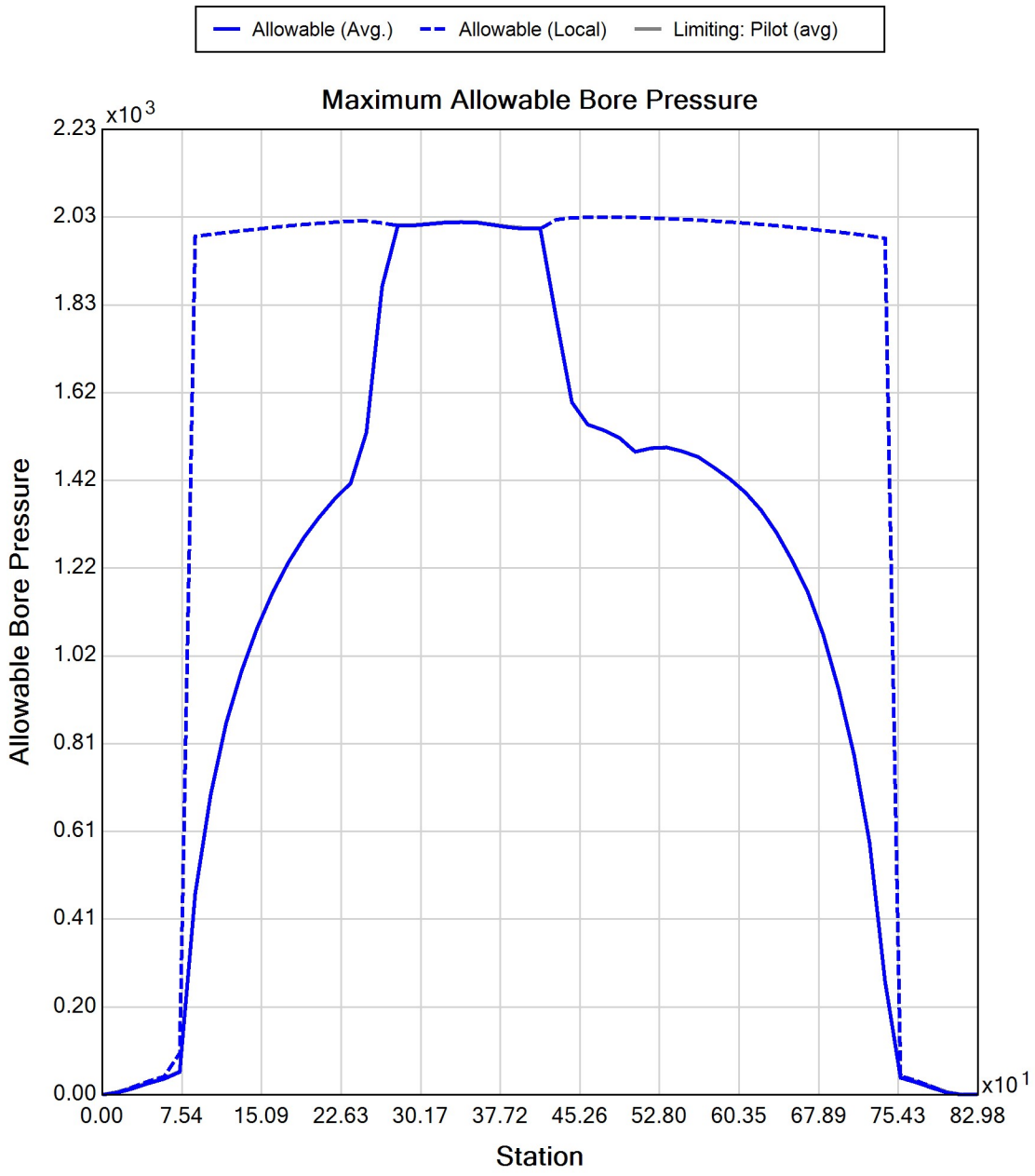


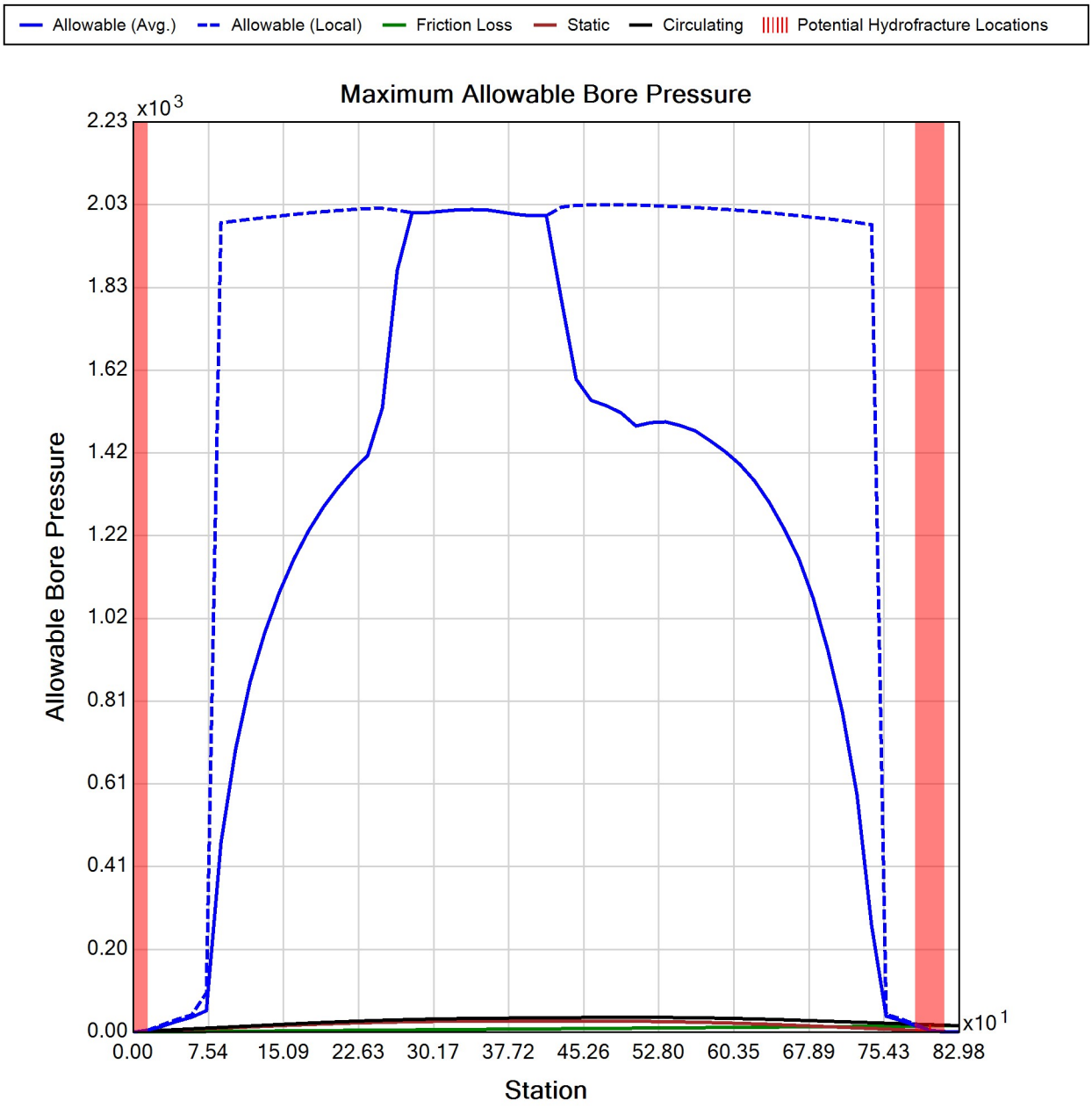












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Project Summary

General:	HDD 53
	P4A
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AB
	CHA
Description:	HDD 53 2-Inch DR 9 Conduit 1

Input Summary

Start Coordinate	(0.00, 0.00, 296.00) ft
End Coordinate	(815.00, 0.00, 295.00) ft
Project Length	815.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 840.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.8	44.9
Water Pressure	10.8	10.8
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.6	55.6
Deflection		
Earth Load Deflection	0.768	12.254
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.797	12.283
Compressive Stress [psi]		
Compressive Wall Stress	61.1	250.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	850.2	850.2
Pullback Stress [psi]	485.8	485.8
Pullback Strain	8.448E-3	8.448E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	485.8	490.7
Tensile Strain	8.448E-3	8.633E-3

Net External Pressure = 31.5 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.797	7.5	9.4	OK
Unconstrained Collapse [psi]	37.0	128.8	3.5	OK
Compressive Wall Stress [psi]	61.1	1150.0	18.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	47.0	228.8	4.9	OK
Tensile Stress [psi]	490.7	1200.0	2.4	OK

Generated Output

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Project Summary

General:	HDD 53
	P4A
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AB
	CHA
Description:	HDD 53 10-inch DR 9 Conduit 2

Input Summary

Start Coordinate	(0.00, 0.00, 295.50) ft
End Coordinate	(815.00, 0.00, 294.30) ft
Project Length	815.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 4

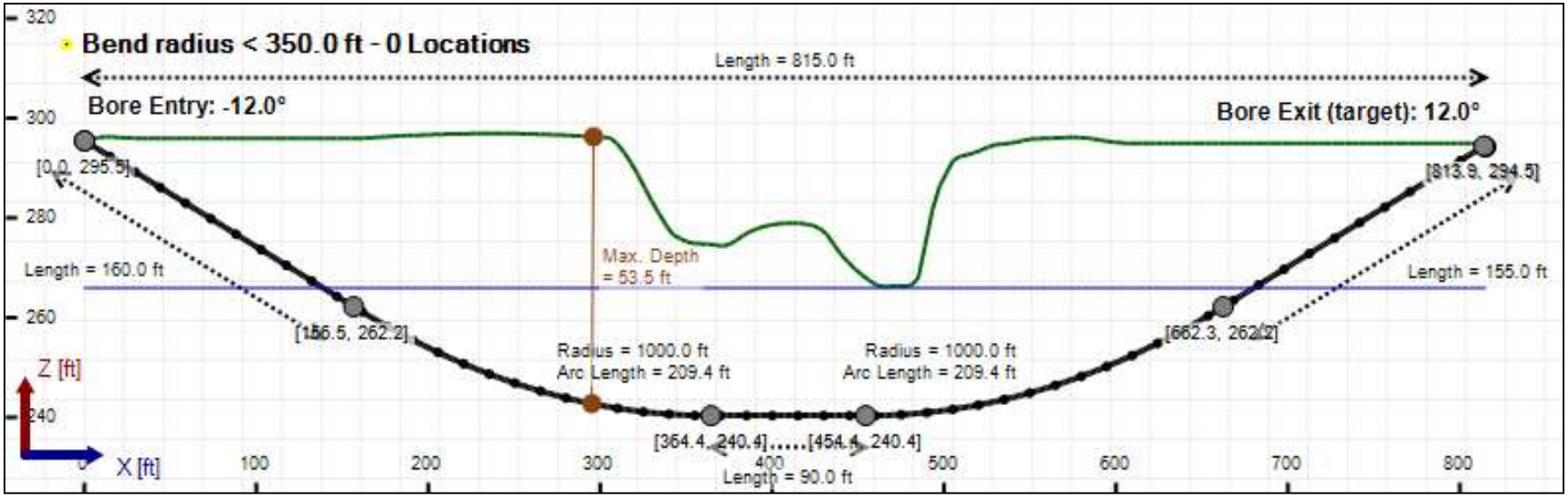
Soil Layer #1 USCS, Silt (M), ML
Depth: 5.00 ft
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 28.00, S.M.: 50.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Sand (S), SM
Depth: 9.50 ft
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 145.00, Coh: 0.00 [psi]

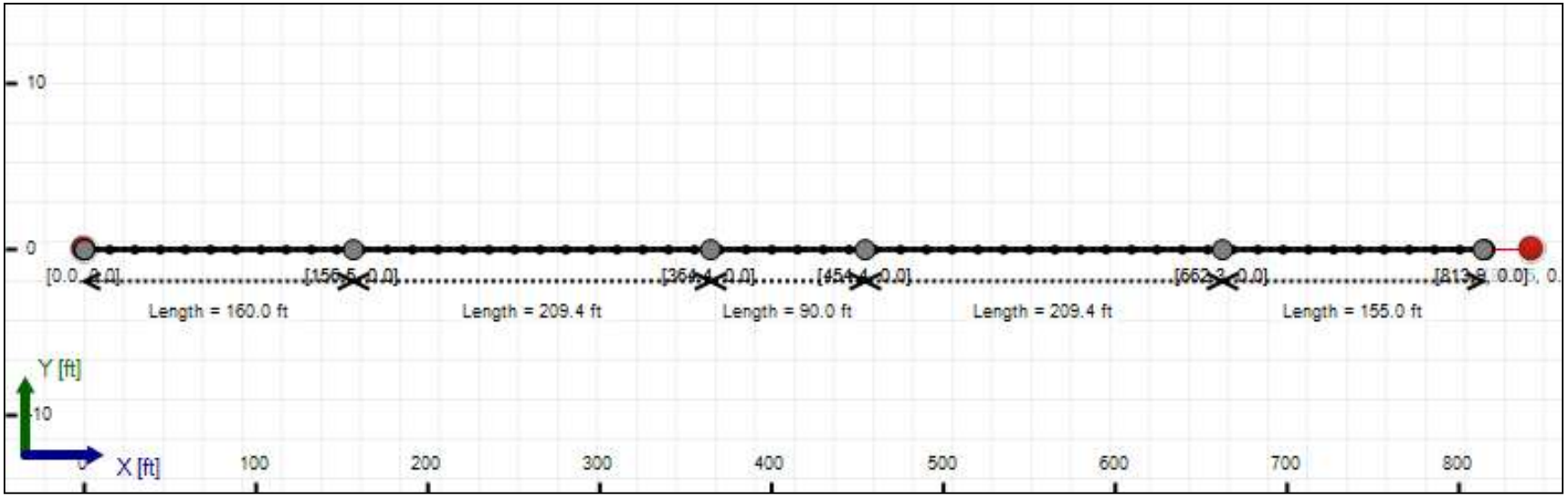
Soil Layer #3 USCS, Silt (M), ML
Depth: 1.50 ft
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #4 Rock, Geological Classification, Sedimentary Rocks
Depth: 50.00 ft
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 2000.00, Coh: 3000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 825.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	7.0	44.0
Water Pressure	11.1	10.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	18.1	54.4
Deflection		
Earth Load Deflection	1.897	12.007
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	2.029	12.139
Compressive Stress [psi]		
Compressive Wall Stress	81.3	244.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	14772.1	14772.1
Pullback Stress [psi]	412.0	412.0
Pullback Strain	7.165E-3	7.165E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	412.0	437.2
Tensile Strain	7.165E-3	8.051E-3

Net External Pressure = 30.3 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	2.029	7.5	3.7	OK
Unconstrained Collapse [psi]	35.8	115.1	3.2	OK
Compressive Wall Stress [psi]	81.3	1150.0	14.1	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	45.8	231.3	5.0	OK
Tensile Stress [psi]	437.2	1200.0	2.7	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	2019.615 psi	2028.817 psi
1	8.00 in	12.00 in	2019.224 psi	2028.610 psi
2	12.00 in	16.13 in	2018.657 psi	2028.310 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

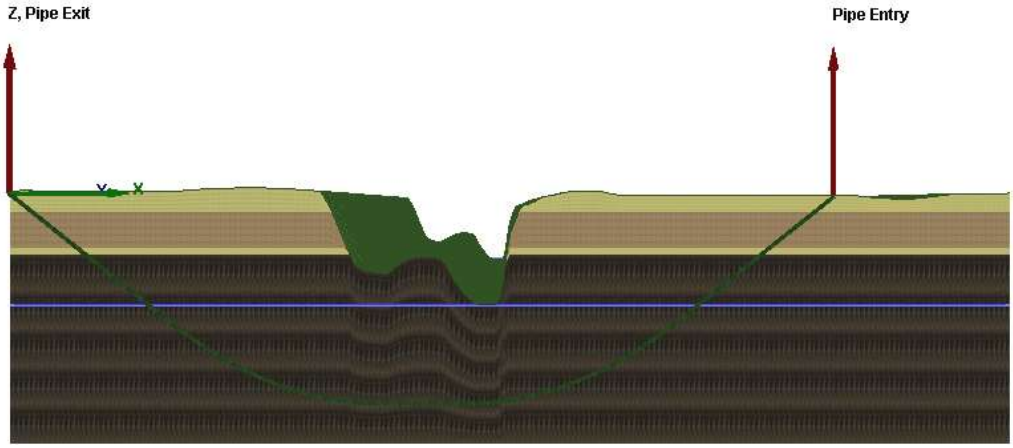
Rheological model: Bingham-Plastic

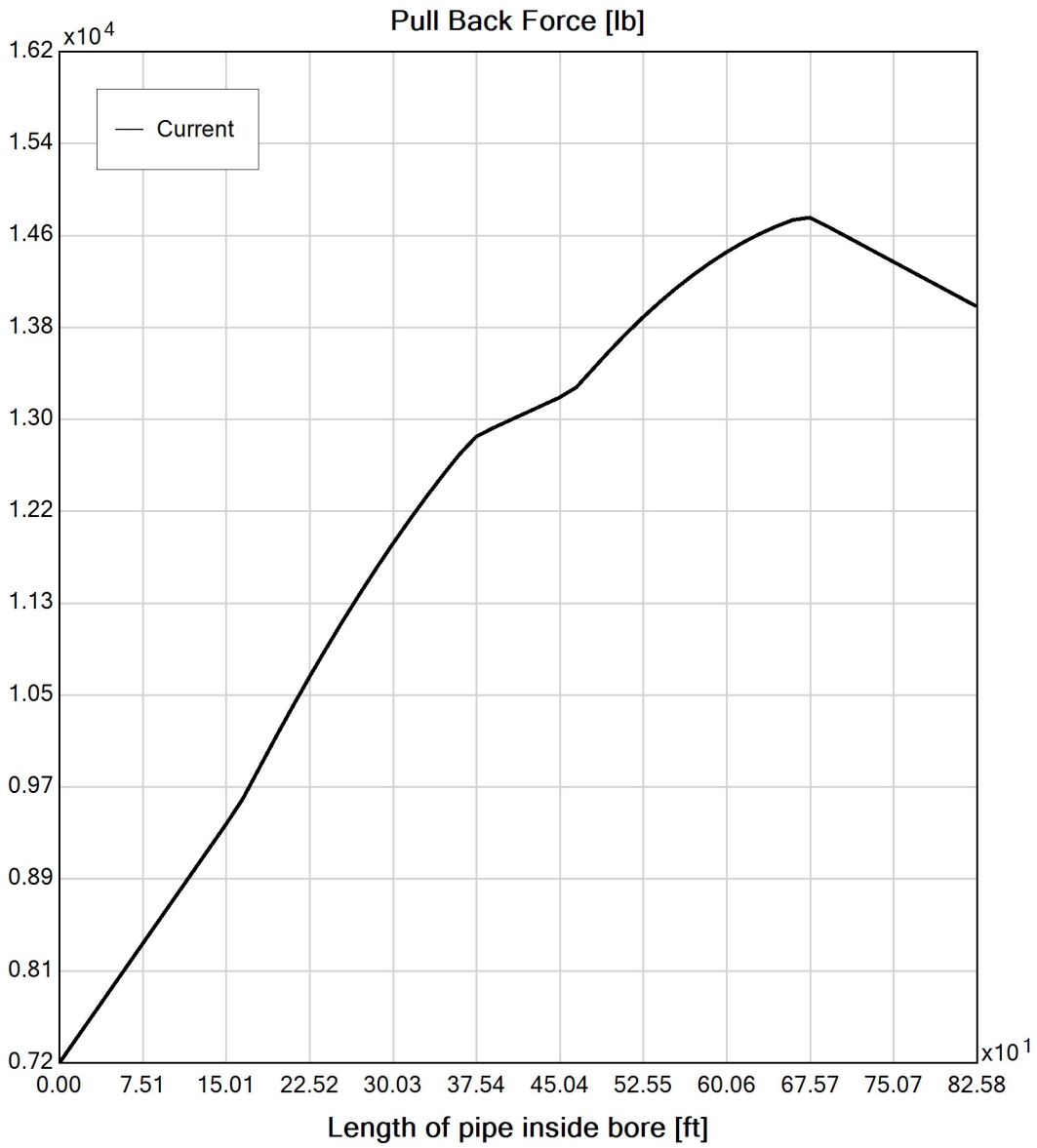
Plastic Viscosity (PV): 25.53

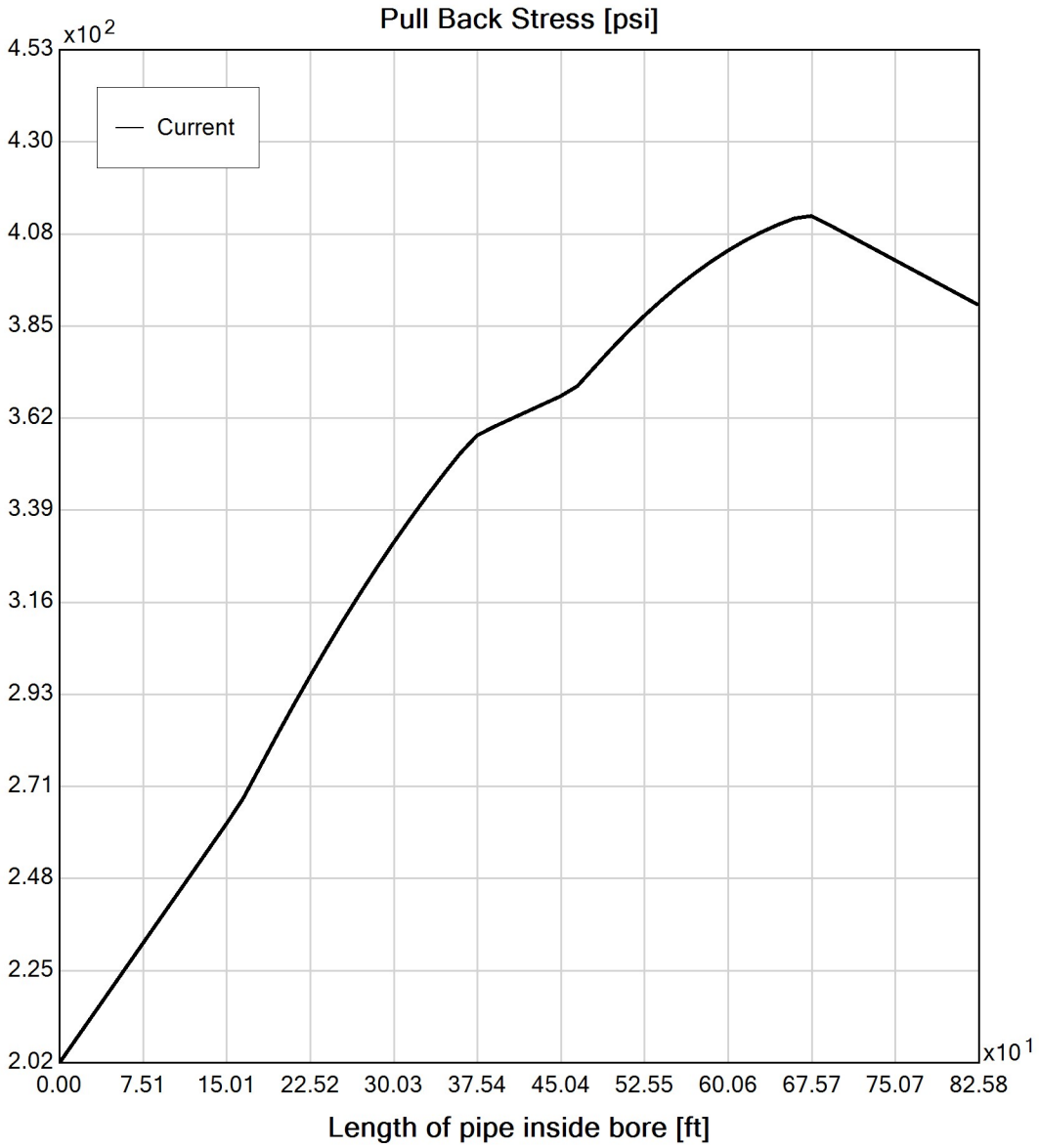
Yield Point (YP): 16.49

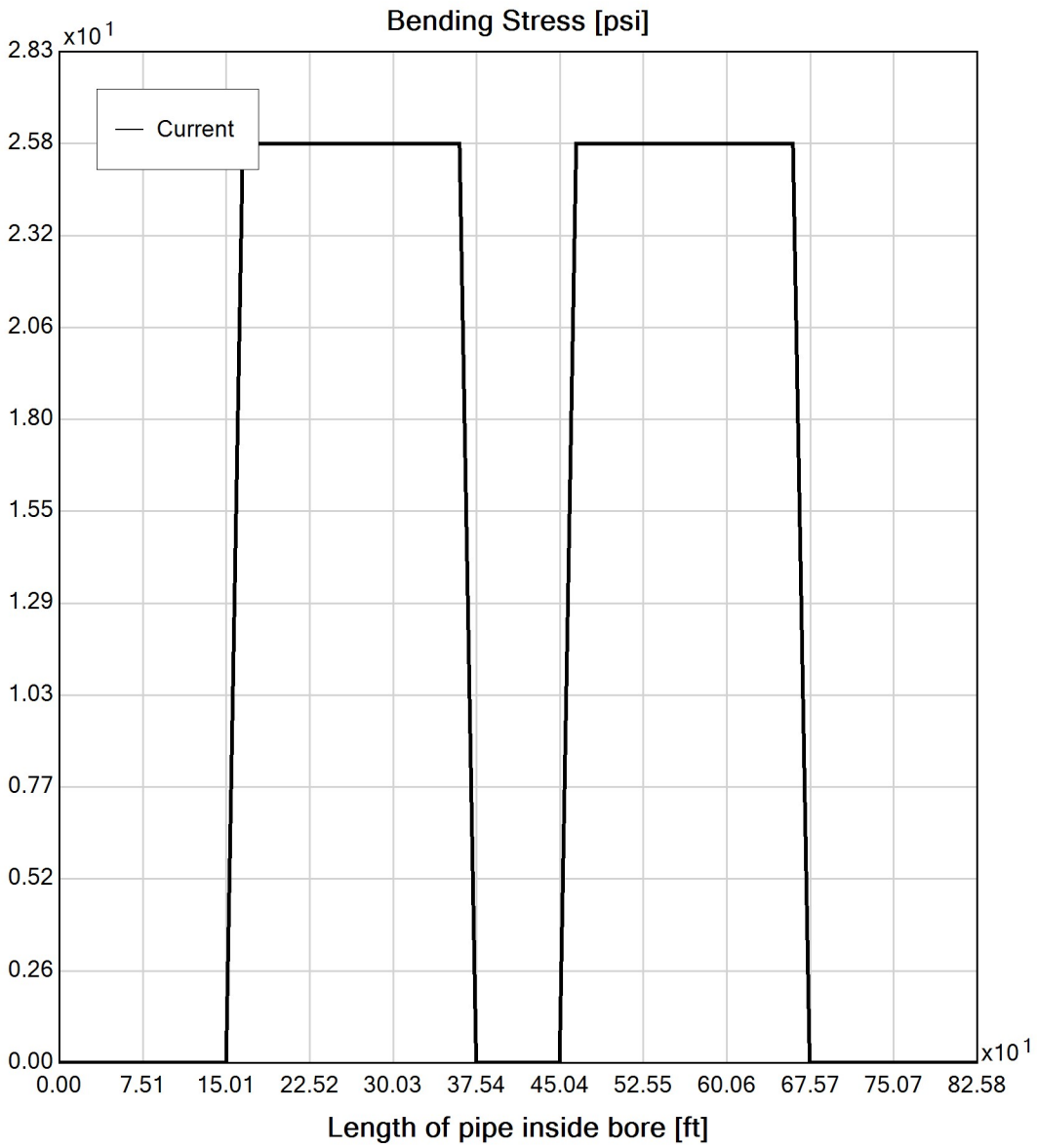
Effective Viscosity (cP): 1202.0

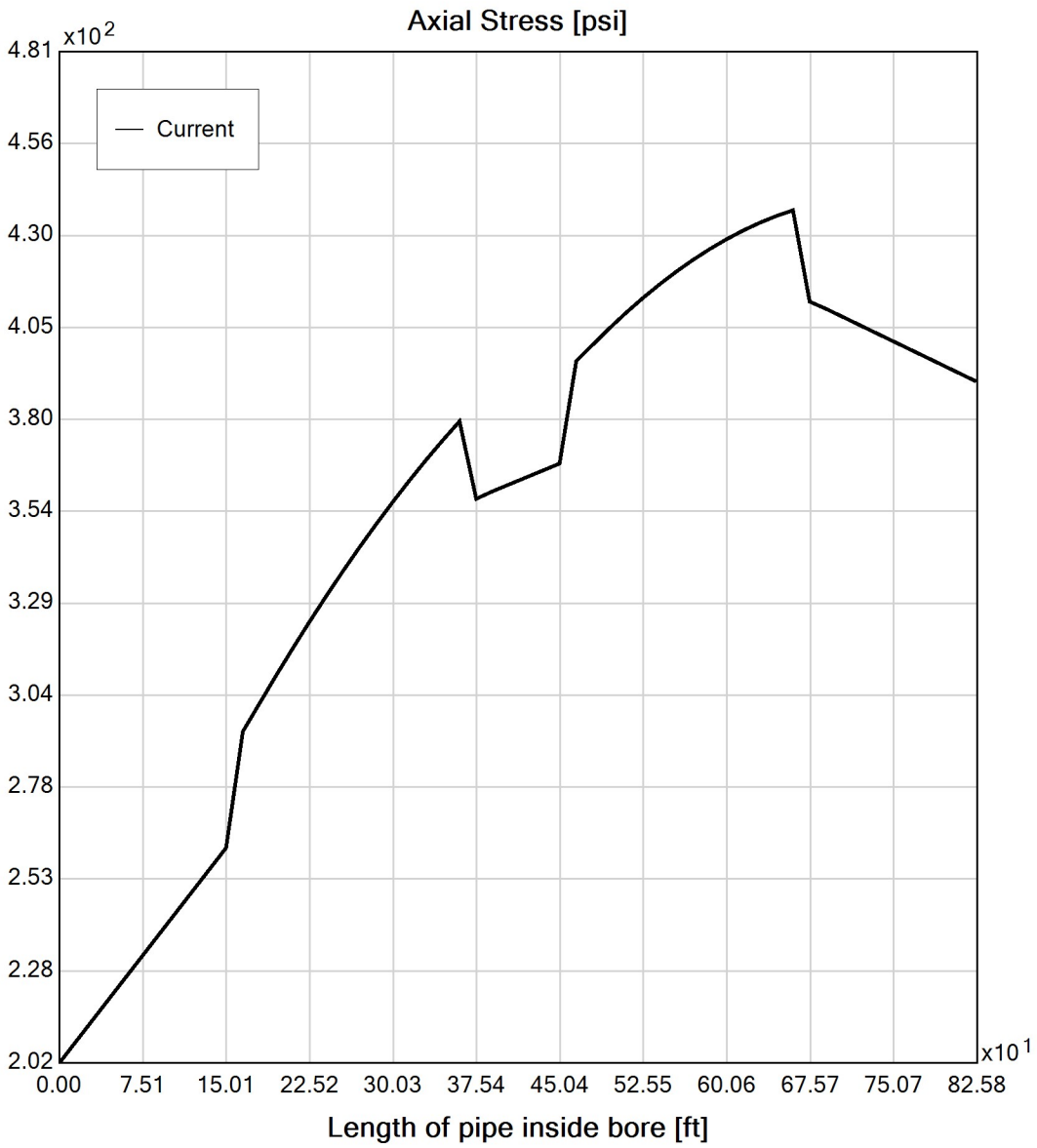
Virtual Site

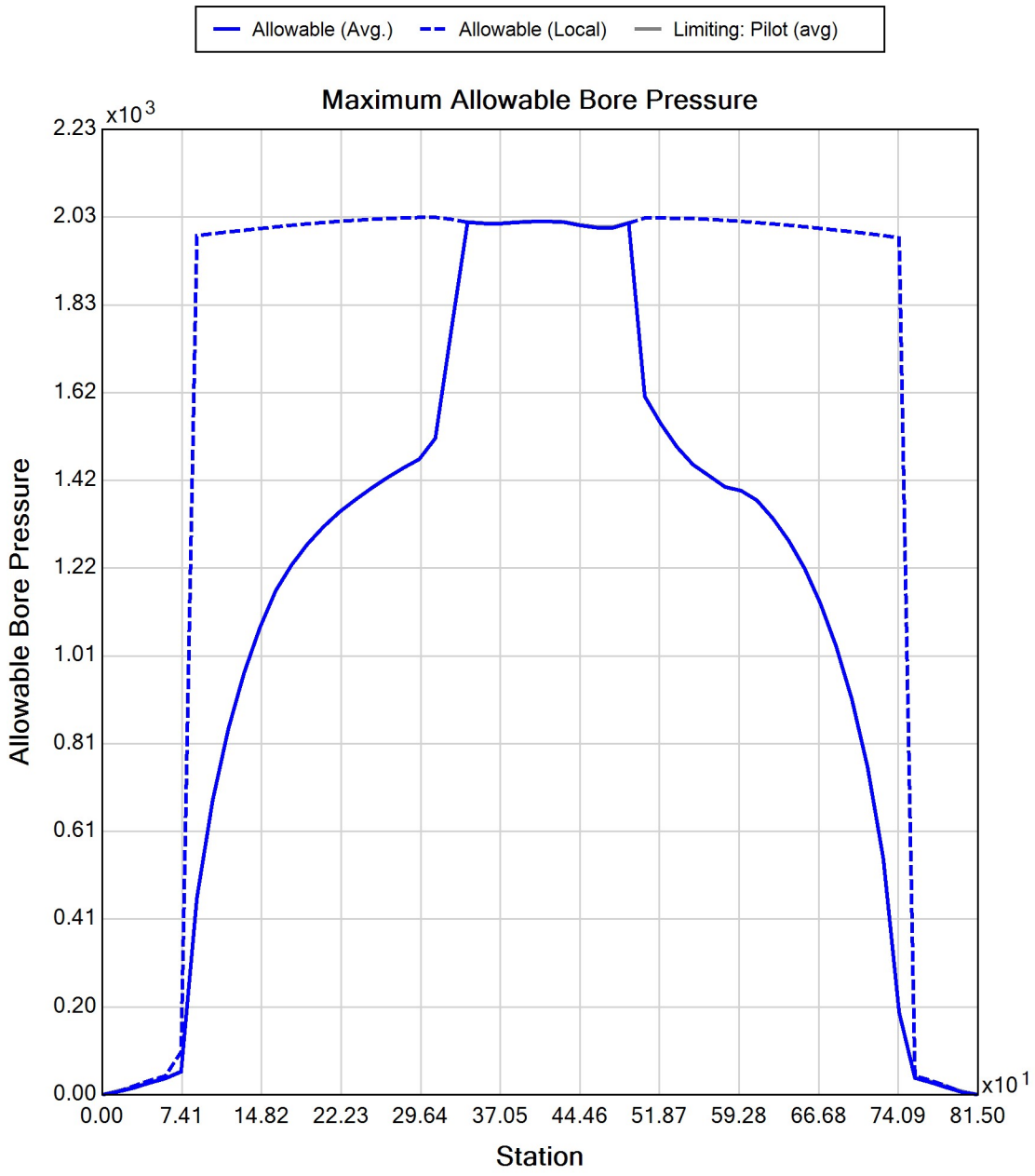


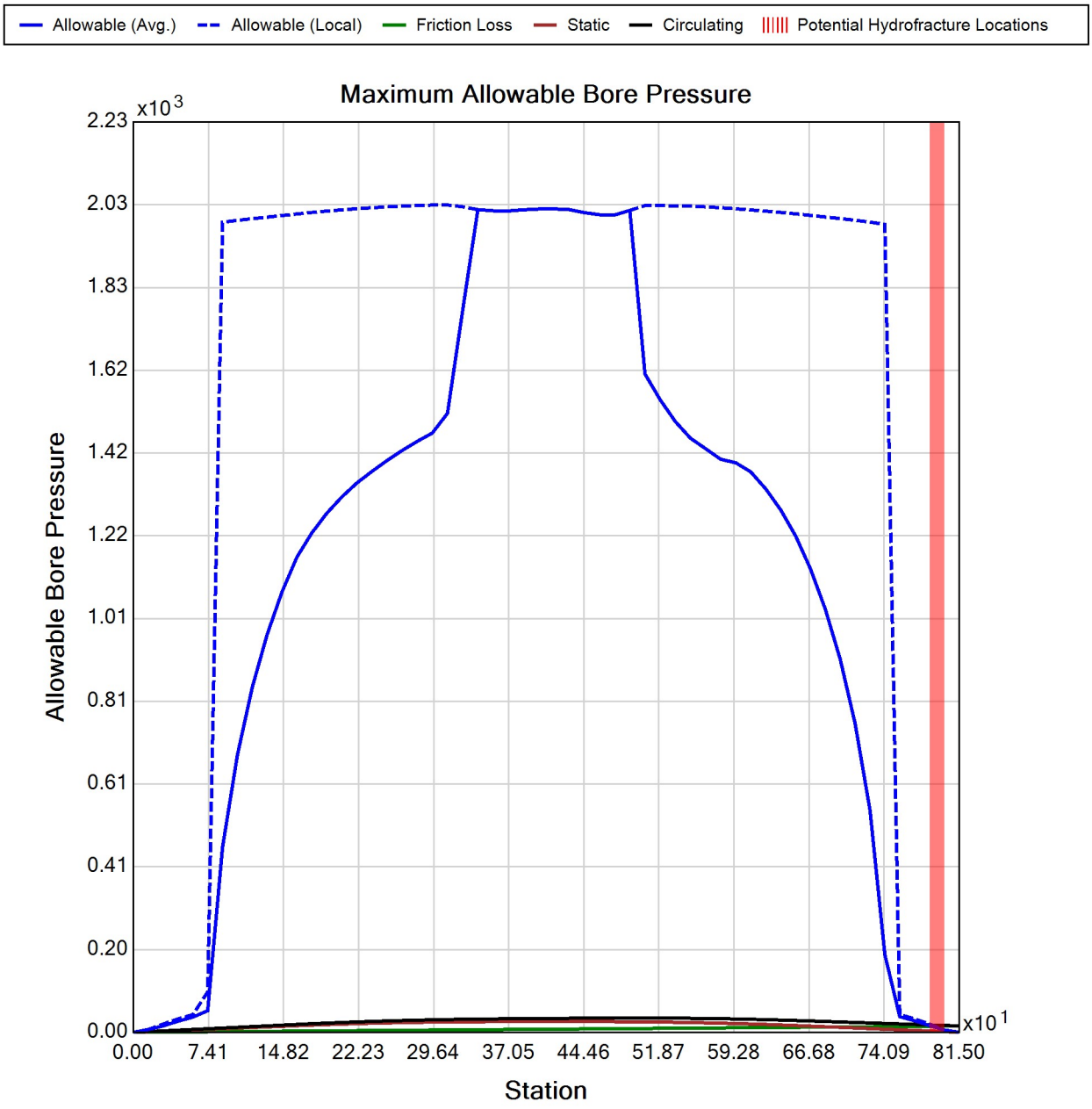












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Project Summary

General:	HDD 53
	P4A
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AB
	CHA
Description:	HDD 53 2-inch DR 9 Conduit 2

Input Summary

Start Coordinate	(0.00, 0.00, 295.50) ft
End Coordinate	(815.00, 0.00, 294.30) ft
Project Length	815.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 825.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.8	44.0
Water Pressure	11.1	10.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.9	54.4
Deflection		
Earth Load Deflection	0.756	12.007
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.785	12.036
Compressive Stress [psi]		
Compressive Wall Stress	62.5	244.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	830.6	830.6
Pullback Stress [psi]	474.6	474.6
Pullback Strain	8.254E-3	8.254E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	474.6	479.7
Tensile Strain	8.254E-3	8.442E-3

Net External Pressure = 30.3 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.785	7.5	9.6	OK
Unconstrained Collapse [psi]	35.8	128.7	3.6	OK
Compressive Wall Stress [psi]	62.5	1150.0	18.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	45.8	229.5	5.0	OK
Tensile Stress [psi]	479.7	1200.0	2.5	OK

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Project Summary

General:	HDD 53A
	P4A
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	TAR
	CHA
Description:	HDD 53A 10-inch DR9

Input Summary

Start Coordinate	(0.00, 0.00, 276.30) ft
End Coordinate	(626.20, 0.00, 276.50) ft
Project Length	626.20 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 4

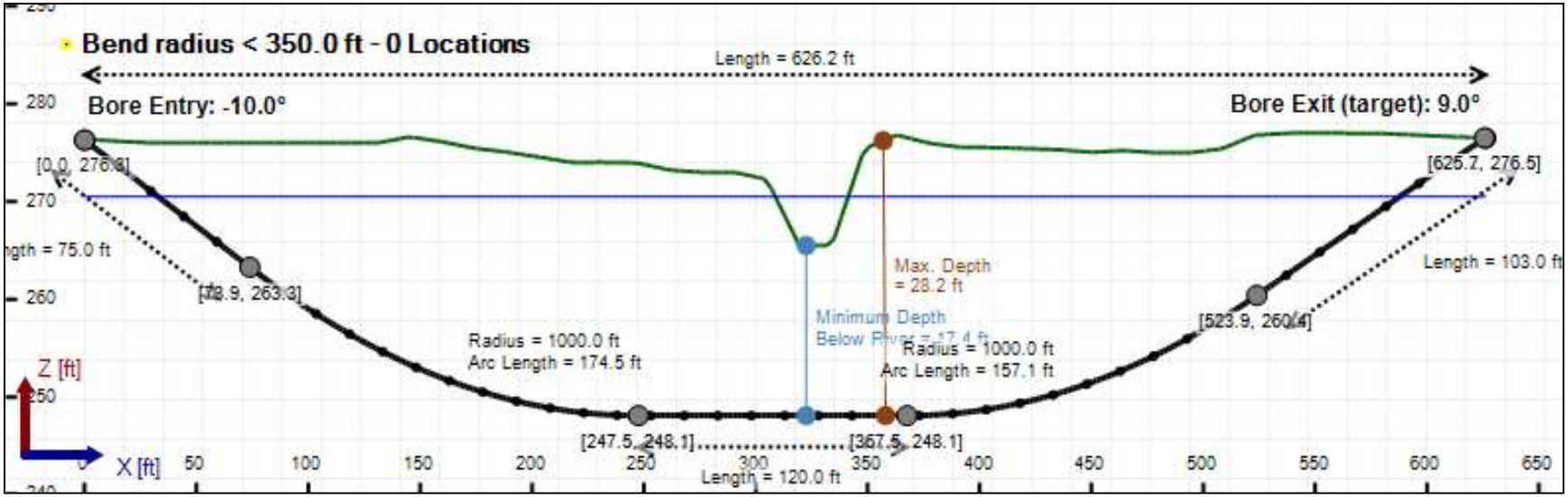
Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Sand (S), SM
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 145.00, Coh: 0.00 [psi]

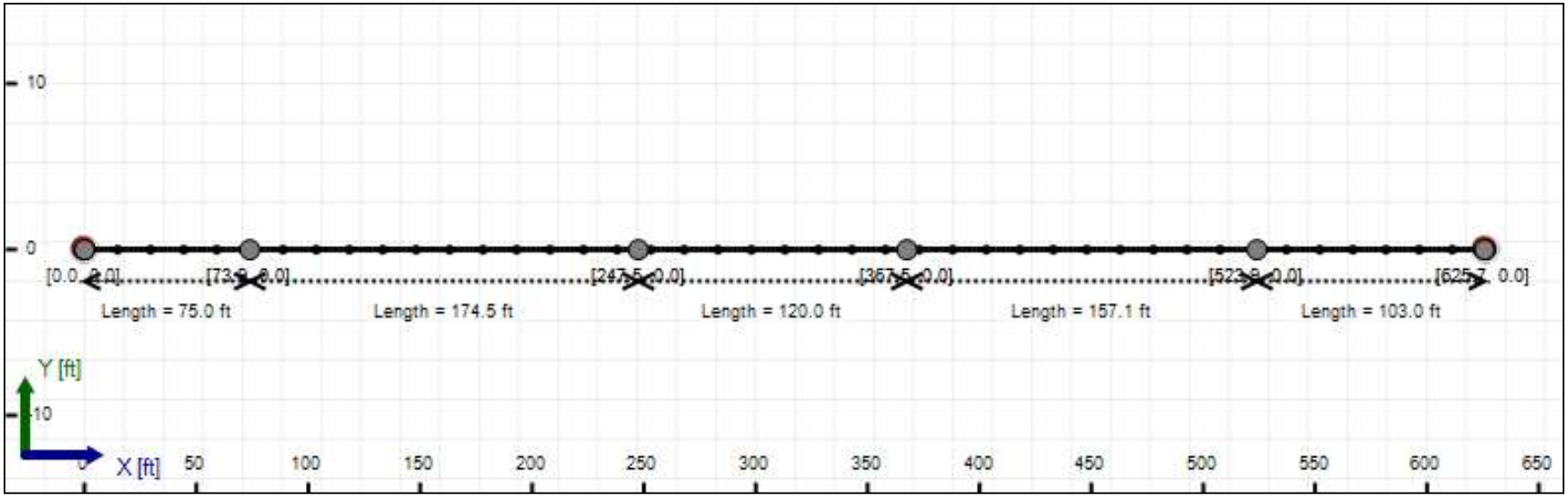
Soil Layer #3 USCS, Gravel (G), GP
From Assistant
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #4 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 2000.00, Coh: 3000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 630.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	17.4	22.3
Water Pressure	9.7	9.7
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	27.1	32.0
Deflection		
Earth Load Deflection	4.740	6.065
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	4.872	6.197
Compressive Stress [psi]		
Compressive Wall Stress	122.0	143.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	10562.9	10562.9
Pullback Stress [psi]	294.6	294.6
Pullback Strain	5.123E-3	5.123E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	294.6	319.1
Tensile Strain	5.123E-3	5.997E-3

Net External Pressure = 18.6 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.872	7.5	1.5	OK
Unconstrained Collapse [psi]	27.1	89.4	3.3	OK
Compressive Wall Stress [psi]	122.0	1150.0	9.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	28.5	238.1	8.4	OK
Tensile Stress [psi]	319.1	1200.0	3.8	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	1038.270 psi	2006.495 psi
1	8.00 in	12.00 in	1036.096 psi	2004.577 psi
2	12.00 in	16.13 in	1032.958 psi	2001.796 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

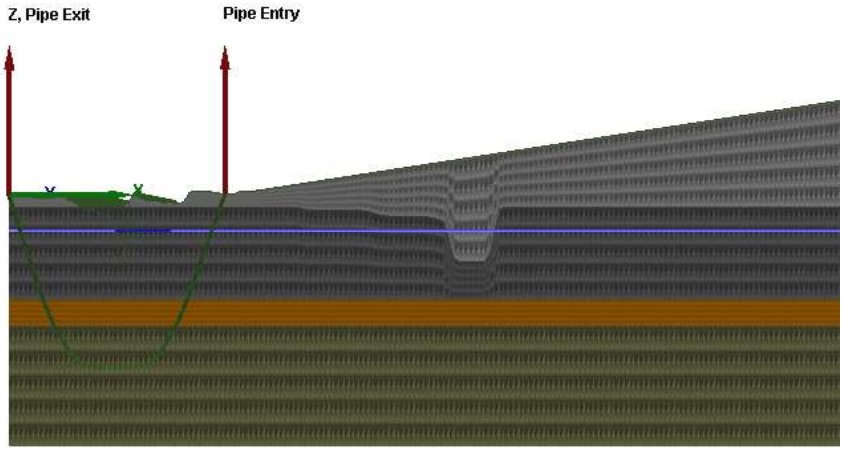
Rheological model: Bingham-Plastic

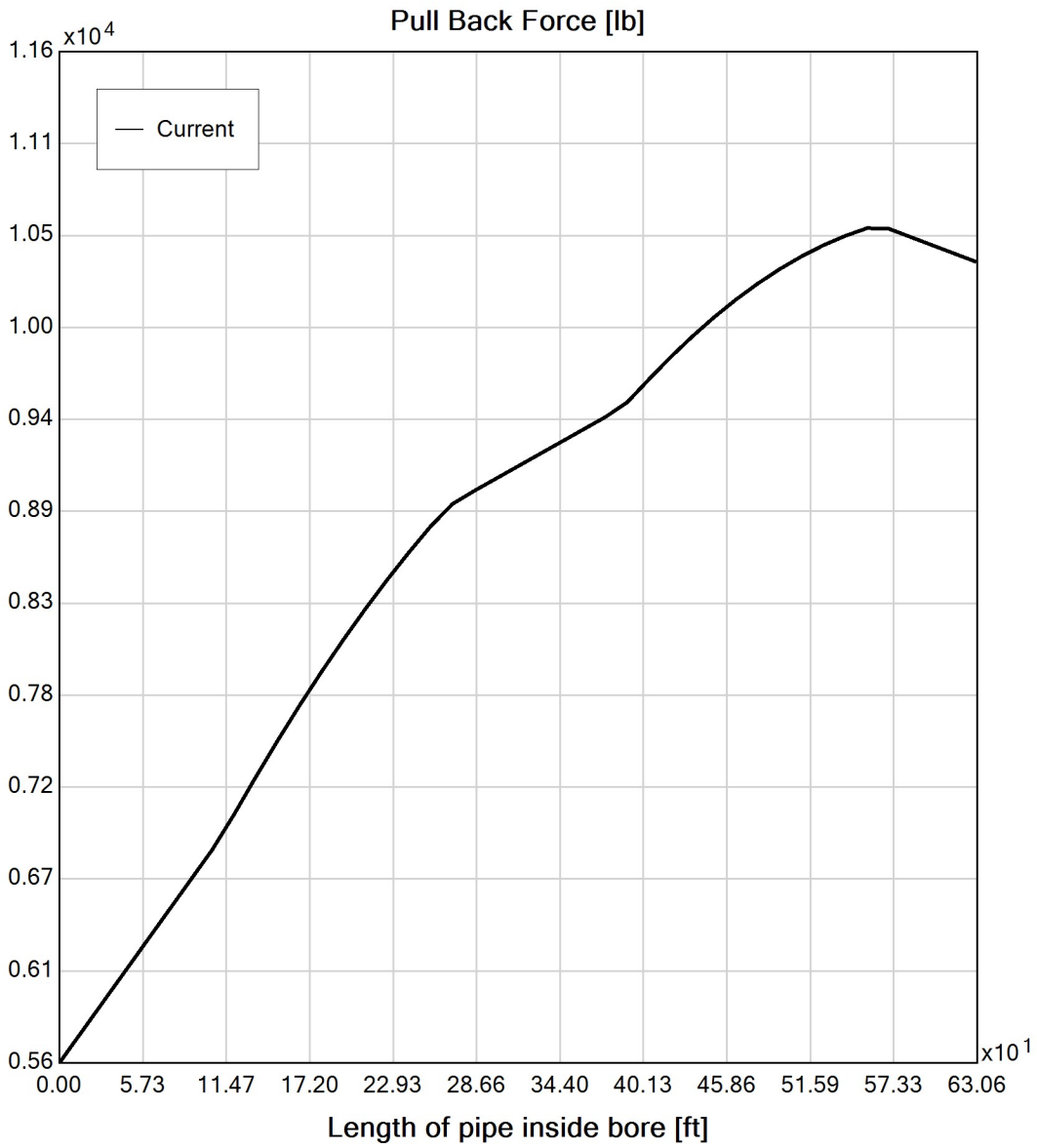
Plastic Viscosity (PV): 25.53

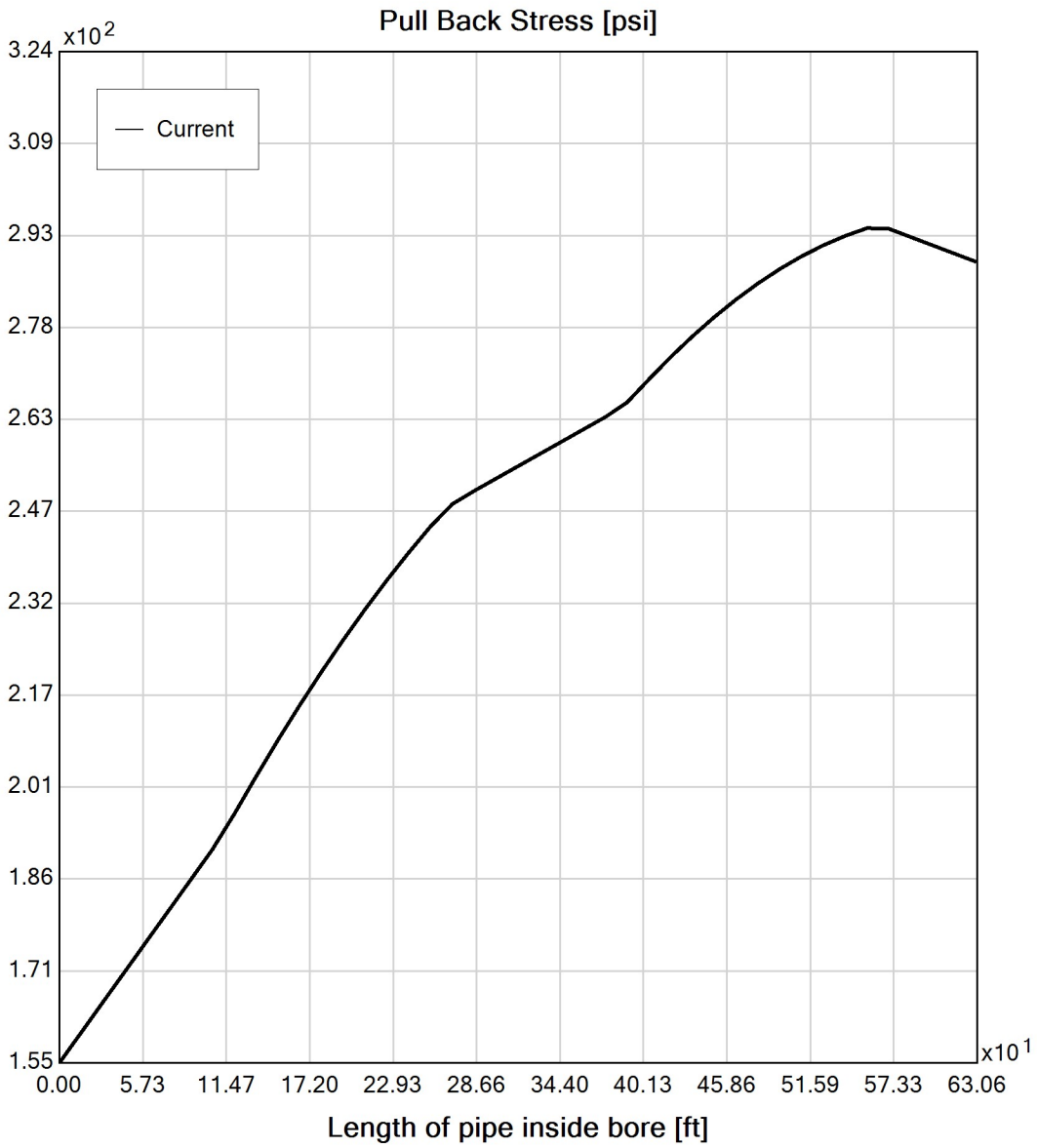
Yield Point (YP): 16.49

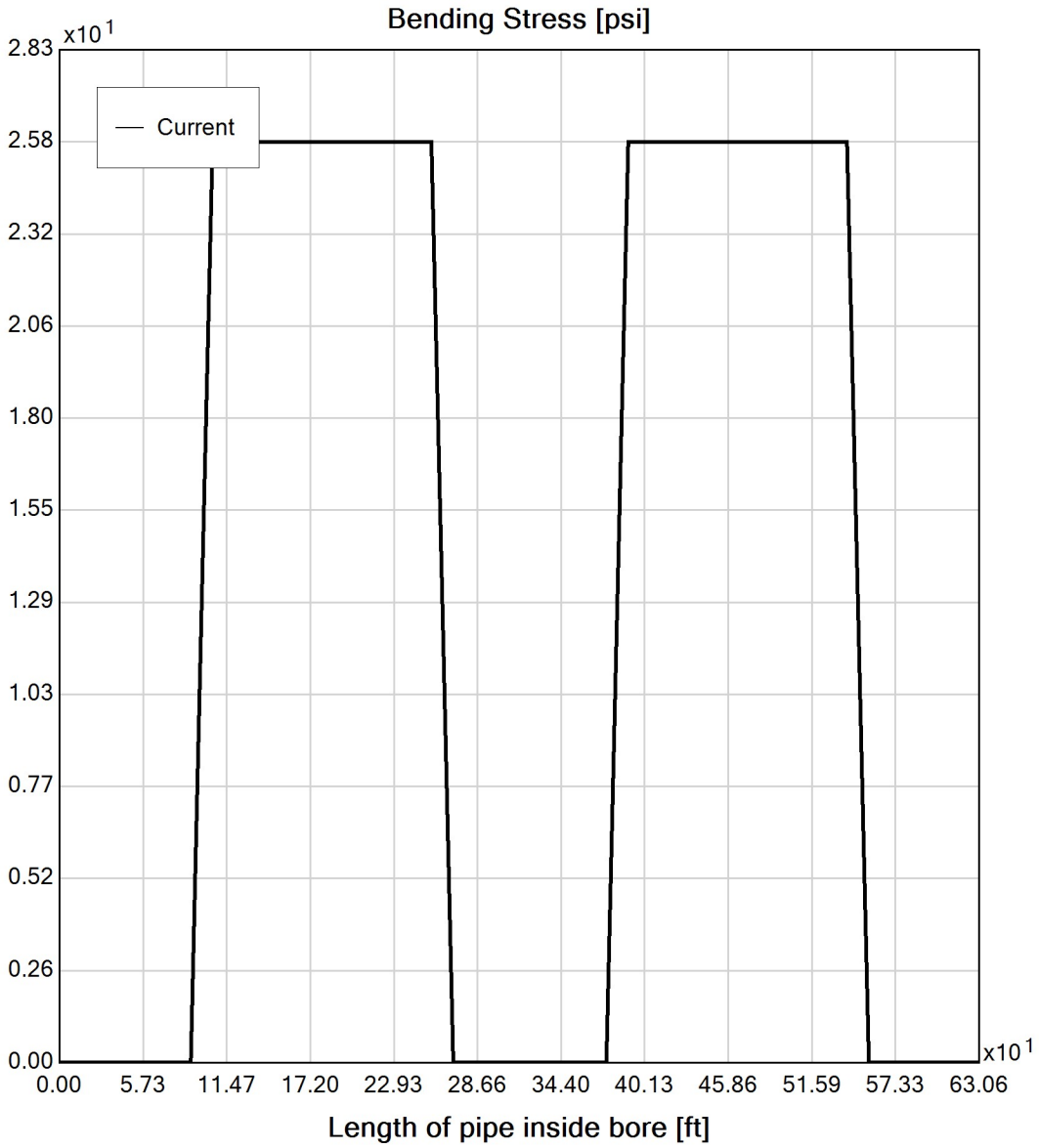
Effective Viscosity (cP): 1202.0

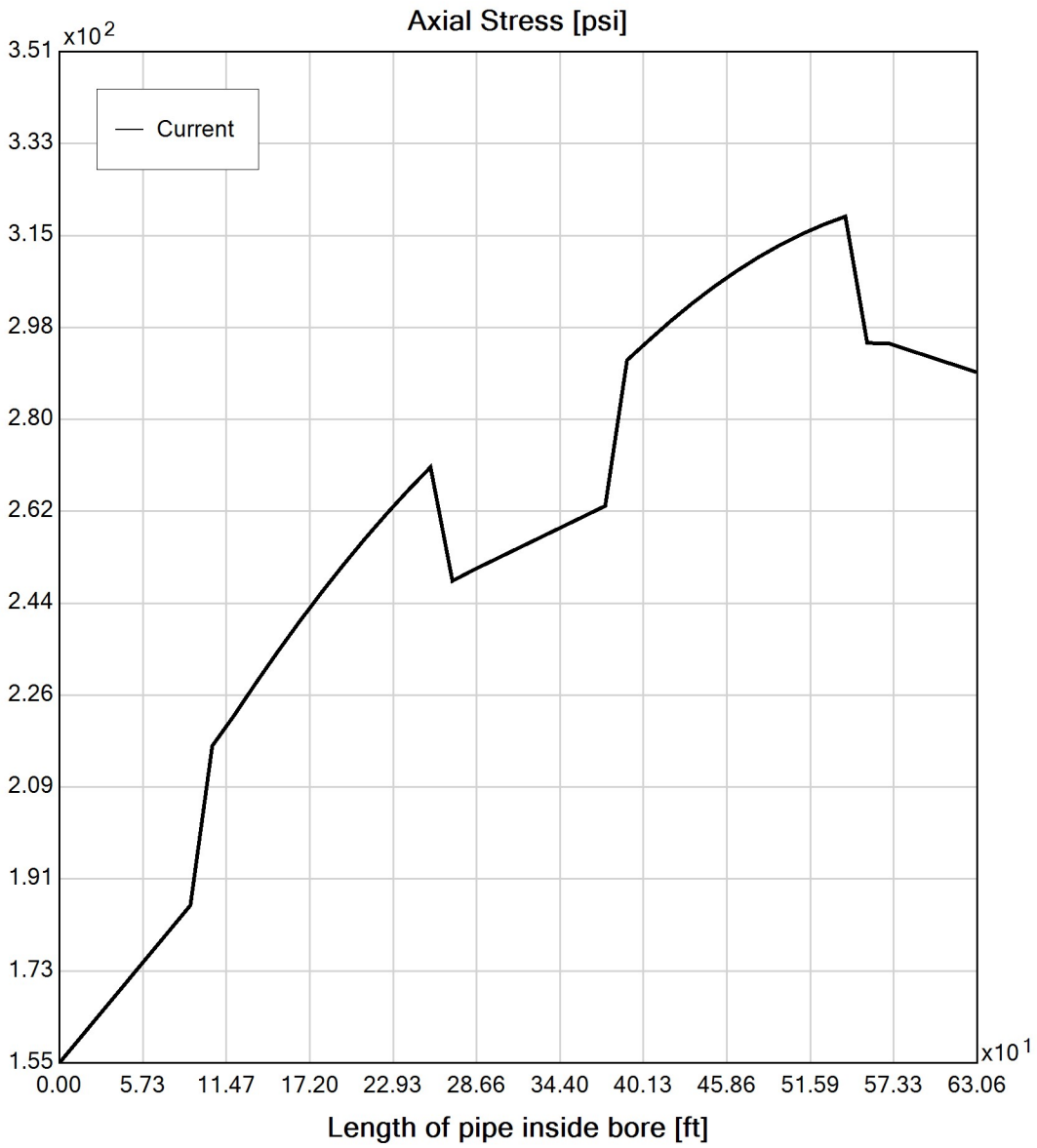
Virtual Site

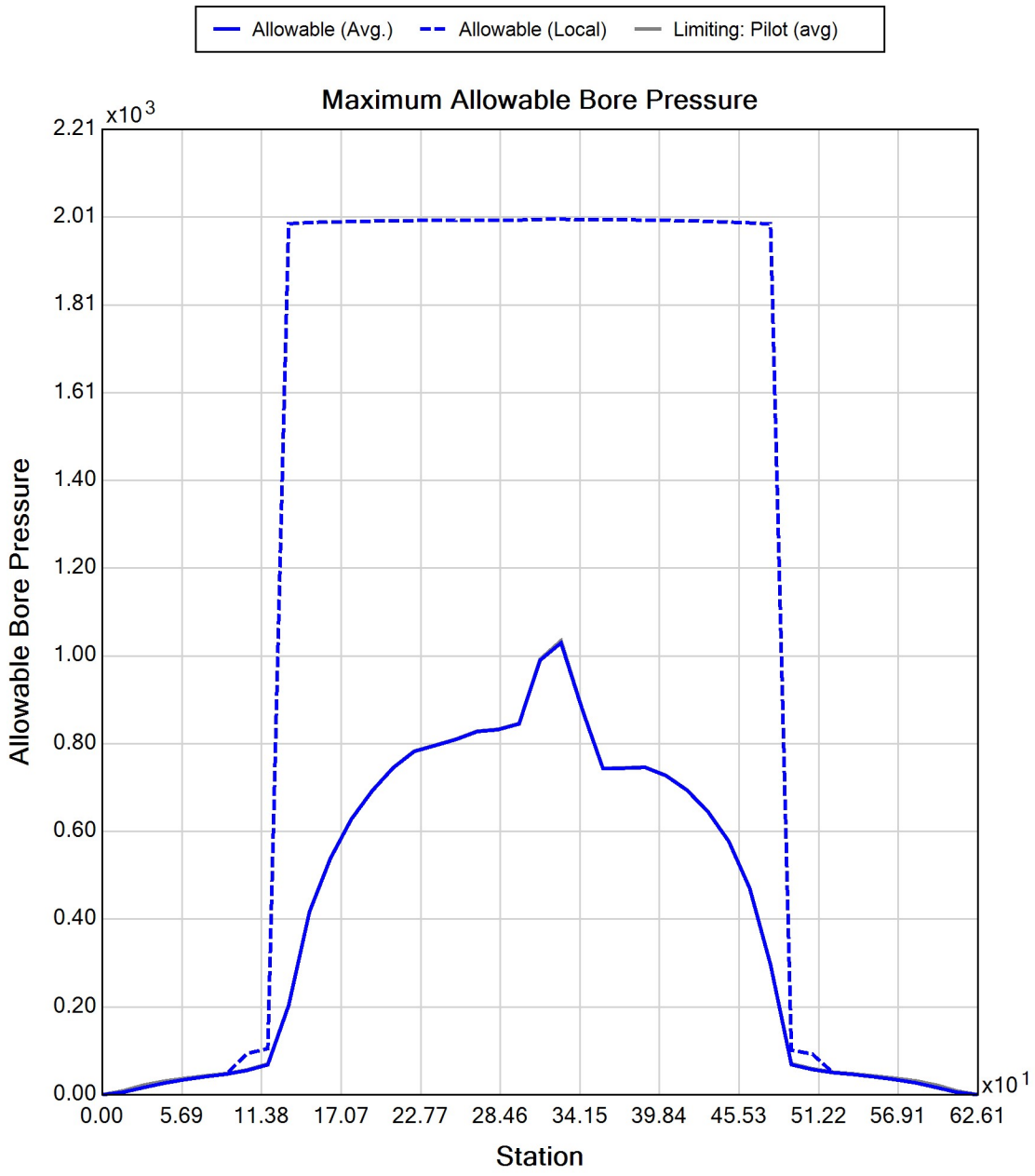


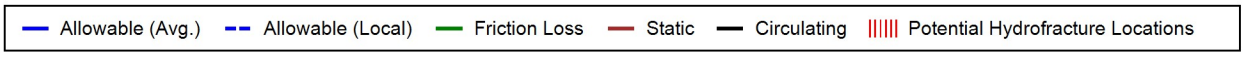


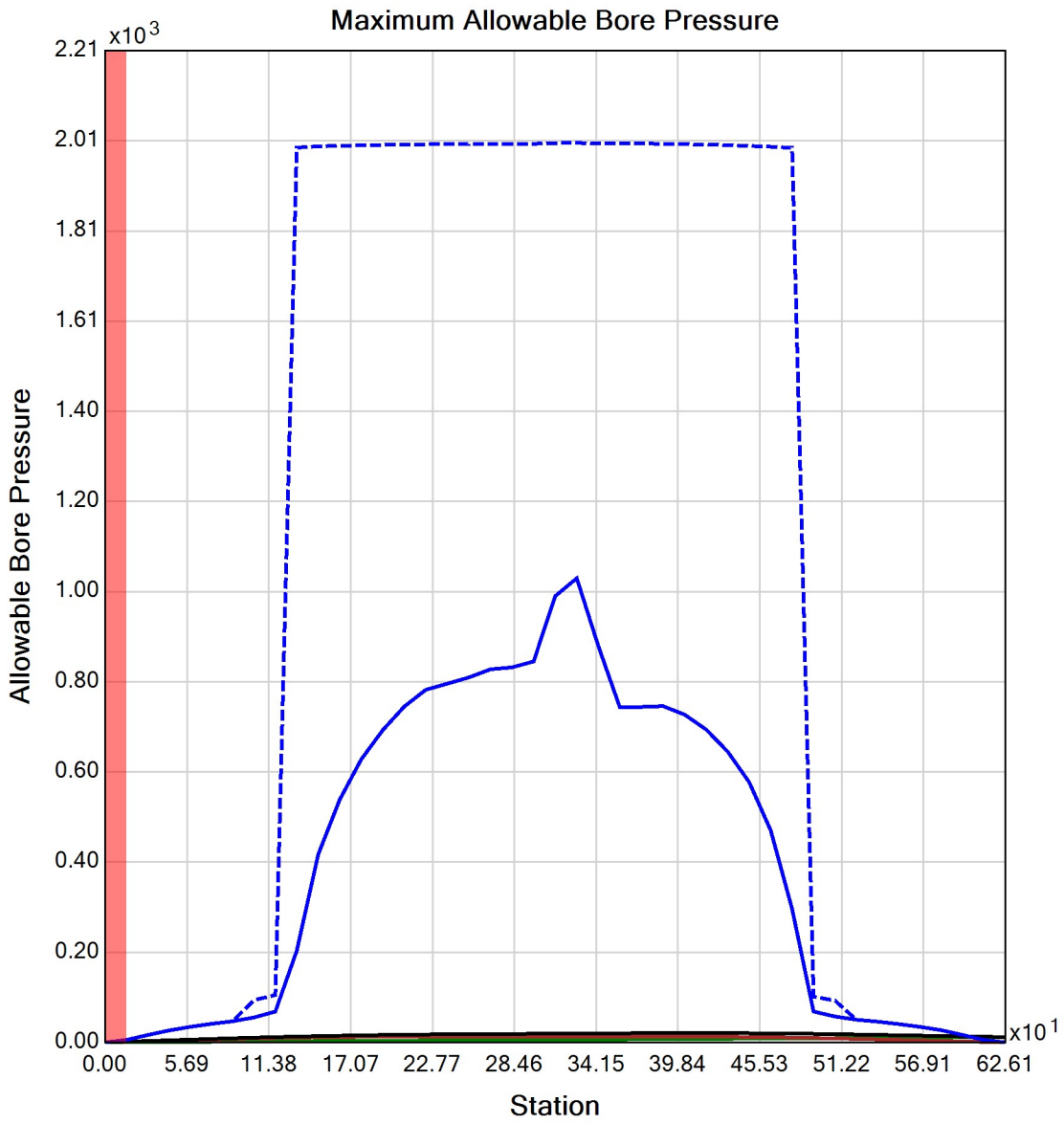












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Project Summary

General:	HDD 53A
	P4A
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	TAR
	CHA
Description:	HDD 53A 2-inch DR9

Input Summary

Start Coordinate	(0.00, 0.00, 276.30) ft
End Coordinate	(626.20, 0.00, 276.50) ft
Project Length	626.20 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 630.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	12.4	22.3
Water Pressure	9.7	9.7
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	22.2	32.0
Deflection		
Earth Load Deflection	3.389	6.065
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	3.418	6.094
Compressive Stress [psi]		
Compressive Wall Stress	99.7	143.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	625.2	625.2
Pullback Stress [psi]	357.2	357.2
Pullback Strain	6.212E-3	6.212E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	357.2	361.6
Tensile Strain	6.212E-3	6.388E-3

Net External Pressure = 18.6 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.418	7.5	2.2	OK
Unconstrained Collapse [psi]	22.2	101.7	4.6	OK
Compressive Wall Stress [psi]	99.7	1150.0	11.5	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	28.5	236.4	8.3	OK
Tensile Stress [psi]	361.6	1200.0	3.3	OK

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Project Summary

General:	CHPE HDD 59 P4A Start Date: 06-07-2023 End Date: 06-07-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 59 Reversed Conduit 1 10-inch DR-9

Input Summary

Start Coordinate	(0.00, 0.00, 260.00) ft
End Coordinate	(1124.00, 0.00, 269.00) ft
Project Length	1124.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 4

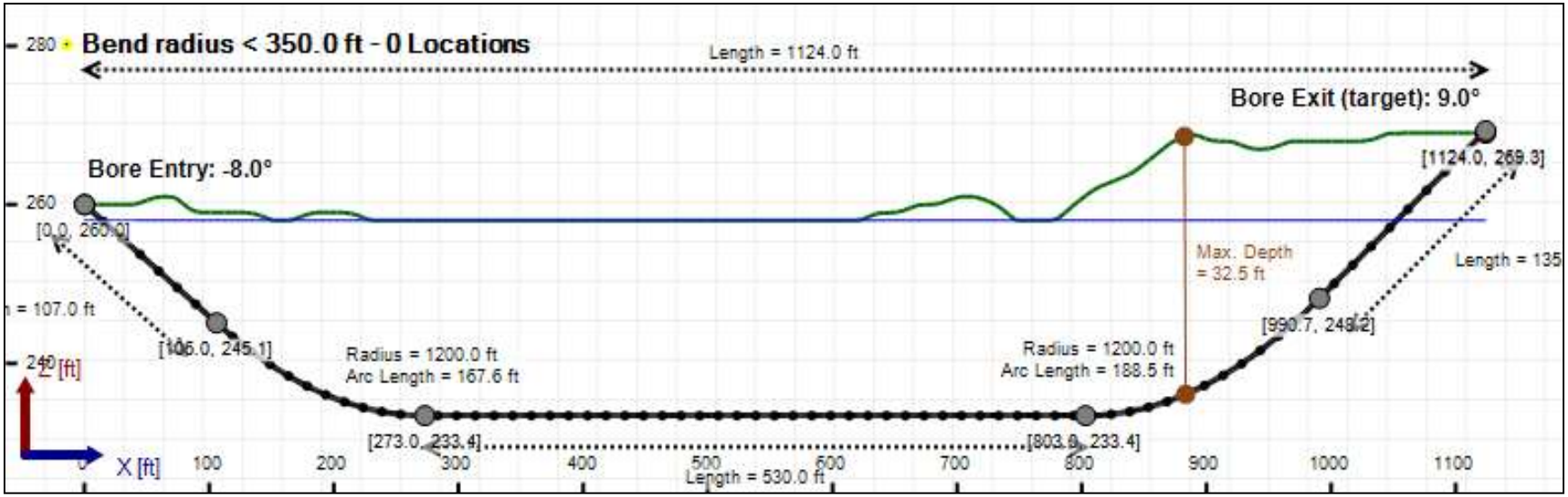
Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 500.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 100.0000 (dry), 120.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 400.00, Coh: 8.30 [psi]

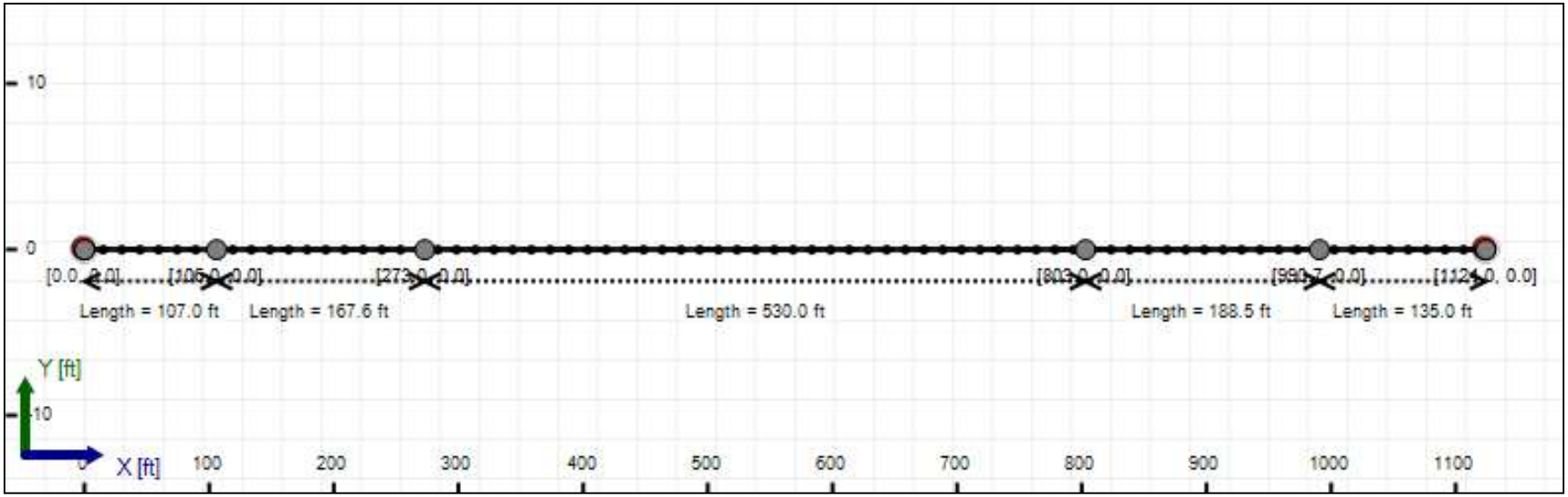
Soil Layer #3 USCS, Gravel (G), GP
From Assistant
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #4 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 2000.00, Coh: 3000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 1140.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.6	24.0
Water Pressure	10.7	9.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	16.3	33.9
Deflection		
Earth Load Deflection	1.558	6.619
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.690	6.751
Compressive Stress [psi]		
Compressive Wall Stress	73.3	152.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	18496.3	18496.3
Pullback Stress [psi]	515.8	515.8
Pullback Strain	8.971E-3	8.971E-3
Bending Stress [psi]	0.0	21.5
Bending Strain	0	3.733E-4
Tensile Stress [psi]	515.8	533.5
Tensile Strain	8.971E-3	9.651E-3

Net External Pressure = 25.4 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.690	7.5	4.4	OK
Unconstrained Collapse [psi]	24.6	118.9	4.8	OK
Compressive Wall Stress [psi]	73.3	1150.0	15.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	34.6	224.8	6.5	OK
Tensile Stress [psi]	533.5	1200.0	2.2	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	1951.828 psi	2009.351 psi
1	8.00 in	12.00 in	1950.883 psi	2008.789 psi
2	12.00 in	16.13 in	1949.513 psi	2007.974 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 120.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

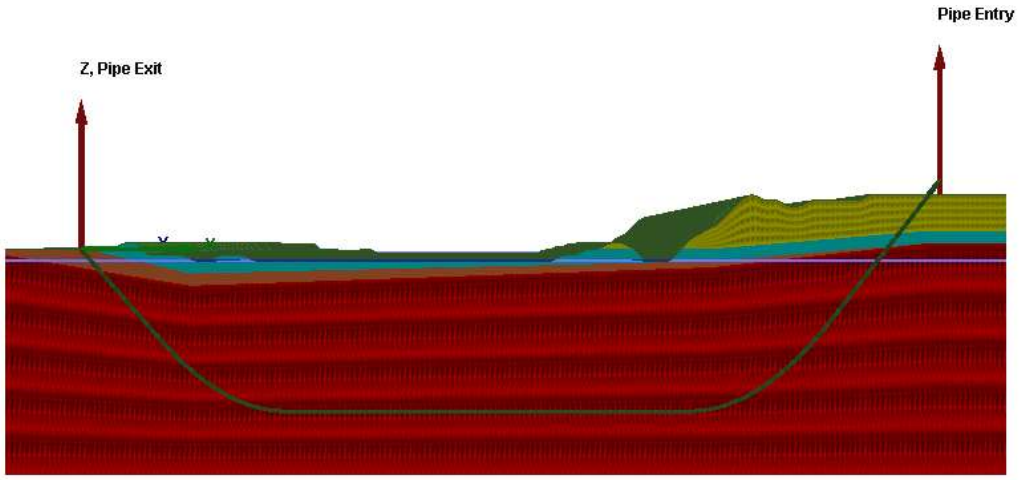
Rheological model: Bingham-Plastic

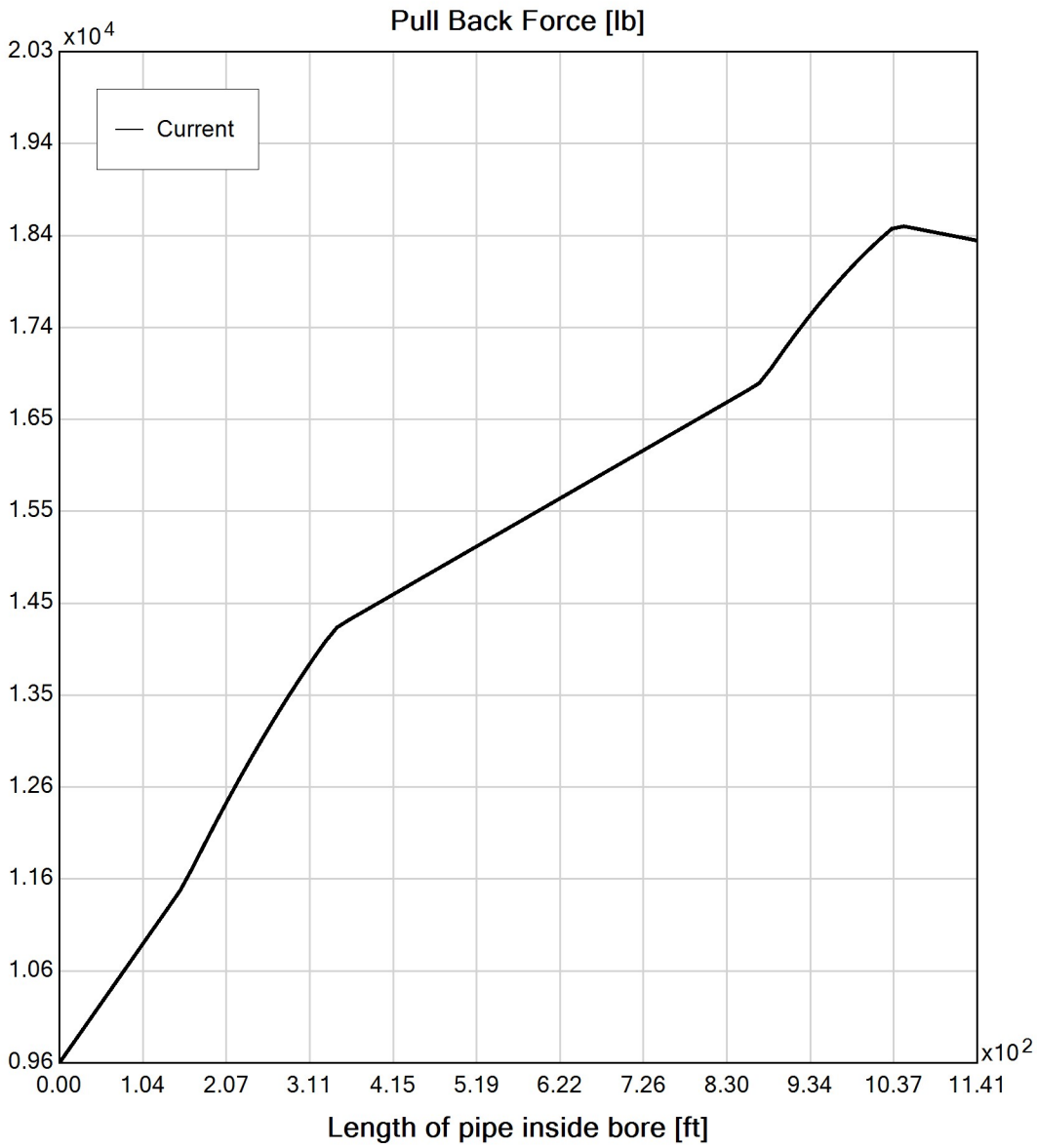
Plastic Viscosity (PV): 25.53

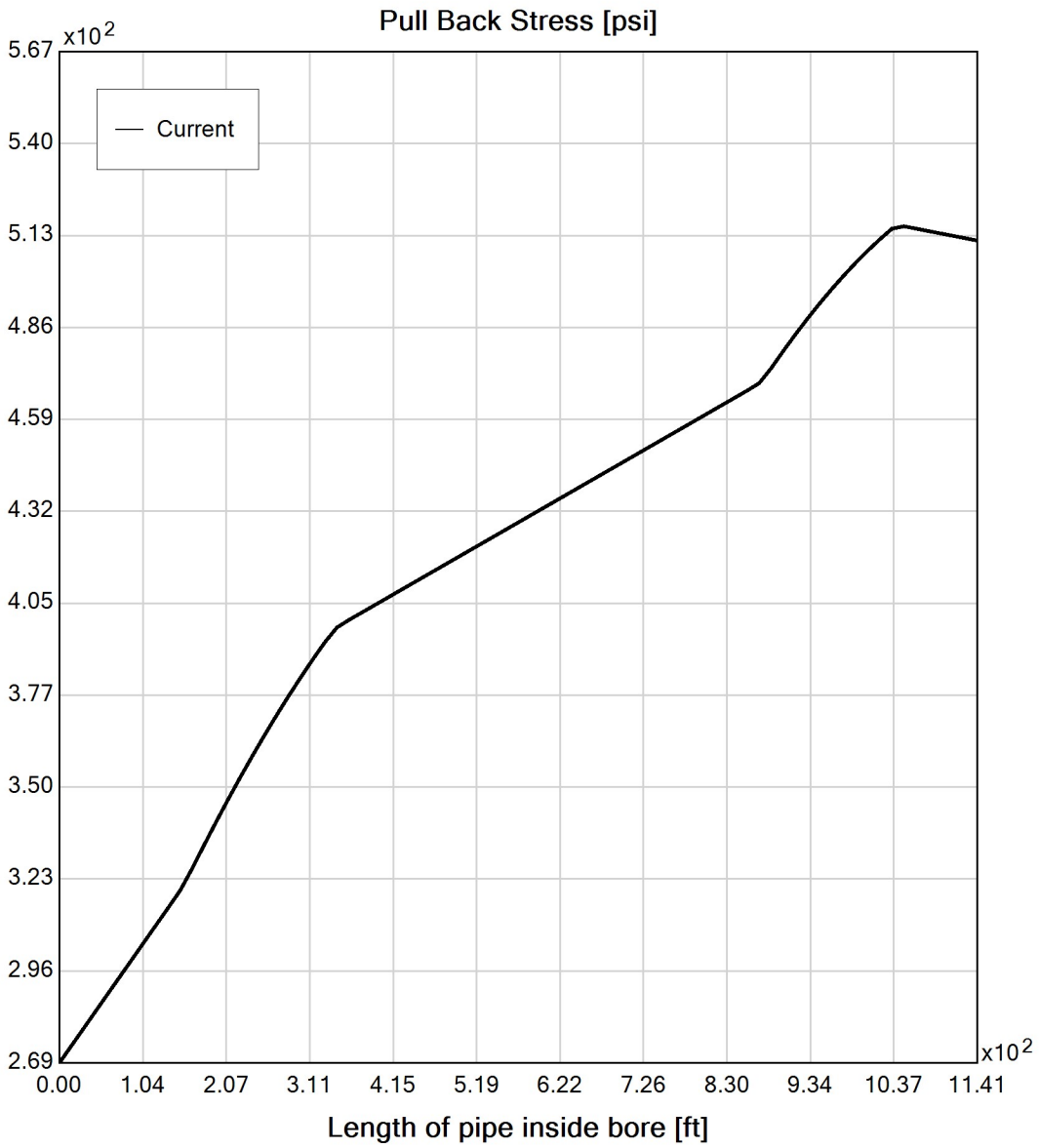
Yield Point (YP): 16.49

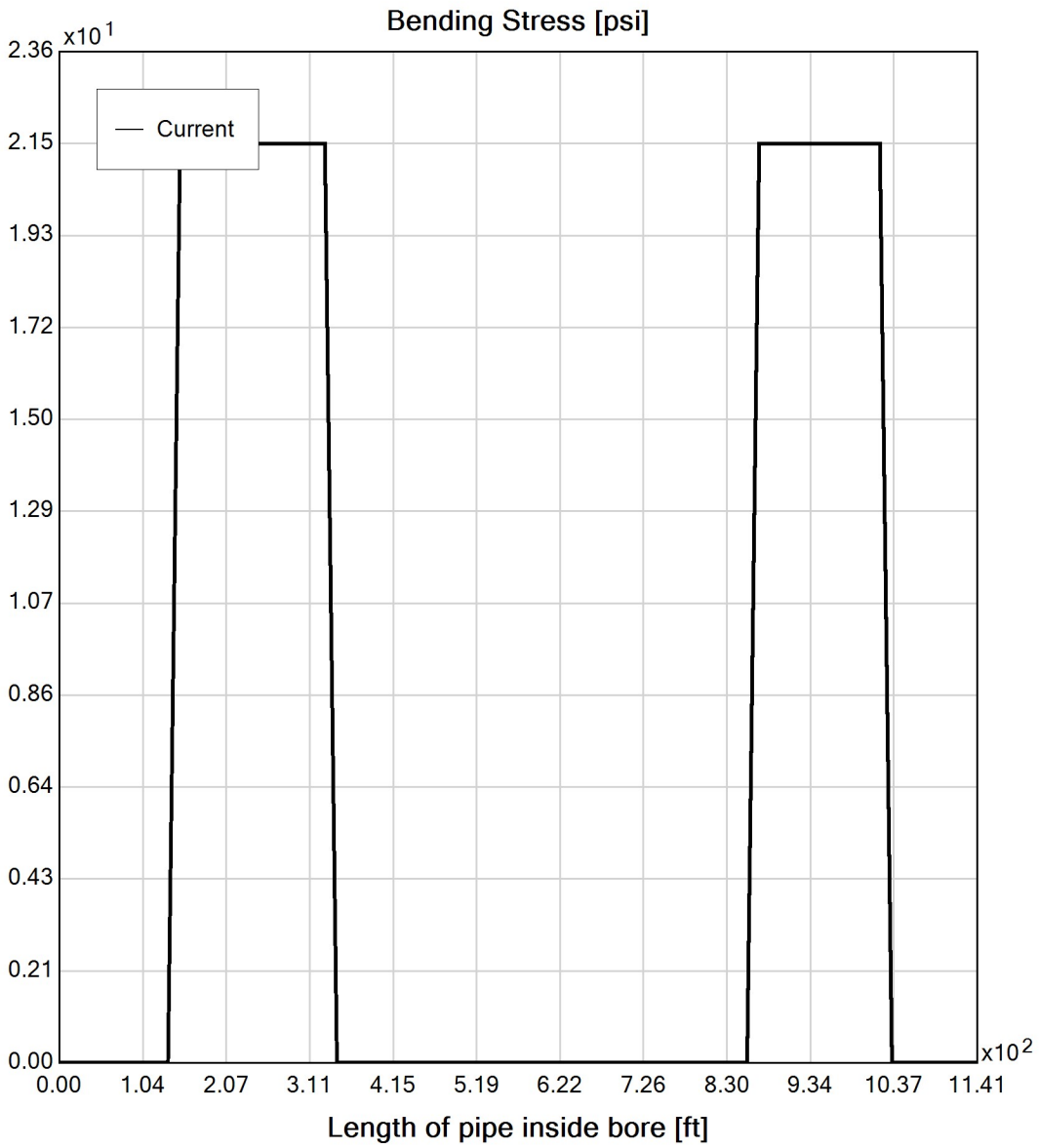
Effective Viscosity (cP): 417.7

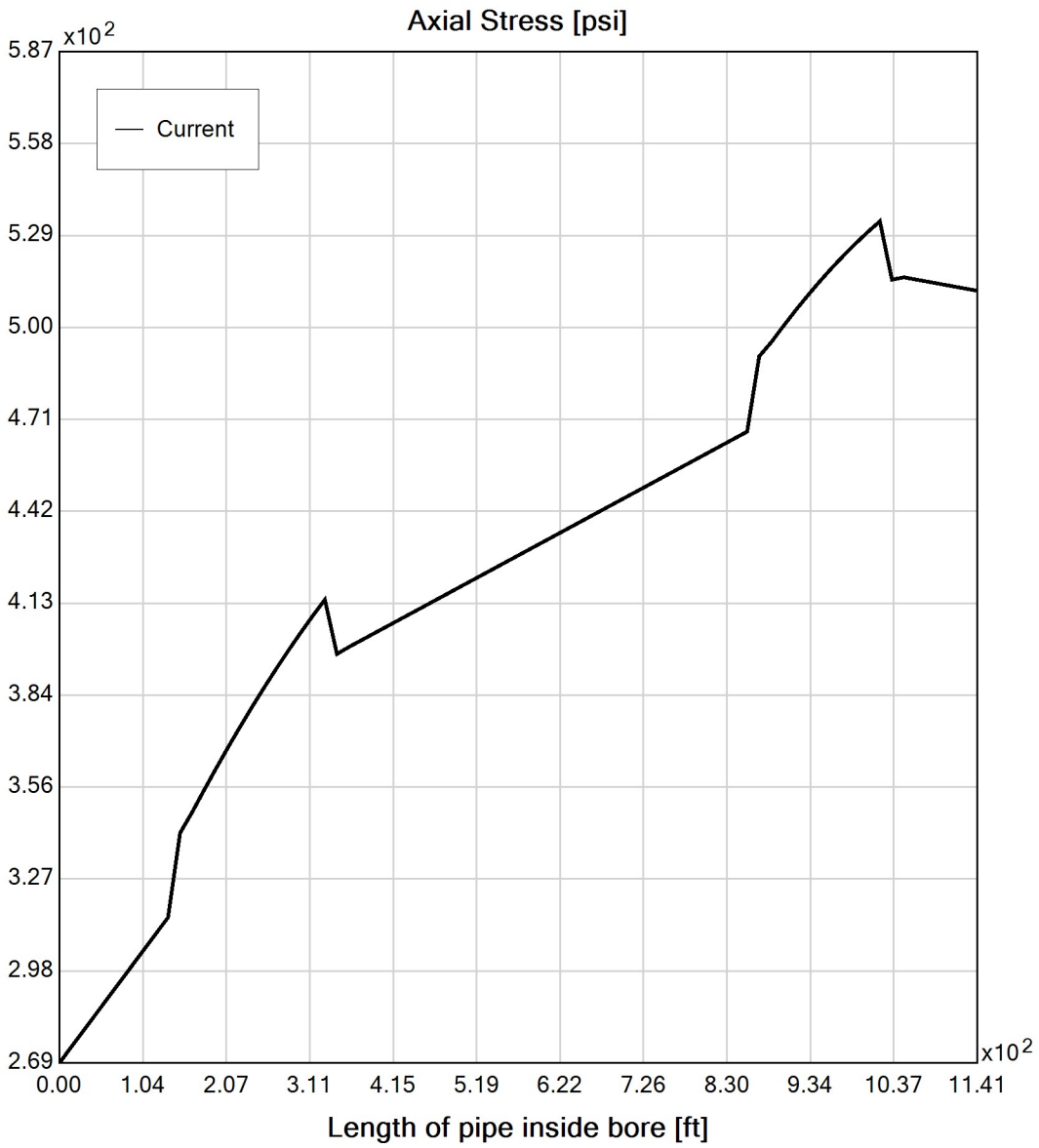
Virtual Site

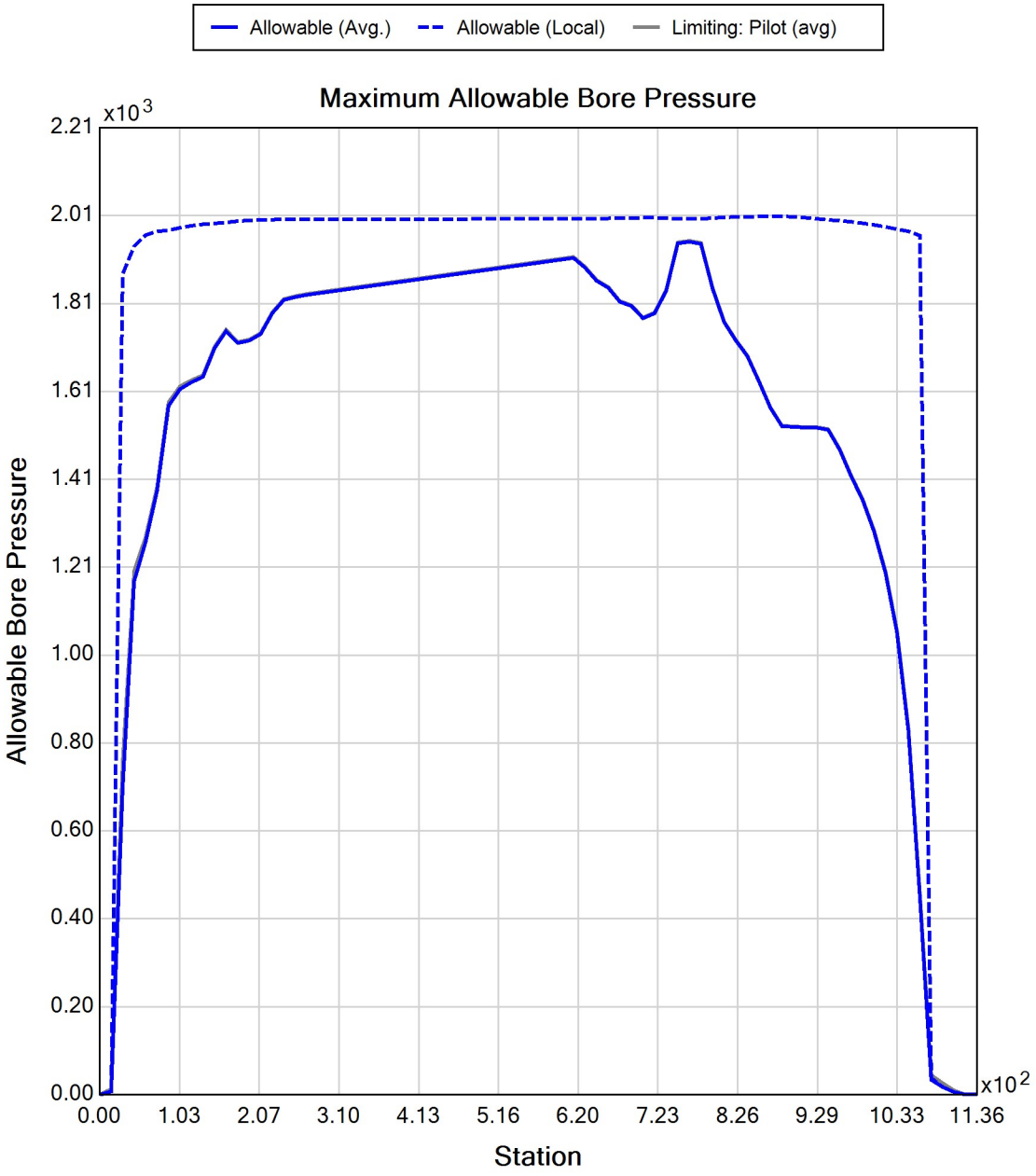


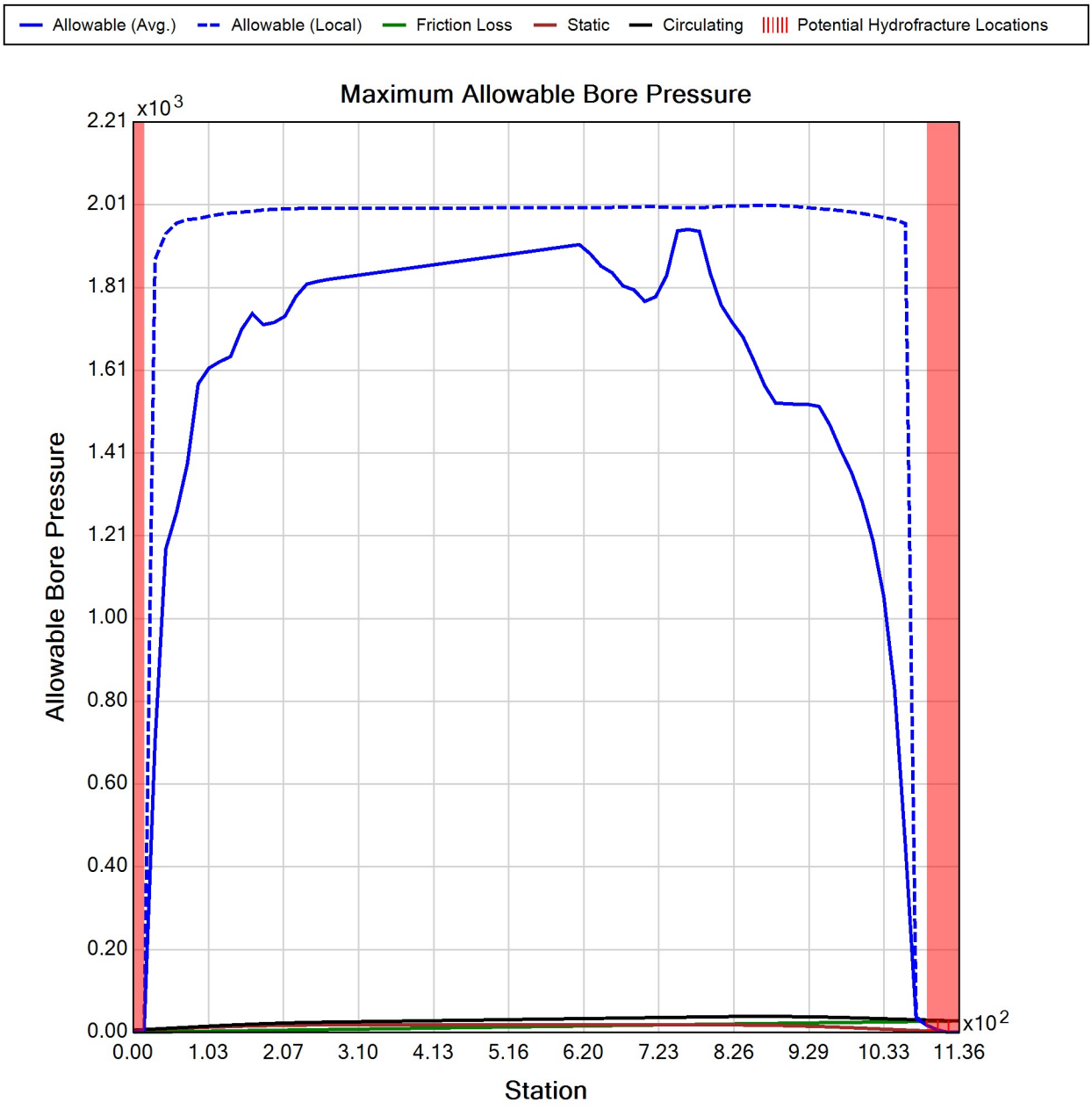












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Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 59 Reversed Conduit 1 2-inch DR-9

Input Summary

Start Coordinate	(0.00, 0.00, 260.00) ft
End Coordinate	(1124.00, 0.00, 269.00) ft
Project Length	1124.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 1140.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.3	24.0
Water Pressure	10.7	9.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.0	33.9
Deflection		
Earth Load Deflection	0.640	6.619
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.669	6.648
Compressive Stress [psi]		
Compressive Wall Stress	58.4	152.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1012.4	1012.4
Pullback Stress [psi]	578.5	578.5
Pullback Strain	1.006E-2	1.006E-2
Bending Stress [psi]	0.0	4.7
Bending Strain	0	8.247E-5
Tensile Stress [psi]	578.5	579.4
Tensile Strain	1.006E-2	1.016E-2

Net External Pressure = 25.4 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.669	7.5	11.2	OK
Unconstrained Collapse [psi]	24.6	130.1	5.3	OK
Compressive Wall Stress [psi]	58.4	1150.0	19.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	34.6	222.6	6.4	OK
Tensile Stress [psi]	579.4	1200.0	2.1	OK

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Project Summary

General:	CHPE HDD 59 P4A Start Date: 06-07-2023 End Date: 06-07-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 59 Reversed Conduit 2 10-inch DR9

Input Summary

Start Coordinate	(0.00, 0.00, 260.00) ft
End Coordinate	(1159.00, 0.00, 268.00) ft
Project Length	1159.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 4

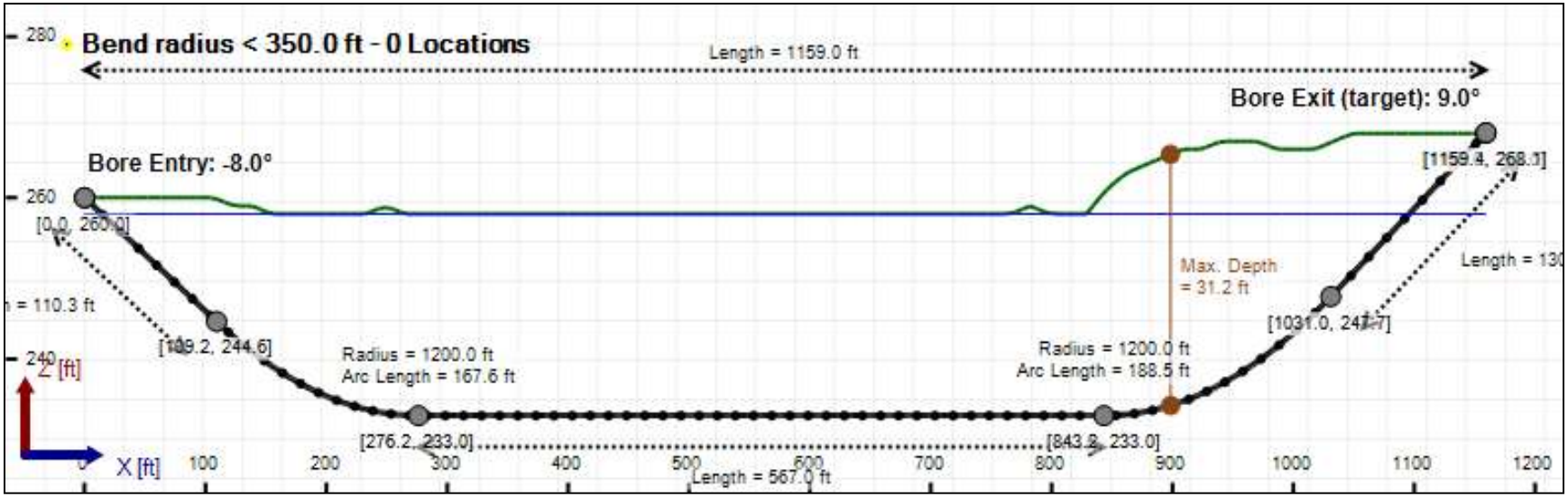
Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 500.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 100.0000 (dry), 120.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 400.00, Coh: 8.30 [psi]

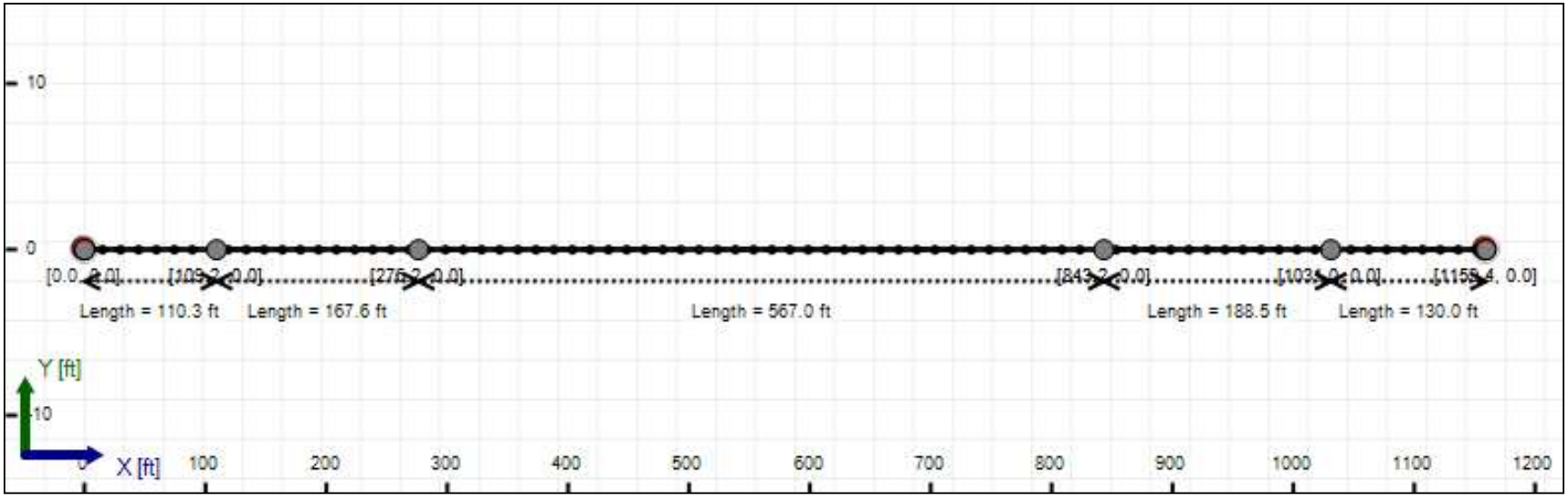
Soil Layer #3 USCS, Gravel (G), GP
From Assistant
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #4 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 2000.00, Coh: 3000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 1170.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.34400002161662 ft
Silo Width: 1.34400002161662 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.7	23.2
Water Pressure	10.9	10.3
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	16.5	33.5
Deflection		
Earth Load Deflection	1.551	6.308
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.683	6.440
Compressive Stress [psi]		
Compressive Wall Stress	74.3	150.6

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	18825.8	18825.8
Pullback Stress [psi]	525.0	525.0
Pullback Strain	9.131E-3	9.131E-3
Bending Stress [psi]	0.0	21.5
Bending Strain	0	3.733E-4
Tensile Stress [psi]	525.0	543.4
Tensile Strain	9.131E-3	9.824E-3

Net External Pressure = 24.1 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.683	7.5	4.5	OK
Unconstrained Collapse [psi]	23.5	118.8	5.1	OK
Compressive Wall Stress [psi]	74.3	1150.0	15.5	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	33.5	224.1	6.7	OK
Tensile Stress [psi]	543.4	1200.0	2.2	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	1959.396 psi	2008.966 psi
1	8.00 in	12.00 in	1958.483 psi	2008.366 psi
2	12.00 in	16.13 in	1957.158 psi	2007.496 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 120.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

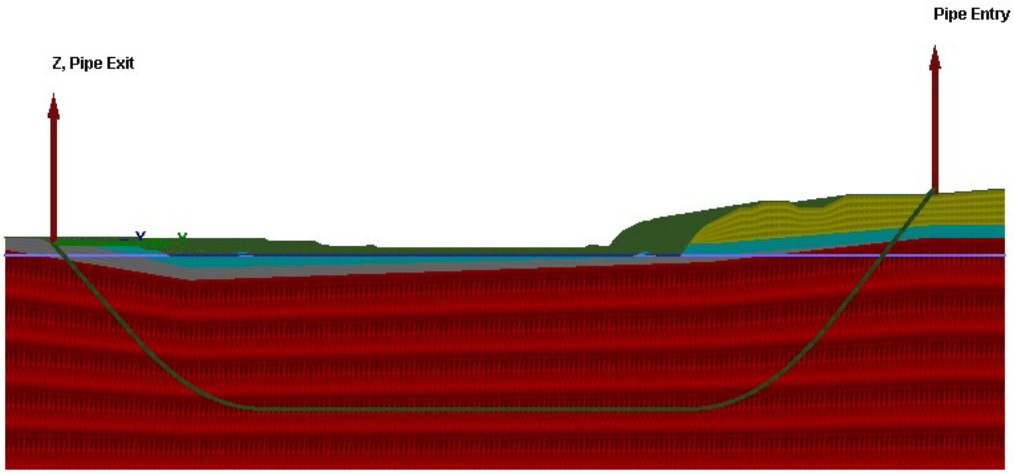
Rheological model: Bingham-Plastic

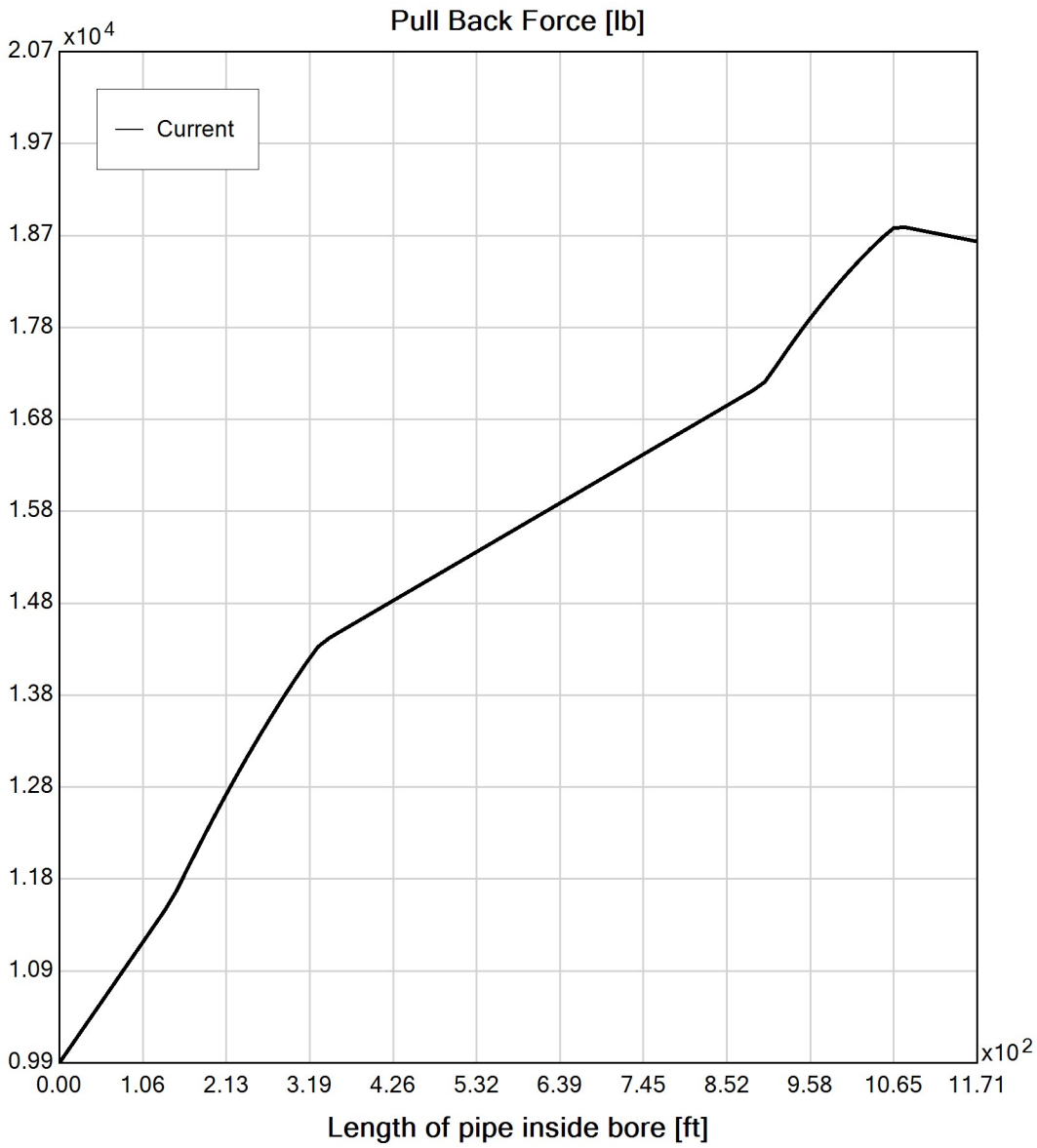
Plastic Viscosity (PV): 25.53

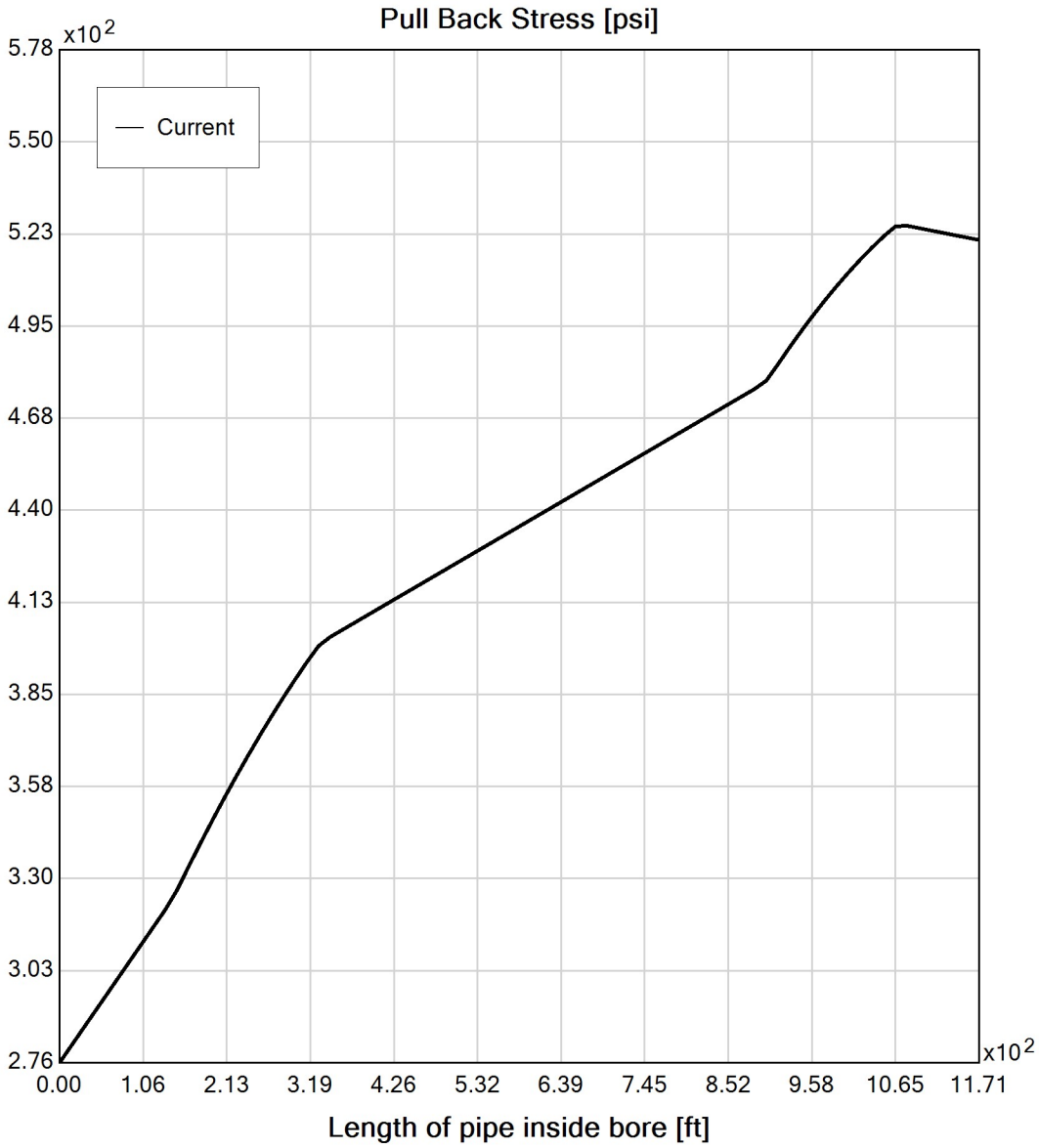
Yield Point (YP): 16.49

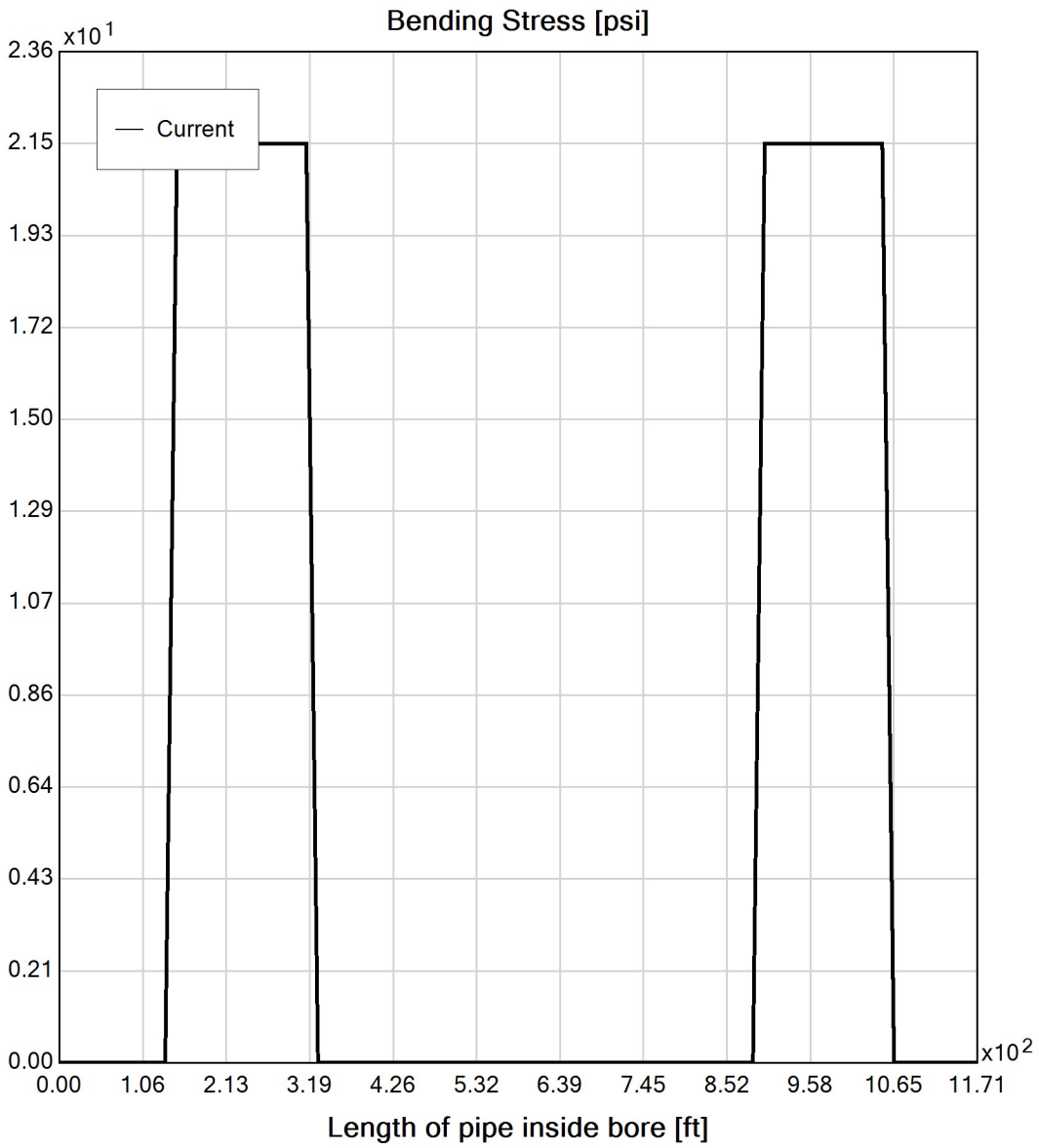
Effective Viscosity (cP): 417.7

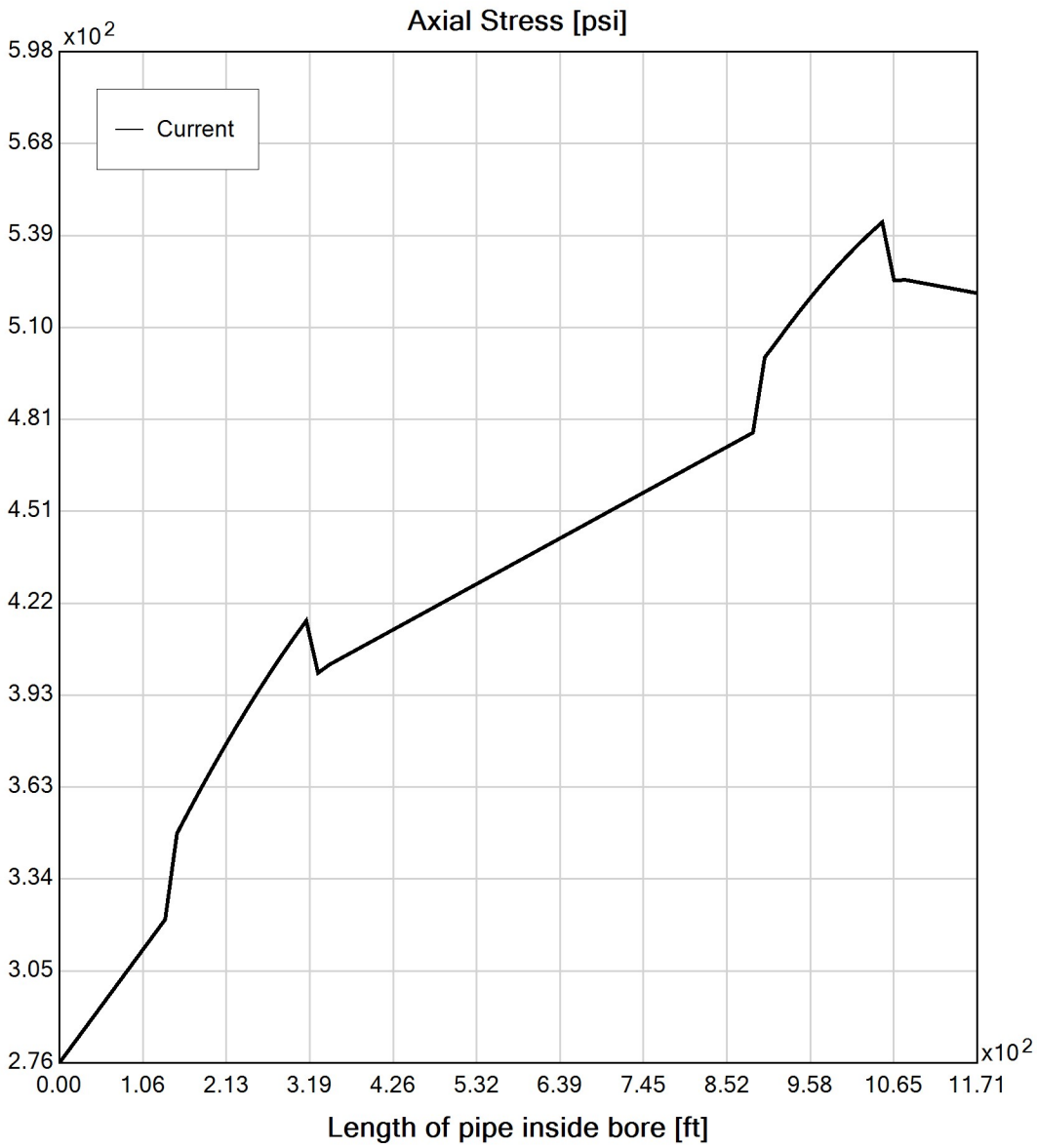
Virtual Site

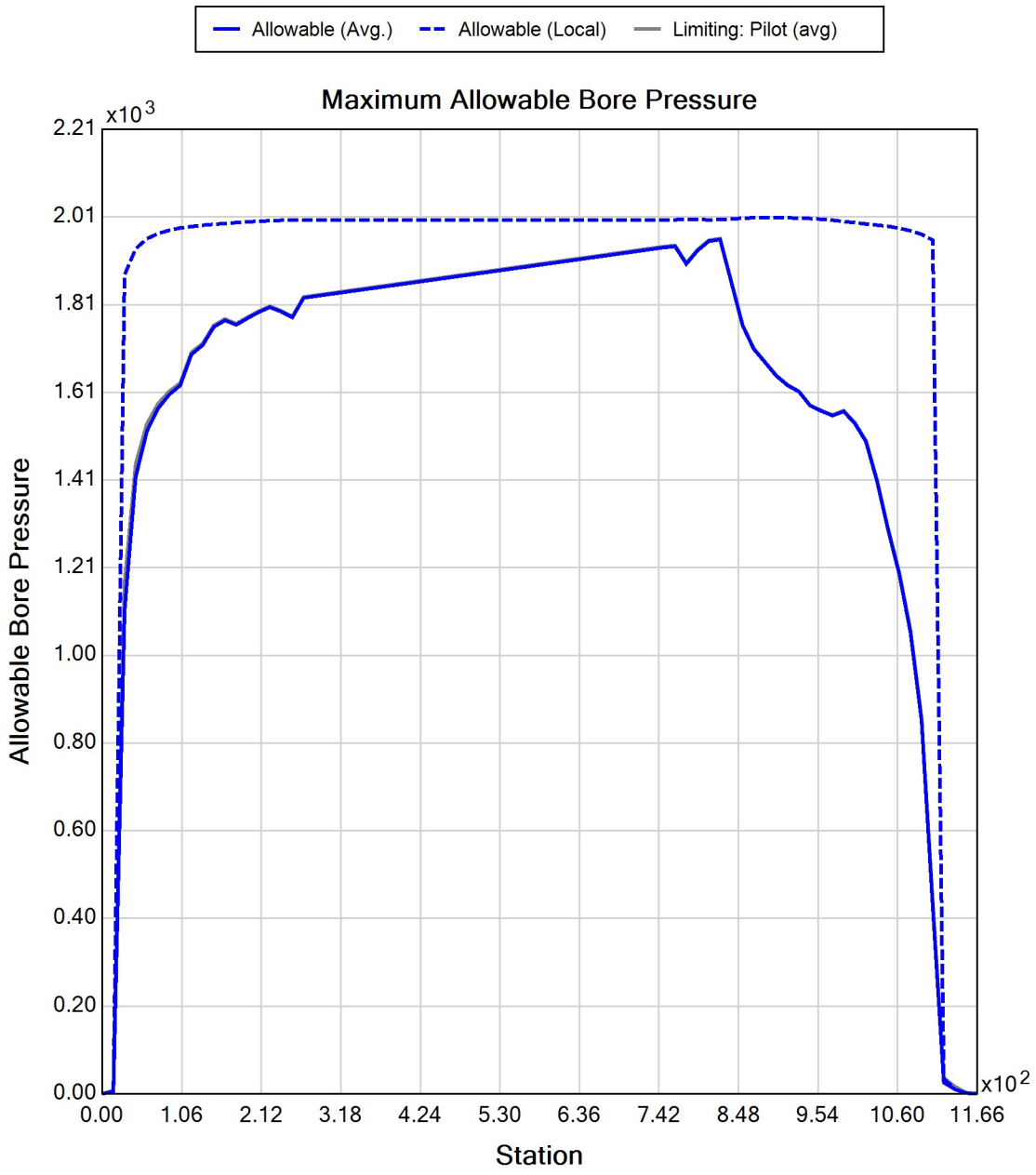


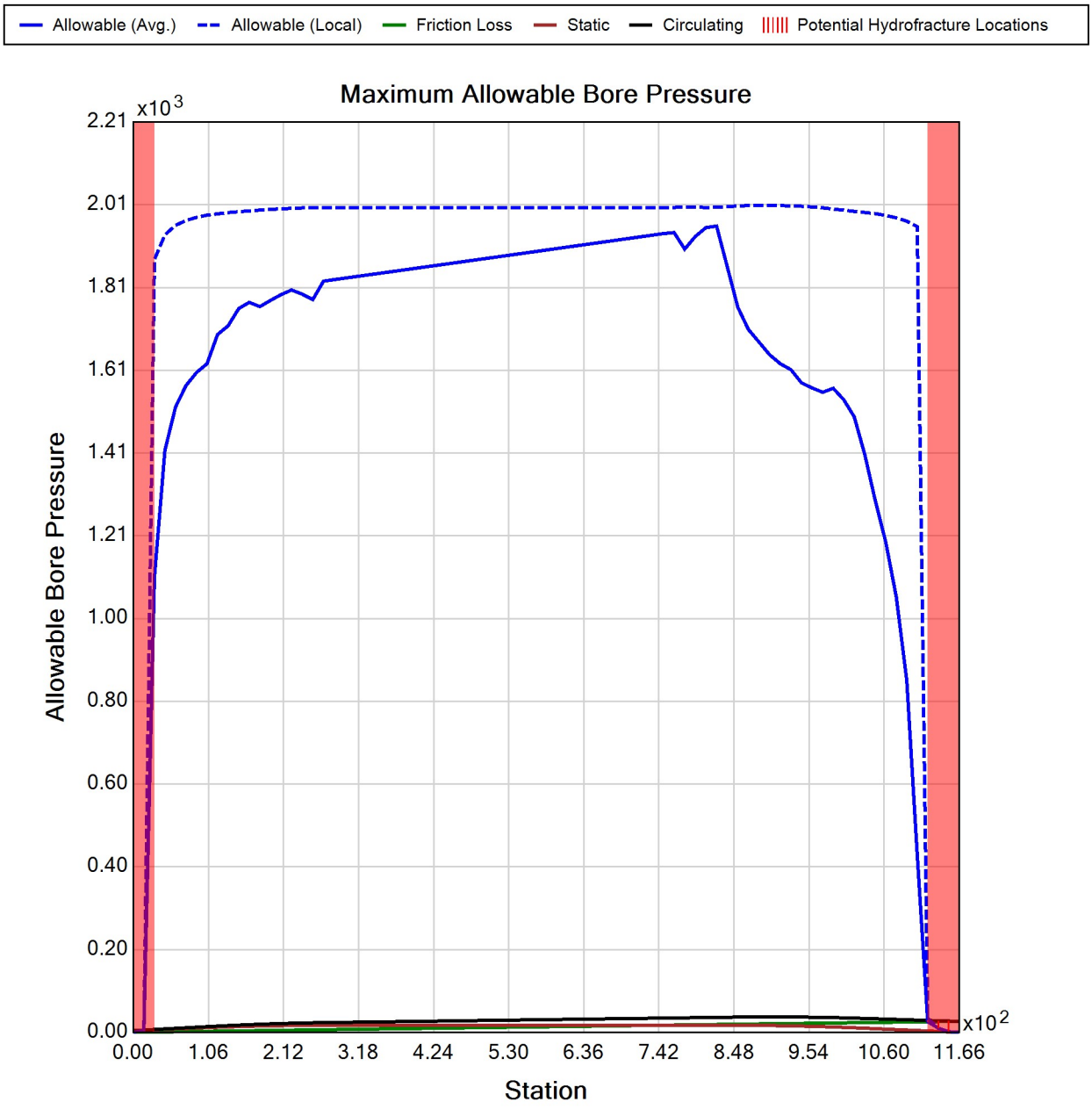












Generated Output

WARNING: The accuracy of the data obtained by the BoreAid® system is highly dependent upon accurate data gathering, data input and proper use of the software. Vermeer is not responsible for that information. BoreAid® data is not intended to replace the need for future on-site utility locating, measuring and verification procedures, which are essential for accurate placement of new underground installations and avoidance of existing utilities.

CALL YOUR ONE-CALL SYSTEM FIRST

WARNING: Always contact your local One-Call system before the start of your digging project. The BoreAid® system is intended to be used with other utility locating methods, such as the use of the One-Call system and the exposing of existing utilities by potholing.

Locate utilities before drilling. Call 811 (U.S. only) or 1-888-258-0808 (U.S. or Canada) or local utility companies or national regulating authority.

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Project Summary

General:	CHPE HDD 59 P4A Start Date: 06-07-2023 End Date: 06-07-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA
Designer:	MDB BCE Amherst, MA
Description:	HDD 59 Reversed Conduit 2 2-inch DR9

Input Summary

Start Coordinate	(0.00, 0.00, 260.00) ft
End Coordinate	(1159.00, 0.00, 268.00) ft
Project Length	1159.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 1170.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.531000018119812 ft
Silo Width: 0.531000018119812 ft
Surface Surcharge: 0 psi
Short Term Modulus: 57500 psi
Long Term Modulus: 28200 psi
Short Term Poisson Ratio: 0.35
Long Term Poisson Ratio: 0.45
Pipe Unit Weight: 59.30500 lb/ft3
Allowable Tensile Stress (Short Term): 1200 psi
Allowable Tensile Stress (Long Term): 1100 psi
Allowable Compressive Stress (Short Term): 1150 psi
Allowable Compressive Stress (Long Term): 1150 psi
Surface-pipe friction coefficient at entrance: 0.5
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.3	23.2
Water Pressure	10.9	10.3
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.2	33.5
Deflection		
Earth Load Deflection	0.641	6.308
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.670	6.337
Compressive Stress [psi]		
Compressive Wall Stress	59.4	150.6

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1028.5	1028.5
Pullback Stress [psi]	587.6	587.6
Pullback Strain	1.022E-2	1.022E-2
Bending Stress [psi]	0.0	4.7
Bending Strain	0	8.247E-5
Tensile Stress [psi]	587.6	589.3
Tensile Strain	1.022E-2	1.033E-2

Net External Pressure = 24.1 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.670	7.5	11.2	OK
Unconstrained Collapse [psi]	23.5	130.1	5.5	OK
Compressive Wall Stress [psi]	59.4	1150.0	19.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	33.5	221.9	6.6	OK
Tensile Stress [psi]	589.3	1200.0	2.0	OK

Generated Output

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Project Summary

General:	CHPE HDD 59A
	P4A
	Start Date: 05-16-2023
	End Date: 05-16-2023
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	MDB
	BCE
Description:	HDD 59A 8 -inch DR18 . Ballast Rollers PVC IPS pipe C1

Input Summary

Start Coordinate	(0.00, 0.00, 264.60) ft
End Coordinate	(1826.00, 0.00, 262.20) ft
Project Length	1826.00 ft
Pipe Type	PVC
OD Classification	IPS
Pipe OD	8.625 in
Pipe DR	18.0
Pipe Thickness	0.48 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 4

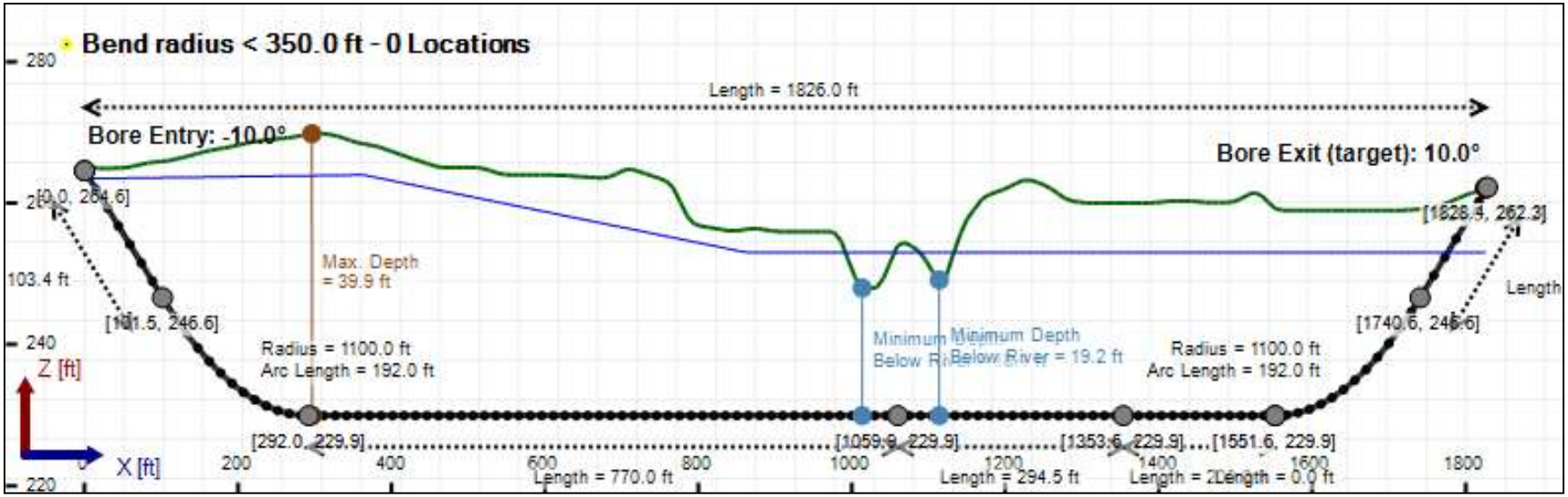
Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 500.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 5.10 [psi]

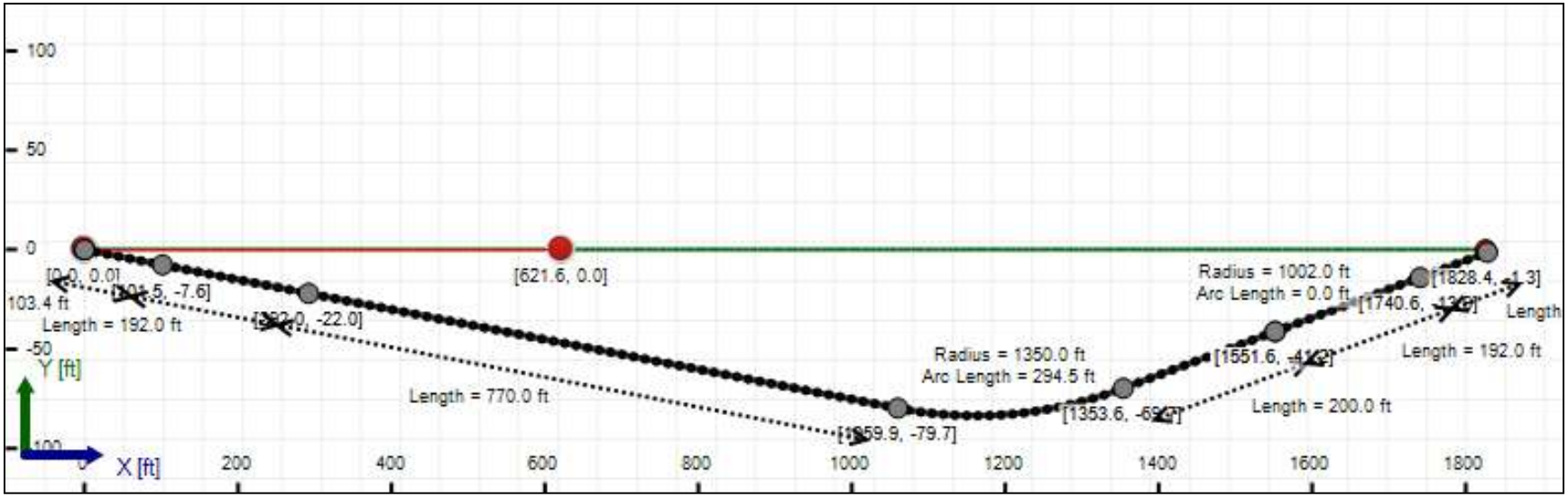
Soil Layer #3 USCS, Gravel (G), GM
From Assistant
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

Soil Layer #4 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 2000.00, Coh: 3000.00 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: PVC
Classification: IPS
Pipe OD: 8" (8.625")
Pipe DR: 18
Pipe Length: 1845.00 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.07799990971883 ft
Silo Width: 1.07799990971883 ft
Surface Surcharge: 0 psi
Short Term Modulus: 400000 psi
Long Term Modulus: 400000 psi
Short Term Poisson Ratio: 0.38
Long Term Poisson Ratio: 0.38
Pipe Unit Weight: 87.40220 lb/ft3
Allowable Tensile Stress (Short Term): 2800 psi
Allowable Tensile Stress (Long Term): 2800 psi
Allowable Compressive Stress (Short Term): 3200 psi
Allowable Compressive Stress (Long Term): 3200 psi
Surface-pipe friction coefficient at entrance: 0.1
Surface-pipe friction coefficient in borehole: 0.3
Pipe-soil friction angle: 30
Slurry Unit Weight: 93.64118 lb/ft3
Hydrokinetic Pressure: 10 psi
Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	4.5	28.3
Water Pressure	14.8	14.7
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	19.3	43.0
Deflection		
Earth Load Deflection	0.857	5.208
Buoyant Deflection	0.060	0.060
Reissner Effect	0	0
Net Deflection	0.917	5.268
Compressive Stress [psi]		
Compressive Wall Stress	173.3	387.0

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	27818.0	27818.0
Pullback Stress [psi]	2268.6	2268.6
Pullback Strain	5.671E-3	5.671E-3
Bending Stress [psi]	0.0	143.5
Bending Strain	0	3.587E-4
Tensile Stress [psi]	2268.6	2391.0
Tensile Strain	5.671E-3	6.304E-3

Net External Pressure = 13.4 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 365.0 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.917	7.5	8.2	OK
Unconstrained Collapse [psi]	22.5	175.3	7.8	OK
Compressive Wall Stress [psi]	173.3	3200.0	18.5	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.060	7.5	125.5	OK
Unconstrained Collapse [psi]	17.5	141.2	8.1	OK
Tensile Stress [psi]	2391.0	2800.0	1.2	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	1998.702 psi	2018.341 psi
1	8.00 in	12.00 in	1996.917 psi	2017.976 psi
2	12.00 in	16.13 in	1994.331 psi	2017.447 psi

Note: The maximum bore pressures presented in this table are the maximum values along the length of the bore and not the maximum allowable at any point. The estimated maximum pressures should be compared to the estimated circulating pressures along the bore to determine potential locations of inadvertant returns.

Estimated Circulating Pressure Summary

Active	Shear Rate [rpm]	Shear Stress [Fann Degrees]
No	600	37
No	300	32
No	200	29
Yes	100	25
Yes	6	17
No	3	15

Flow Rate (Q): 40.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

Rheological model: Power-Law

Fluid Consistency Index (K): 63.17

Power Law Exponent (n): 0.14

Effective Viscosity (cP): 859.3

Virtual Site