Inadvertent Release Contingency Plan for Horizontal Directional Drilling in Segments 4 & 5 - Package 3

Fort Edward to Milton
Washington County to Saratoga County, New York

CHA Project Number: 066076

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TABLE OF CONTENTS

LIST OF REFERENCED APPENDICES

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 a larger diameter (i.e. 12-inch and 3-inch) HDPE conduits and larger DR values, thicker walls, (i.e. DR 7) to resist tension stresses during installation and collapsing long-term. 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 Segments 4 & 5 - Package 3 which includes thirty (30) HDD crossings: HDD#21B through HDD#50, including A and B designations.

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, to congested areas, to 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 if 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 Holder, 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 HDD 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, (formally National Sanitation Foundation) 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 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 slurry (bentonite and water) 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 cuttings from the 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 lubricant during the pipe 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 (SDS) regarding any additives 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 or 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 lists 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 Holder	Name, Title TDI Phone Email
Construction Manager	TBD
HDD Construction Subcontractor	
	TBD
HDD Design Engineer Team	TBD - contact
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 Division of Environmental Permits 625 Broadway, 4th Floor Albany, NY 12233-1750 518-402-9167 depenergy@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 Holder, 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 railroad tracks. Measures are discussed throughout this report to control/mitigate any potential releases before environmentally sensitive boundaries are reached or impacted.

3.3 CERTIFICATE HOLDER

The project Certificate Holder is 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 Design Engineer 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 selected Third Party Engineer will be assisting Transmission Developers Inc with the review of the 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, and local and federal regulations.

3.7 HDD CONSTRUCTION SUBCONTRACTOR

The HDD Construction Subcontractors (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 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 HDD 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/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

Each 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 soil 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, 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 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;

- Use of conductor casings/conduits at the entry and exit ends of bores when ability of the ground to provide sufficient confinement to resist the drilling slurry pressures is expected;
- 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 NSF certified drilling solution 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 HDD 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 HDD 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 and to prevent inadvertent releases of drilling fluid;
- 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;
- Safety Data Sheet (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;
- For HDD operations within 100 feet of a water body, secondary containment will be required where overnight storage of materials and equipment occurs and where refueling occurs.
- 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). Intended approach shall 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) Certificate Holders 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 layouts are to be adjusted based on actual

space available and constraints 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 HDD. However, the drilling fluid management system and subsequent disposal will adhere to the following requirements:

- Drilling fluid will be processed through an initial clearing that separates the solid materials from the fluid;
- Solids will be sifted out by a screening apparatus/system and the solids deposited into a roll-off 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;
- 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; and,
- Under no circumstances will drilling fluid that has escaped containment be reused in the drilling system.

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.

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 buildup 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 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 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, 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 HDD Subcontractor will be required to contain/isolate and remove any fluid that has emanated from the 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 immediately respond 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 HDD Subcontractor will work closely to determine the best course of action for inadvertent releases occurring within upland areas.

Upon containment of the release, the HDD 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 place 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 (i.e., when 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 HDD 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 Subcontractor must abandon the drilled hole, a plan to fill the abandoned hole will be implemented as detailed in the 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 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 of steering difficulties due to the presence of a hydraulic connection causing drill fluid loss to the abandoned hole.

9.0 CROSSING SPECIFIC DISCUSSION

9.1 HDD CROSSING #21B

HDD #21B consists of two HDD bores located west of the CP Railroad Canadian Mainline, east of the Hudson River. The bores are approximately 903 feet and 947 feet long as shown in Appendix B. The HDD bores will remain on the westly side of the railroad tracks and will pass approximately 30feet underneath a 60" RCP culvert in Fort Edward, NY. The ground surface elevation at the entry pit of bore alignment is approximately El.143 and at exit pit is approximately El. 135, while in middle it undulates between El. 132 to El. 147 along the path (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. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #21B – Based on borings drilled for this project, the soil profile for the HDD #21B BoreAid analysis was divided into five (5) layers: loose fill, medium compact poorly graded sand, medium stiff low plasticity clay, medium compact well graded sand and very soft low plasticity clay. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #21B 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 underneath a 60" RCP culvert is approximately 30 feet. Preliminary analysis of the bore, assuming typical drilling methods, indicates that the allowable lowest maximum allowable pressure capacity in the middle of the bore is approximately 64 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 28 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 99 psi and the approximate applied slurry pressure during drilling ranges from 0 to 34 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 to 30 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.

9.2 HDD CROSSING #22

HDD #22 consists of two HDD bores under the CP Railroad Canadian Mainline, north of the Hudson River. The bores are approximately 1251 feet and 1277 feet long as shown in Appendix B. The HDD bores will pass approximately 33 to 36 feet below railroad tracks and 25 to 30 feet below East Street in Fort Edward, NY. HDD bores will have both vertical and horizontal curves. The ground surface gently fluctuates between approximately El. 142 and El. 137 (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 then East St. No portion of work zones are to be within 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 #22 – Based on the borings drilled for this project, the soil profile for the HDD #22 BoreAid analysis will be divided into eight (8) layers: loose fill (SP), dense well graded sand (SW), loose well graded gravel (GW), loose poorly graded sand (SP), loose well graded sand (SW), loose poorly graded sand (SP), loose well graded sand (SW), and soft fat clay (CH). The soil profiles used for BoreAid analyses for the HDD in these segments are presented in Appendix A.

Specific design considerations for HDD #22 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover underneath railroad tracks is approximately 33 to 36 feet and 25 to 30 feet below East Street. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 74 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 bores the maximum allowable pressure ranges from approximately 0 to 77 psi and the approximate applied slurry pressure during drilling ranges from 0 to 37 psi. Sketches 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 the entry pit and ending 28 ft of each bore near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.

9.3 HDD CROSSING #24

HDD #24 consists of two HDD bores located east of the CP Railroad Canadian Mainline, north of the Hudson River. The bores are approximately 3406 feet and 3549 feet long as shown in Appendix B. The HDD bores will pass approximately 75 feet below Canal Street and Broadway approximately 45 to 50 feet below the Hudson River in Fort Edward, NY. The ground surface elevation at the entry point is approximately El. 133, gently fluctuates between El. 130 and El.145

for the first half of alignment, while dipping down near water level at El.120 and then climbing up to El. 163 at the exit point (reference datum NAVD 1988).

Ground conditions at HDD #24 - Based on the borings drilled for this project, the soil profile for the preliminary HDD #24 BoreAid analysis will be divided into four (4) layers: loose silty sand, soft lean clay, medium dense poorly graded sand, and shale bedrock. The soil profiles used for BoreAid analyses for the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #24 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover underneath estimated mudline is approximately 40 to 50 feet and 75 feet below Canal Street. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 775 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 98 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 1303 psi and the approximate applied slurry pressure during drilling ranges from 0 to 140 psi. Sketches 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 20 ft of each bore near the entry pit and ending 265 ft of each bore near the exit pits exist. Due to this condition, the use of the intersecting bore method with a conductor casing at the south end is recommended to better control drilling pressures and the risk of a potential inadvertent release.
- 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 pressure with down-the-hole sensors during pilot hole drilling,
- Recommending the use of intersect bore method (drilling the pilot bore from each end and meeting in the middle) to reduced slurry pressures at the exit end during pilot bore drilling, thereby reducing the potential for a released at the exit end of the pilot bore, and
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.4 HDD CROSSING #24A

HDD #24A consists of two HDD bores under the CP Railroad Canadian Mainline, south of the Hudson River. The bores are approximately 884 feet long as shown in Appendix B. The HDD bores will pass approximately 30 to 33 feet below W. River Road and the railroad tracks and approximately 30 feet below a 24'' CMP culvert. The ground surface elevation along the path of HDD #24A gently undulates between El. 155 and El. 163 (reference datum NAVD 1988).

Portions of the work zones on entry 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 #24A - Based on the borings drilled for this project, the soil profile for the HDD #24A BoreAid analysis will be divided into six (6) layers: loose fill, loose clayey gravel, loose poorly graded sand, very soft low plasticity clay, very dense weathered rock and shale bedrock. The soil profiles used for BoreAid analyses for the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #24A include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the 24" CMP Culvert is approximately 30 feet and 33 feet below W. River Road and the railroad tracks. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 37 psi (conduit 1) & 31 psi (conduit 2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 26 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 56 psi (conduit 1) & 61 psi (conduit 2) and the approximate applied slurry pressure during drilling ranges from 0 to 30 psi. Sketches 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 to 30 ft of each bore near the entry and exit pits. 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.5 HDD CROSSING #25

HDD #25 consists of two HDD bores located under the CP Railroad Canadian Mainline, south of the Hudson River. The bores are approximately 1754 feet and 1726 feet long as shown in Appendix B. The HDD bores will pass approximately 40 to 60 feet below wetlands and approximately 40 feet below a 28" (cast-in-place) CIP Culvert located west of the CP Railway. The ground surface elevation along the path of HDD #25 ranges from approximately El. 152 at the entry point of bore alignment, to approximately El. 125 at the middle of the bore, to El. 147 at the exit point of bore alignment (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 #25 - Based on borings drilled for this project, the soil profile for the HDD #25 BoreAid analysis was divided into six (6) layers: loose poorly graded sand, medium stiff lean clay, soft lean clay, medium dense well graded sand, loose well graded sand, and shale. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #25 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the 28" CIP Culvert is approximately 40 feet. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle

of the bores is approximately 70 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 50 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 670 psi (conduit 1) & 560 psi (conduit 2) and the approximate applied slurry pressure during drilling ranges from 0 to 60 psi. Sketches 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 ending 30 to 60 ft of each bore near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain

drilling fluids during drilling reaming and pullback.

9.6 HDD CROSSING #25A

HDD #25A consists of two, straight, HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 765 feet long as shown in Appendix B. The HDD bores will pass approximately 25 feet below wetlands and a 45" reinforced concrete pipe (RCP) located east of the CP Railway. The ground surface elevation fluctuates between approximately at El. 153 at the highest point down to El. 131 at the wetlands near the 45" RCP. The entry/exit pits are between El. 142 and El. 144 (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #25A - Based on borings drilled for this project, the soil profile for the HDD #25A BoreAid analysis was divided into six (6) layers: loose fill, medium stiff low plasticity clay, medium stiff low plasticity silt, loose silty sand, loose clayey sand and shale bedrock. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #25A include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under wetlands is approximately 25 feet near the center of the bores. Preliminary analyses of the bore indicate the lowest maximum allowable pressure capacity in the middle of the bore is to be approximately 380 psi (conduit 1) & 500 psi (conduit 2). The total circulating pressure estimated to occur in the middle portion of the bore is approximately 25 psi (conduit 1 & conduit 2) assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 530 psi (conduit 1) & 0 to 670 psi (conduit 2) and the approximate applied slurry pressure during drilling ranges from 0 to 26 psi (conduit 1 & conduit 2). Sketches 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 of inadvertent release at the starting 10 to 15 feet and ending 15 to 45 feet of each bore near entry and 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, and
- 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 each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.7 HDD CROSSING #26

HDD #26 consists of two, curved (in plan view), HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River in Moreau, NY. The bores are approximately 2036 feet and 2042 feet long as shown in Appendix B. The HDD bores will pass approximately 29-52 feet below designated wetlands and runs parallel about 700-1700 feet west of Route 29 (West River Road). The ground surface elevations along the path of HDD #26 gently slopes downward towards the center of the HDD alignment then upwards towards the exit pit, north to south, from approximately El. 147 to El. 132 to El. 155 (reference datum NAVD 1988). No waterbodies are present along the HDD path.

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. The majority of the work zones in this location are proposed to be within and minorly impact wetlands for both bore paths. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #26 - Based on borings drilled for this project, the soil profile for the HDD #26 BoreAid analyses will be divided into four [4] layers loose well graded sand, medium stiff high plasticity clay, dense weathered rock, and shale. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #26 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 wetlands is approximately 29 or more feet with a depth of cover of about 29 feet near the center of the bore path, and a maximum depth of cover of about 37 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 800 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 670 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 800 psi and the approximate applied slurry pressure during drilling ranges from 0 to 60 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 20 feet from the entry pit and last 100 feet, approximately, as each bore approaches the exit pit exist. This is related to the length and depth of the bores, and the increase in the ground surface elevation of approximately 8 feet from the entry to the exit pit.
- 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 each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.8 HDD CROSSING #27

HDD #27 consists of two, straight, HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 1087 feet long as shown in Appendix B. The HDD bores will pass approximately 48 feet below wetlands, and approximately 31 feet below a large, currently unknown sized culvert located west of the CP Railway. The ground surface elevation gently undulates between El. 158 and El. 151 for Conduit 2. Conduit 1 has a greater change in elevation, ranging from approximately El. 119 to El. 155 (reference datum NAVD 1988).

The bores will have vertical curves (no horizontal curves). The vertical curves of the bore path

are designed so that the bore will pass beneath the railroad tracks and the stream. 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 #27- Based on borings drilled for this project, the soil profile for the HDD #27 BoreAid analyses will be divided into four [4] layers: loose well graded sand, soft low plasticity clay, loose well graded sand, and soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #27 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 large (currently) unknown sized culvert is approximately 31 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 75 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 42 psi assumed standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 165 psi and the approximate applied slurry pressure during drilling ranges from 0 to 47 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 last 15 feet, approximately, as each bore approaches the exit pit exist. This is related to the length and depth of the bores, and the slight increase in elevation near the exit pit.
- 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 each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.9 HDD CROSSING #28

HDD #28 consists of two HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 636 feet and 645 feet long as shown in Appendix B. The HDD bores will pass below wetlands, and a 36-inch CMP culvert located west of the CP Railway. The ground surface elevation is at approximately El. 163 at the entry and exit points and gently dips to El. 153 at the center of the bores and the culvert crossing (reference datum NAVD 1988).

Portion of the work zone on southern 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 #28- Based on borings drilled for this project, the soil profile for the HDD #28 BoreAid analysis was divided into three (3) layers: medium dense silty sand, loose low plasticity silt, and soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #28 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General

depth of cover under the 36" CPM Culvert is approximately 16 feet. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 25 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 18 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 29 psi and the approximate applied slurry pressure during drilling ranges from 0 to 21 psi. Sketches 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 pits and the ending 30 feet near the exit pits exists. 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.10 HDD CROSSING #29

HDD #29 consists of two HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 1047 feet and 1049 feet long as shown in Appendix B. The HDD bores will pass approximately 28-32 feet below the wetlands and ending approximately 2500 feet northeast of where the railroad intersects Mott Road. The ground surface elevation is approximately El. 170 at the entry point and El. 174 at the exit points. It fluctuates gently between El. 168 and El. 177 (reference datum NAVD 1988). No waterbodies are present along the HDD path.

The bores will have no horizontal curves. The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks. The majority of the work zones in this location are proposed to be within and minorly impact wetlands for both bore paths. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #29 – Based on the borings drilled for this project, the soil profile for the HDD #29 BoreAid analyses will be divided into three [3] layers: loose well graded sand, medium dense well graded sand, and soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #29 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 wetlands is 28 or more feet with a depth of cover of about 28-32 feet near the center of the bore path. Preliminary analysis of the bore, assuming typical drilling

methods, indicates that lowest maximum allowable pressure capacity in the middle of the bore is approximately 43 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 27 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 54 psi and the approximate applied slurry pressure during drilling ranges from 0 to 33 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 pits and the ending 45 feet near the exit pits exists. 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 at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.11 HDD CROSSING #30

HDD #30 consists of two HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 1918 feet long as shown in Appendix B. The HDD bores will pass approximately 50+ feet below existing ground surface and approximately 15 feet below an irregular stone culvert. The ground surface elevations along the path of HDD #30 gently undulates between El. 160 and El. 220 (reference datum NAVD 1988). Snook Kill River passes under the railroad approximately halfway through the HDD alignment.

The bores will have no horizontal curves. The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks and Snook Kill River. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #30 - Based on the borings drilled for this project, the soil profile for the HDD #30 BoreAid analyses will be divided into five [5] layers: loose well graded sand, soft low plasticity clay, medium stiff fat clay, dense weathered rock, and shale bedrock. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #30 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, river or ground surface. General depth of cover under the existing ground surface is 50 or more feet with a depth of cover of about 15 feet below a stone culvert. 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 785 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 70 psi assumed standard HDD drilling

methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 1315 psi and the approximate applied slurry pressure during drilling ranges from 0 to 95 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 10 feet from the entry pit, approximately and the ending 150 to 250 feet from 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.
- 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 each end of each bore to contain

drilling fluids during drilling reaming and pullback.

9.12 HDD CROSSING #31

HDD #31 consists of two HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 1061 feet and 1070 feet long as shown in Appendix B. The HDD bores will pass approximately 27 feet below existing ground and 19 feet below a stream which connects to Rice Brook. The ground surface elevations along the path of HDD #31 gently slopes downwards from the proposed entry pit location (~El. 269) under the stream and wetlands (~El. 262) and then slopes upwards towards the proposed exit pit at approximately El. 270 (reference datum NAVD 1988). A stream feeding into Rice Brook and surrounding wetlands are present along the HDD path.

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 #31 - Based on the borings drilled for this project, the soil profile for the HDD #31 BoreAid analyses will be divided into three [3] layers: loose poorly graded sand, soft fat clay and medium dense poorly graded sand. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #31 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, stream/wetlands, or ground surface. General depth of cover under the existing ground is about 28 or more feet, and approximately 19 or more feet under the stream/wetlands near the center of the bore path. 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 39 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 24 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 48 psi and the approximate applied slurry pressure during drilling ranges from 0 to 29 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 10 feet from the entry pit and the last 30 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 each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.13 HDD CROSSING #32

HDD #32 consists of two HDD bores located parallel to the CP Railroad Canadian Mainline, north of Ballard Street. The bores are approximately 757 feet and 872 feet long as shown in Appendix B. The HDD bores will pass below the Ballard Street and the CP Railway that crosses Ballard St. The HDD bores will pass approximately 26 feet below railroad tracks. The ground surface elevation gently undulates between El. 304 and El. 309 (reference datum NAVD 1988). The proposed work at HDD#32 on the entry point is located to the west of CP Rail railroad track and at the exit point it will be on the east side of railroad tracks

No work is proposed within water bodies or 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 #32 - Based on borings drilled for this project, the soil profile for the HDD #9 BoreAid analysis was divided into three (3) layers: dense fill, loose silty sand, and medium dense silty sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #32 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the railroad tracks is approximately 26 ft near the center of the bore path. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 60 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 18 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 64 psi and the approximate applied slurry pressure during drilling ranges from 0 to 24 psi. Sketches 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 pits and the ending 15 feet near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.

9.14 HDD CROSSING #32A

HDD #32A consists of two HDD bores located east of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 633 feet long as shown in Appendix B. The HDD bores will pass approximately 25-30 feet below the existing ground. The HDD bores stays on the east side of the railway tracks for entire drill and pass underneath an environmentally sensitive area. The ground surface elevations along the path of HDD #32A gently slopes downwards from the proposed entry pit location (~El. 308) towards the exit pit at approximately El. 303 (reference datum NAVD 1988). No waterbodies are present along the HDD path.

The bores will have no horizontal curves. The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #32A - Based on borings drilled for this project, the soil profile for the HDD #32A BoreAid analysis was divided into two (2) layers: medium dense poorly graded sand

and loose silty sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix B.

Specific design considerations for HDD #32A include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, stream/wetlands, or ground surface. General depth of cover under the existing ground surface is about 25 or more 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 72 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 22 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 76 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 a potential for releases in approximately the last 15 feet, approximately, as each bore approaches the exit pit exist. This is related to the length and depth of the bores and the downward slope of the ground surface from the entry to exit pit being about 5 feet lower.
- 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.

9.15 HDD CROSSING #33

HDD #33 consists of two HDD bores located east of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 1859 feet long as shown in Appendix B. The HDD bores will pass approximately 55 feet below railroad tracks, south of Scout Road and 35 feet below Delegan Brook. Near the entry pits and work zone, both bores cross underneath an environmentally sensitive area. The ground surface elevations along the path of HDD #33 gently slopes upwards from the proposed entry pit location El. 319, while hovering most of the run between El. 305 and El. 315, following towards the proposed exit pit at approximately El. 313 (reference datum NAVD 1988). Delegan Brook and surrounding wetlands are present along the HDD path.

The bores will have vertical and horizontal curves; however, no compound will be present. The center of the bores will pass the CP Railway, the 48-inch cast iron drainage, and wetlands located within this location. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #33 - Based on the borings drilled for this project, the soil profile for the HDD #33 BoreAid analyses will be divided into four [4] layers: very dense ballast, medium dense poorly graded sand, loose poorly graded sand, and medium dense poorly graded sand. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #33 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, stream/wetlands, or ground surface. General depth of cover under the railroad is about 55 or more feet, and approximately 35 or more feet under the brook/wetlands near the center/south end of the bore path. 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 153 psi (conduit-1) & 124 psi (conduit-2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 45 psi (conduit-1) & 39 psi

(conduit-2) assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 181 psi (conduit-1) & 0 to 148 psi (conduit-2) and the approximate applied slurry pressure during drilling ranges from 0 to 52 psi (conduit-1) and 0 to 47 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 last 15 to 30 ft, 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 casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.16 HDD CROSSING #35

HDD #35 consists of two HDD bores located east of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 2550 feet and 2552 feet long as shown in Appendix B. The HDD bores will pass approximately 40 feet below estimated mudline and 48 feet below

wetlands south of Edie Road and west of Route 50. At the south end of the drill path, near the exit pits, both bores cross underneath an environmentally sensitive area. The ground surface elevations along the path of HDD #35 gently undulates along the HDD alignment (~El. 318 to El. 330) and slopes upwards near the exit pit at approximately El. 324 (reference datum NAVD 1988). Wetlands are present along the HDD path.

The bores will have horizontal and vertical curves. The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks and under the brook/wetlands and the horizontal curves are designed for the bore to stay within the work area easements. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #35 – Based on the borings drilled for this project, the soil profile for the HDD #35 BoreAid analyses will be divided into five [5] layers: loose poorly graded sand, very loose poorly graded sand, medium dense silty sand, loose silty sand, and medium dense silty sand. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #35 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, stream/wetlands, or ground surface. General depth of cover under the designated wetlands is about 48 feet, and approximately 40 feet below estimated mudline. 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 130 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 50 psi assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 143 psi and the approximate applied slurry pressure during drilling ranges from 0 to 62 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 30 feet from the entry pit and the last 90 feet, approximately, as each bore approaches the exit pit exist. This is related to the length and depth of the bores and the upward slope near the exit pit.
- 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 each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.17 HDD CROSSING #36

HDD #36 consists of two straight HDD bores located west of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 630 feet and 645 feet long as shown in

Appendix B. The HDD bores located west of the CP railway, will pass 55 feet below a Jones Road (road-bridge). The rail line in this area is straight and the bores are located on the west side of the rail bed. The ground surface elevation along the path of HDD #36 gently undulates from approximately El. 314 at the north end of the bore alignment, to approximately El. 327 at the south end of the bore alignment (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #36 – Based on borings drilled for this project, the soil profile for the HDD #36 BoreAid analysis was divided into three (3) layers: loose silty sand, loose poorly graded sand, and loose silty sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Special Design considerations for HDD #36 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the Jones Road (road-bridge) is approximately 55 ft near the centers of the bore paths. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 73 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 23 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 114 psi and the approximate applied slurry pressure during drilling ranges from 0 to 25 psi. Sketches 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 30 ft of each bore near entry pits and the ending 15 to 30 feet near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.18 HDD CROSSING #37

HDD #37 consists of two, straight, HDD bores located west of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 765 feet and 773 feet long as shown in Appendix B. Both the HDD bores will pass below the bottom of CP Rail Canadian Mainline Centerline and an at-grade road crossing (Adirondack Northway). The ground surface elevations at the entry and exit points are approximately El. 323 and El. 324 respectively. The surface elevation increases drastically to about El. 356 where it remains for several hundred feet before plummeting back down to El. 324 (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #37 – Based on borings drilled for this project, the soil profile for the HDD #37 BoreAid analysis was divided into one (1) layer: loose poorly graded sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Special Design considerations for HDD #37 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the Adirondack Northway crossing is approximately 50 ft near the centers of the bore paths. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 102 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 18 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 108 psi and the approximate applied slurry pressure during drilling ranges from 0 to 20 psi. Sketches 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 pits and the ending 30 feet near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.19 HDD CROSSING #38

HDD #38 consists of two straight HDD bores located on the north side of the CP Rail railroad tracks west of the Hudson River. The bores are approximately 1473 feet and 1518 feet long as shown in Appendix B. Both the HDD bores will pass underneath a 10' wide stone culvert at Spring Run. The ground surface elevations at the entry are at El. 323 fluctuates between to a peak of approximately E. 327 and a low of approximately El. 293 before reaching the exit at approximate El. 310 (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #38 – Based on borings drilled for this project, the soil profile for the HDD #38 BoreAid analysis divided into two (2) layers: medium dense poorly graded sand (SP) and medium dense silty sand (SM). The soil profiles used for BoreAid analyses for the HDD in these segments are presented in Appendix A.

Specific design considerations for HDD #38 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the 10' culvert is approximately 21 feet. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 99 psi (conduit 1) & 90 psi (conduit 2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 42 psi

assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 120 psi (conduit 1) & 106 psi (conduit 2) and the approximate applied slurry pressure during drilling ranges from 0 to 50 psi. Sketches 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 last 75 to 90 ft, 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.
- 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.20 HDD CROSSING #39

HDD #39 consists of two, straight, HDD bores located west of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 606 feet and 968 feet long as shown in Appendix B. The rail line in this area is straight and the bores are located on the west side of the

rail bed, crossing Maple Avenue. One of the conduits passes underneath a wingwall of the rail bridge. The subsurface extent of the wingwall and abutment is unknown at this time, an estimated depth of 10' below grade is currently being used until this can be determined. The ground surface elevation at the entry pit is at El. 329 and as the bore runs towards the exit pit it steeps down to El. 321 (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #39 – Based on borings drilled for this project, the soil profile for the HDD #39 BoreAid analysis was divided into four (4) layers: loose poorly graded sand, loose silty sand, medium dense poorly graded sand, medium dense silty sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #39 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under NYS Route 9 is approximately 22 feet (conduit-1) and 56 feet (conduit-2). Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 55 psi (conduit-1) & 132 psi (conduit-2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 20 psi (conduit-1) & 39 psi (conduit-2) assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 63 psi (conduit-1) & 137 psi (conduit-2) and the approximate applied slurry pressure during drilling ranges from 0 to 22 psi (conduit-1) & 42 psi (conduit-2). Sketches 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 30 ft of each bore near entry pits and the ending 15 to 30 feet near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.21 HDD CROSSING #40

HDD #40 consists of two HDD bores located between the connection of two CP Railroad Canadian Mainline rails, west of the Hudson River. The bores are approximately 1349 feet and 1291 feet long as shown in Appendix B. The HDD bores will pass 36 feet below the CP Railway twice and minor wetlands located within the area. Both bores are located east of Bloomfield Road in Greenfield, NY. The ground surface elevation at the entry is approximately El. 340 and gently undulates to approximately El. 332 at the exit of the segments (reference datum NAVD 1988).

The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks and under the wetlands. Wetlands are present along the HDD path. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #40 – Based on borings drilled for this project, the soil profile for the HDD #40 BoreAid analysis was divided into two (2) layers: medium dense fill, soft low plasticity

silt (ML). The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #40 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the CP Rail railroad tracks is approximately 35 feet. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 60 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 28 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 85 psi and the approximate applied slurry pressure during drilling ranges from 0 to 36 psi. Sketches 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 last 30 to 60 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.22 HDD CROSSING #41

HDD #41 consists of two HDD bores located west of the CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 712 feet long as shown in Appendix B. The HDD bores will pass below a 52-inch culvert and stream located north-west of the CP Railway. The HDD bores will remain on the west side of railroad tracks for the entire run. The ground surface elevation gently undulates between El. 327 and El. 313 (reference datum NAVD 1988).

Wetlands are present along the HDD path. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #41 – Based on borings drilled for this project, the soil profile for the HDD #41 BoreAid analysis was divided into four (4) layers: dense poorly graded sand, dense silty sand, very stiff low plasticity silt, and medium dense silty sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Special Design considerations for HDD #41 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General

depth of cover under the 52" culvert is approximately 18 feet. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 55 psi (conduit 1) & 51 psi (conduit 2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 25 to 27 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 85 psi (conduit-1) & 0 to 81 psi (conduit-2) and the approximate applied slurry pressure during drilling ranges from 0 to 28 psi. Sketches 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 at the ending 10 to 15 feet of conduit 2 near the exit pit. 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 the drill paths being located adjacent to wetlands, measures to mitigate the potential inadvertent release are required:
    - Barriers to contain the releases to 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 pressure with down-the-hole sensors during pilot hole drilling.

9.23 HDD CROSSING #42

HDD #42 consists of two HDD bores located west of the CP Railroad Canadian Mainline, north of Church Street. The bores are approximately 565 feet and 690 feet long as shown in Appendix B. The HDD bores will pass below an at-grade road crossing (NY 9N). The vertical curves of the bore path are designed so that the bore will pass beneath the culvert west of the CP rail. The ground surface elevation gently hovers between El. 322 and El. 328 and the road crossing is at El. 354 (reference datum NAVD 1988).

Minor Waterbodies are present along the HDD path. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #42 – Based on borings drilled for this project, the soil profile for the HDD #42 BoreAid analysis was divided into four (4) layers: dense fill, loose silty sand, loose poorly graded sand, and medium dense silty sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #42 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the Church Street is approximately 60 feet. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 74 psi (conduit 1) & 45 psi (conduit 2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 22 psi (conduit 1) & 15 psi (conduit 2) assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 120 psi (conduit 1) & 0 to 100 psi (conduit 2) and the approximate applied slurry pressure during drilling ranges from 0 to 24 psi (conduit 1) & 0 to 15 psi (conduit 2). Sketches

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 at the ending 30 feet of each bore near the exit pit 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.24 HDD CROSSING #43

HDD #43 consists of two, straight, HDD bores, located west of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 1050 feet long as shown in Appendix B. The HDD bores will pass approximately 27 to 28 feet below the bottom of the CP Rail Canadian Mainline centerline and bores are located to the west and east of the CP railway, north of Washington Street. One of the rail lines in this area is curved and crosses above the bores at a 21-degree angle. Both bores also pass underneath existing utility lines. The ground surface elevation at the entry and exit points is approximately El. 321 and El. 324, while for conduit 2 it hovers approximately at El. 317 and El. 322. The surface elevation peaks to El. 349 toward the center of the bore (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #43 – Based on borings drilled for this project, the soil profile for the HDD #43 BoreAid analysis was divided into three (3) layers: medium dense poorly graded sand, medium stiff high plasticity silt, and dense poorly graded sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Special design considerations for HDD #43 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the CP Rail railroad tracks is approximately 27 feet and approximately 55 feet below Washington Street. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 75 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 24 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 121 psi and the approximate applied slurry pressure during drilling ranges from 0 to

28 psi. Sketches 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 10 to 15 feet and ending 10 to 15 feet of each bore near the entry and exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.

9.25 HDD CROSSING #44

HDD #44 consists of two, straight, HDD bores, located west of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 538 feet and 575 feet long as shown in Appendix B. The HDD bores are located west of the CP railway and north of Grand Avenue. The rail line in this area is straight and the bores are located on the west side of the rail, crossing Grand Avenue and some minor waterbodies present. The bottom tangent of the bores will be crossing Church Street. The ground surface elevation undulated between El. 316 and El. 309 (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #44 – Based on borings drilled for this project, the soil profile for the HDD #44 BoreAid analysis was divided into five (5) layers: dense poorly graded sand, loose poorly graded sand, loose well graded sand, soft low plasticity silt and medium dense poorly graded sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Special Design considerations for HDD #44 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the Grand Ave. crossing is approximately 50 ft near the centers of the bore paths. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 101 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 14 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 105 psi and the approximate applied slurry pressure during drilling ranges from 0 to 18 psi. Sketches 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 10 to 15 ft of each bore near entry pits and the ending 10 to 15 feet near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.

9.26 HDD CROSSING #45

HDD #45 consists of two, straight, HDD bores, located west of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 630 feet long as shown in Appendix B. The HDD bores are located west of the CP railway and north of Geyser Road in Saratoga Springs, NY. The rail line in this area is straight and the bores are located on the west side of the rail bed, crossing below Geyser Road. The ground surface elevation hovers between El. 324 to El. 318 for majority of the bore path (reference datum NAVD 1988).

. No work is proposed within water bodies or 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 #45 – Based on borings drilled for this project, the soil profile for the HDD #45 BoreAid analysis was divided into three (3) layers: loose poorly graded gravel, medium dense well graded sand, and dense poorly graded sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Special design considerations for HDD #45 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General depth of cover under the Geyser Road road-crossing is approximately 58 ft near the centers of the bore paths. Preliminary analyses of the bores, indicates that the lowest

maximum allowable pressure capacity in the middle of the bores is approximately 76 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 20 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 123 psi and the approximate applied slurry pressure during drilling ranges from 0 to 24 psi. Sketches 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 at the ending 10 to 15 feet of each bore near the exit pit. 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 pressure with down-the-hole sensors during pilot hole drilling.

9.27 HDD CROSSING #46

HDD #46 consists of two, straight (in plan view) HDD bores located west of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 3150 feet long as shown in Appendix B. The HDD bores will pass approximately 38 feet below the existing ground surface and about 31 feet below wetlands between Geyser Road Route 50. The approximate center of the HDD bores is located at latitude 43.051167°N and longitude -73.818128°W, in Saratoga Springs,

NY. The ground surface elevations along the path of HDD #46 gently undulates along the HDD alignment (~El. 308 to El. 325) and slopes upwards near the exit pit at approximately El. 320 (reference datum NAVD 1988).

The bores will have only vertical curves (no horizontal curves). The vertical curves of the bore path are designed so that the bore will pass beneath the railroad tracks and under the wetlands. Wetlands are present along the HDD path. The proposed work at this location must be construction in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #46 – Based on the borings drilled in this project, the soil profile for the HDD #46 BoreAid analyses will be divided into seven [7] layers medium dense well graded sand, medium stiff fat clay, medium dense well graded sand, medium stiff fat clay, stiff low plasticity clay, dense weathered rock, and shale bedrock. The soil profiles used for BoreAid analyses of the HDDs in this segments are presented in Appendix A.

Specific design considerations for HDD #46 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, stream/wetlands, or ground surface. General depth of cover under the existing ground surface is about 38 or more feet, and approximately 30 or more feet under the wetlands. 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 1150 psi and the pressure estimated to occur in the middle portion ranges from 60 to 70 psi assumed standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 1230 psi and the approximate applied slurry pressure during drilling ranges from 0 to 105 psi. A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A for both an east to west boring direction and a west to east boring direction.
- It appears that a potential for releases in approximately the first 30 feet from the entry pit and the last 210 feet (south end), approximately, as each bore approaches the exit pit exist. This is related to the length and depth of the bores and the upward slope near the exit pit. Due to this condition, the use of the intersecting bore method with a conductor casing at

the south end is recommended to better control drilling pressures and the risk of a potential inadvertent release.

- 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,
- Recommending the use of intersect bore method (drilling the pilot bore from each end and meeting in the middle) to reduced slurry pressures at the exit end during pilot bore drilling, thereby reducing the potential for a released at the exit end of the pilot bore, and
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.28 HDD CROSSING #47

HDD #47 consists of two HDD bores located west of CP Railroad Canadian Mainline, west of the Saratoga Lake. The bores are approximately 562 feet and 584 feet long as shown in Appendix B. The HDD bores will pass about 54 feet below Ballston Avenue. The ground surface elevation at the entry point is approximately El. 328 and at exit point approximately El. 318. The surface elevation peaks to El. 350 toward the center of the bore (reference datum NAVD 1988).

No work is proposed within water bodies or 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#47 – Based on borings drilled for this project, the soil profile for the HDD #47 BoreAid analysis was divided into seven (7) layers: loose well graded sand, loose poorly graded sand (SP), loose poorly graded gravel, loose silty sand, medium dense poorly graded sand (SP), medium dense well graded sand, and dense well graded sand. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD 47 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, stream/wetlands, or ground surface. General depth of cover under the Ballston Avenue is about 54 or more 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 118 psi and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 21 psi assumed standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 118 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 for both an east to west boring direction and a west to east boring direction.

- It appears that a potential for releases in approximately 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 casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.29 HDD CROSSING #49

HDD #49 consists of two HDD bores located west of CP Railroad Canadian Mainline, north of Malta Avenue. The bores are approximately 1932 feet long as shown in Appendix B. The HDD bores will pass more than 100 feet below railroad tracks and about 41 feet below estimated mudline (assuming 5’ depth). The ground surface elevation at the entry point is approximately El. 229 and at exit point approximately El. 290, while it undulates between El. 277 to El. 297 (reference datum NAVD 1988).

No work is proposed within water bodies or 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#49 – Based on borings drilled for this project, the soil profile for the HDD #49 BoreAid analysis was divided into four (4) layers: loose poorly graded sand, medium dense poorly graded sand, dense weathered rock, and shale bedrock. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #49 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the road, railroad, stream/wetlands, or ground surface. General depth of cover under the railroad is about 45 or more feet, and approximately 42 or more feet under the wetlands. 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 670 psi (conduit 1) & 778 psi (conduit 2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 140 psi (conduit 1) & 160 psi (conduit 2) assuming standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 1100 (conduit 1) & 1700 psi (conduit 2) psi and the approximate applied slurry pressure during drilling ranges from 0 to 150 psi (conduit-1 & 2). A sketch showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A for both an east to west boring direction and a west to east boring direction.
- It appears that there is a potential for inadvertent releases in the starting 45 to 90 ft of each bore near entry pits and the ending 75 feet near the exit pits 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

9.30 HDD CROSSING #50

HDD #50 consists of two, straight, HDD bores, located east of CP Railroad Canadian Mainline, west of the Hudson River. The bores are approximately 703 feet and 715 feet long as shown in Appendix B. The HDD bores will pass approximately 29/30 feet below railroad tracks and below associated wetlands. Both bores are on the east side the CP Rail railroad tracks in Milton, NY and crosses underneath the rails to the west side. The ground surface elevations along the path of HDD #50 gently undulates along the HDD alignment (~El. 290 to El. 293) and slopes downward near the exit pit at approximately El. 279 (reference datum NAVD 1988).

No work is proposed within water bodies or 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 #50 – Based on borings drilled for this project, the soil profile for the HDD #50 BoreAid analysis was divided into three (3) layers: dense poorly graded sand, dense poorly graded gravel, and shale bedrock. The soil profiles used for BoreAid analyses of the HDDs in these segments are presented in Appendix A.

Specific design considerations for HDD #50 include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, road, wetlands, or ground surface. General

depth of cover under the CP Rail railroad tracks is approximately 32 feet near the centers of the bore paths. Preliminary analyses of the bores, indicates that the lowest maximum allowable pressure capacity in the middle of the bores is approximately 780 psi (conduit-1) & 730 psi (conduit-2) and the total circulating pressure estimated to occur in the middle portion of the bore is approximately 22 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 884 psi (conduit-1) & 0 to 860 psi (conduit-2) and the approximate applied slurry pressure during drilling ranges from 0 to 26 psi. Sketches 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 last 15 to 40 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 pressure with down-the-hole sensors during pilot hole drilling.
- The use of conductor casings, temporary steel casing at each end of each bore to contain drilling fluids during drilling reaming and pullback.

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 21B Conduit 1
	P3
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AJB
	CHA
Description:	HDD 21B 10-inch DR 9 Conduit 1

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Input Summary

Start Coordinate	(0.00, 0.00, 142.70) ft
End Coordinate	(903.00, 0.00, 136.00) ft
Project Length	903.00 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

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Soil Summary

Number of Layers: 5

Soil Layer #1 USCS, Sand (S), SC
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 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 #3 USCS, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 145.00, Coh: 5.56 [psi]

Soil Layer #4 USCS, Sand (S), SW
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 #5 USCS, Clay (C), CL
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

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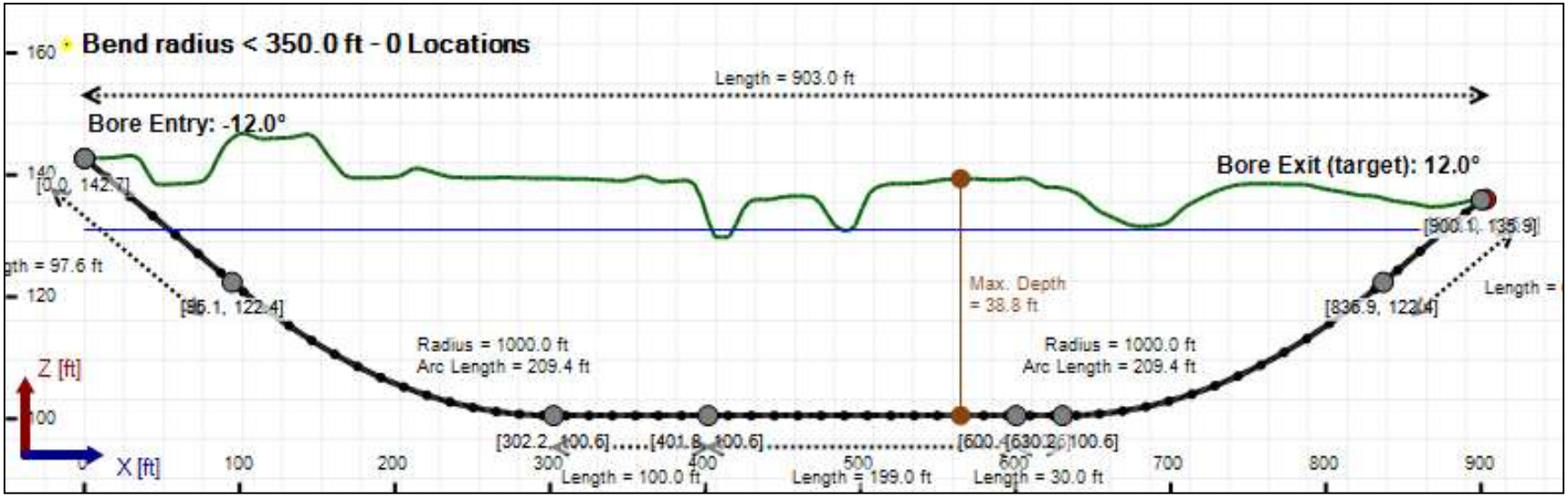
Bore Cross-Section View



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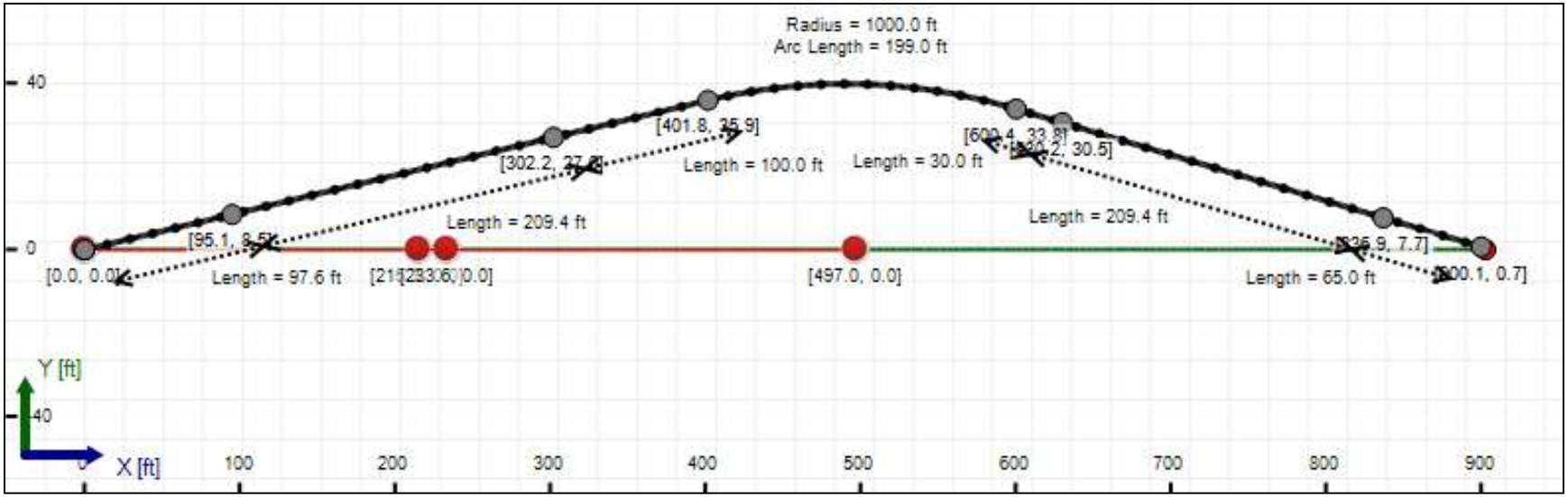
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 914.99 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	3.7	19.0
Water Pressure	13.2	13.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	16.9	32.2
Deflection		
Earth Load Deflection	1.255	5.277
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.387	5.409
Compressive Stress [psi]		
Compressive Wall Stress	75.9	145.0

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	16153.8	16153.8
Pullback Stress [psi]	450.5	450.5
Pullback Strain	7.835E-3	7.835E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	450.5	475.3
Tensile Strain	7.835E-3	8.713E-3

Net External Pressure = 22.2 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.387	7.5	5.4	OK
Unconstrained Collapse [psi]	27.4	124.8	4.6	OK
Compressive Wall Stress [psi]	75.9	1150.0	15.2	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	37.4	228.8	6.1	OK
Tensile Stress [psi]	475.3	1200.0	2.5	OK

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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	86.709 psi	84.374 psi
1	8.00 in	12.00 in	86.625 psi	84.273 psi
2	12.00 in	16.13 in	86.503 psi	84.127 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: 68.670 lb/ft3

Rheological model: Bingham-Plastic

Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

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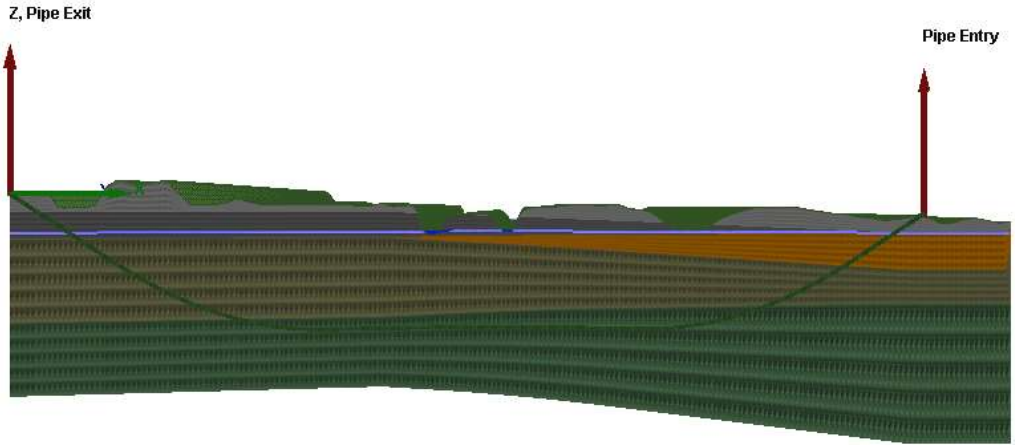
Virtual Site



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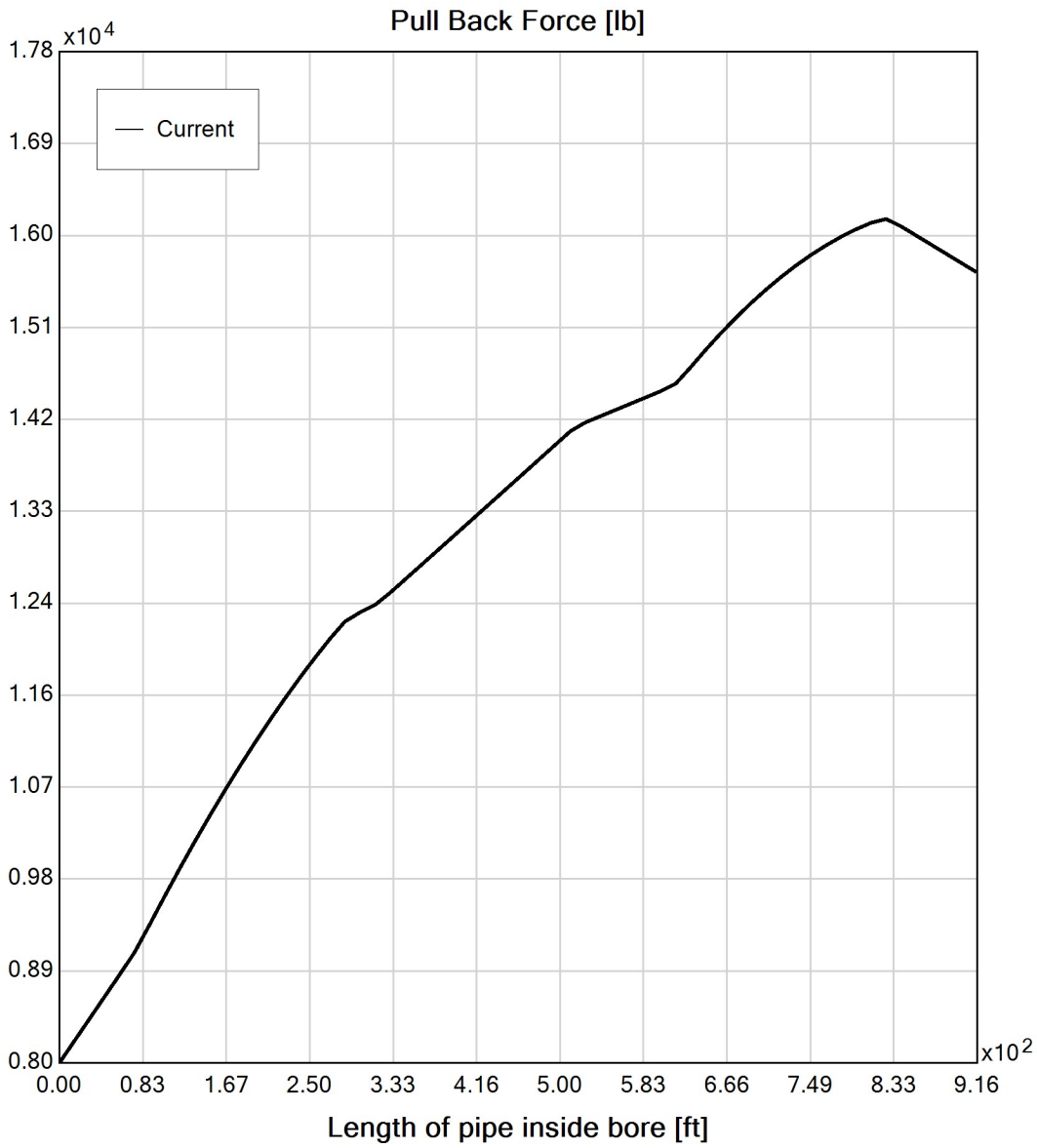

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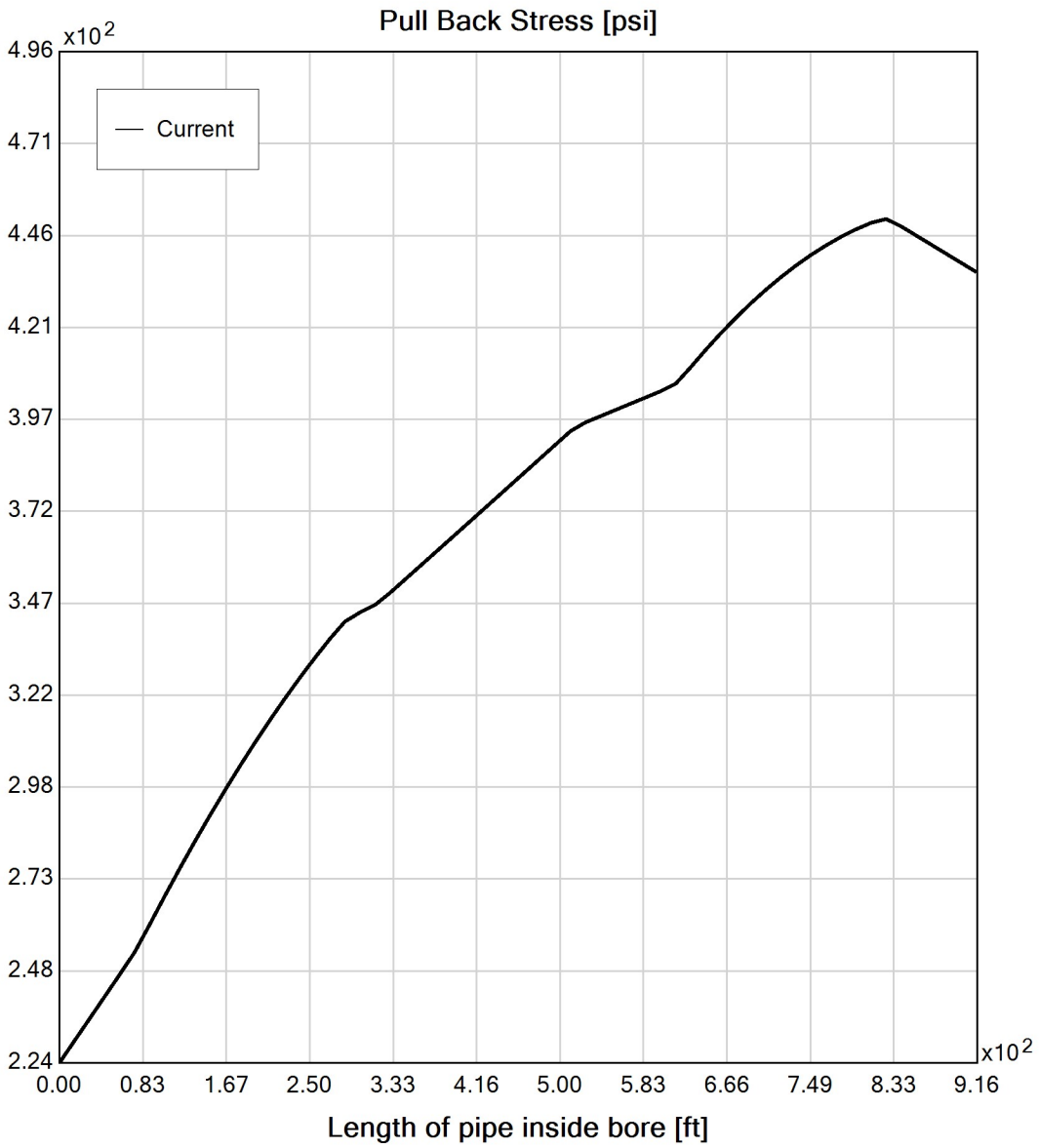

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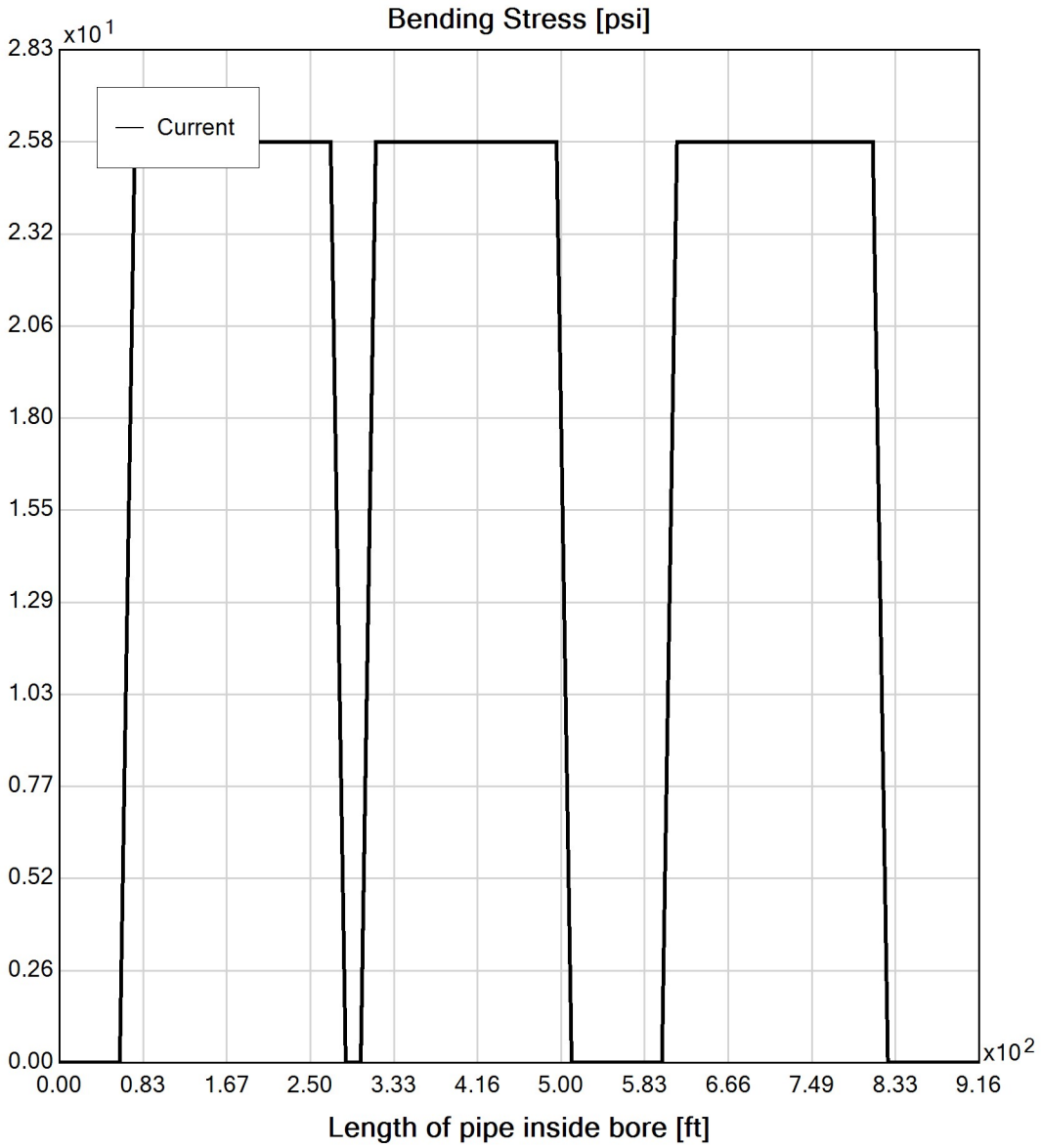

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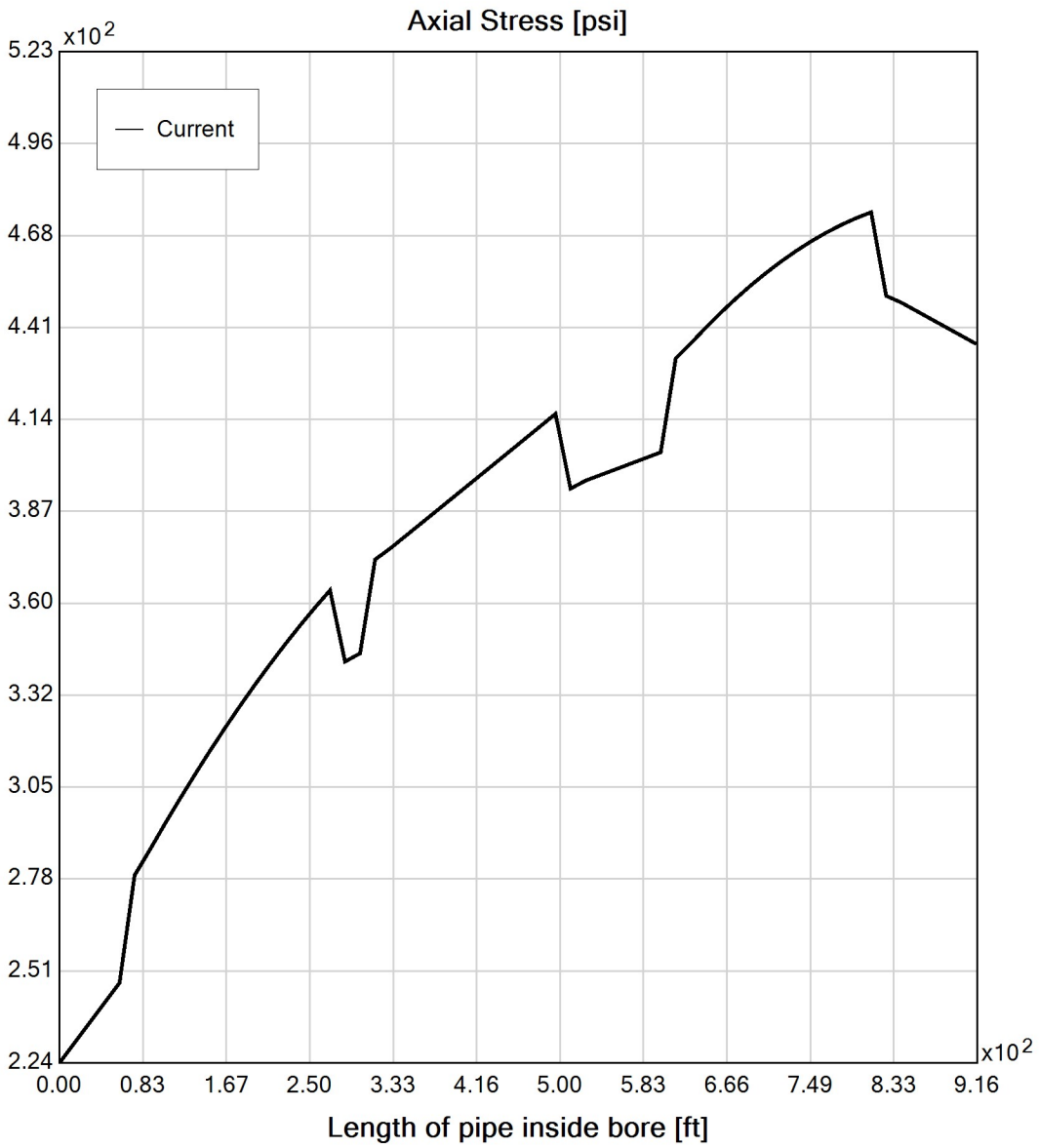

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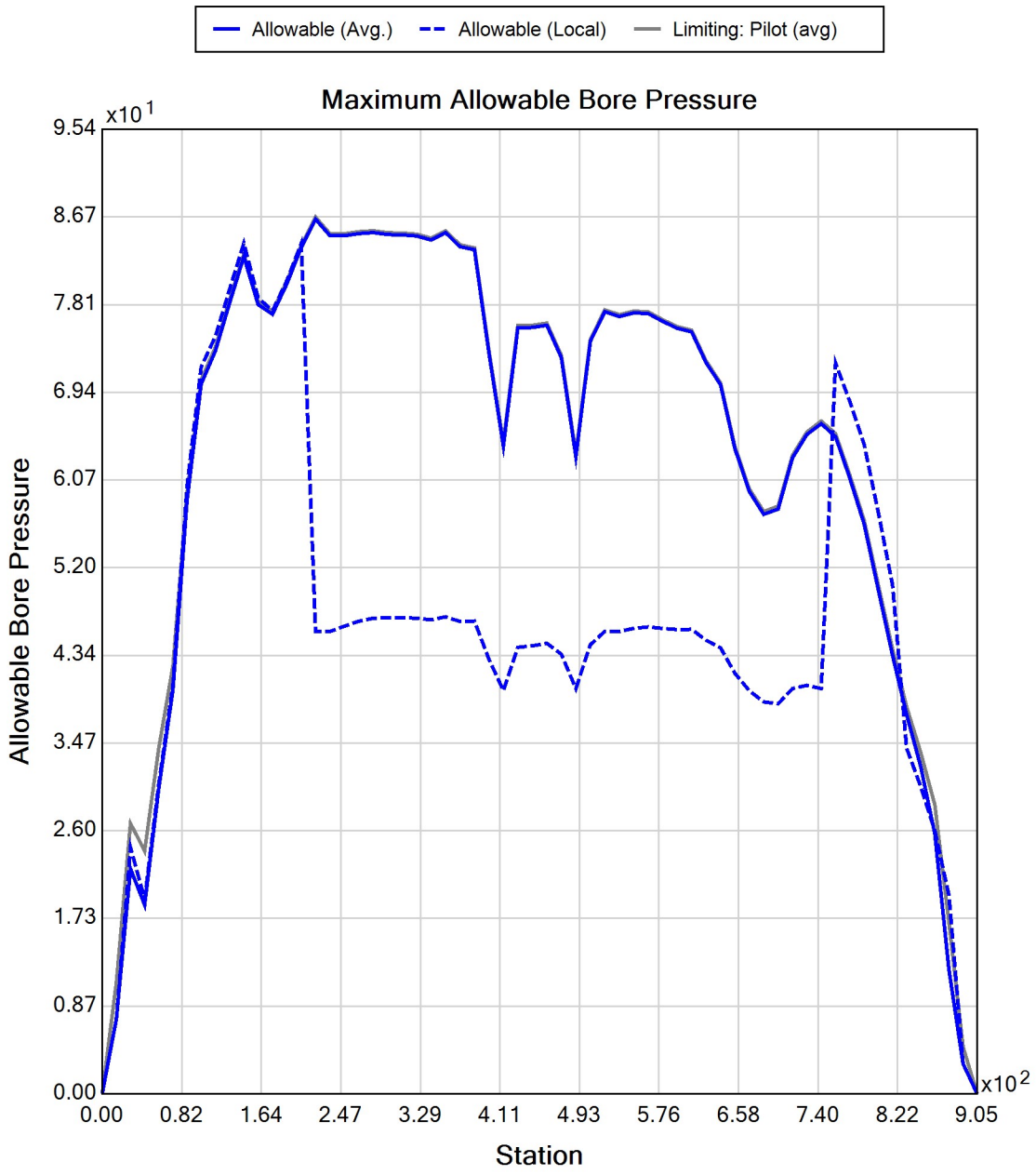

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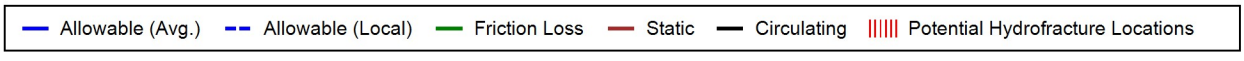

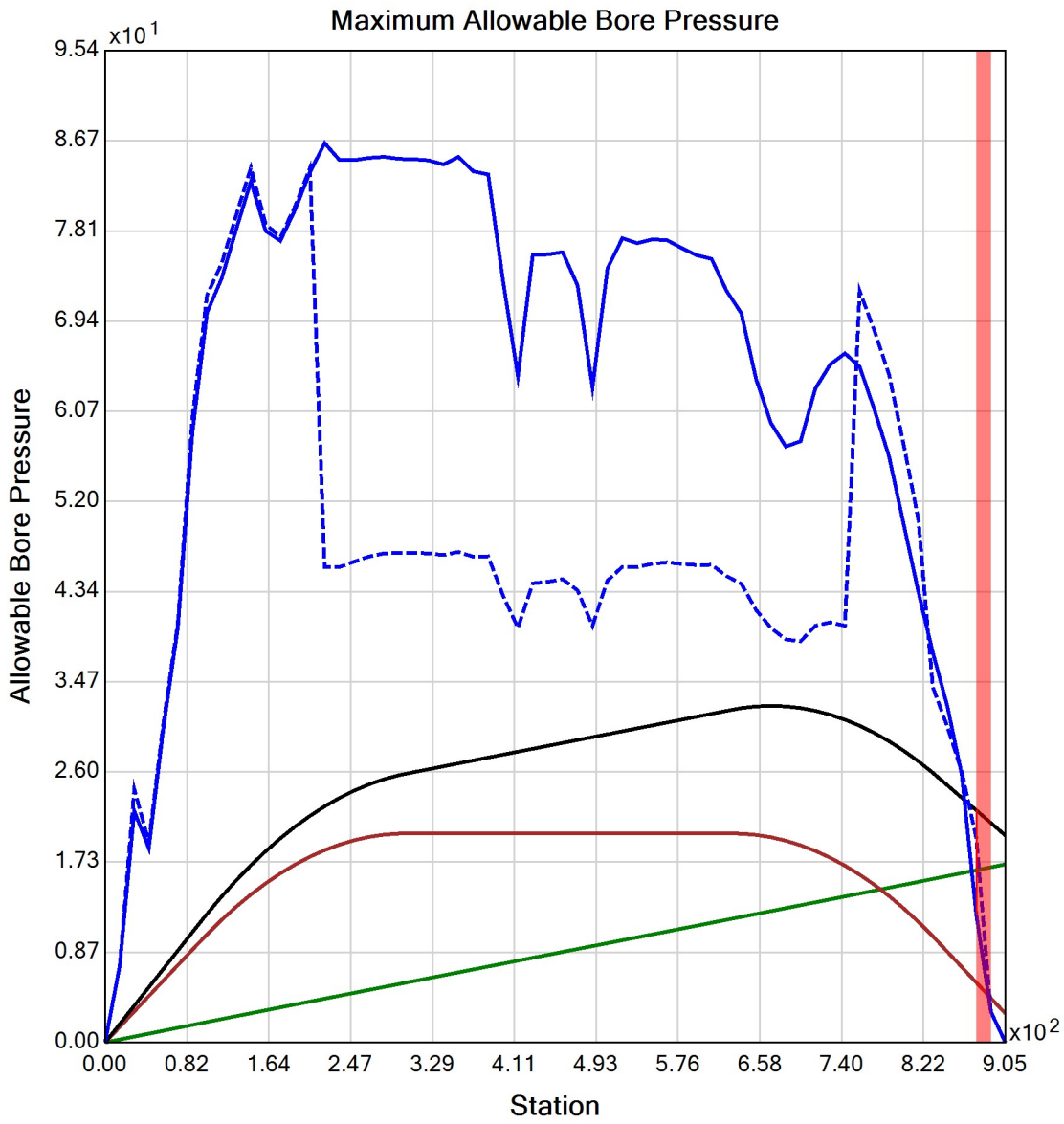

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Generated Output

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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.

Input Summary

Start Coordinate	(0.00, 0.00, 142.70) ft
End Coordinate	(903.00, 0.00, 136.00) ft
Project Length	903.00 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

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 914.99 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.5	19.0
Water Pressure	13.2	13.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.7	32.2
Deflection		
Earth Load Deflection	0.565	5.277
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.594	5.306
Compressive Stress [psi]		
Compressive Wall Stress	65.9	145.0

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	898.1	898.1
Pullback Stress [psi]	513.1	513.1
Pullback Strain	8.924E-3	8.924E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	513.1	517.8
Tensile Strain	8.924E-3	9.104E-3

Net External Pressure = 22.2 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.594	7.5	12.6	OK
Unconstrained Collapse [psi]	27.4	132.9	4.9	OK
Compressive Wall Stress [psi]	65.9	1150.0	17.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	37.4	227.0	6.1	OK
Tensile Stress [psi]	517.8	1200.0	2.3	OK

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Project Summary

General:	CHPE HDD 21B Conduit 2
	P3
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AJB
	CHA
Description:	HDD 21B 10-inch DR9 Conduit 2

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Input Summary

Start Coordinate	(0.00, 0.00, 144.00) ft
End Coordinate	(947.20, 0.00, 135.50) ft
Project Length	947.20 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

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Soil Summary

Number of Layers: 5

Soil Layer #1 USCS, Sand (S), SC
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 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 #3 USCS, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 145.00, Coh: 5.56 [psi]

Soil Layer #4 USCS, Sand (S), SW
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 #5 USCS, Clay (C), CL
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

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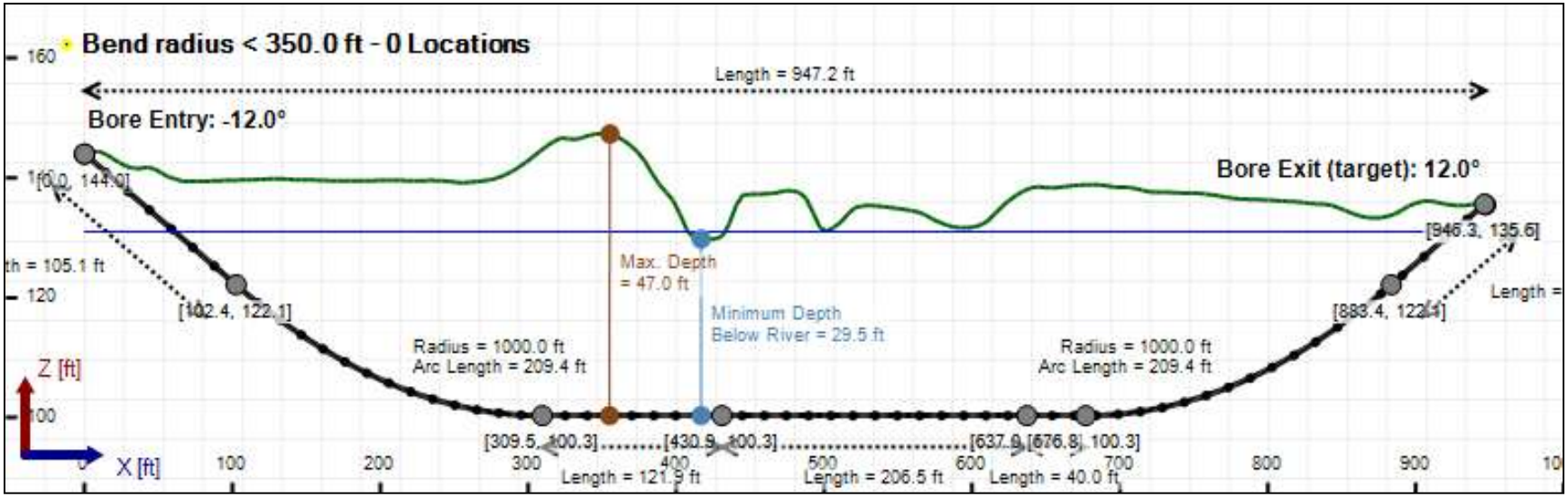
Bore Cross-Section View



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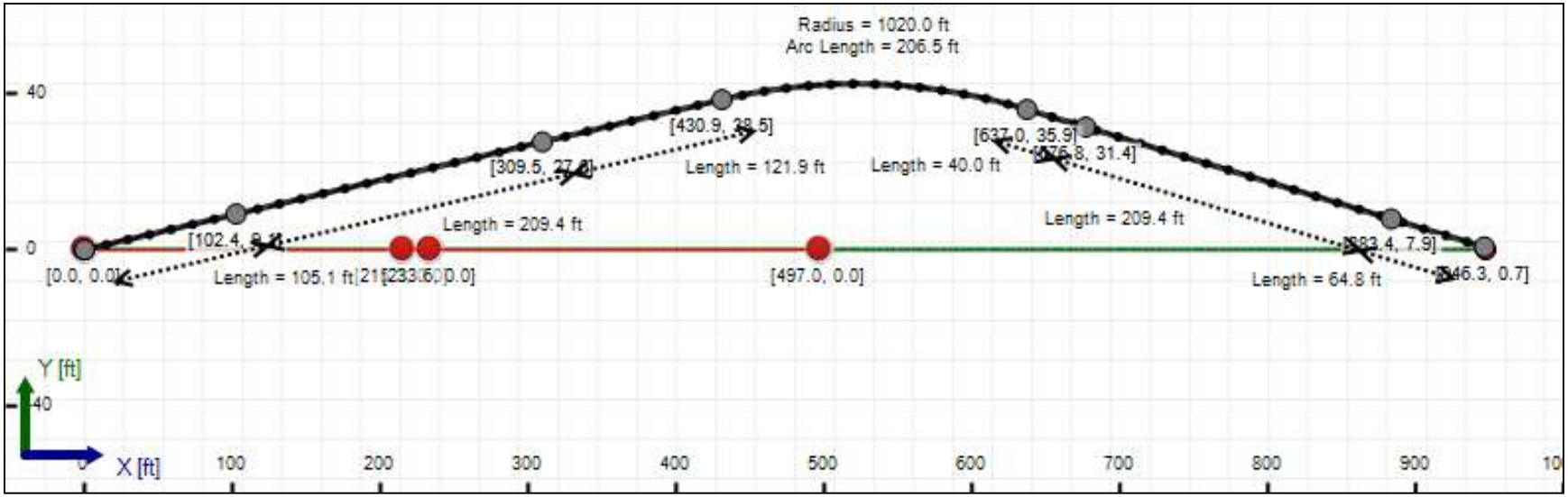
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 960.09 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	4.0	24.8
Water Pressure	13.3	13.3
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	17.3	38.1
Deflection		
Earth Load Deflection	1.117	6.756
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.249	6.888
Compressive Stress [psi]		
Compressive Wall Stress	77.7	171.5

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	16821.9	16821.9
Pullback Stress [psi]	469.1	469.1
Pullback Strain	8.159E-3	8.159E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	469.1	493.0
Tensile Strain	8.159E-3	9.018E-3

Net External Pressure = 24.2 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.249	7.5	6.0	OK
Unconstrained Collapse [psi]	28.4	123.9	4.4	OK
Compressive Wall Stress [psi]	77.7	1150.0	14.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	38.4	227.6	5.9	OK
Tensile Stress [psi]	493.0	1200.0	2.4	OK

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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	98.726 psi	84.643 psi
1	8.00 in	12.00 in	98.680 psi	84.548 psi
2	12.00 in	16.13 in	98.613 psi	84.412 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: 68.670 lb/ft3

Rheological model: Bingham-Plastic

Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

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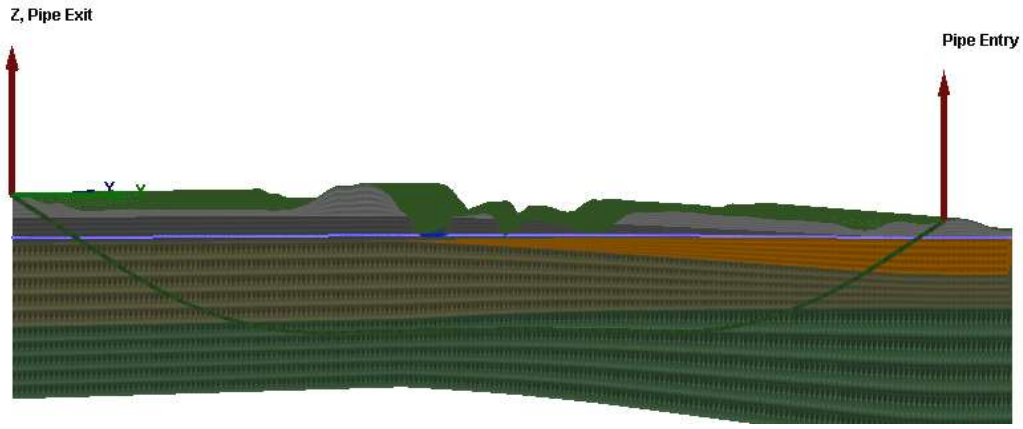
Virtual Site



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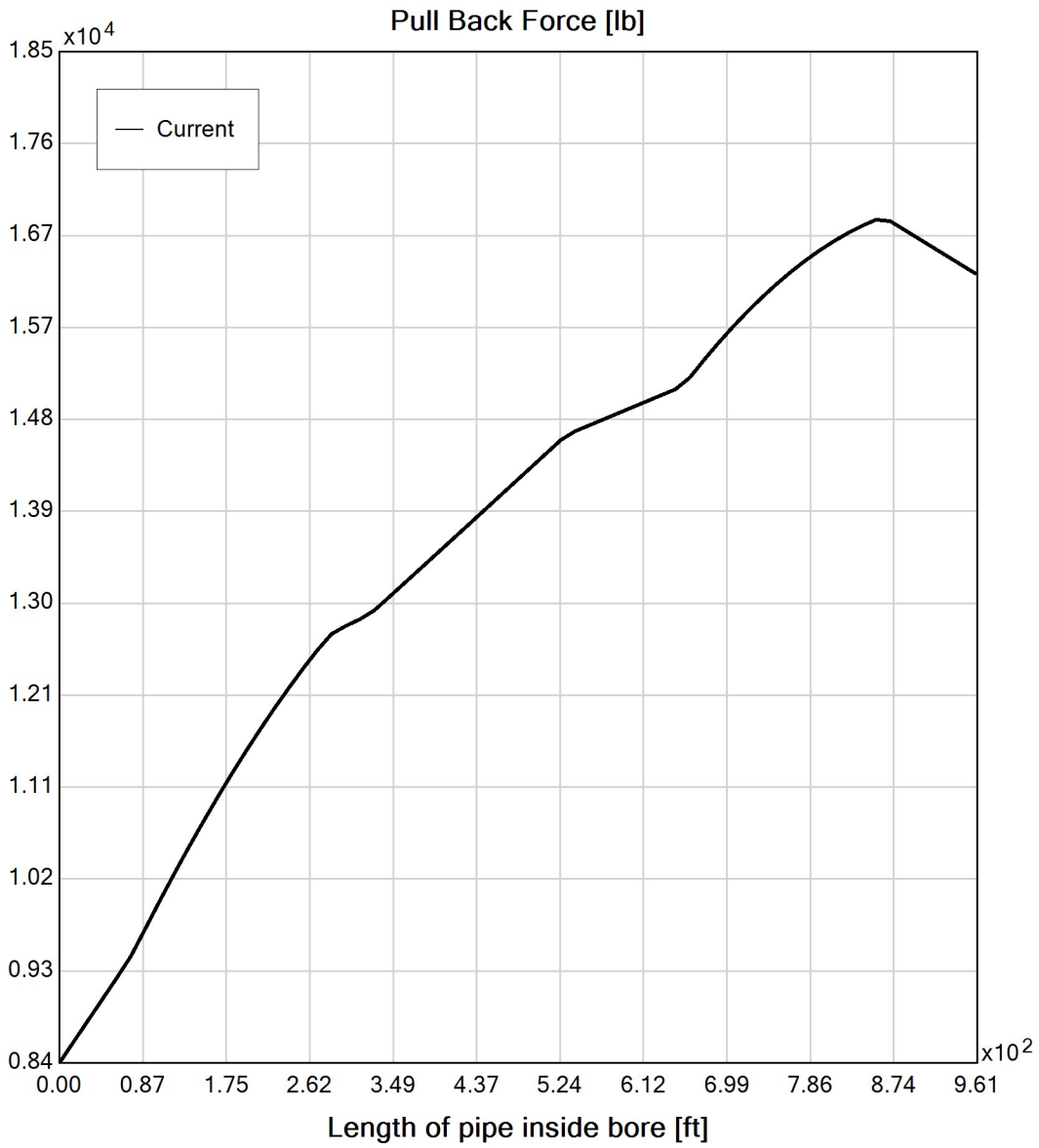

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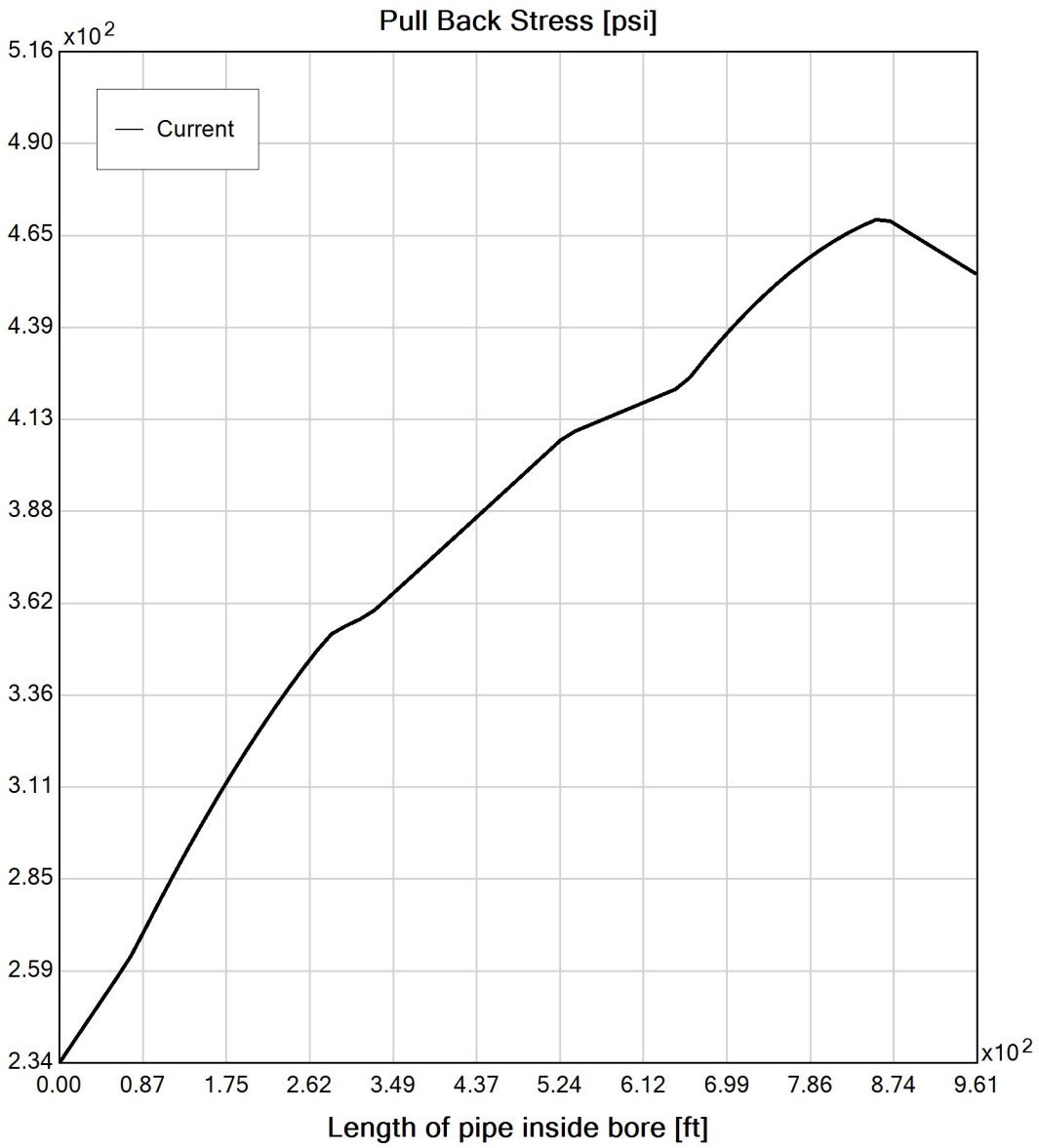

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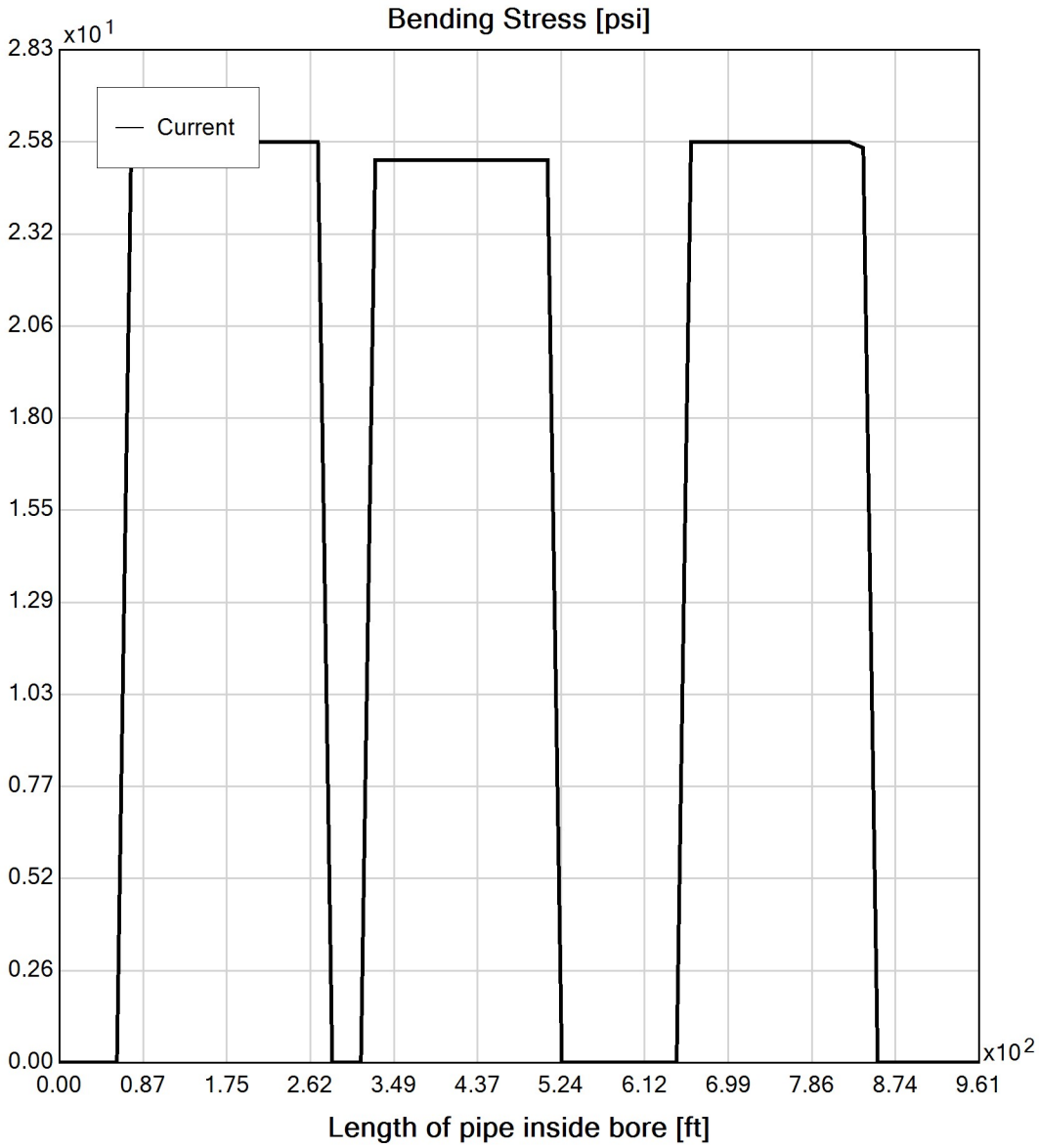

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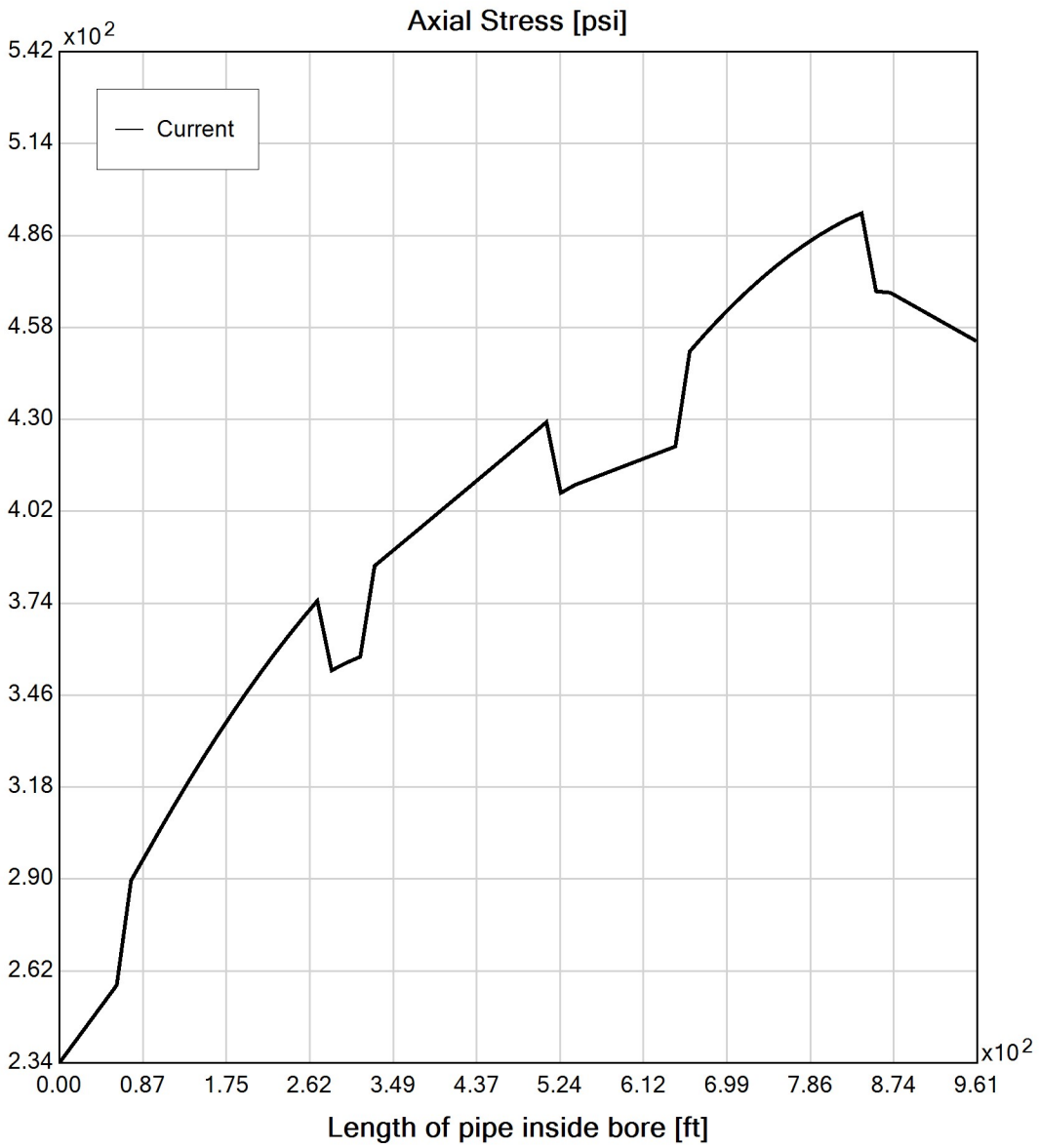

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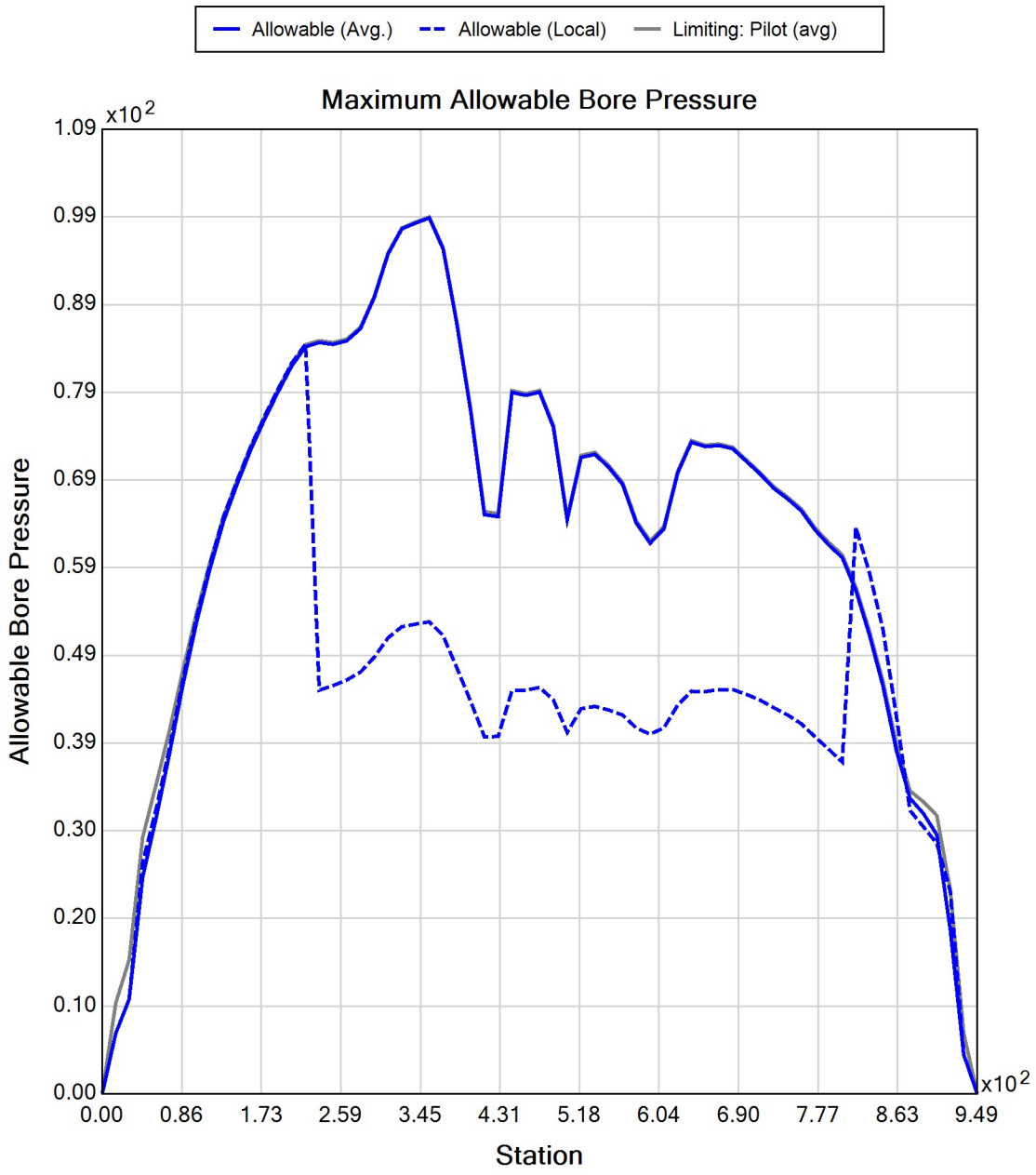

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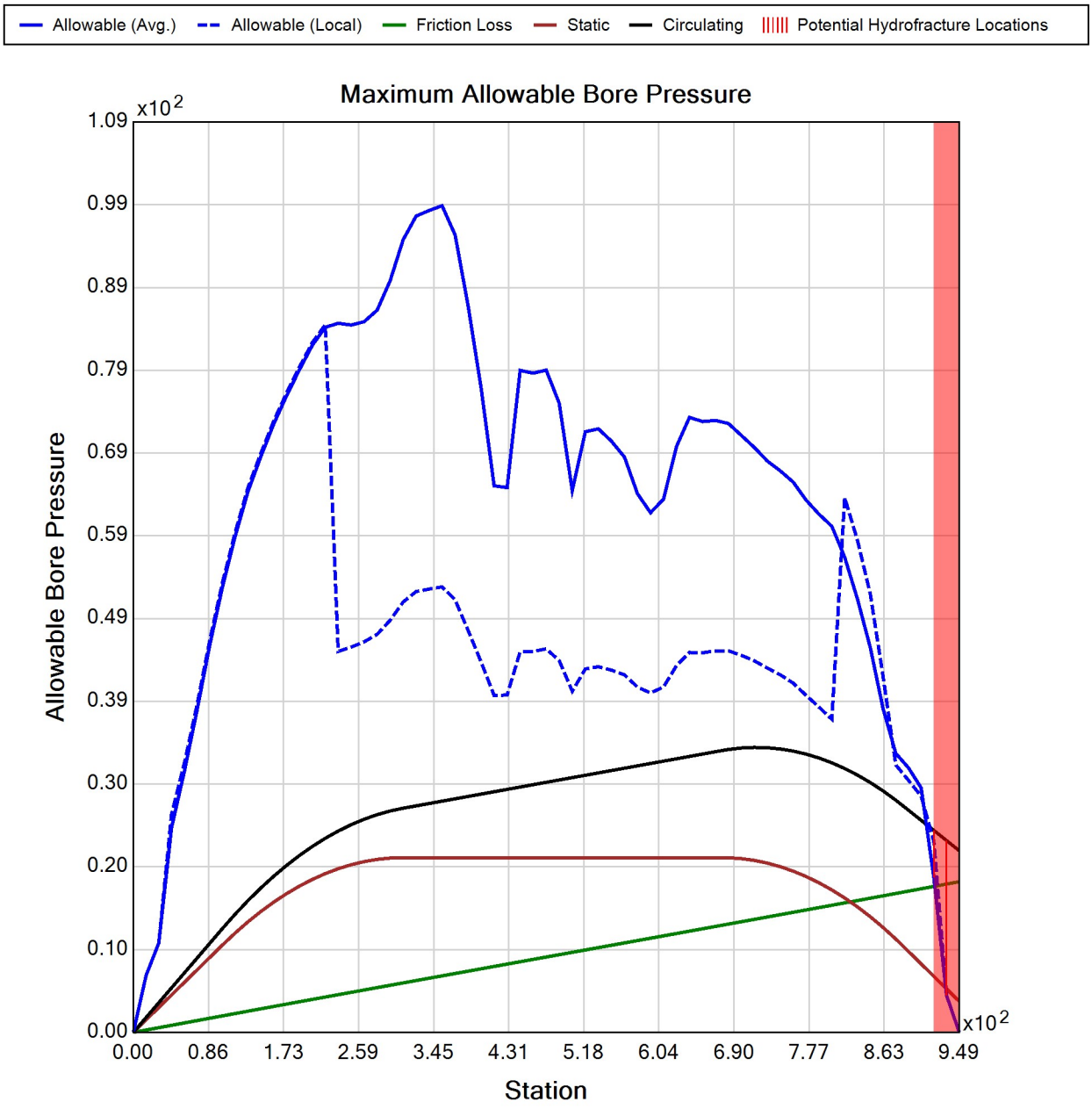

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Input Summary

Start Coordinate	(0.00, 0.00, 144.00) ft
End Coordinate	(947.20, 0.00, 135.50) ft
Project Length	947.20 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

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 960.09 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.6	24.8
Water Pressure	13.3	13.3
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.9	38.1
Deflection		
Earth Load Deflection	0.601	6.756
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.631	6.785
Compressive Stress [psi]		
Compressive Wall Stress	67.0	171.5

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	930.7	930.7
Pullback Stress [psi]	531.8	531.8
Pullback Strain	9.248E-3	9.248E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	531.8	535.6
Tensile Strain	9.248E-3	9.414E-3

Net External Pressure = 24.2 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.631	7.5	11.9	OK
Unconstrained Collapse [psi]	28.4	132.6	4.7	OK
Compressive Wall Stress [psi]	67.0	1150.0	17.2	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	38.4	225.6	5.9	OK
Tensile Stress [psi]	535.6	1200.0	2.2	OK

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Generated Output

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Project Summary

General:	CHPE HDD 22 Conduit 1
	P3
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AJB
	CHA
Description:	HDD 22 10-inch DR 9 Conduit 1

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Input Summary

Start Coordinate	(0.00, 0.00, 140.50) ft
End Coordinate	(1280.00, 0.00, 141.50) ft
Project Length	1280.00 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

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Soil Summary

Number of Layers: 8

Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Sand (S), SW
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #3 USCS, Gravel (G), GW
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #4 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #5 USCS, Gravel (G), GW
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #6 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

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Soil Layer #7 USCS, Sand (S), SW

From Assistant

Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]

Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #8 USCS, Clay (C), CH

From Assistant

Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

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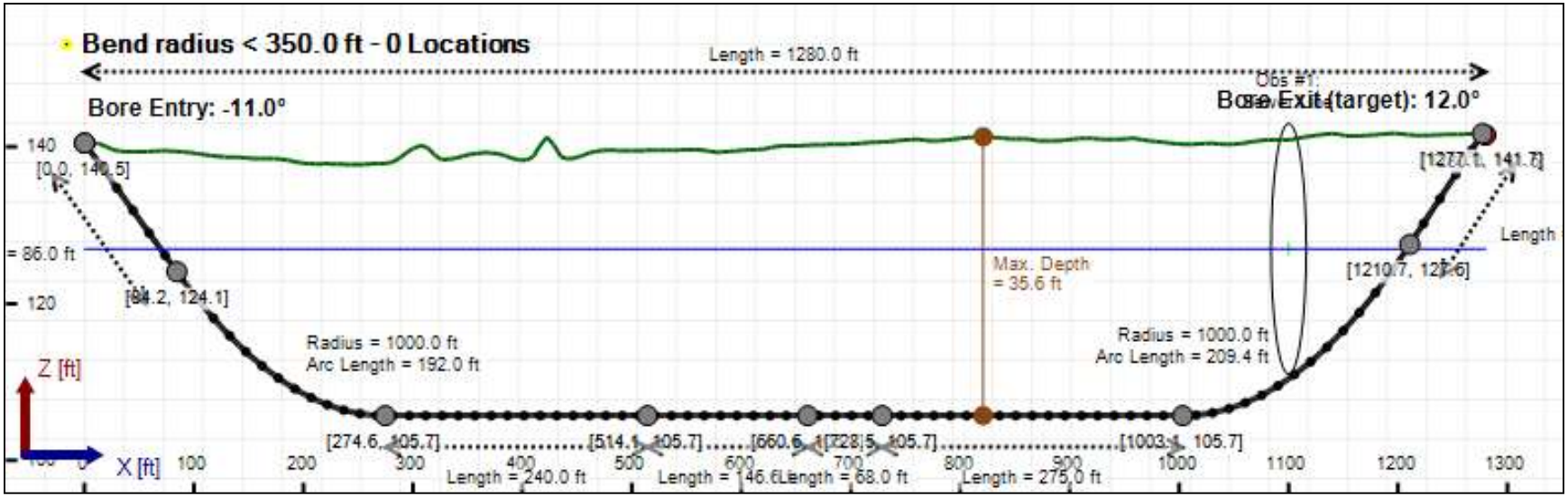
Bore Cross-Section View



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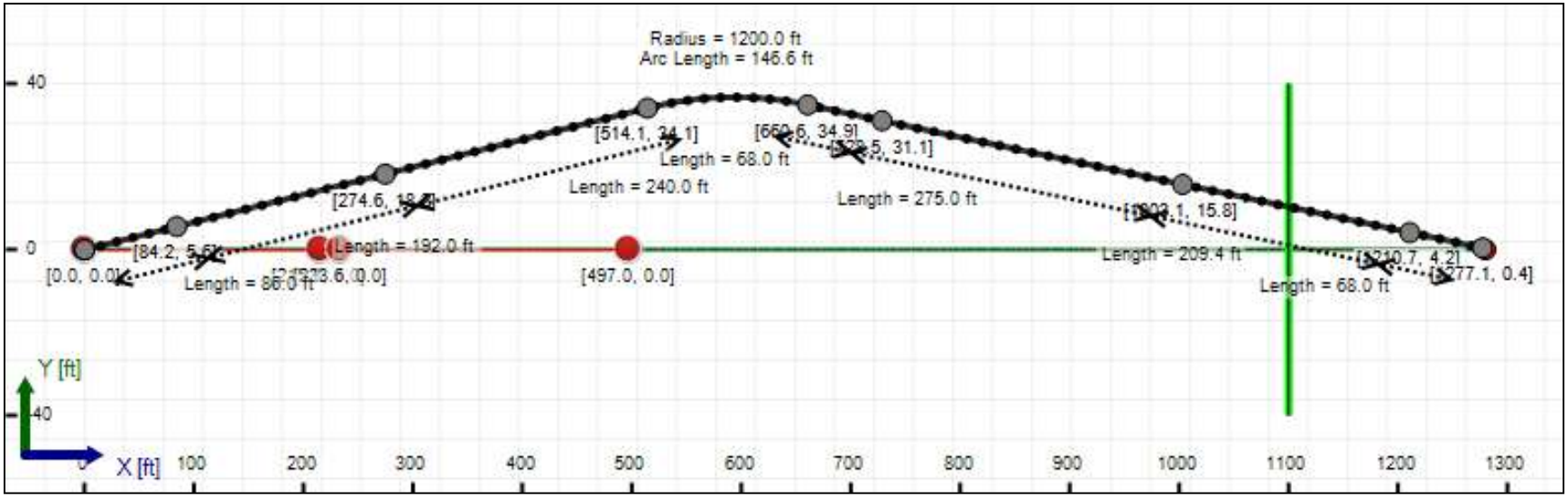
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 1290.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	3.8	18.2
Water Pressure	9.2	9.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.0	27.4
Deflection		
Earth Load Deflection	1.274	4.957
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.406	5.089
Compressive Stress [psi]		
Compressive Wall Stress	58.7	123.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	22019.9	22019.9
Pullback Stress [psi]	614.1	614.1
Pullback Strain	1.068E-2	1.068E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	614.1	637.9
Tensile Strain	1.068E-2	1.154E-2

Net External Pressure = 20.8 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.406	7.5	5.3	OK
Unconstrained Collapse [psi]	24.1	124.3	5.2	OK
Compressive Wall Stress [psi]	58.7	1150.0	19.6	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	34.1	218.6	6.4	OK
Tensile Stress [psi]	637.9	1200.0	1.9	OK

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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	77.852 psi	77.852 psi
1	8.00 in	12.00 in	77.762 psi	77.762 psi
2	12.00 in	16.13 in	77.633 psi	77.633 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: 68.670 lb/ft3

Rheological model: Bingham-Plastic

Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

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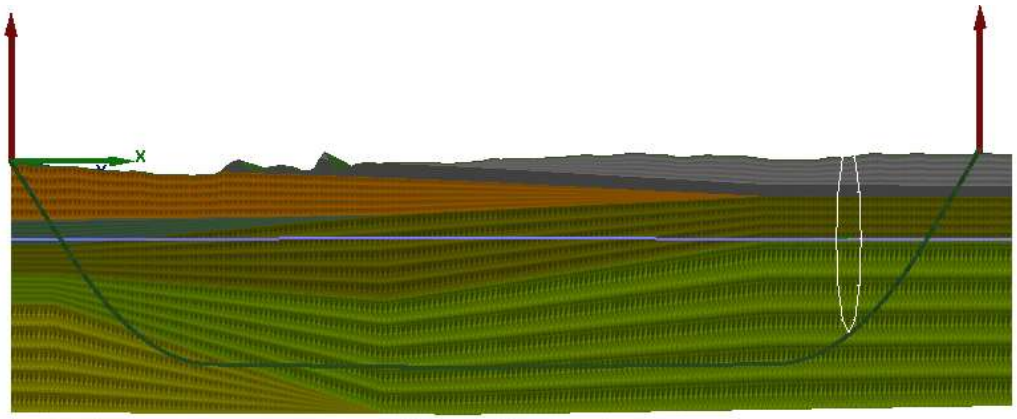
Virtual Site



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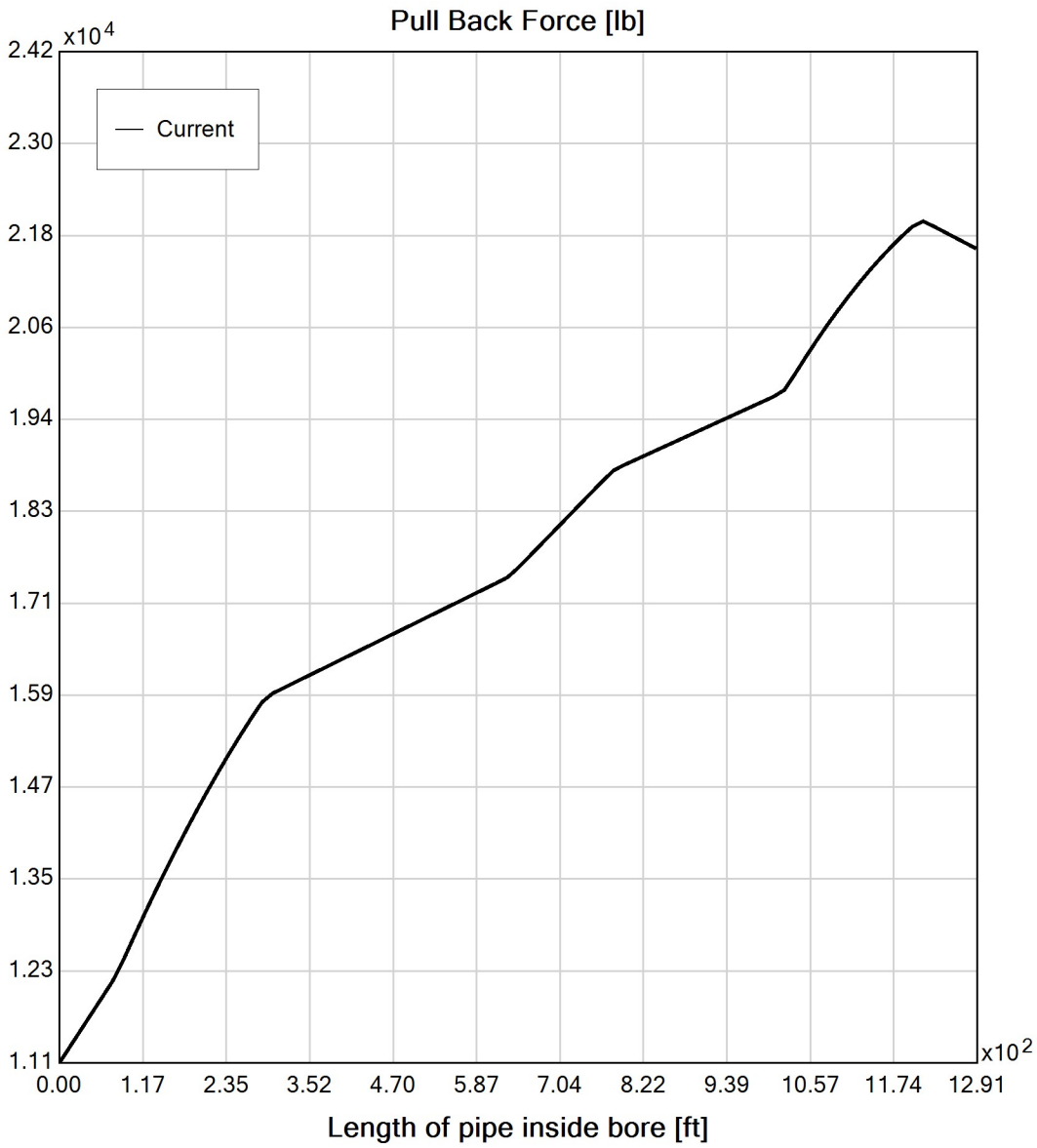

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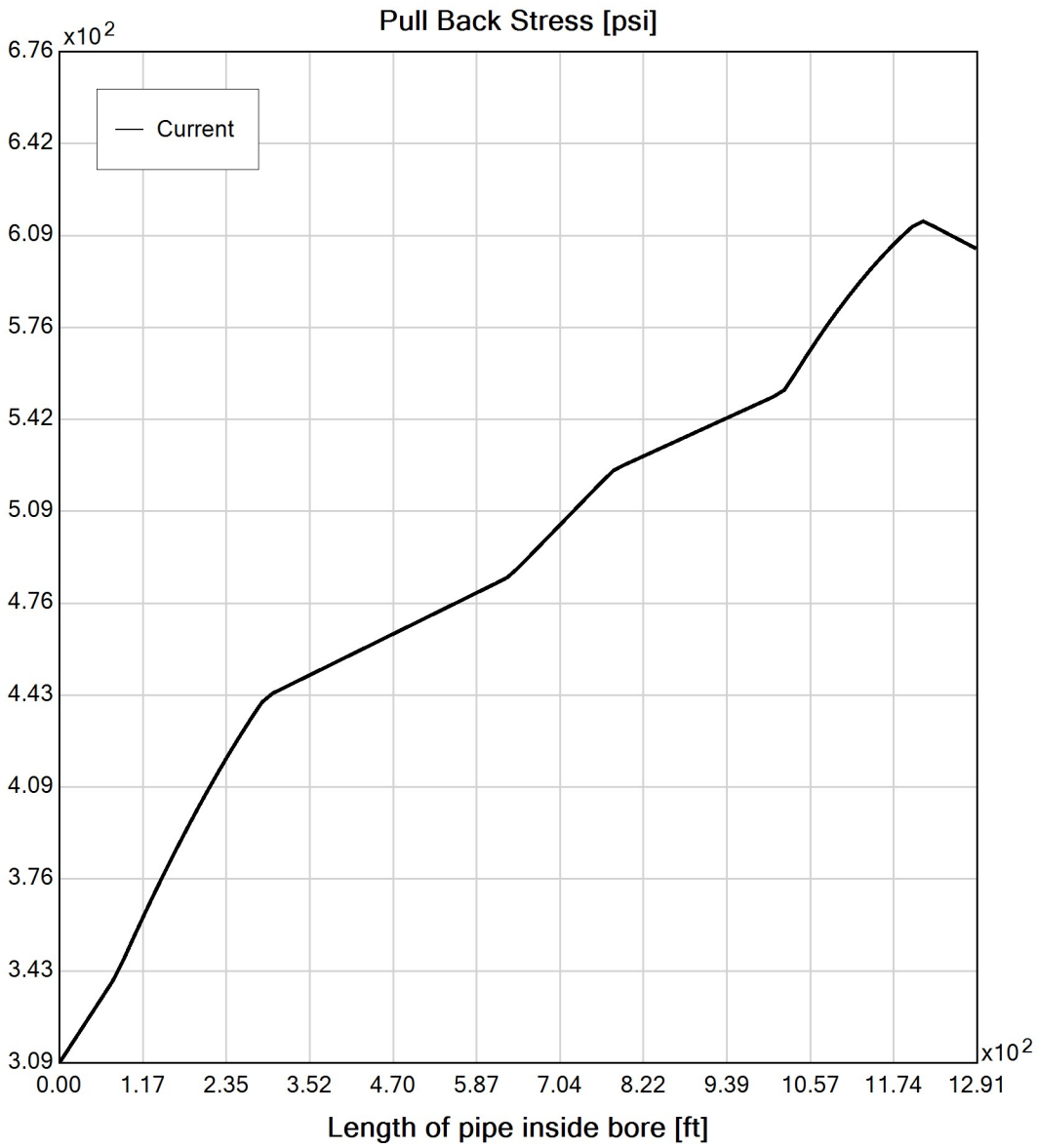

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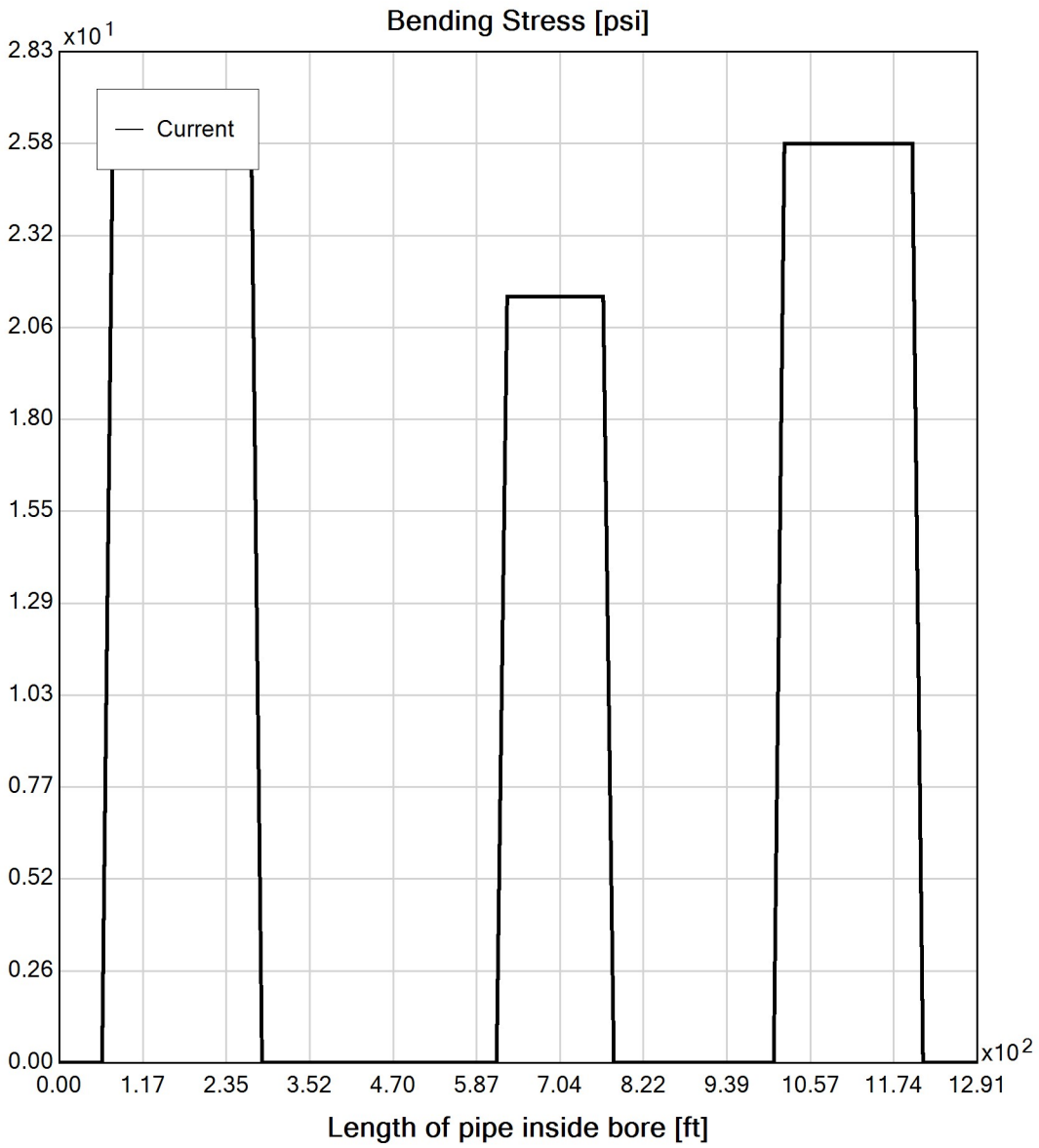

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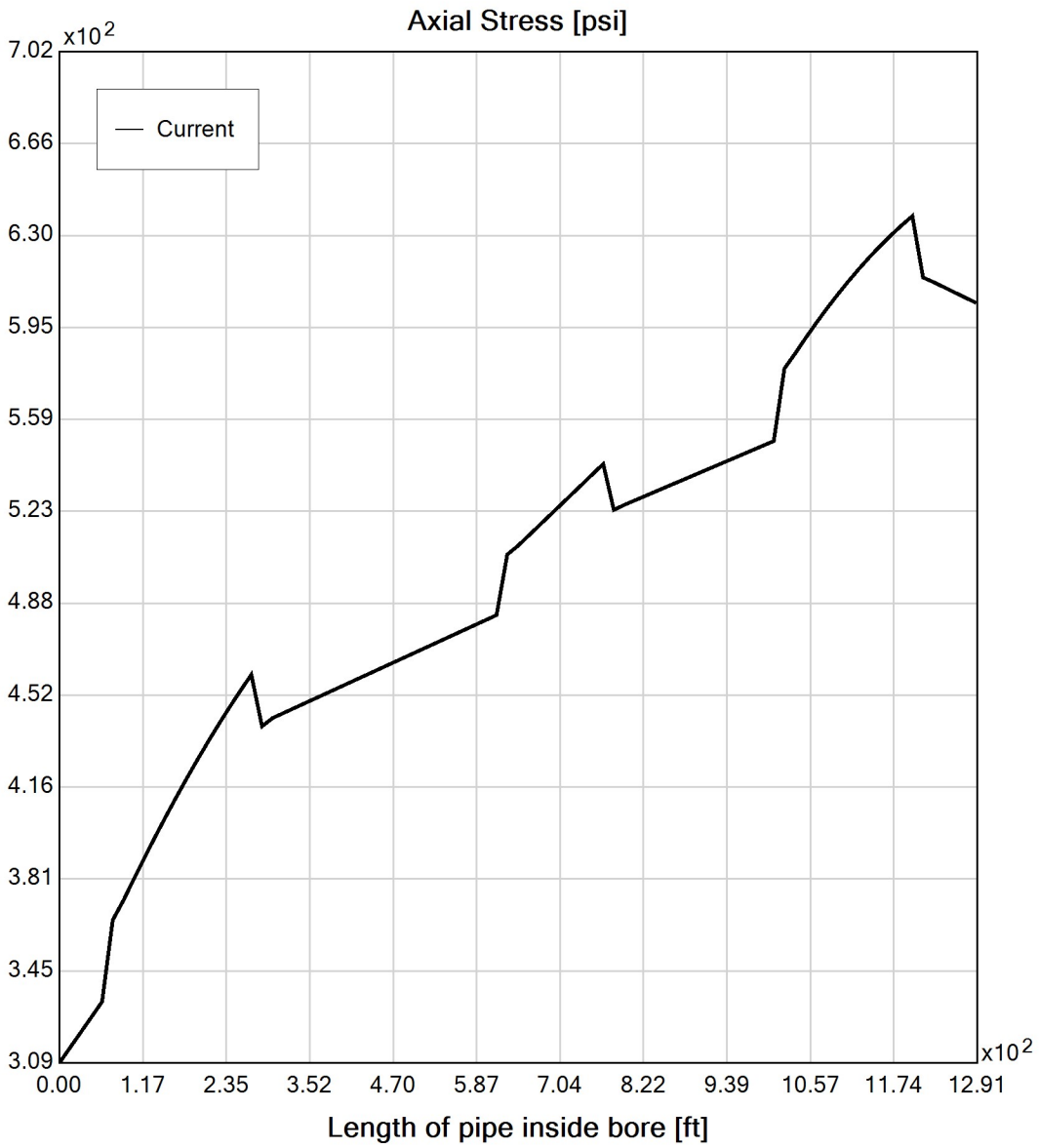

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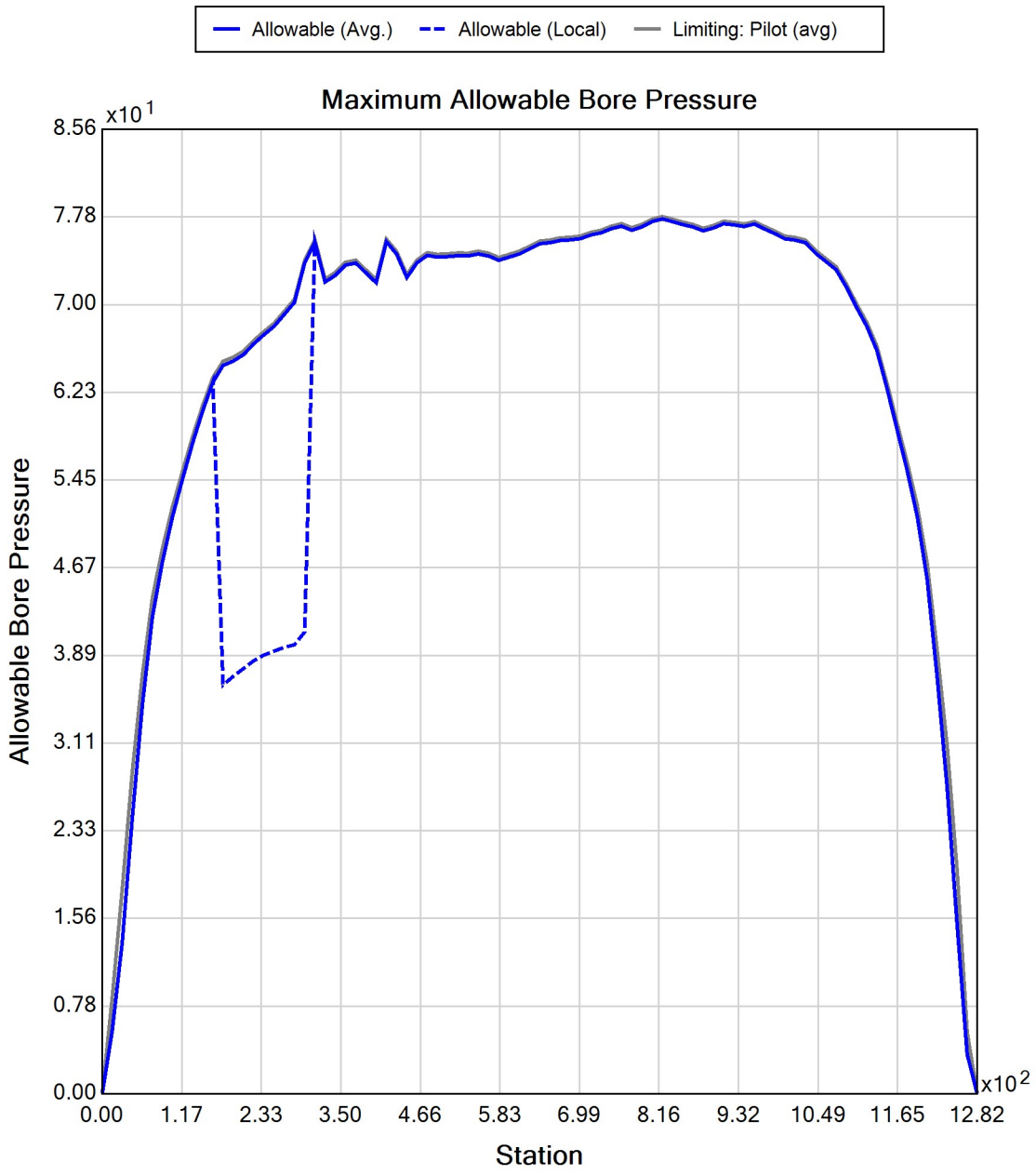

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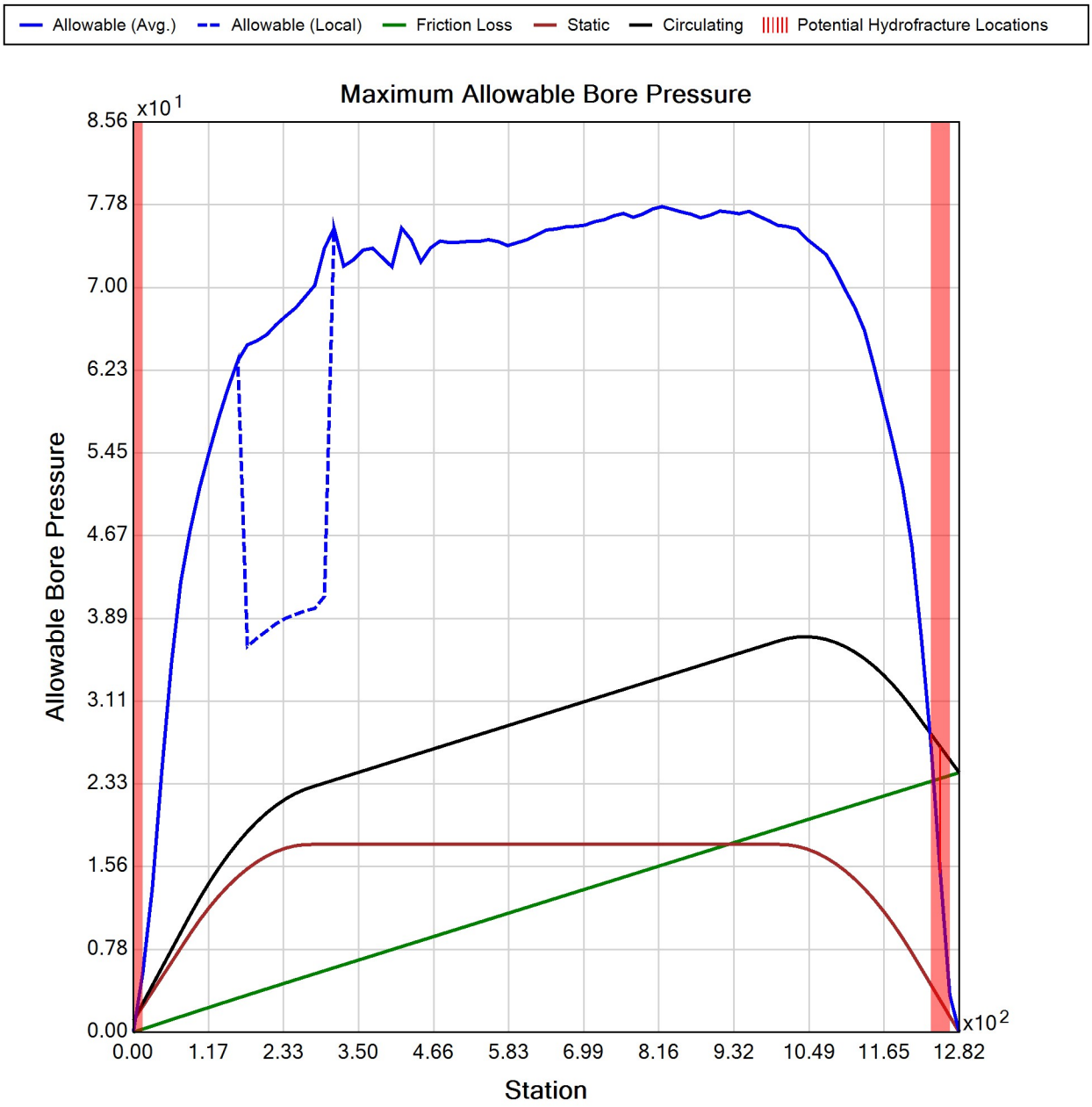

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Input Summary

Start Coordinate	(0.00, 0.00, 140.50) ft
End Coordinate	(1280.00, 0.00, 141.50) ft
Project Length	1280.00 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

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 1290.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.5	18.2
Water Pressure	9.2	9.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	10.7	27.4
Deflection		
Earth Load Deflection	0.586	4.957
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.615	4.986
Compressive Stress [psi]		
Compressive Wall Stress	48.4	123.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1184.4	1184.4
Pullback Stress [psi]	676.7	676.7
Pullback Strain	1.177E-2	1.177E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	676.7	680.5
Tensile Strain	1.177E-2	1.193E-2

Net External Pressure = 20.8 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.615	7.5	12.2	OK
Unconstrained Collapse [psi]	24.1	132.7	5.5	OK
Compressive Wall Stress [psi]	48.4	1150.0	23.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	34.1	216.4	6.4	OK
Tensile Stress [psi]	680.5	1200.0	1.8	OK

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Project Summary

General:	CHPE HDD 22 Conduit 2
	P3
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA/BCE
Designer:	AJB
	CHA
Description:	HDD 22 10-inch DR 9 Conduit 2

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Input Summary

Start Coordinate	(0.00, 0.00, 140.50) ft
End Coordinate	(1280.00, 0.00, 141.50) ft
Project Length	1280.00 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

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Soil Summary

Number of Layers: 8

Soil Layer #1 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Sand (S), SW
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #3 USCS, Gravel (G), GW
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #4 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #5 USCS, Gravel (G), GW
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #6 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

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Soil Layer #7 USCS, Sand (S), SW

From Assistant

Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]

Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #8 USCS, Clay (C), CH

From Assistant

Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

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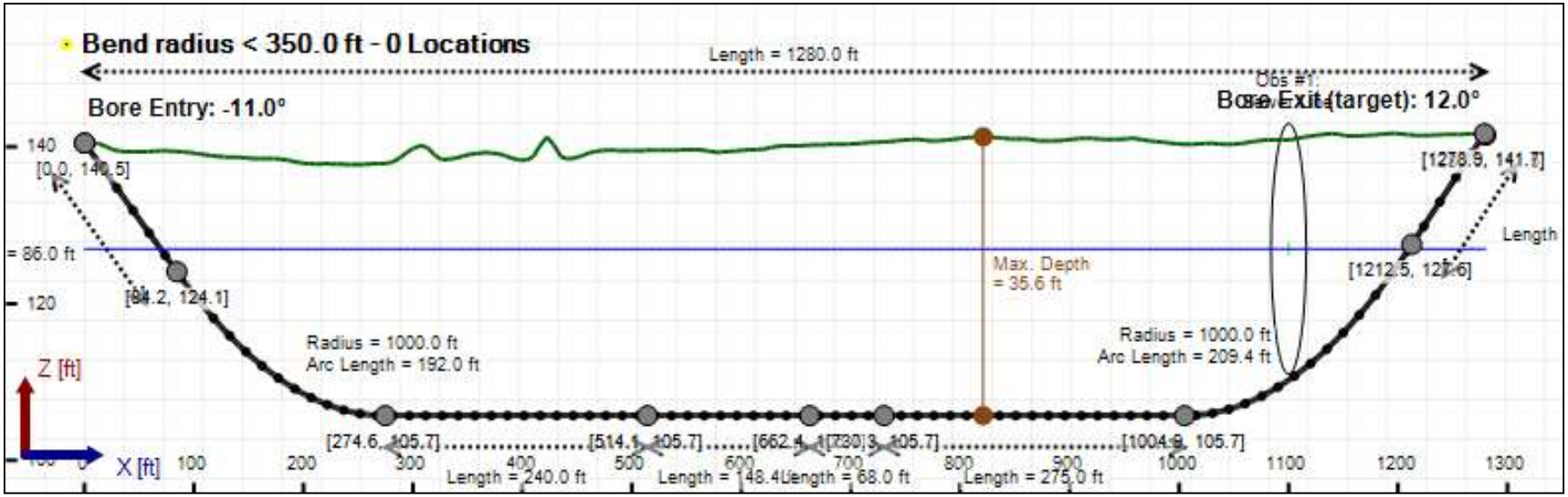
Bore Cross-Section View



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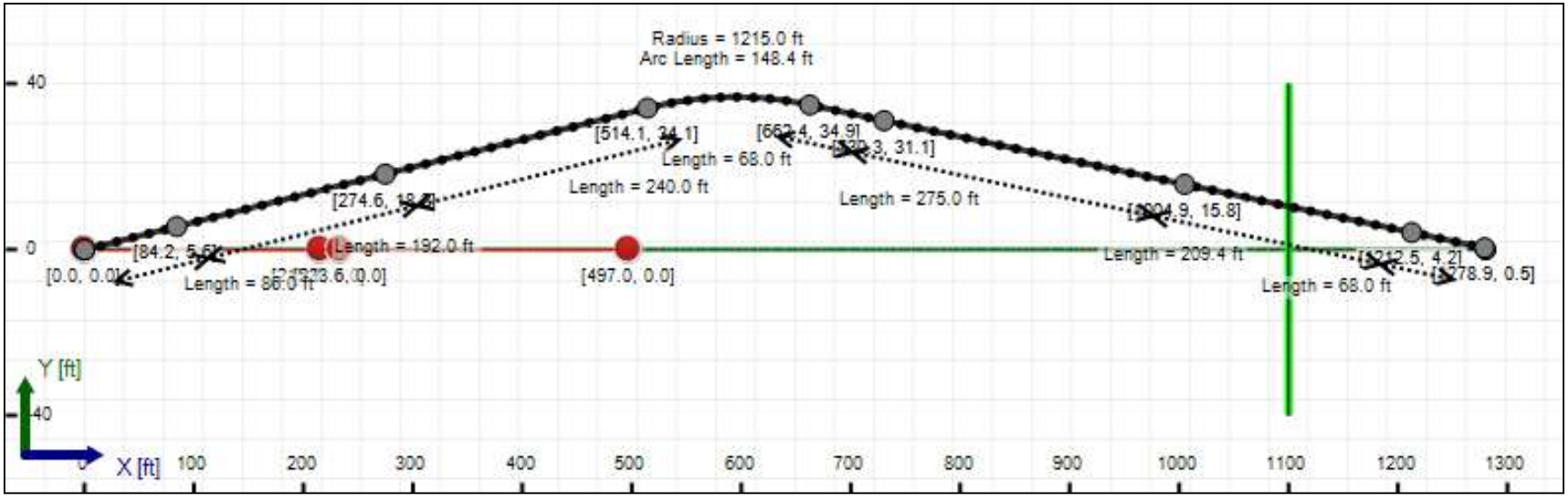
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 1290.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	3.8	18.2
Water Pressure	9.2	9.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.0	27.4
Deflection		
Earth Load Deflection	1.275	4.957
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.407	5.089
Compressive Stress [psi]		
Compressive Wall Stress	58.7	123.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	21993.8	21993.8
Pullback Stress [psi]	613.4	613.4
Pullback Strain	1.067E-2	1.067E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	613.4	637.2
Tensile Strain	1.067E-2	1.153E-2

Net External Pressure = 20.5 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.407	7.5	5.3	OK
Unconstrained Collapse [psi]	23.8	124.3	5.2	OK
Compressive Wall Stress [psi]	58.7	1150.0	19.6	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	33.8	218.6	6.5	OK
Tensile Stress [psi]	637.2	1200.0	1.9	OK

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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	77.852 psi	77.852 psi
1	8.00 in	12.00 in	77.762 psi	77.762 psi
2	12.00 in	16.13 in	77.633 psi	77.633 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

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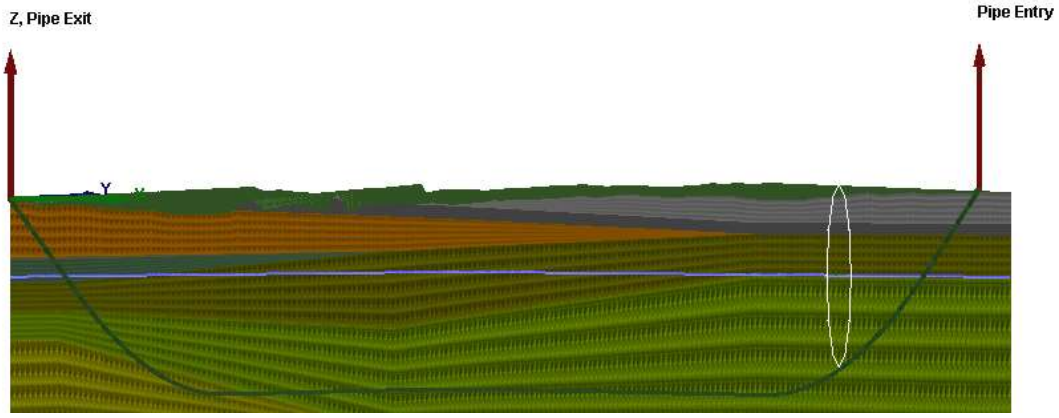
Virtual Site



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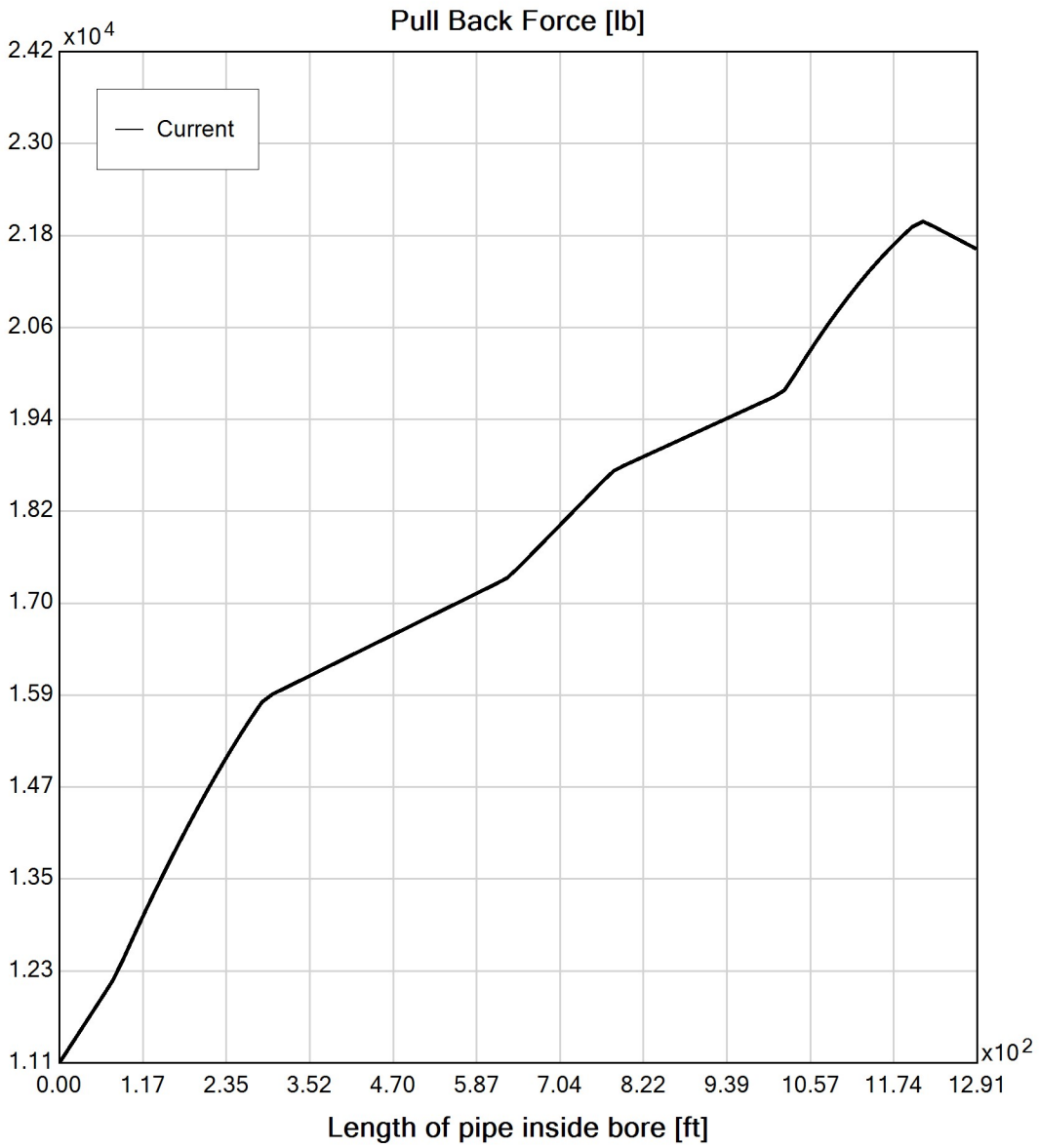

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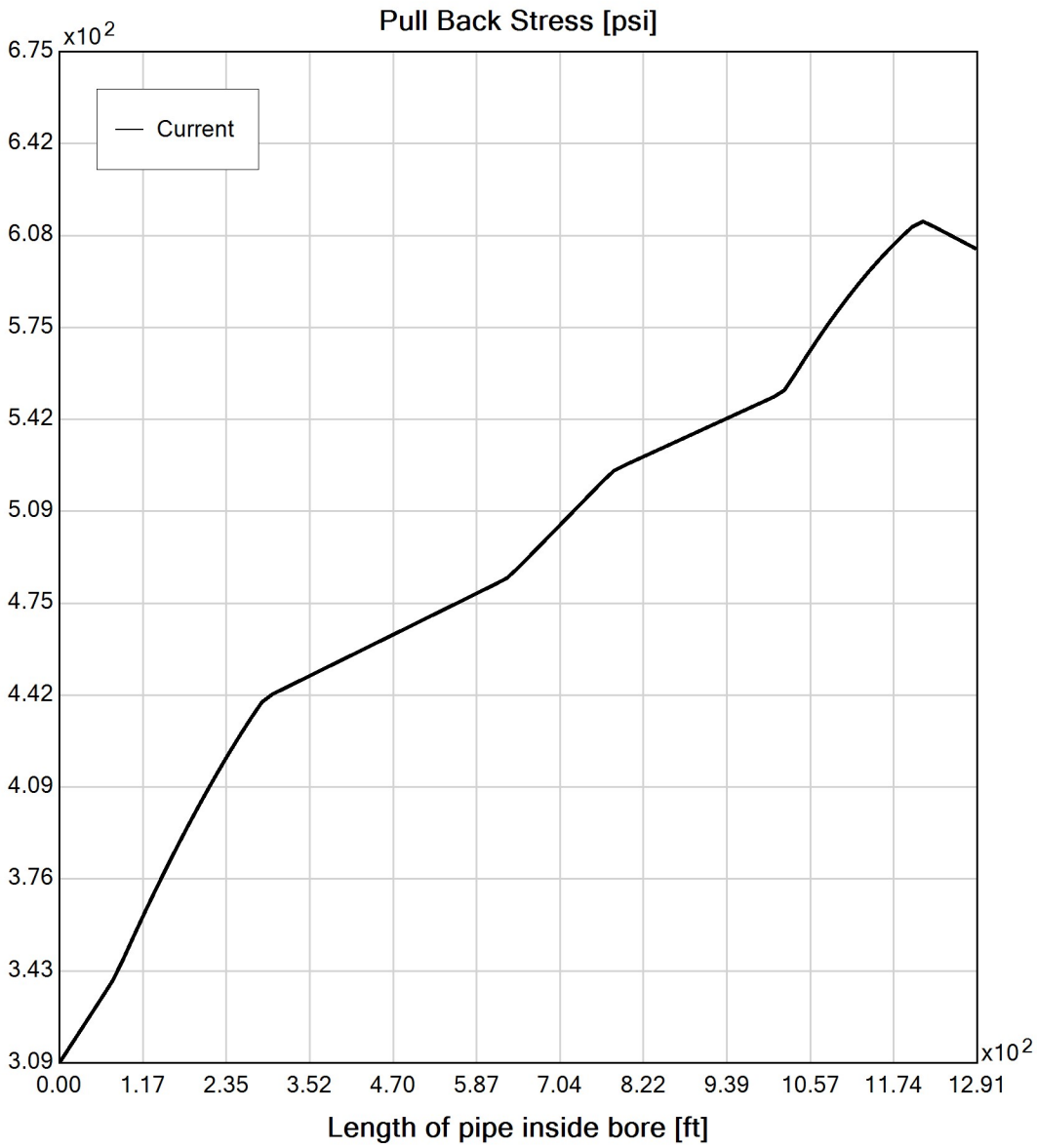

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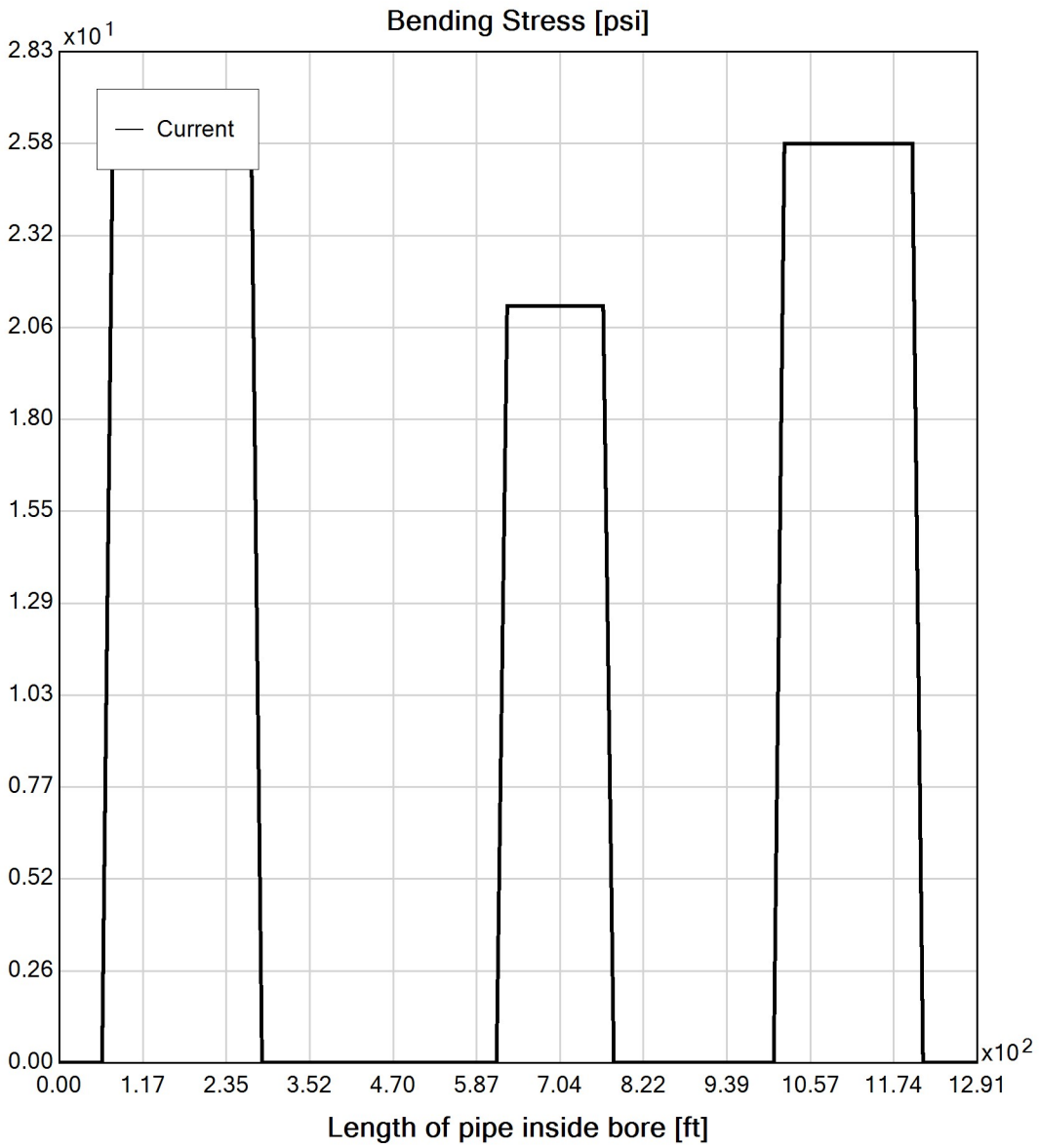

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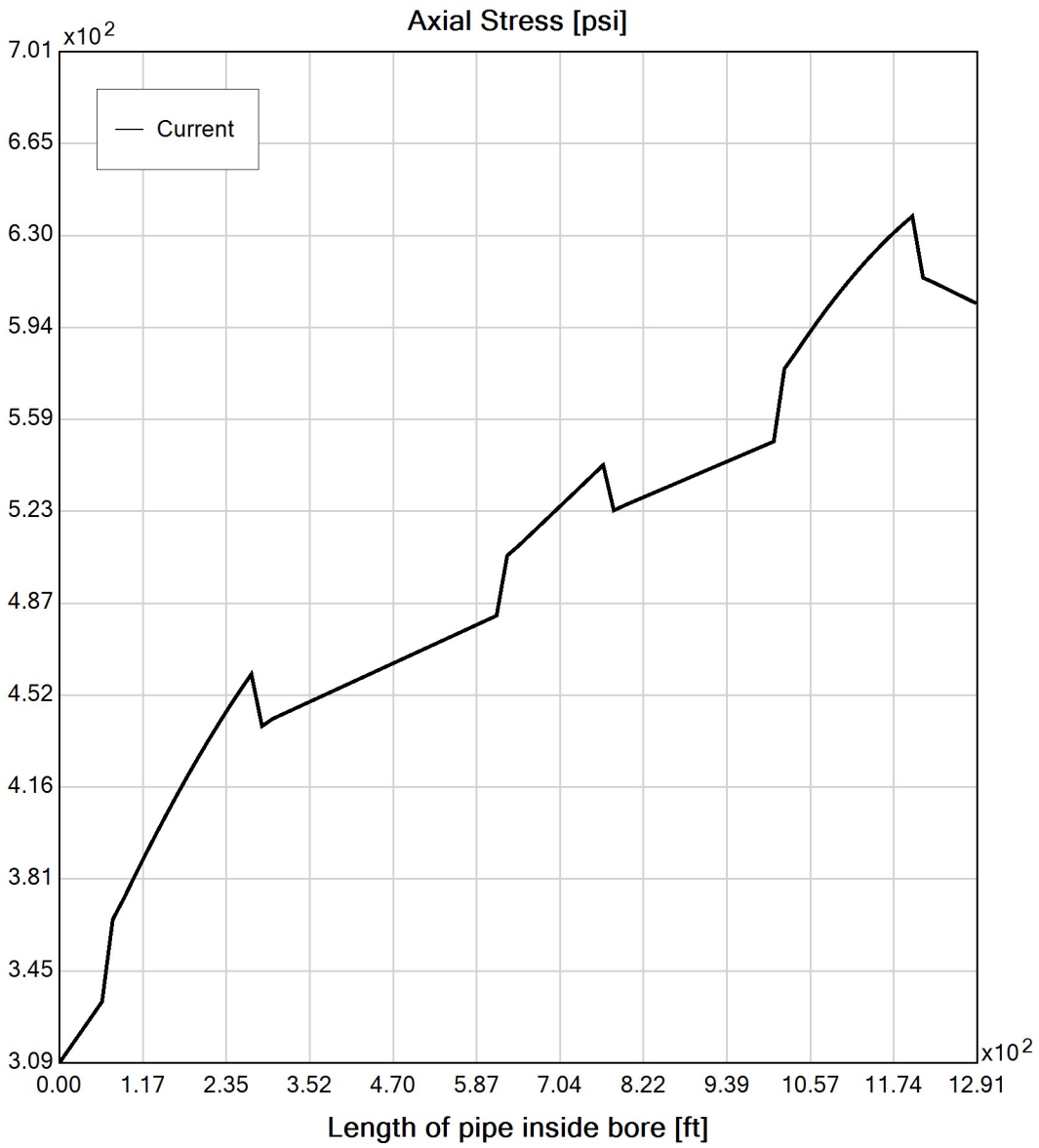

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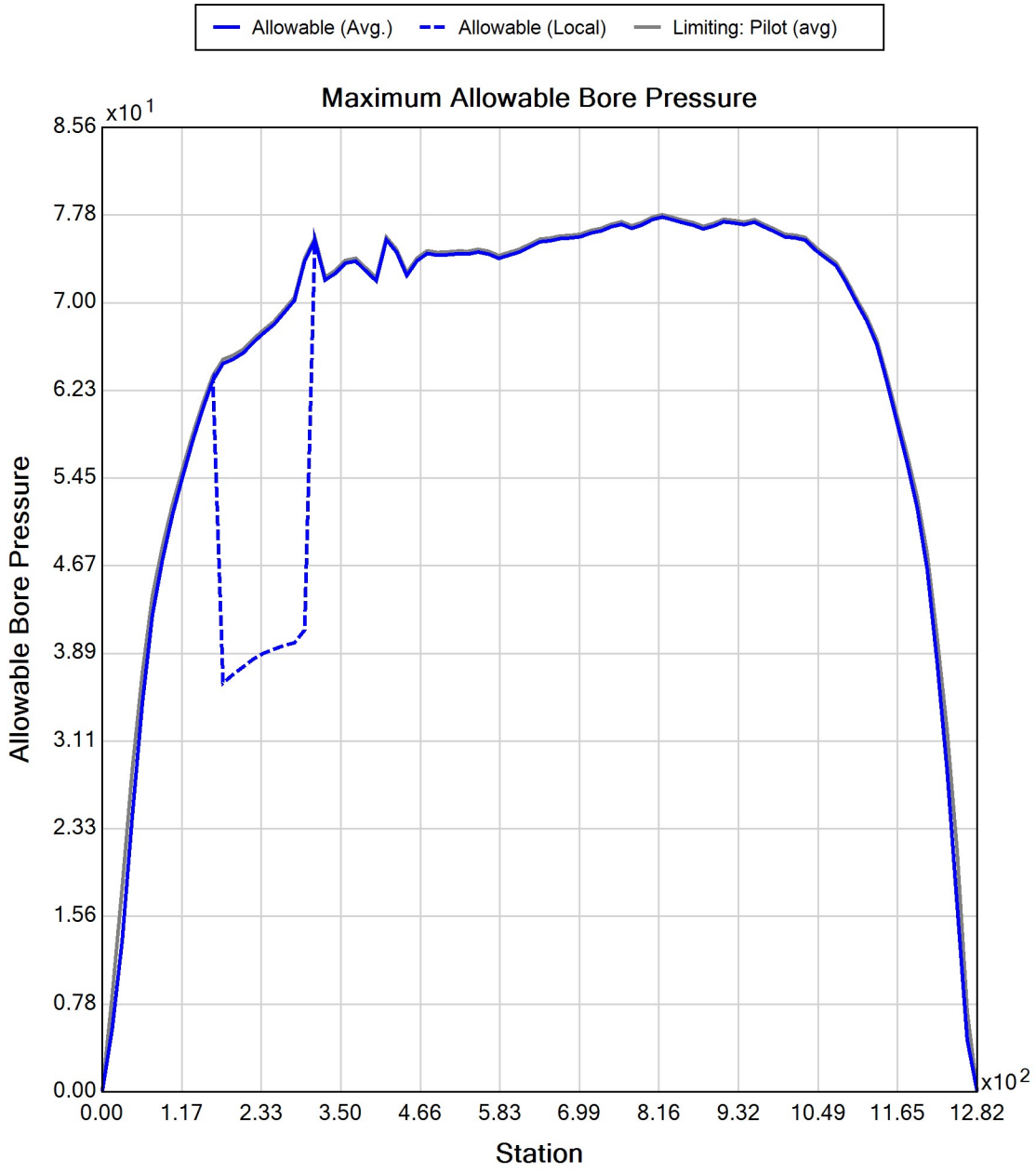

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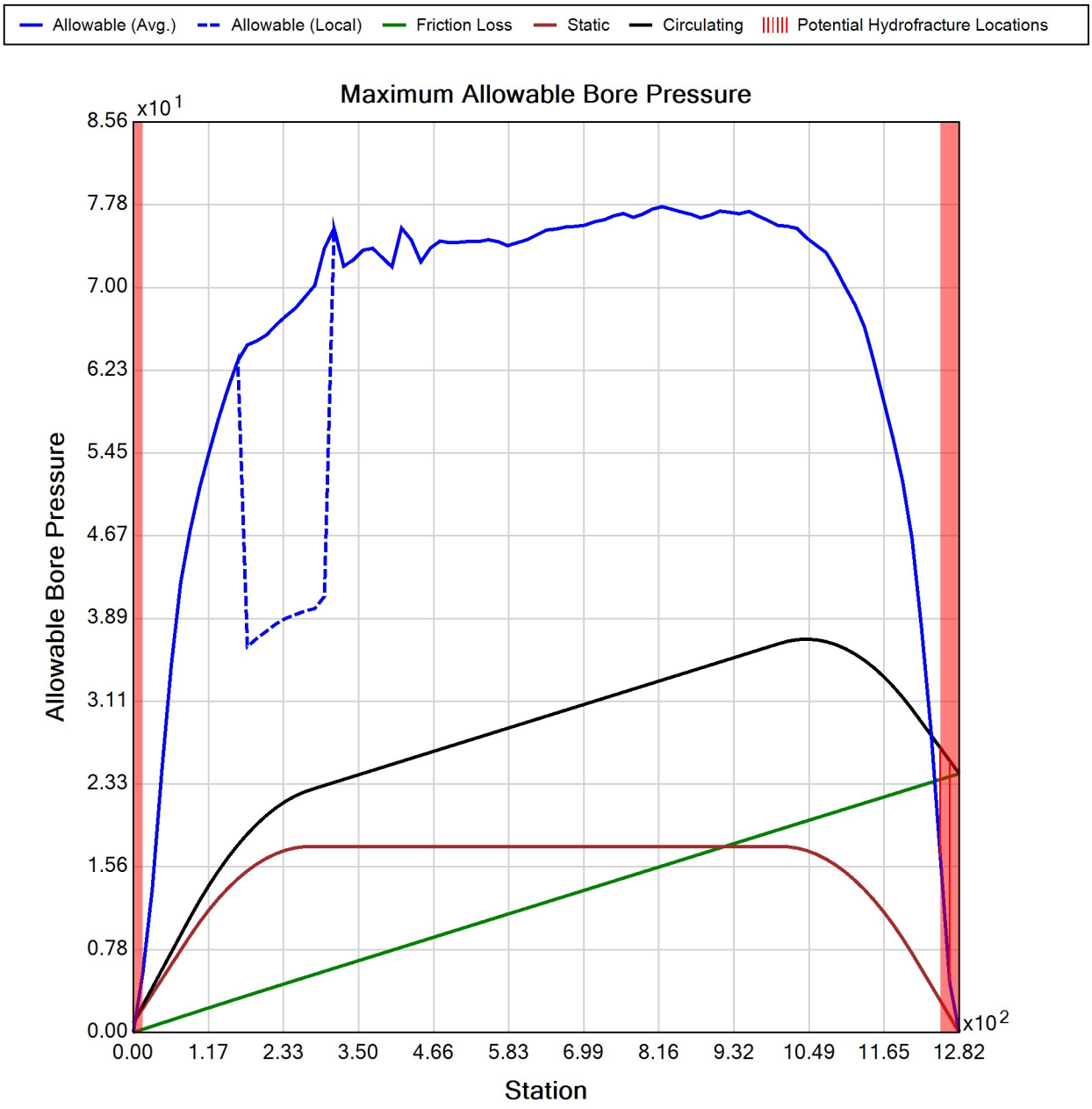

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Input Summary

Start Coordinate	(0.00, 0.00, 140.50) ft
End Coordinate	(1280.00, 0.00, 141.50) ft
Project Length	1280.00 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

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 1290.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.5	18.2
Water Pressure	9.2	9.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	10.7	27.4
Deflection		
Earth Load Deflection	0.582	4.957
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.611	4.986
Compressive Stress [psi]		
Compressive Wall Stress	48.4	123.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1183.1	1183.1
Pullback Stress [psi]	676.0	676.0
Pullback Strain	1.176E-2	1.176E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	676.0	679.8
Tensile Strain	1.176E-2	1.192E-2

Net External Pressure = 20.5 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.611	7.5	12.3	OK
Unconstrained Collapse [psi]	23.8	132.7	5.6	OK
Compressive Wall Stress [psi]	48.4	1150.0	23.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	33.8	216.5	6.4	OK
Tensile Stress [psi]	679.8	1200.0	1.8	OK

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Project Summary

General:	CHPE Package 2 HDD 24 Draft
	J2105
	Start Date: 10-03-2022
	End Date: 10-03-2022
Project Owner:	TDI
Project Contractor:	Kiewit
Project Consultant:	CHA-BCE
Designer:	MDB
	BCE
	Amherst, MA
Description:	North to South 12" DR7 curved alignment

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Input Summary

Start Coordinate	(0.00, 0.00, 135.00) ft
End Coordinate	(3320.00, 0.00, 162.00) ft
Project Length	3320.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	12.750 in
Pipe DR	7.0
Pipe Thickness	1.82 in
Rod Length	20.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

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Soil Summary

Number of Layers: 4

Soil Layer #1 USCS, Sand (S), SM
From Assistant
Unit Weight: 117.1584 (dry), 132.8832 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 5.00 [psi]

Soil Layer #3 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 32.00, S.M.: 250.00, Coh: 0.00 [psi]

Soil Layer #4 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 107.8272 (dry), 177.6384 (sat) [lb/ft3]
Phi: 35.00, S.M.: 1450.40, Coh: 2900.80 [psi]

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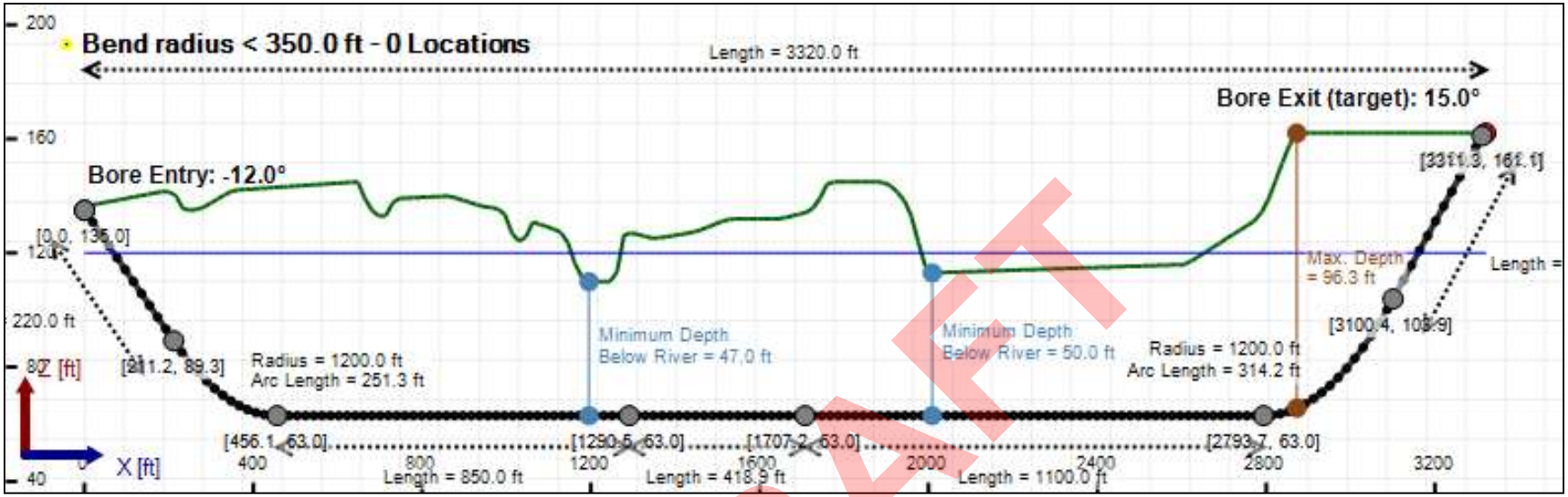
Bore Cross-Section View



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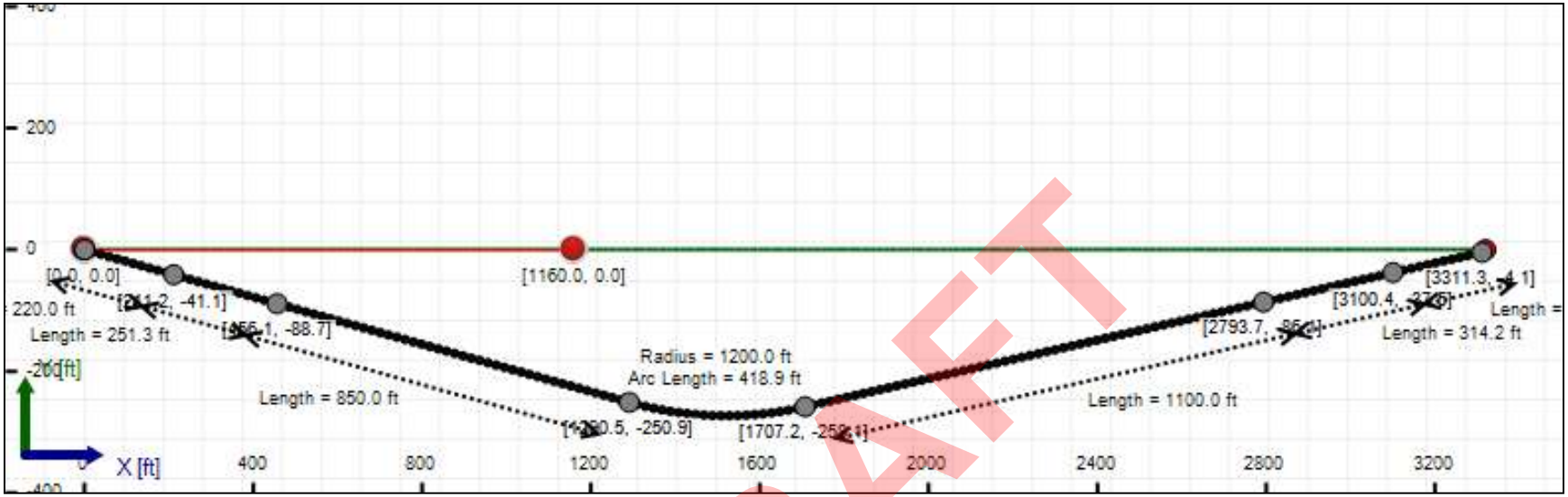
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 12" (12.75")
Pipe DR: 7
Pipe Length: 3379.99 ft
Internal Pressure: 0 psi
Borehole Diameter: 1.59400002161662 ft
Silo Width: 1.59400002161662 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	7.4	63.5
Water Pressure	24.7	24.7
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	32.1	88.2
Deflection		
Earth Load Deflection	0.845	7.294
Buoyant Deflection	0.074	0.074
Reissner Effect	0	0
Net Deflection	0.919	7.368
Compressive Stress [psi]		
Compressive Wall Stress	112.2	308.6

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	57985.6	57985.6
Pullback Stress [psi]	927.2	927.2
Pullback Strain	1.613E-2	1.613E-2
Bending Stress [psi]	0.0	25.5
Bending Strain	0	4.427E-4
Tensile Stress [psi]	927.2	943.6
Tensile Strain	1.613E-2	1.685E-2

Net External Pressure = 31.5 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 798.4 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.919	7.5	8.2	OK
Unconstrained Collapse [psi]	64.6	301.5	4.7	OK
Compressive Wall Stress [psi]	112.2	1150.0	10.3	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.036	7.5	207.6	OK
Unconstrained Collapse [psi]	31.5	451.0	14.3	OK
Tensile Stress [psi]	943.6	1200.0	1.3	OK

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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	1303.855 psi	1380.179 psi
1	8.00 in	12.00 in	1303.692 psi	1380.123 psi
2	12.00 in	16.13 in	1303.455 psi	1380.041 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): 0.00 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): Infinity

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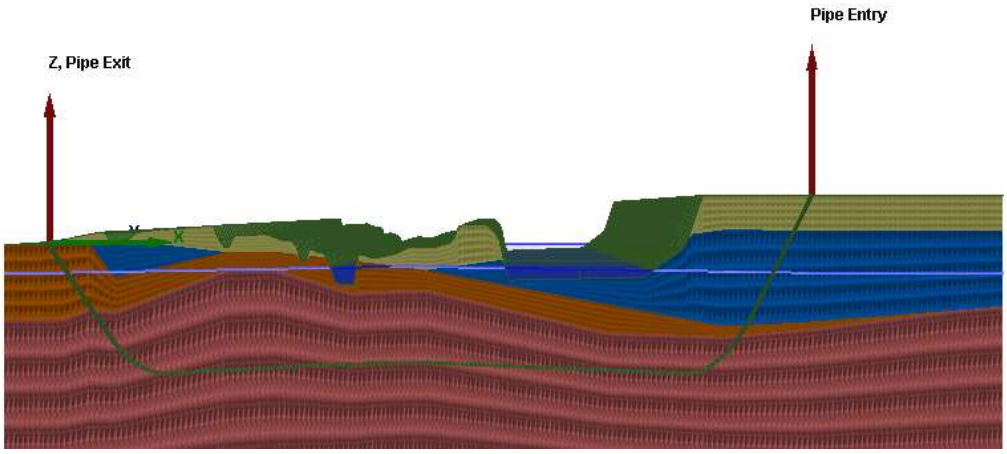
Virtual Site



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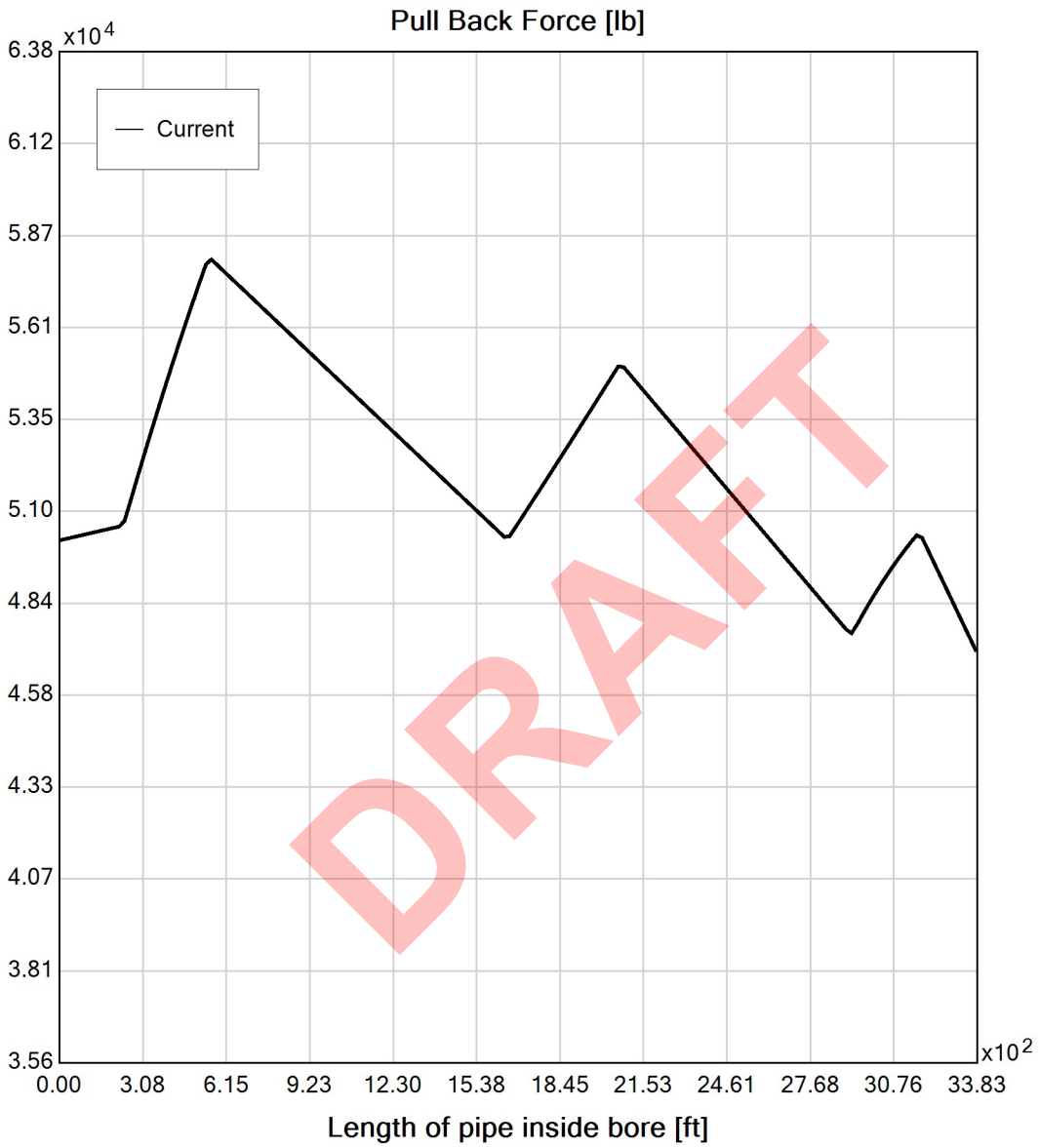

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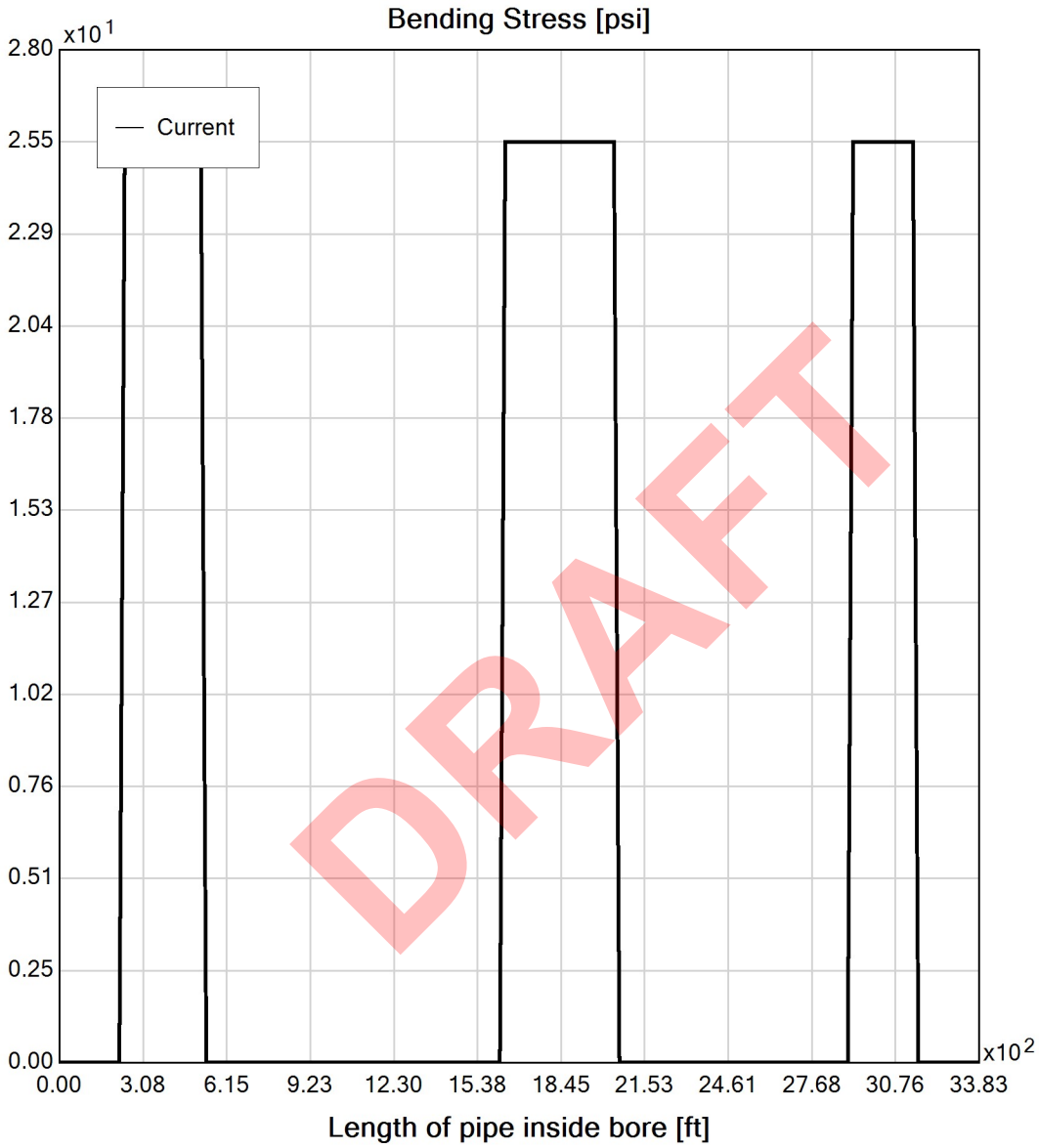

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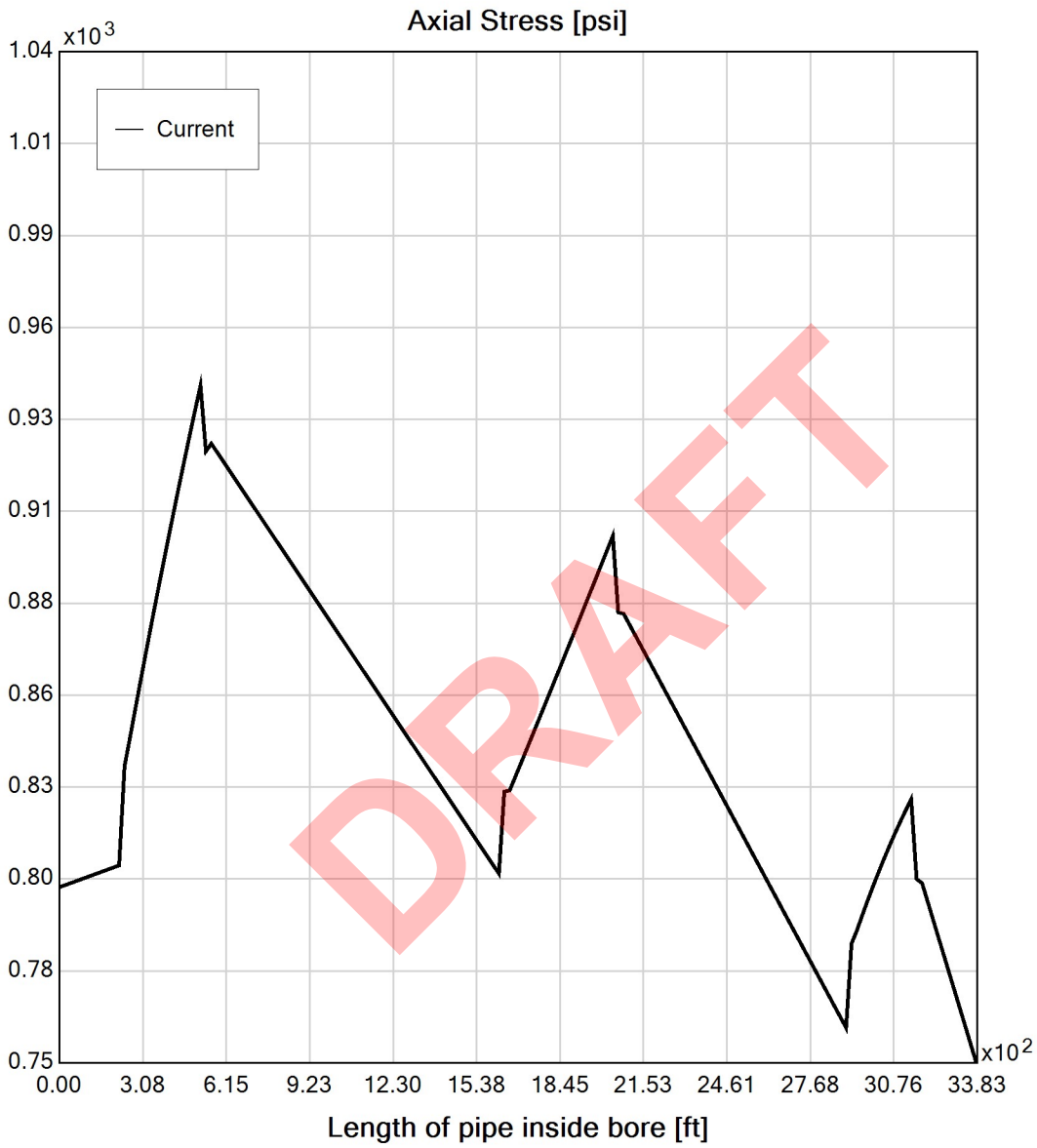

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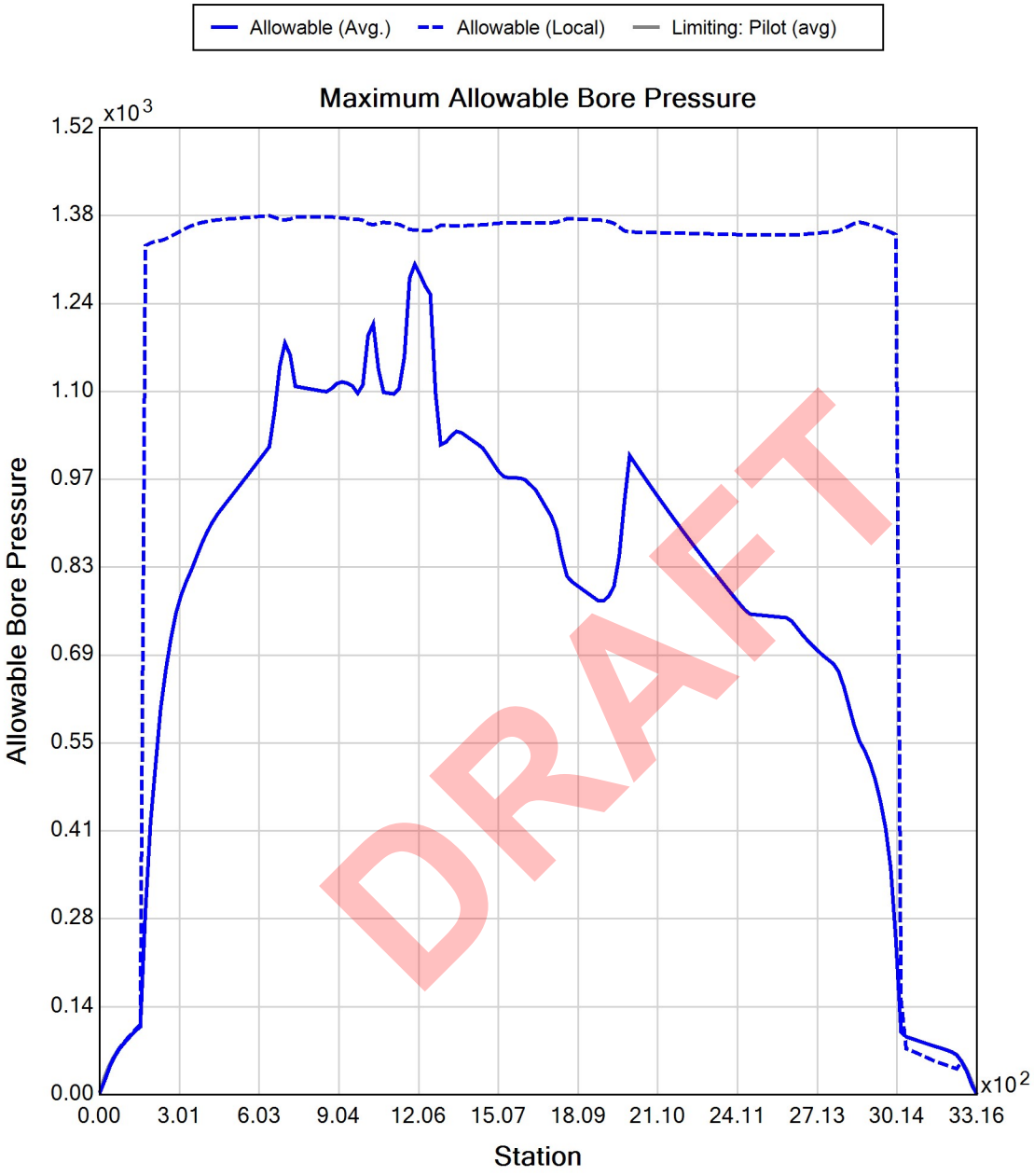

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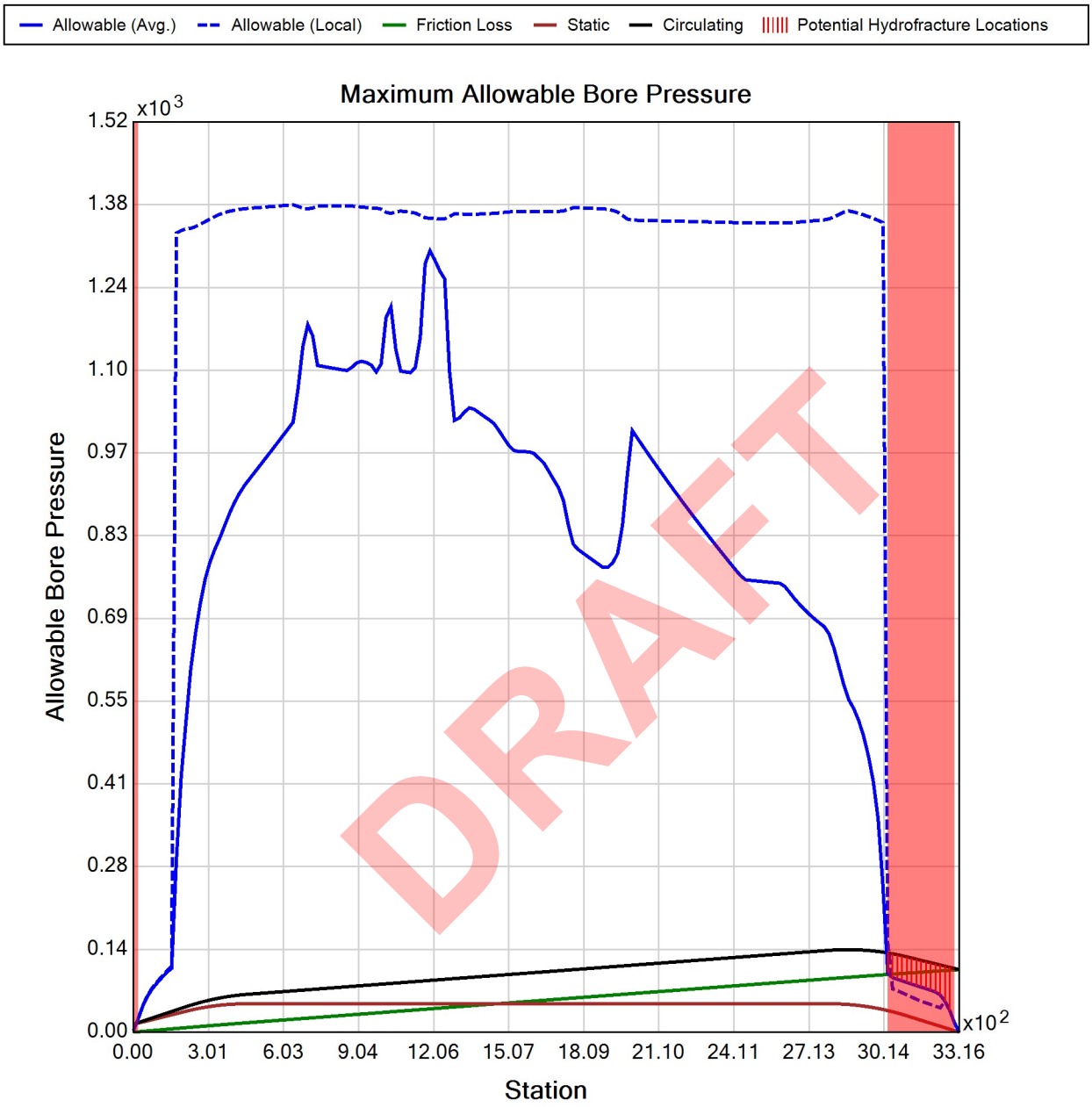

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Input Summary

Start Coordinate	(0.00, 0.00, 135.00) ft
End Coordinate	(3320.00, 0.00, 162.00) ft
Project Length	3320.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	3.500 in
Pipe DR	7.0
Pipe Thickness	0.50 in
Rod Length	20.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 3" (3.5")
Pipe DR: 7
Pipe Length: 3379.99 ft
Internal Pressure: 0 psi
Borehole Diameter: 0.625 ft
Silo Width: 0.625 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.9	63.5
Water Pressure	24.7	24.7
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	27.6	88.2
Deflection		
Earth Load Deflection	0.332	7.294
Buoyant Deflection	0.020	0.020
Reissner Effect	0	0
Net Deflection	0.352	7.315
Compressive Stress [psi]		
Compressive Wall Stress	96.5	308.6

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	4482.2	4482.2
Pullback Stress [psi]	951.1	951.1
Pullback Strain	1.654E-2	1.654E-2
Bending Stress [psi]	0.0	7.0
Bending Strain	0	1.215E-4
Tensile Stress [psi]	951.1	951.1
Tensile Strain	1.654E-2	1.663E-2

Net External Pressure = 31.5 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 172.8 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.352	7.5	21.3	OK
Unconstrained Collapse [psi]	64.6	317.2	4.9	OK
Compressive Wall Stress [psi]	96.5	1150.0	11.9	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.010	7.5	756.1	OK
Unconstrained Collapse [psi]	31.5	450.6	14.3	OK
Tensile Stress [psi]	951.1	1200.0	1.3	OK

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Generated Output

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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 24A Conduit 1 P3 Start Date: 12-10-2021 End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Designer:	AJB CHA
Description:	HDD 25 10-inch DR 9 Conduit 1

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Input Summary

Start Coordinate	(130.00, 0.00, 157.20) ft
End Coordinate	(1014.10, 0.00, 158.20) ft
Project Length	884.10 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

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Soil Summary

Number of Layers: 6

Soil Layer #1 USCS, Sand (S), SM
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Gravel (G), GC
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #3 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #4 USCS, Clay (C), CL
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

Soil Layer #5 USCS, Gravel (G), GW
From Assistant
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #6 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1450.40, Coh: 2000.00 [psi]

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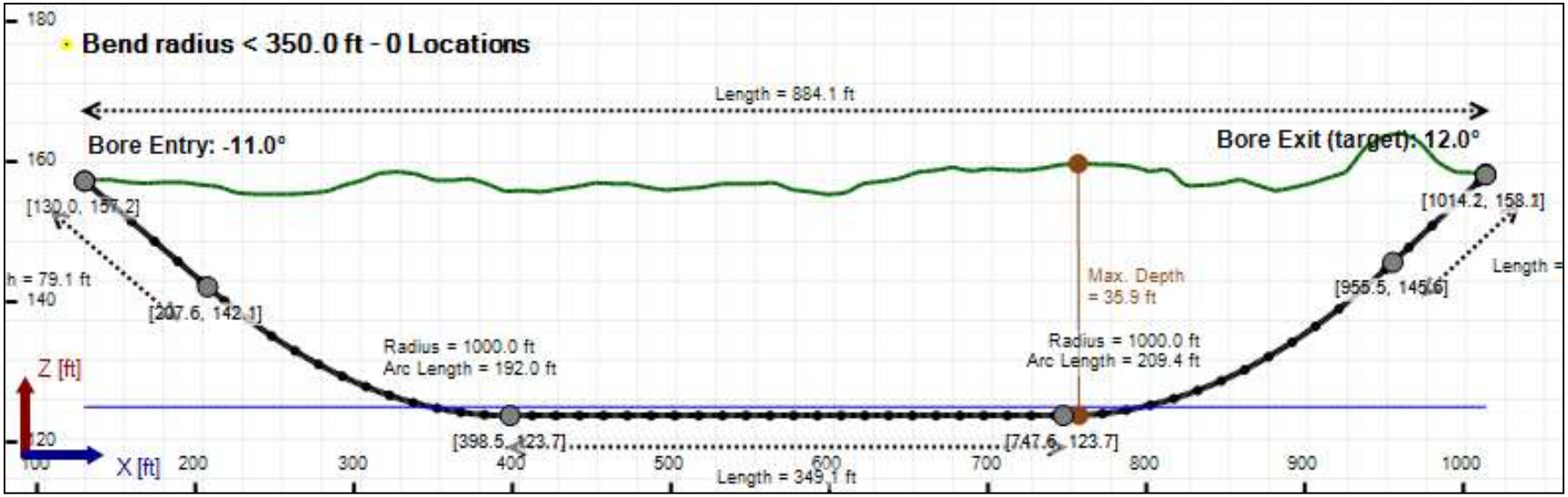
Bore Cross-Section View



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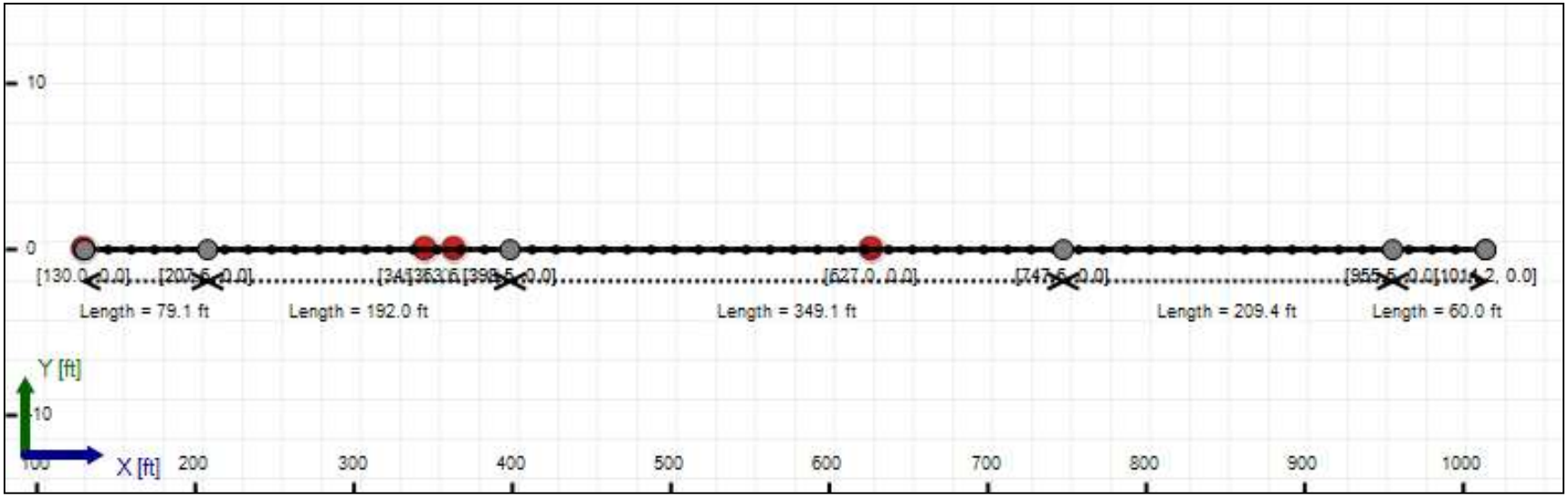
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 900.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	7.7	20.5
Water Pressure	0.5	0.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	8.2	21.1
Deflection		
Earth Load Deflection	2.092	5.590
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	2.224	5.722
Compressive Stress [psi]		
Compressive Wall Stress	37.0	94.7

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	15318.0	15318.0
Pullback Stress [psi]	427.2	427.2
Pullback Strain	7.430E-3	7.430E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	427.2	451.2
Tensile Strain	7.430E-3	8.295E-3

Net External Pressure = 21.3 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	2.224	7.5	3.4	OK
Unconstrained Collapse [psi]	23.7	113.1	4.8	OK
Compressive Wall Stress [psi]	37.0	1150.0	31.0	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	33.7	230.4	6.8	OK
Tensile Stress [psi]	451.2	1200.0	2.7	OK

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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	56.951 psi	56.951 psi
1	8.00 in	12.00 in	56.614 psi	56.614 psi
2	12.00 in	16.13 in	56.140 psi	56.140 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

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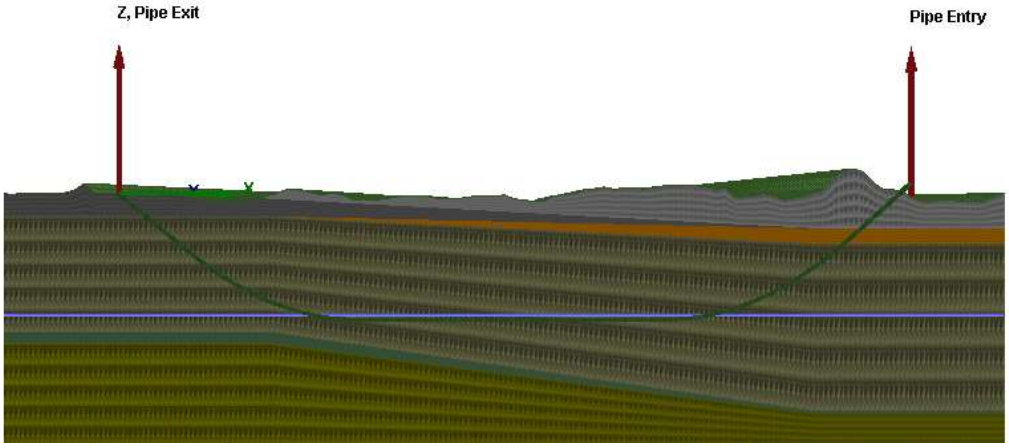
Virtual Site



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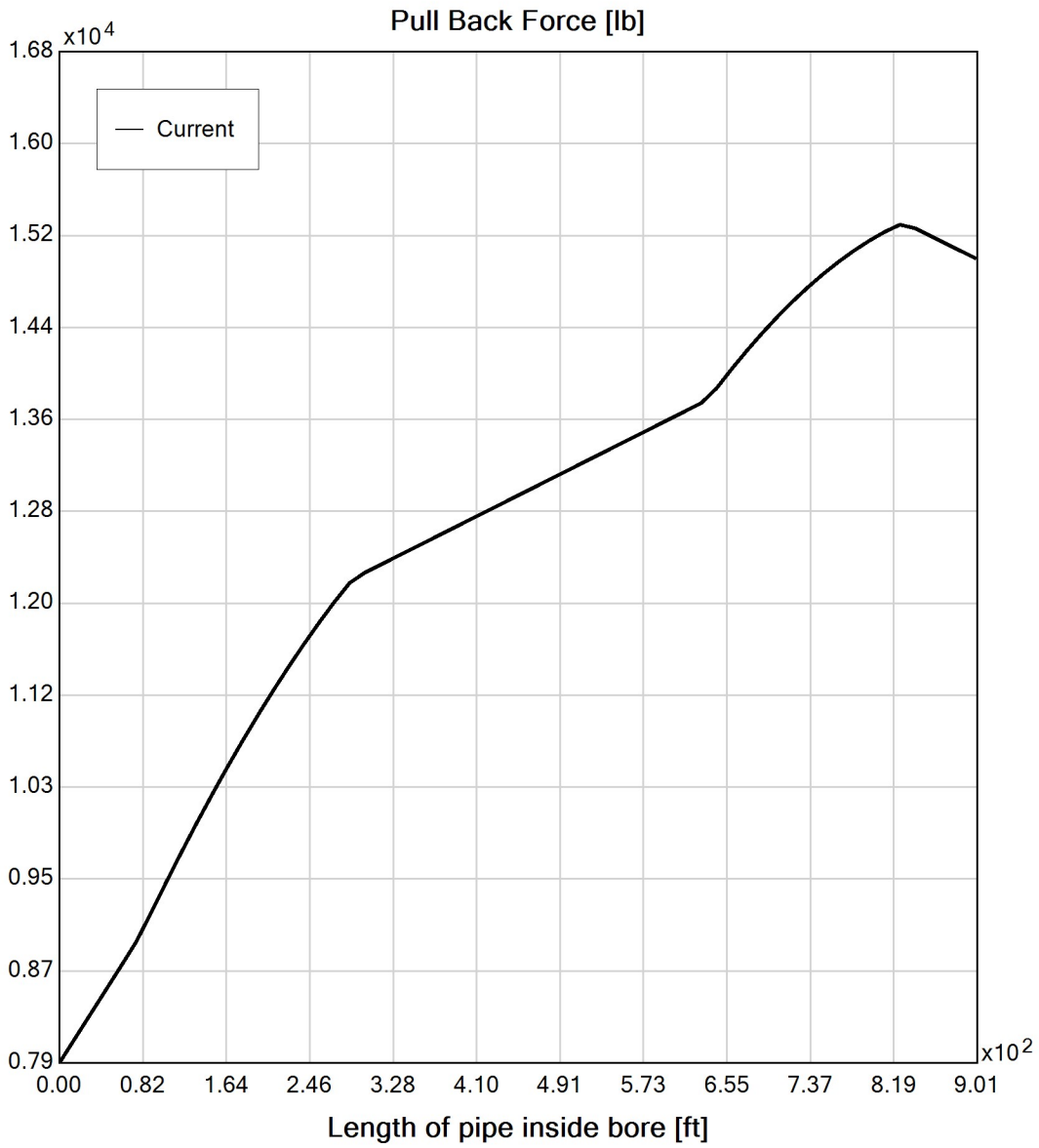

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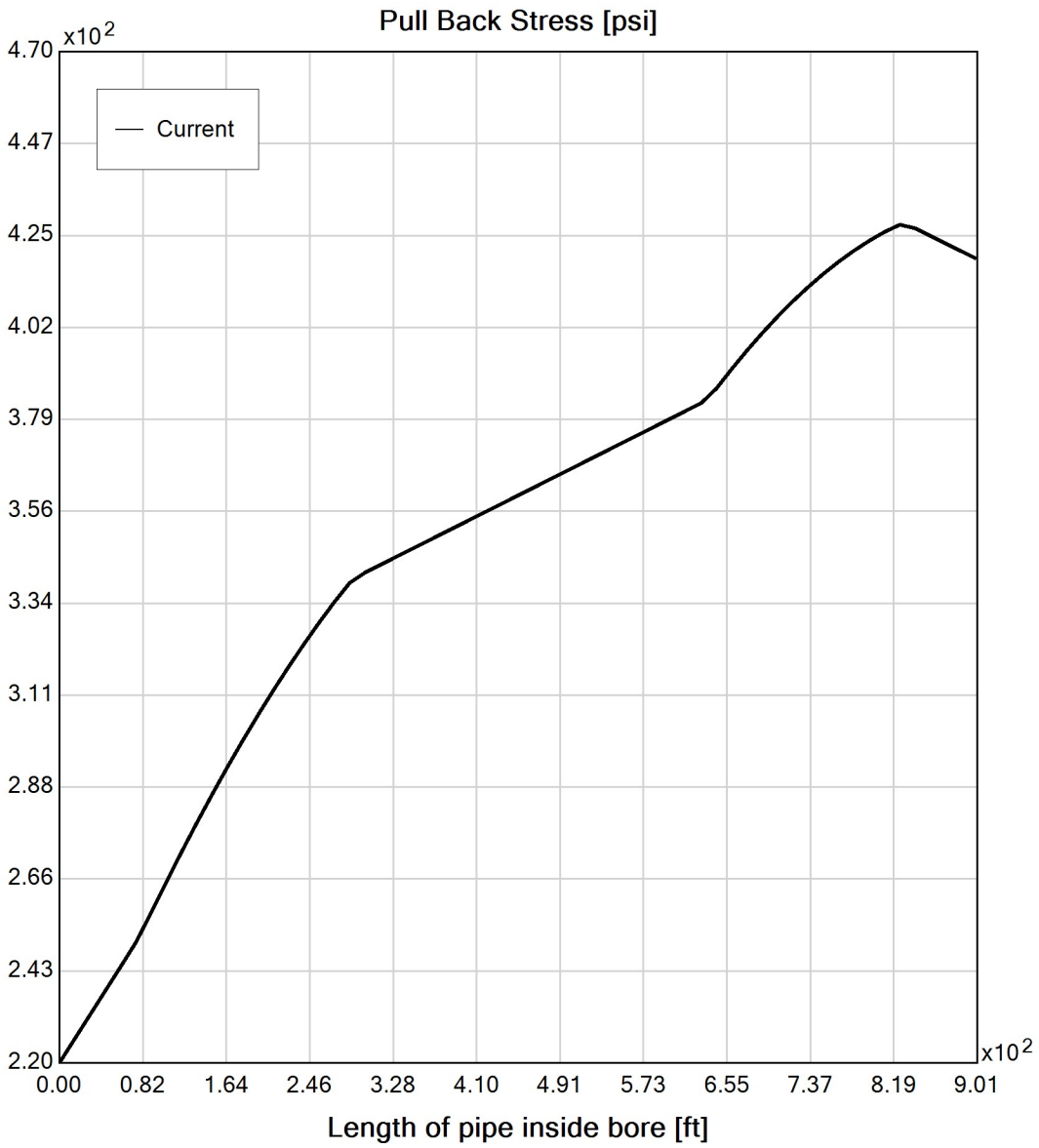

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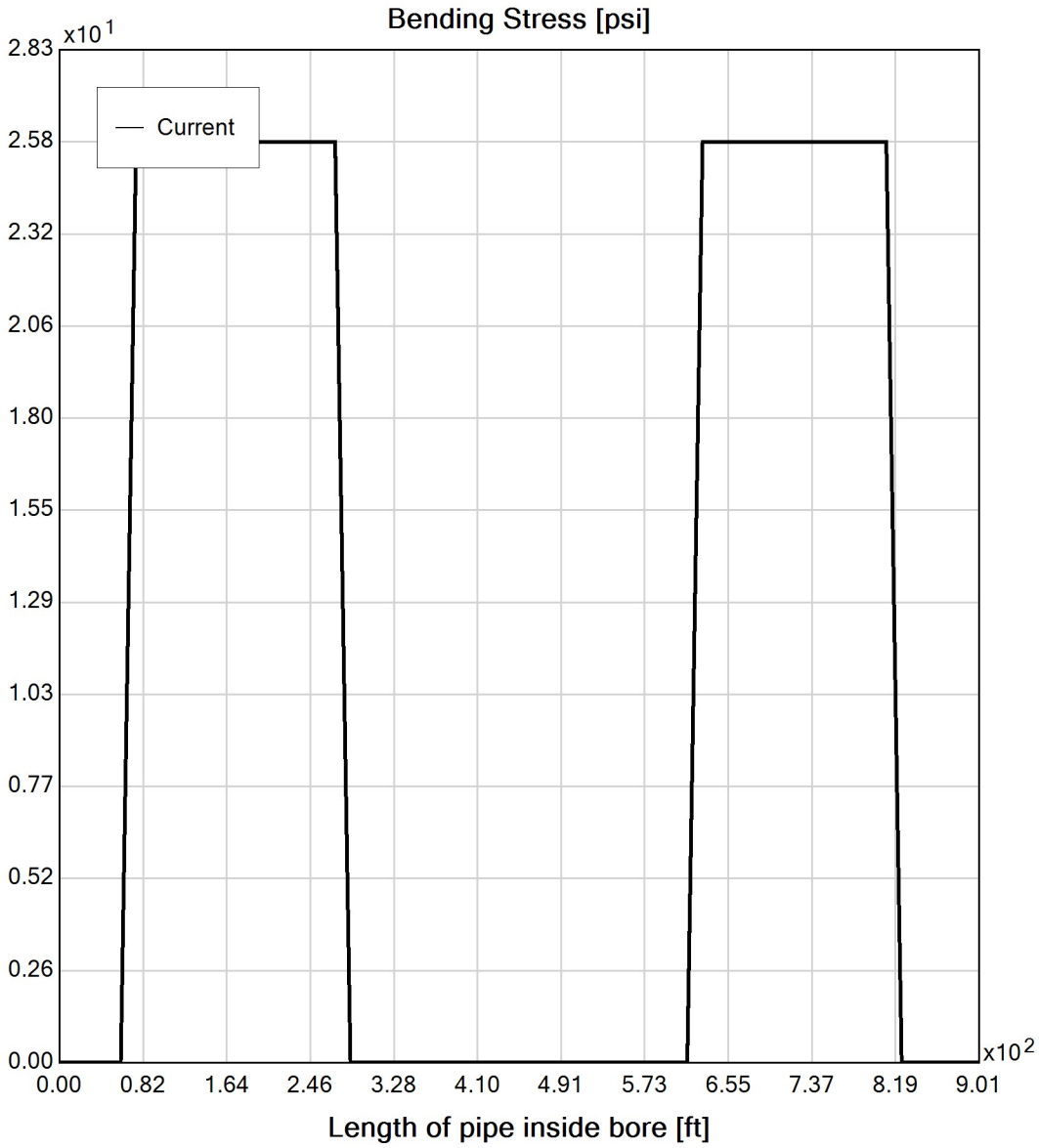

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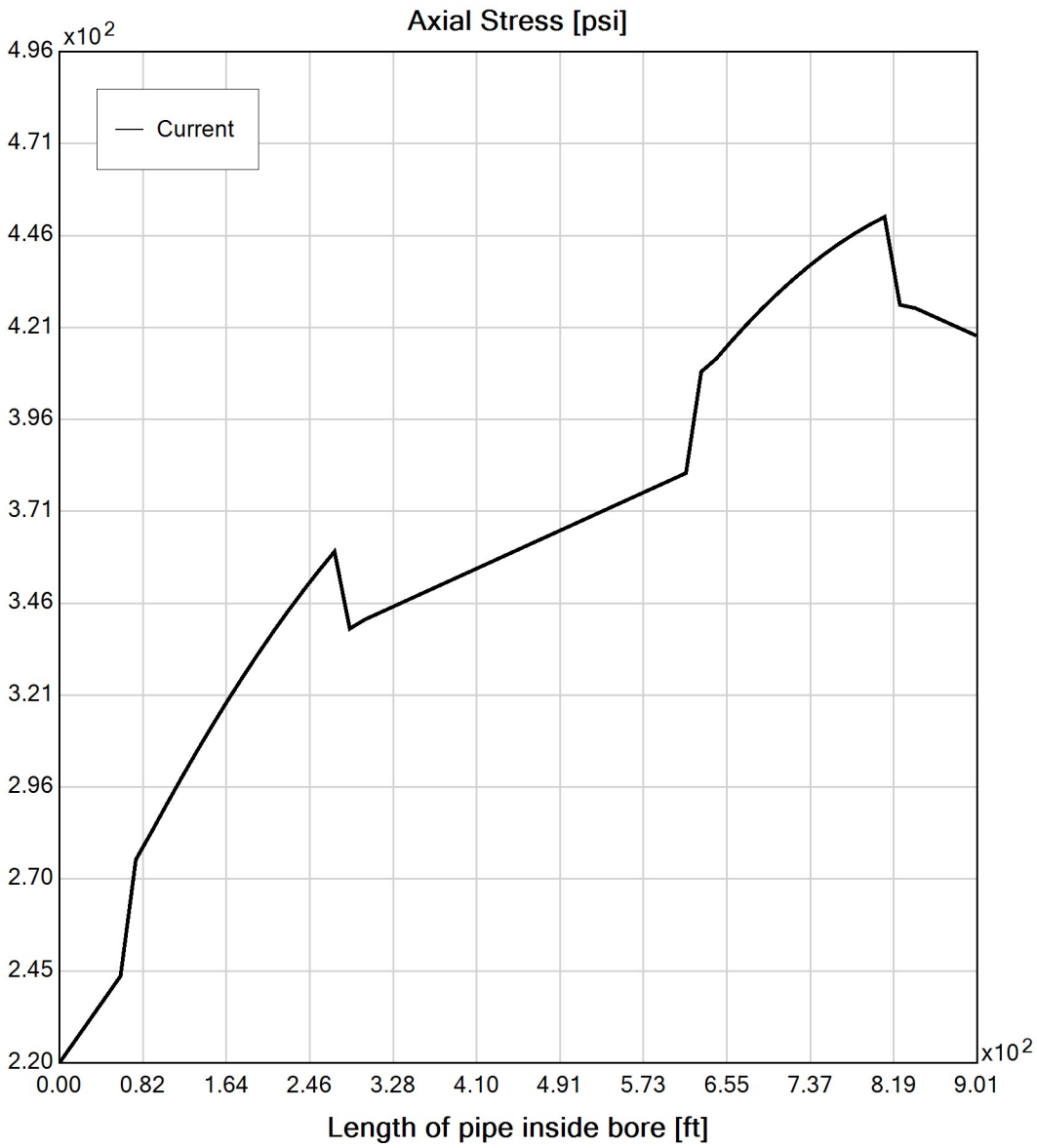

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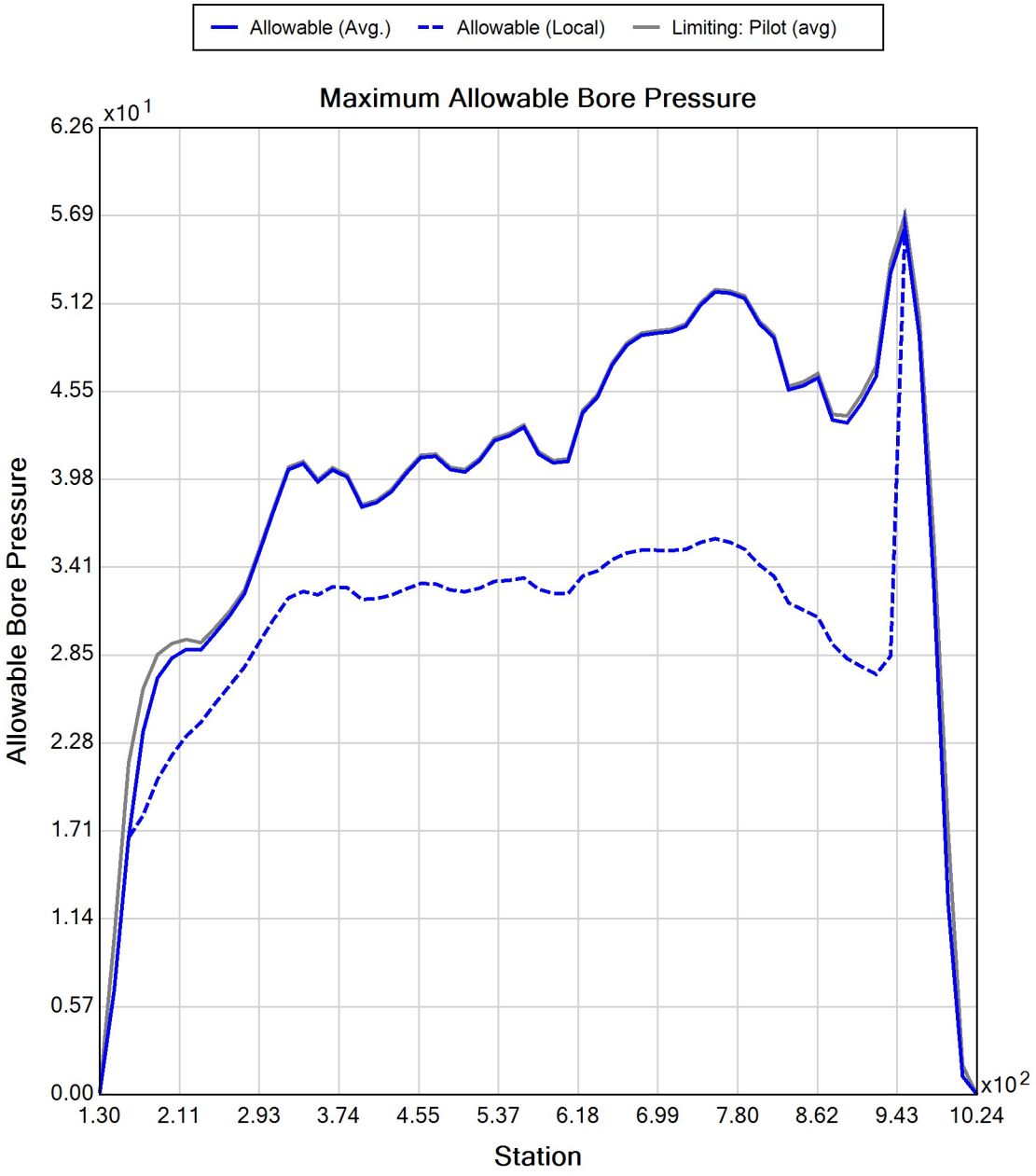

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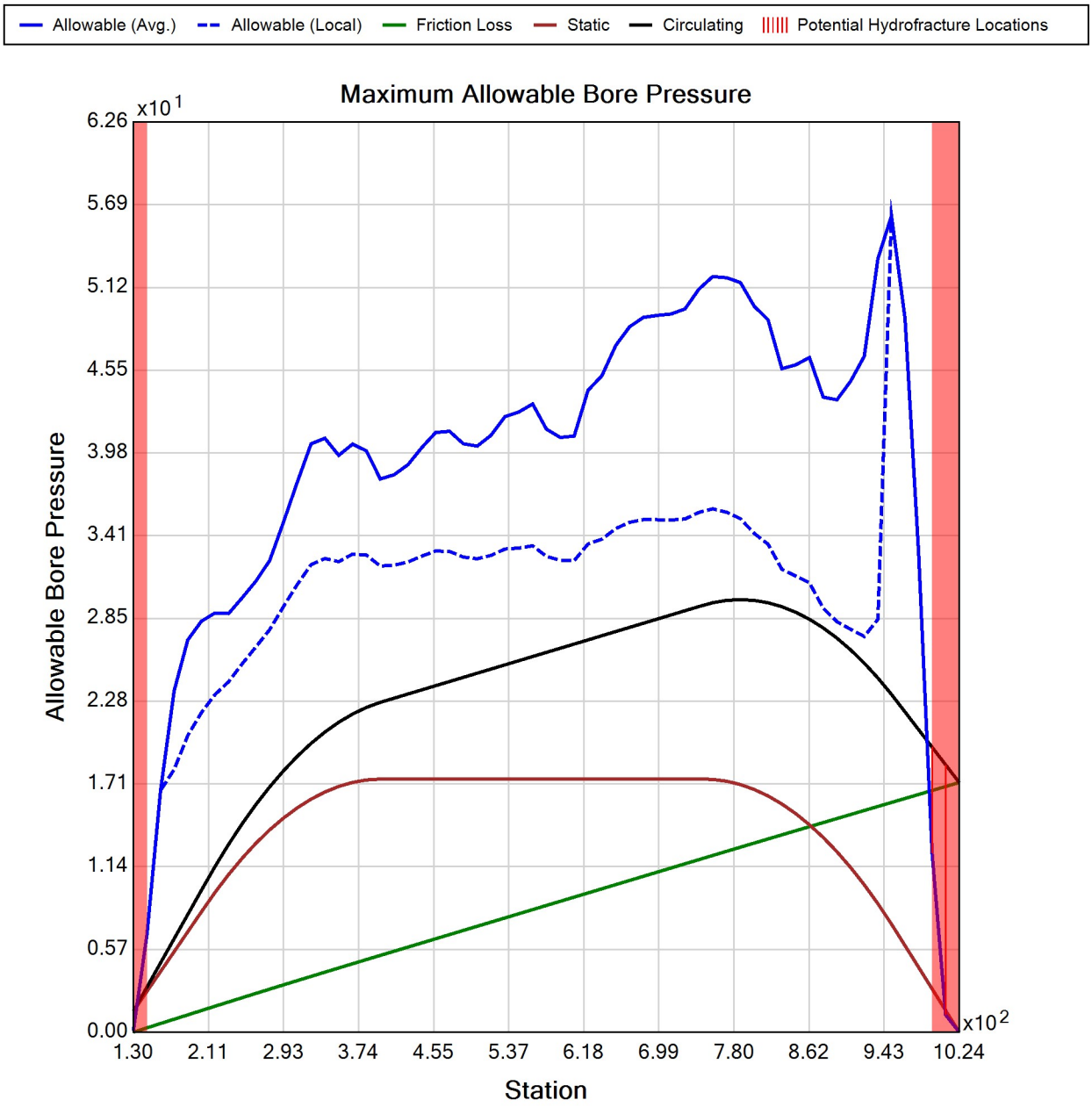

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Input Summary

Start Coordinate	(130.00, 0.00, 157.20) ft
End Coordinate	(1014.10, 0.00, 158.20) ft
Project Length	884.10 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

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 900.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	3.6	20.5
Water Pressure	0.5	0.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	4.1	21.1
Deflection		
Earth Load Deflection	0.978	5.590
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.008	5.619
Compressive Stress [psi]		
Compressive Wall Stress	18.6	94.7

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	857.3	857.3
Pullback Stress [psi]	489.8	489.8
Pullback Strain	8.518E-3	8.518E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	489.8	493.7
Tensile Strain	8.518E-3	8.686E-3

Net External Pressure = 21.3 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.008	7.5	7.4	OK
Unconstrained Collapse [psi]	23.7	126.2	5.3	OK
Compressive Wall Stress [psi]	18.6	1150.0	61.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	33.7	228.5	6.8	OK
Tensile Stress [psi]	493.7	1200.0	2.4	OK

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Project Summary

General:	CHPE HDD 24A Conduit 2 P3 Start Date: 12-10-2021 End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Designer:	AJB CHA
Description:	HDD 25 10-inch DR 9 Conduit 2

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Input Summary

Start Coordinate	(130.00, 0.00, 157.20) ft
End Coordinate	(1014.10, 0.00, 158.50) ft
Project Length	884.10 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

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Soil Summary

Number of Layers: 6

Soil Layer #1 USCS, Sand (S), SM
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Gravel (G), GC
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #3 USCS, Sand (S), SP
From Assistant
Unit Weight: 105.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 30.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #4 USCS, Clay (C), CL
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 145.00, Coh: 3.13 [psi]

Soil Layer #5 USCS, Gravel (G), GW
From Assistant
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 145.00, Coh: 0.00 [psi]

Soil Layer #6 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 160.0000 (dry), 170.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1450.40, Coh: 2000.00 [psi]

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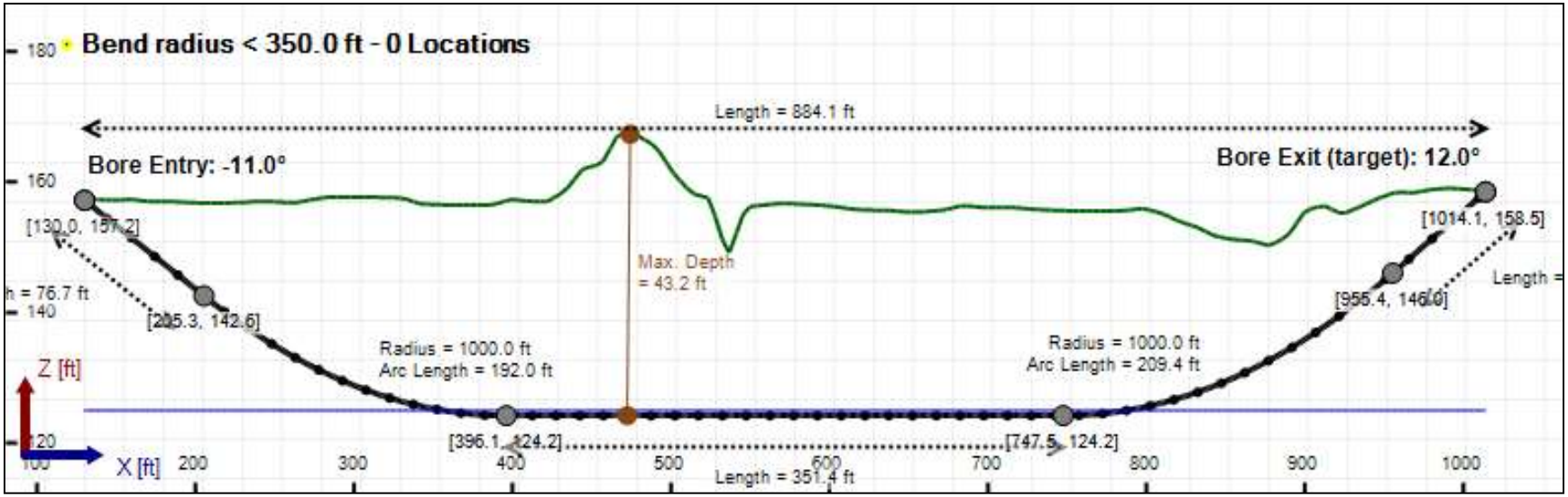
Bore Cross-Section View



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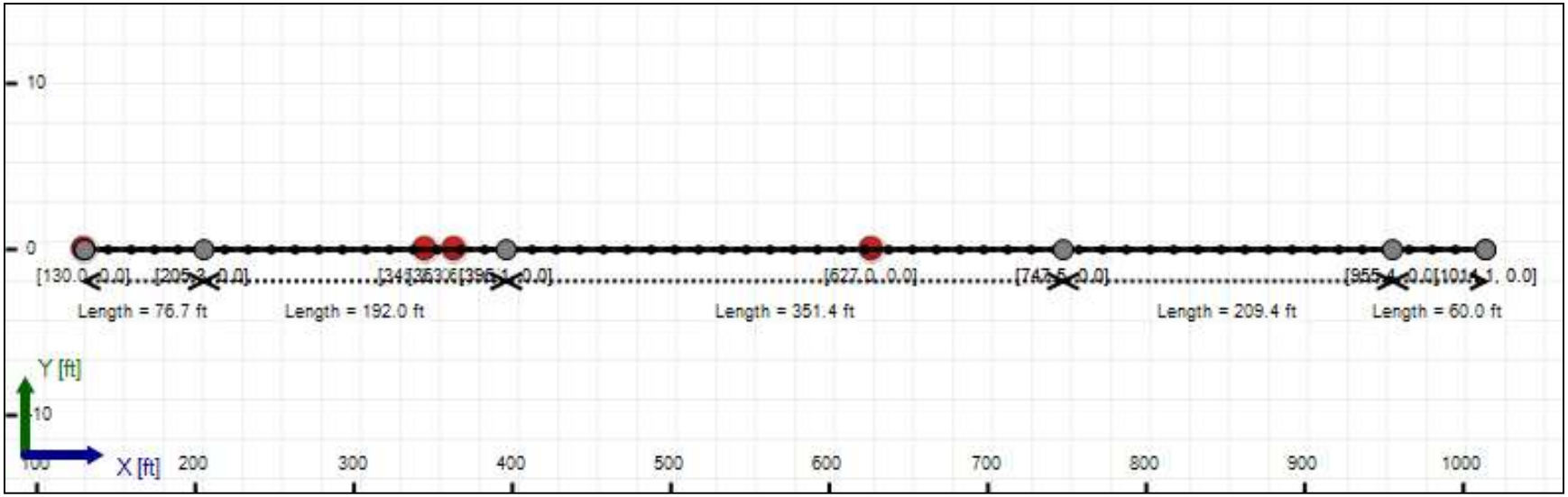
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 900.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	8.9	25.2
Water Pressure	0.4	0.4
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	9.2	25.6
Deflection		
Earth Load Deflection	2.417	6.870
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	2.549	7.002
Compressive Stress [psi]		
Compressive Wall Stress	41.5	115.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	15325.5	15325.5
Pullback Stress [psi]	427.4	427.4
Pullback Strain	7.433E-3	7.433E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	427.4	451.2
Tensile Strain	7.433E-3	8.296E-3

Net External Pressure = 21.6 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	2.549	7.5	2.9	OK
Unconstrained Collapse [psi]	23.7	109.9	4.6	OK
Compressive Wall Stress [psi]	41.5	1150.0	27.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	33.7	230.2	6.8	OK
Tensile Stress [psi]	451.2	1200.0	2.7	OK

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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	61.579 psi	43.322 psi
1	8.00 in	12.00 in	61.538 psi	42.534 psi
2	12.00 in	16.13 in	61.478 psi	41.484 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

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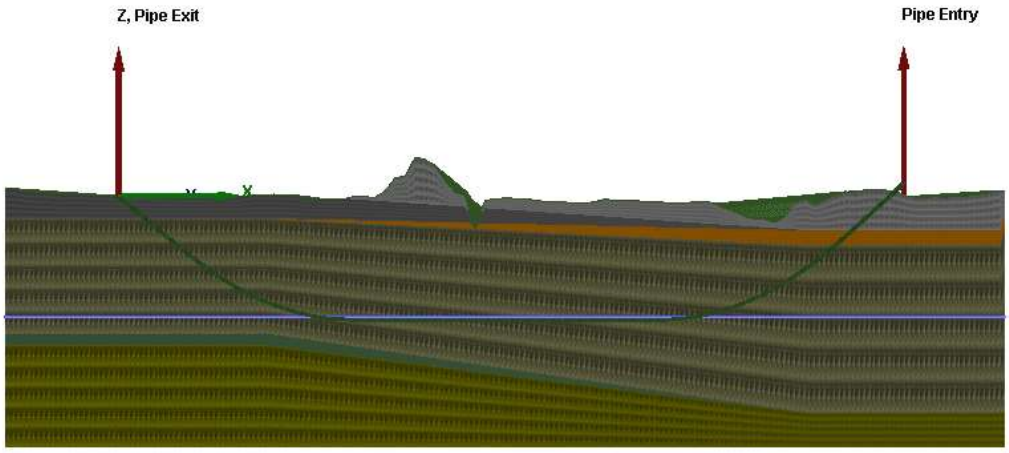
Virtual Site



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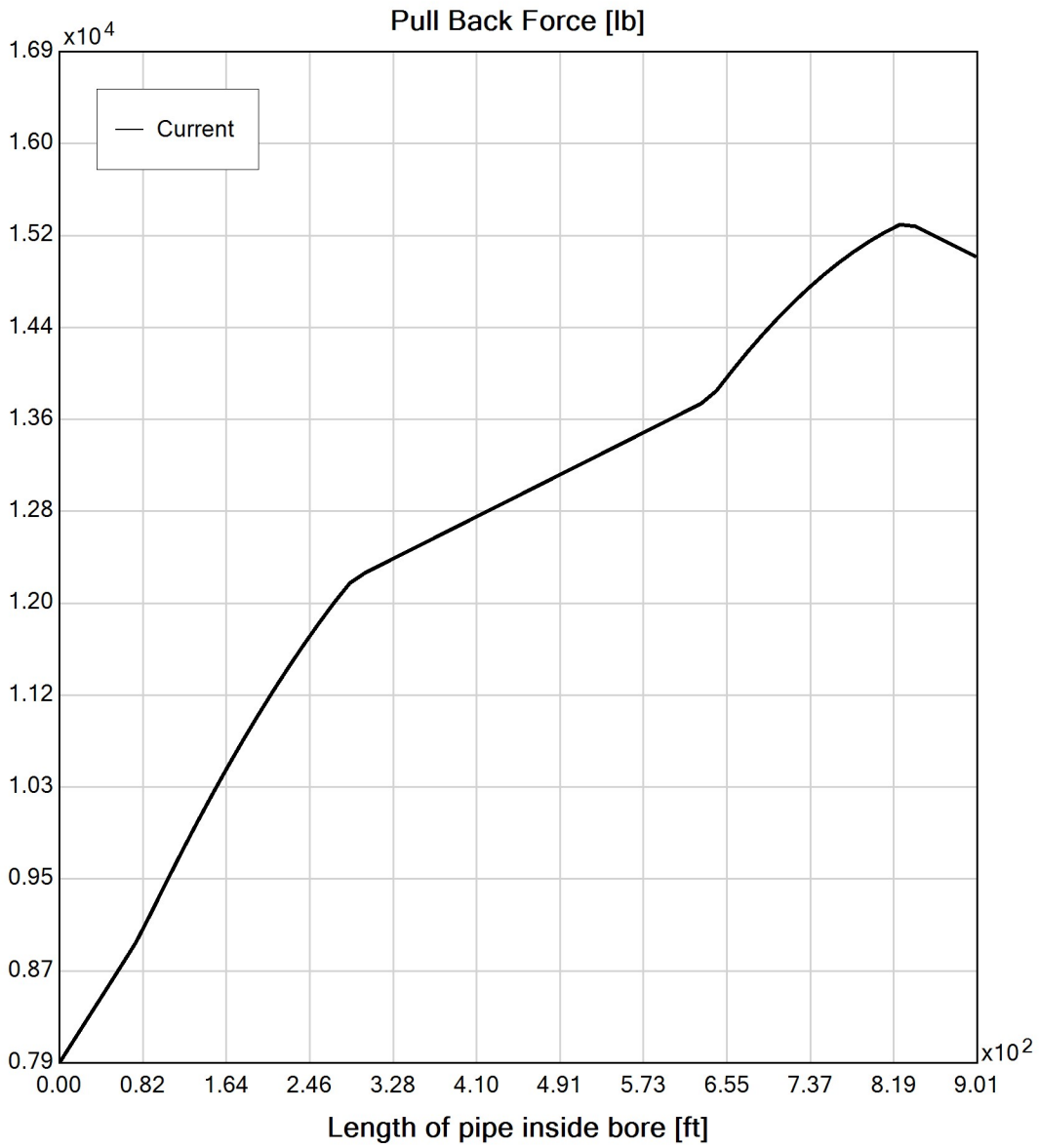

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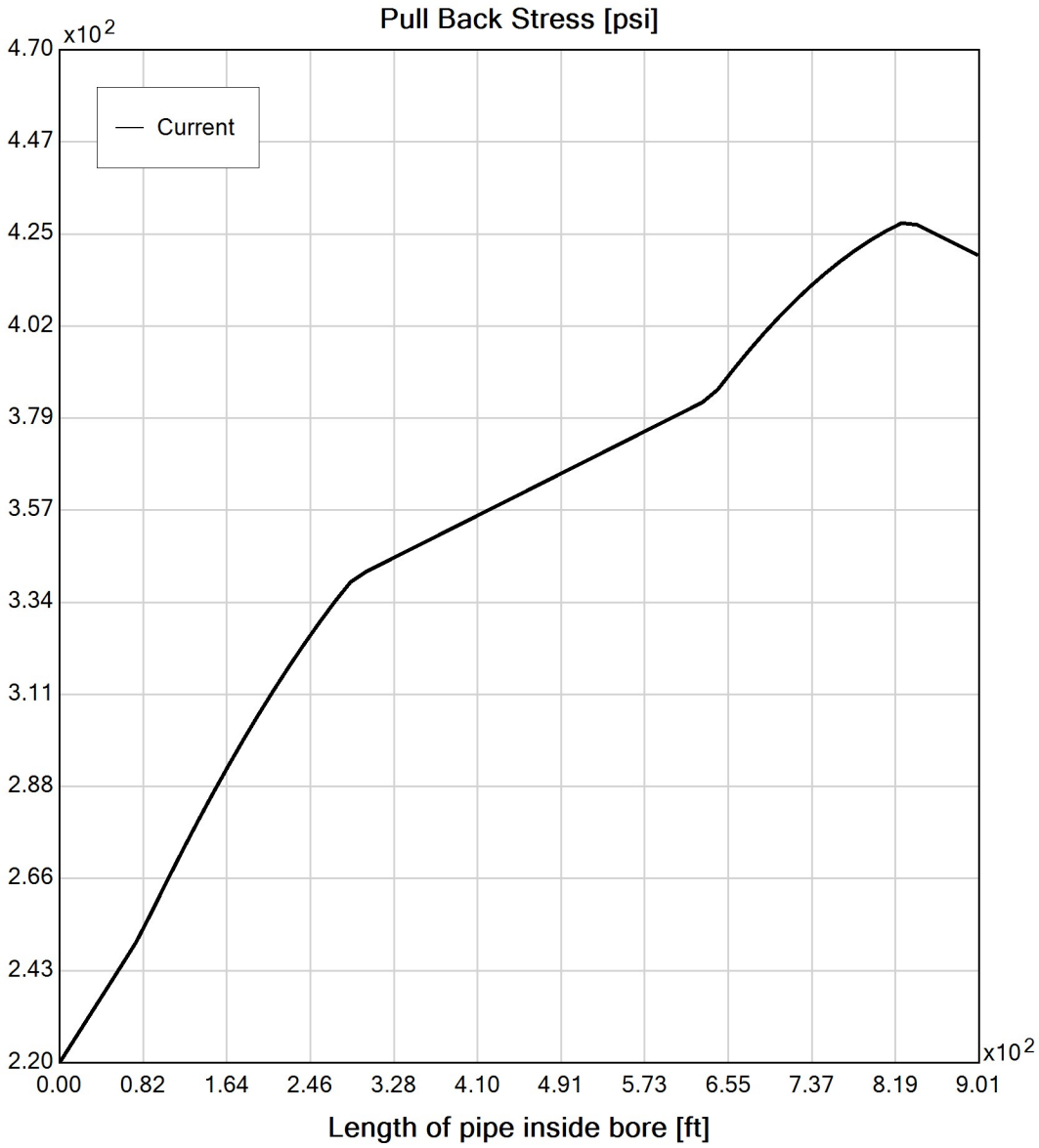

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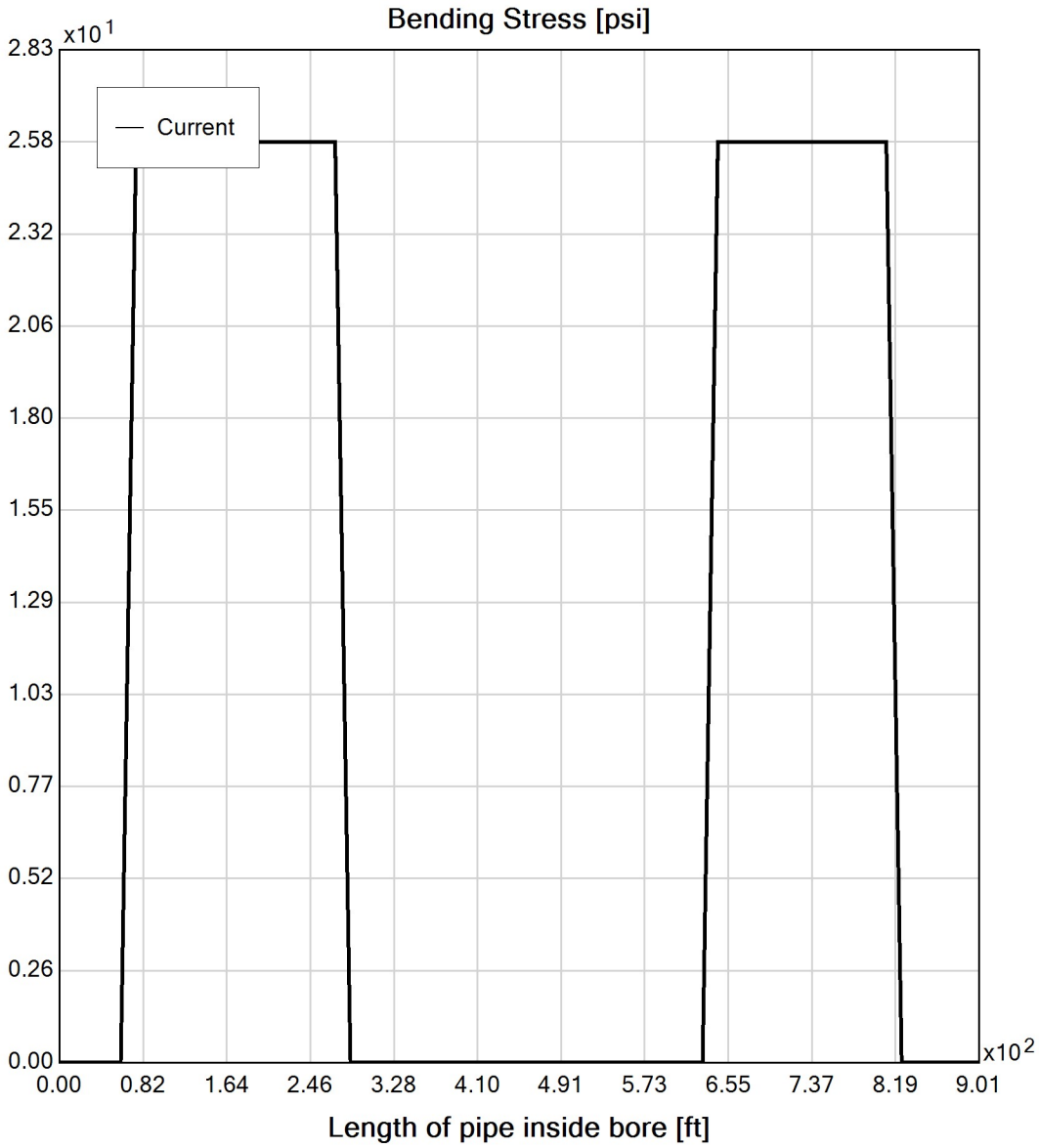

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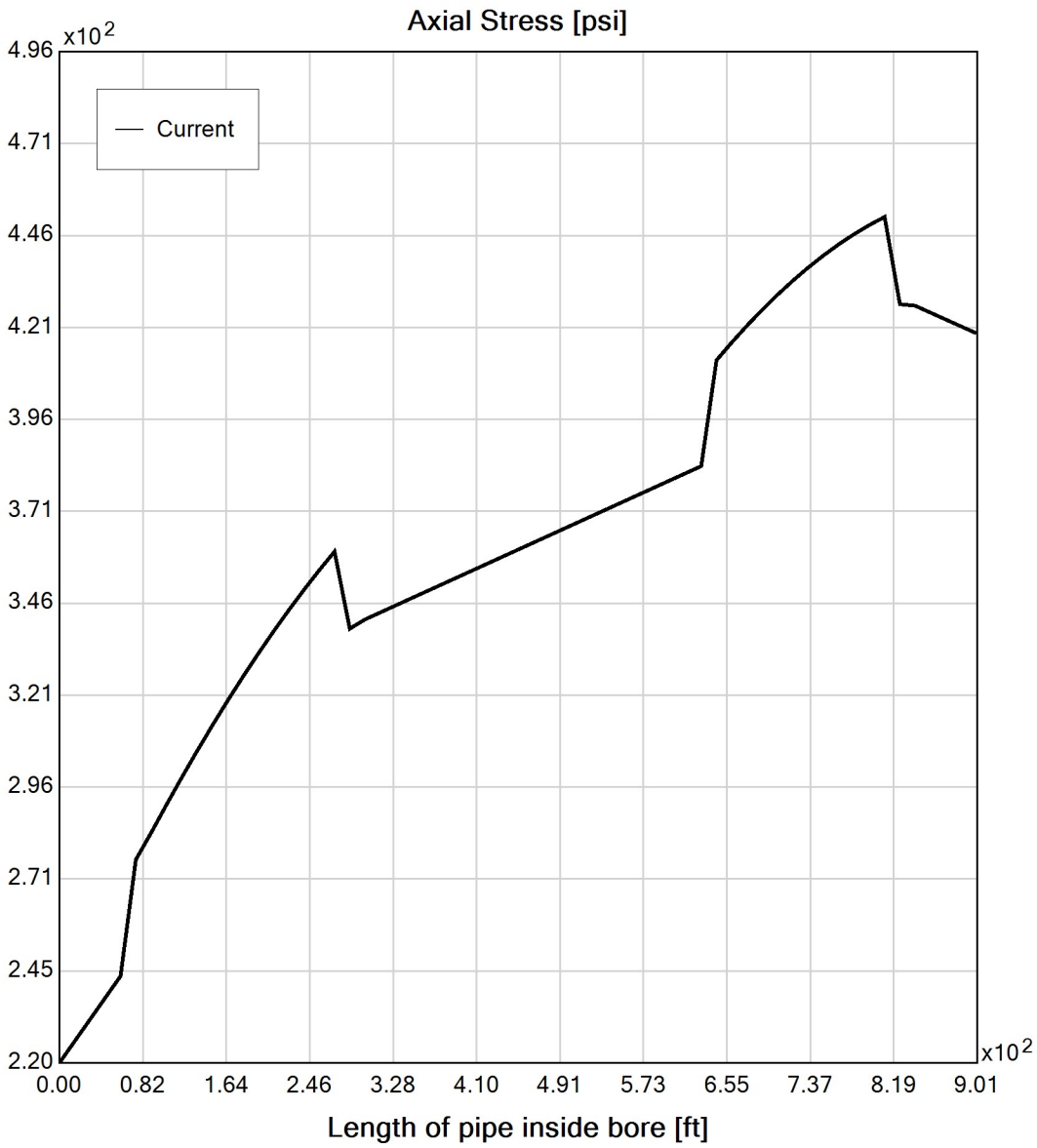

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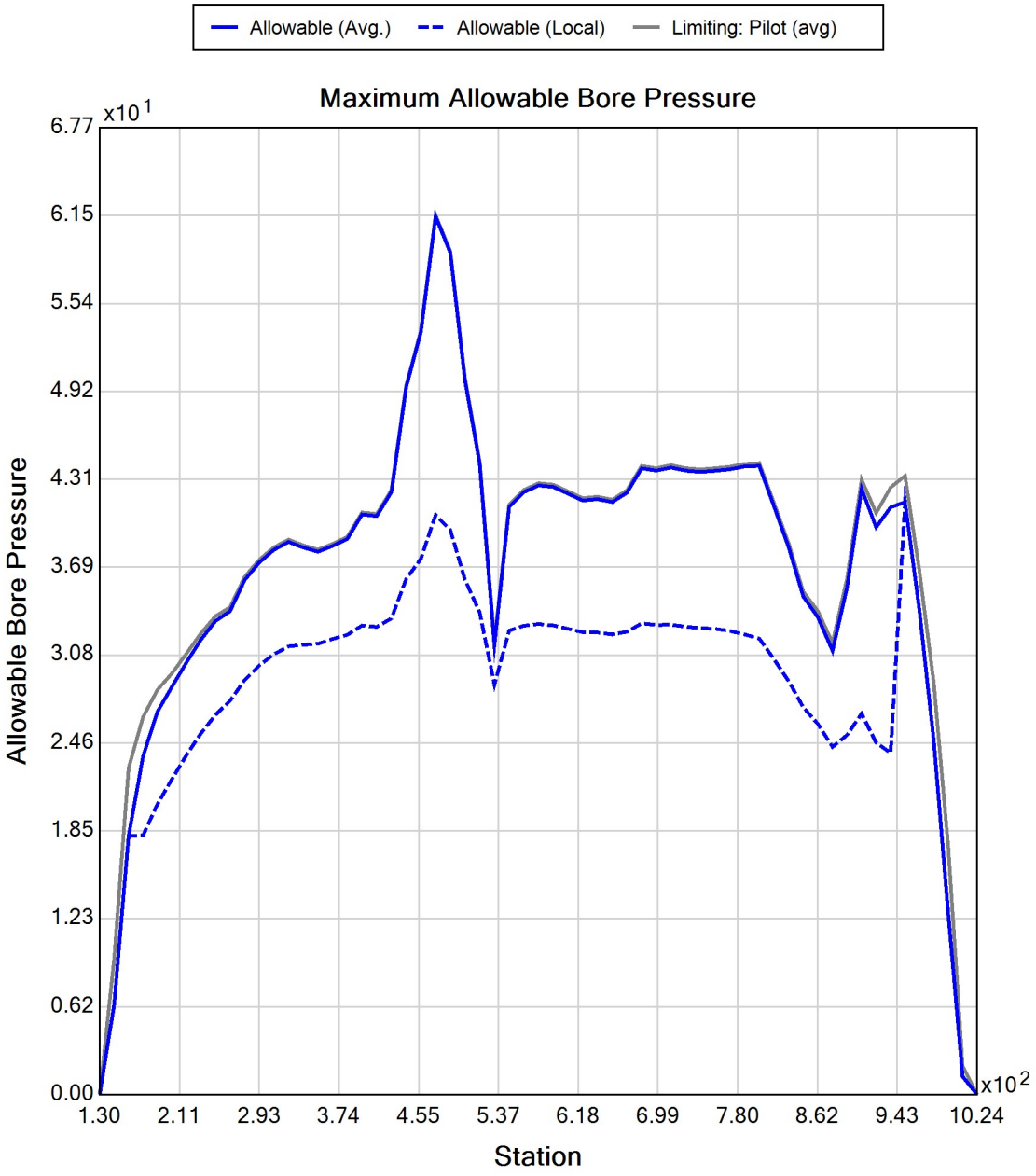

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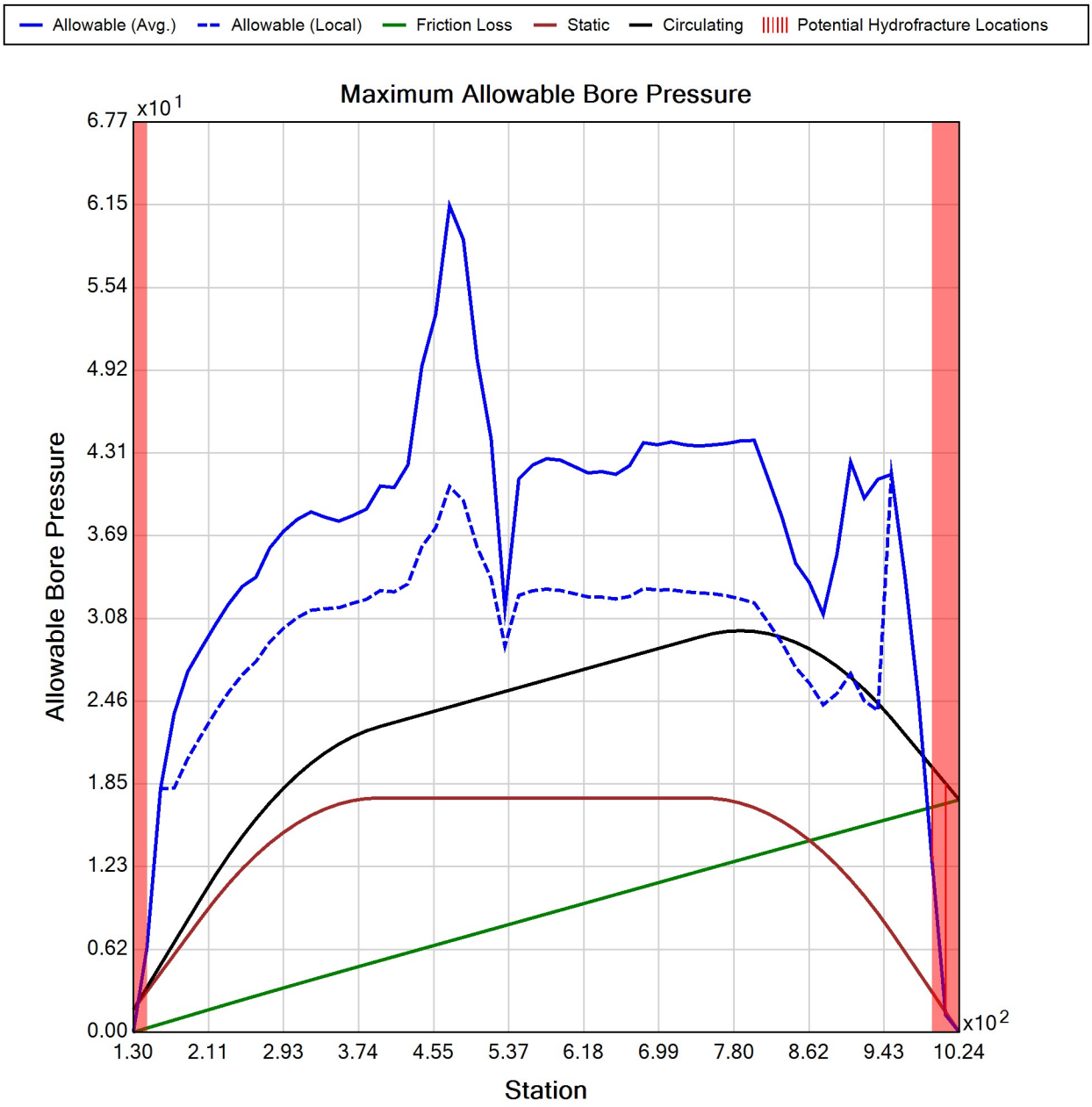

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Input Summary

Start Coordinate	(130.00, 0.00, 157.20) ft
End Coordinate	(1014.10, 0.00, 158.50) ft
Project Length	884.10 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

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 900.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.3	25.2
Water Pressure	0.4	0.4
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	5.6	25.6
Deflection		
Earth Load Deflection	1.434	6.870
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.463	6.900
Compressive Stress [psi]		
Compressive Wall Stress	25.3	115.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	857.6	857.6
Pullback Stress [psi]	490.0	490.0
Pullback Strain	8.522E-3	8.522E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	490.0	493.8
Tensile Strain	8.522E-3	8.687E-3

Net External Pressure = 21.6 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.463	7.5	5.1	OK
Unconstrained Collapse [psi]	23.7	121.1	5.1	OK
Compressive Wall Stress [psi]	25.3	1150.0	45.5	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	33.7	228.3	6.8	OK
Tensile Stress [psi]	493.8	1200.0	2.4	OK

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Project Summary

General:	CHPE HDD 25 Conduit 1
	P3
	Start Date: 12-10-2021
	End Date: 12-10-2021
Project Owner:	TDI
Project Contractor:	Kiewit
Designer:	AJB
	CHA
Description:	HDD 25 10-inch DR 9 Conduit 1

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Input Summary

Start Coordinate	(0.00, 0.00, 152.20) ft
End Coordinate	(1754.60, 0.00, 147.00) ft
Project Length	1754.60 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

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Soil Summary

Number of Layers: 6

Soil Layer #1 USCS, Sand (S), SP
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, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 7.30 [psi]

Soil Layer #3 USCS, Clay (C), CL
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 7.30 [psi]

Soil Layer #4 USCS, Sand (S), SW
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 #5 USCS, Sand (S), SW
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 #6 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 107.8272 (dry), 177.6384 (sat) [lb/ft3]
Phi: 35.00, S.M.: 1450.40, Coh: 2900.80 [psi]

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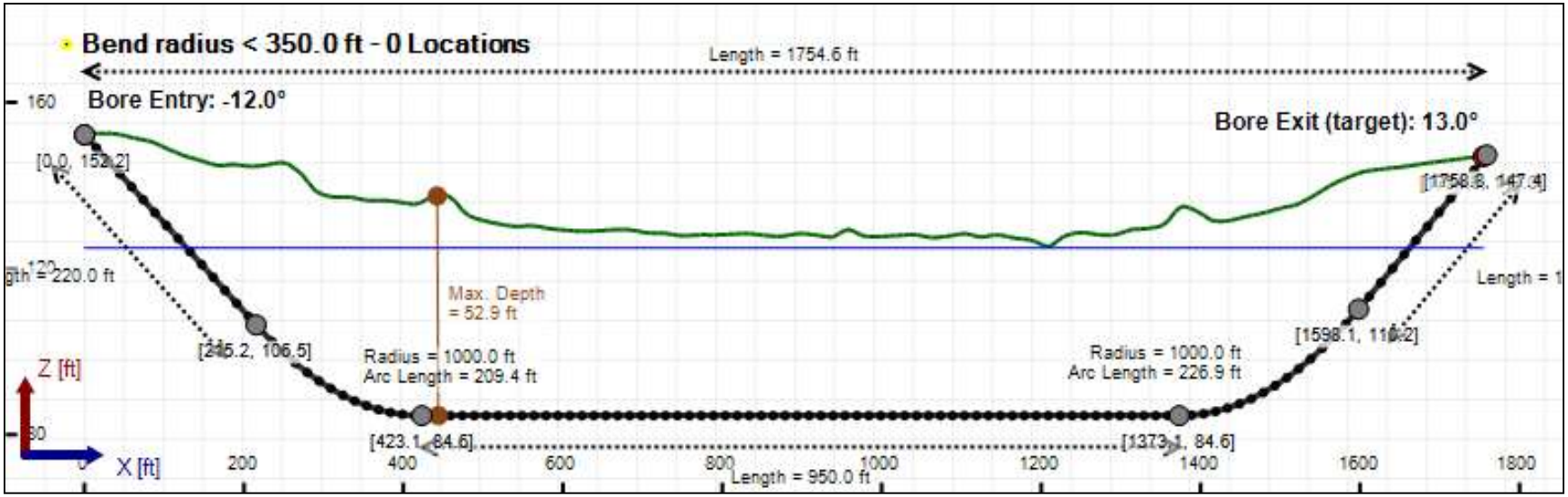
Bore Cross-Section View



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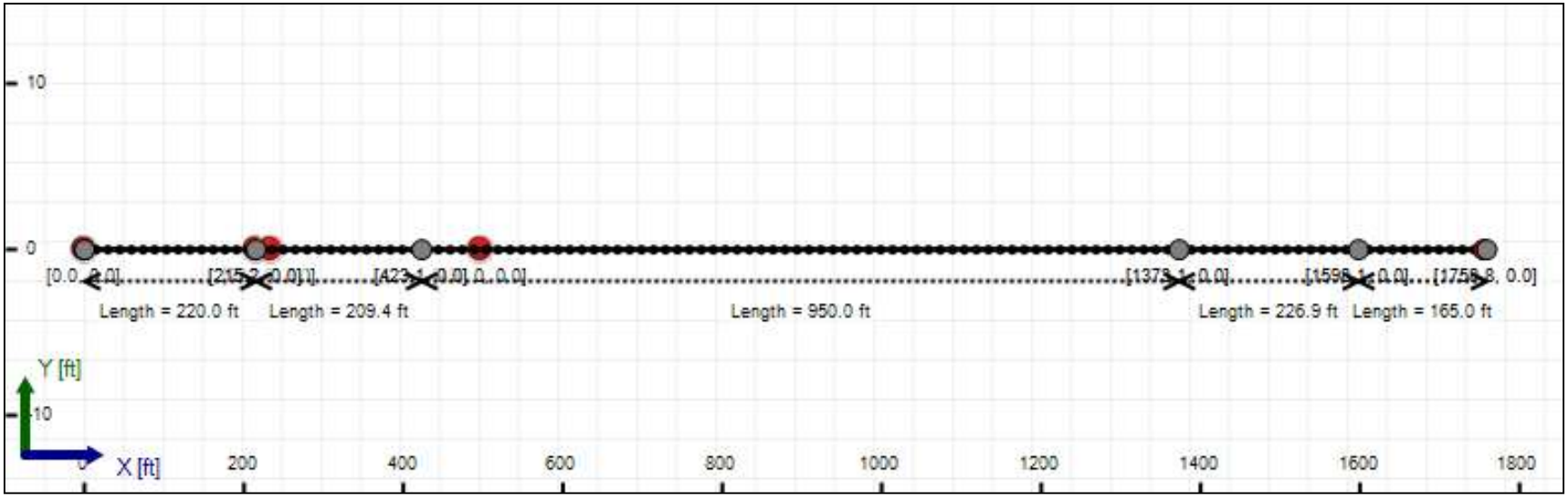
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 1785.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	11.9	24.7
Water Pressure	17.5	17.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	29.4	42.2
Deflection		
Earth Load Deflection	3.237	6.729
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	3.369	6.861
Compressive Stress [psi]		
Compressive Wall Stress	132.3	189.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	30380.6	30380.6
Pullback Stress [psi]	847.3	847.3
Pullback Strain	1.474E-2	1.474E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	847.3	869.5
Tensile Strain	1.474E-2	1.557E-2

Net External Pressure = 38.4 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.369	7.5	2.2	OK
Unconstrained Collapse [psi]	44.0	102.2	2.3	OK
Compressive Wall Stress [psi]	132.3	1150.0	8.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	53.9	203.2	3.8	OK
Tensile Stress [psi]	869.5	1200.0	1.4	OK

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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	674.880 psi	1340.597 psi
1	8.00 in	12.00 in	674.785 psi	1340.444 psi
2	12.00 in	16.13 in	674.647 psi	1340.222 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

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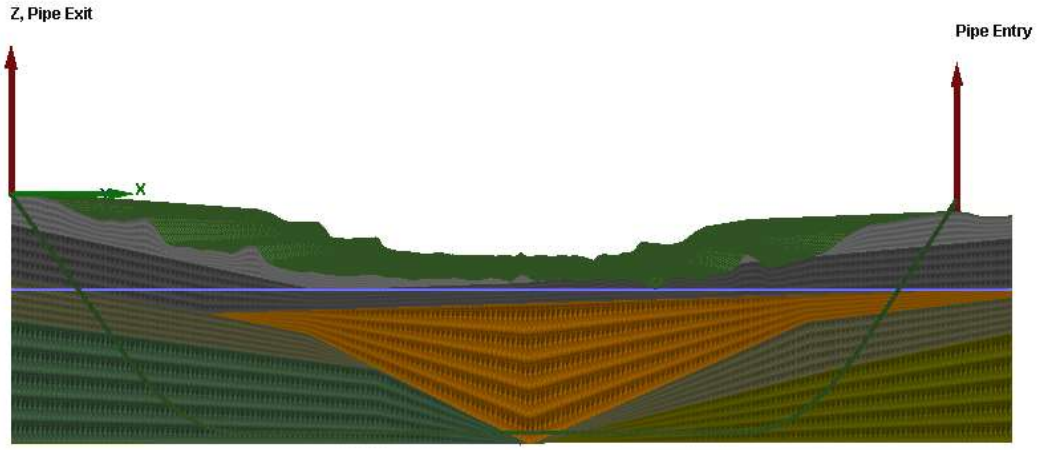
Virtual Site



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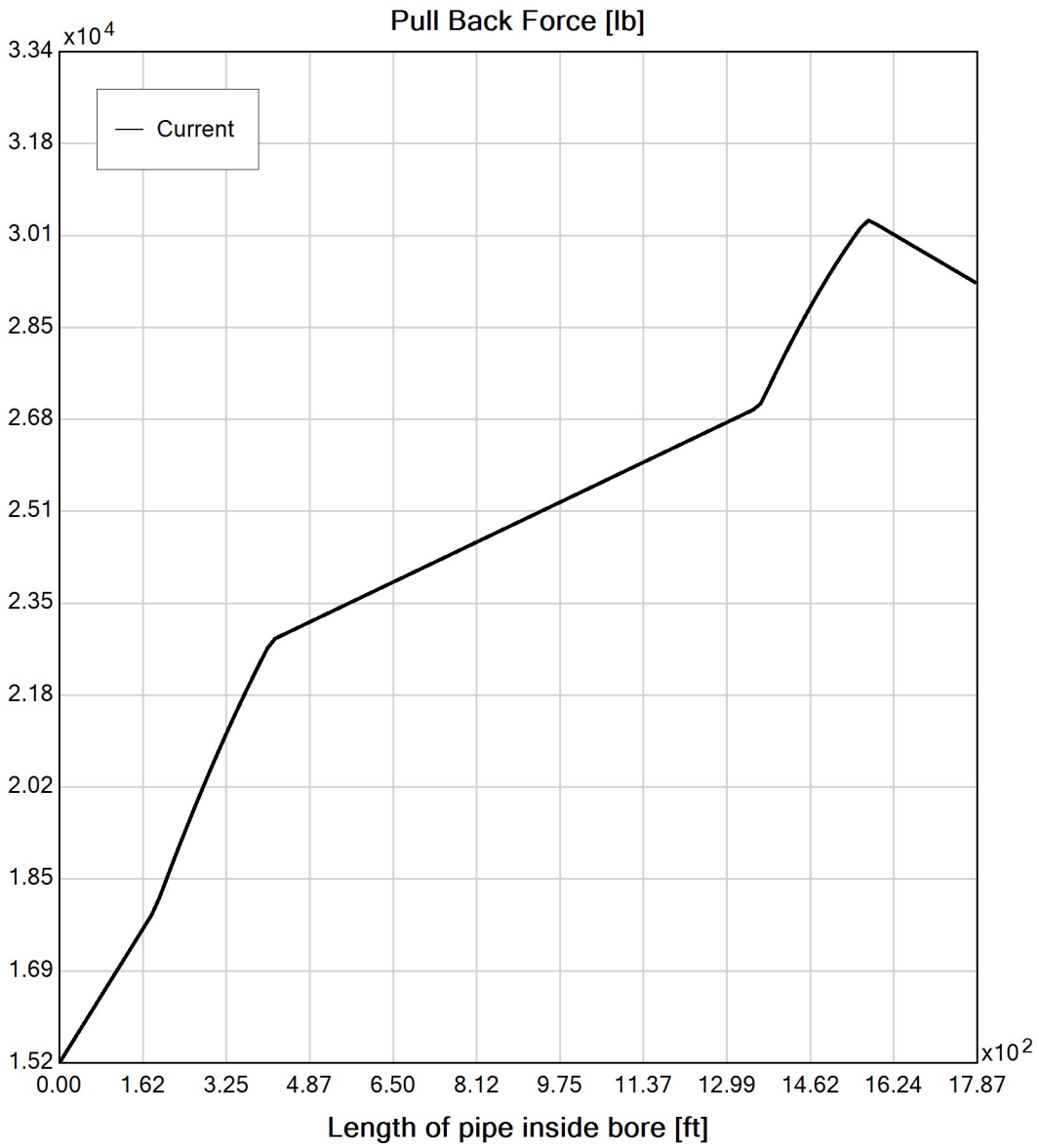

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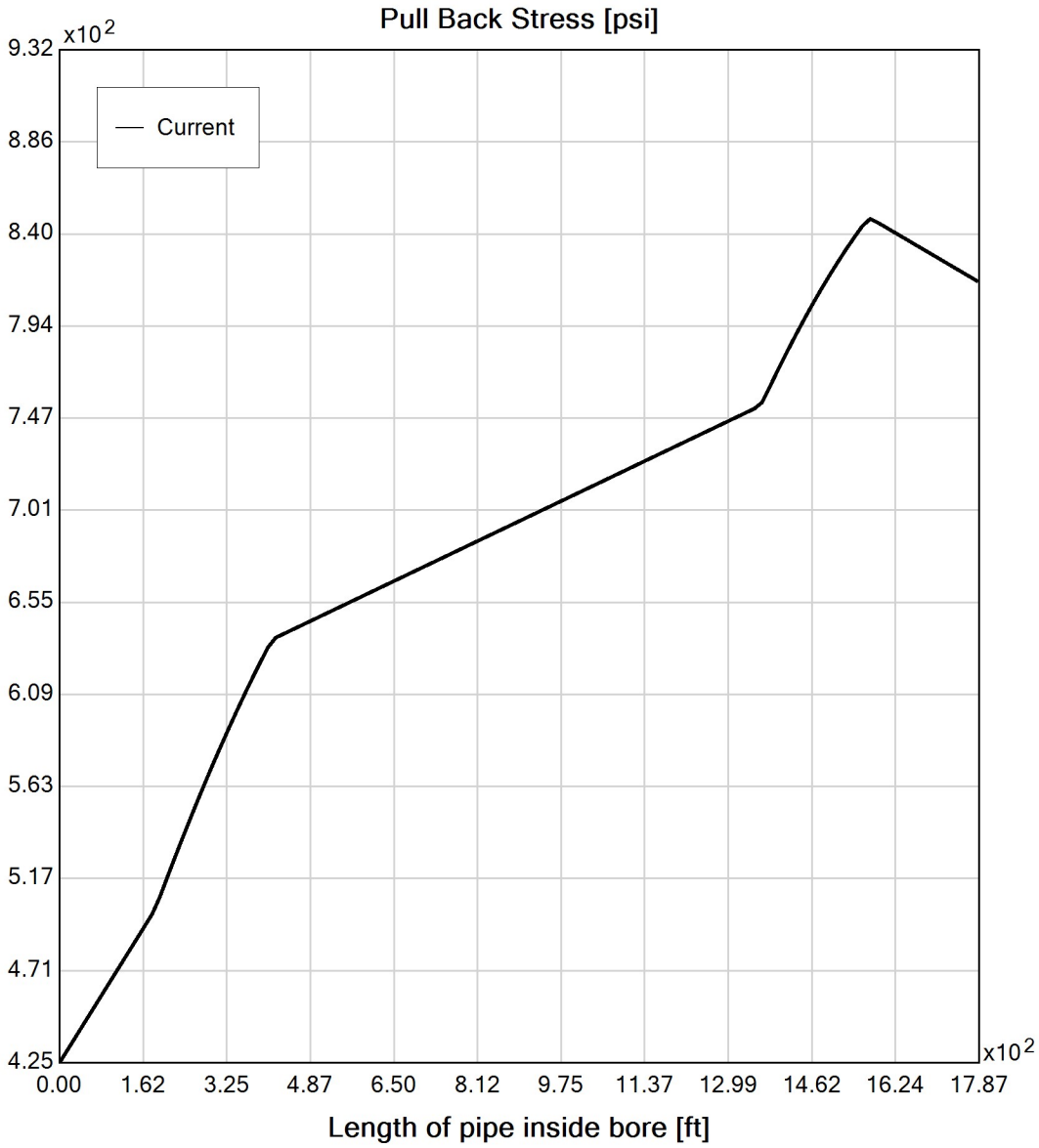

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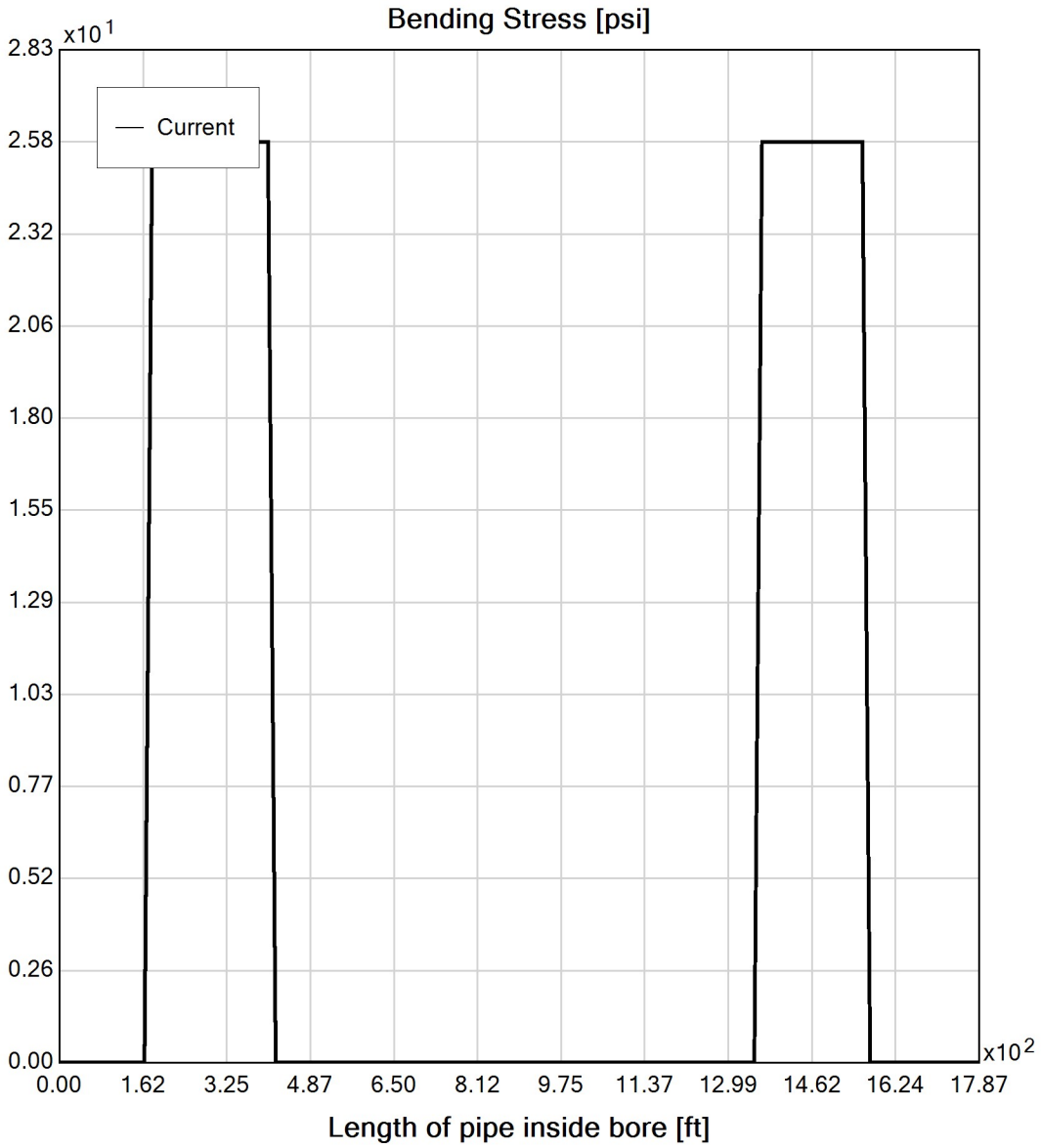

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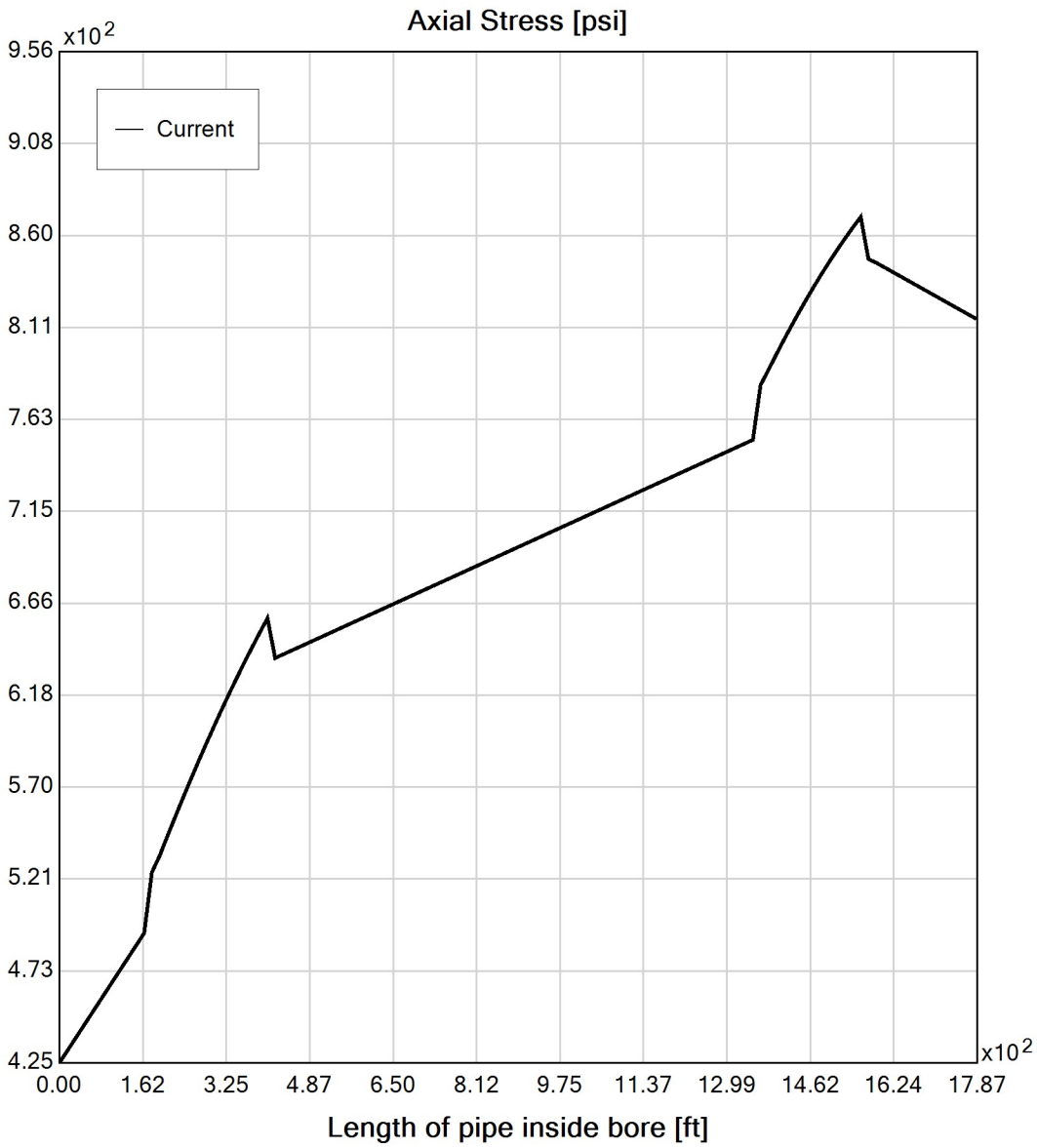

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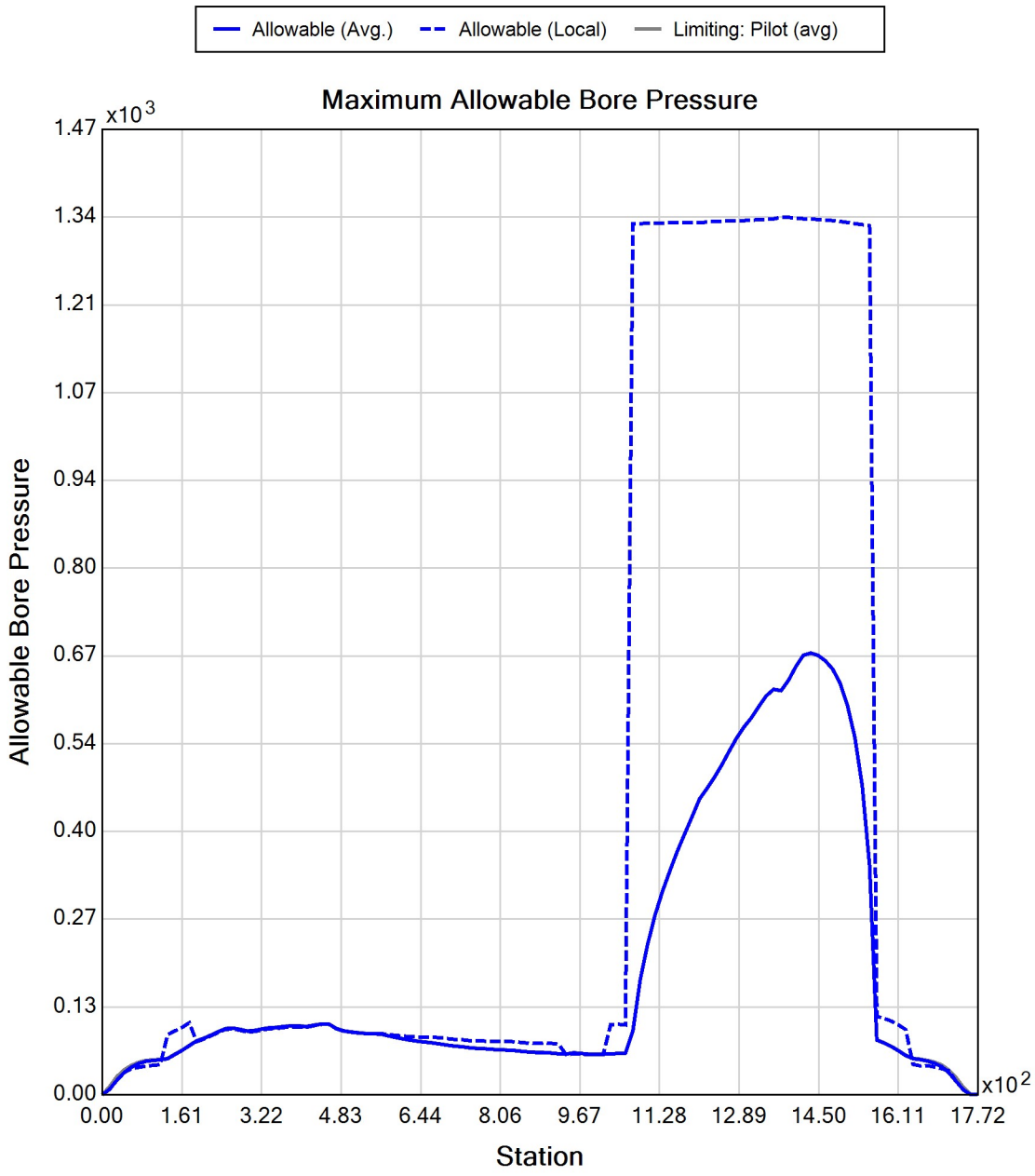

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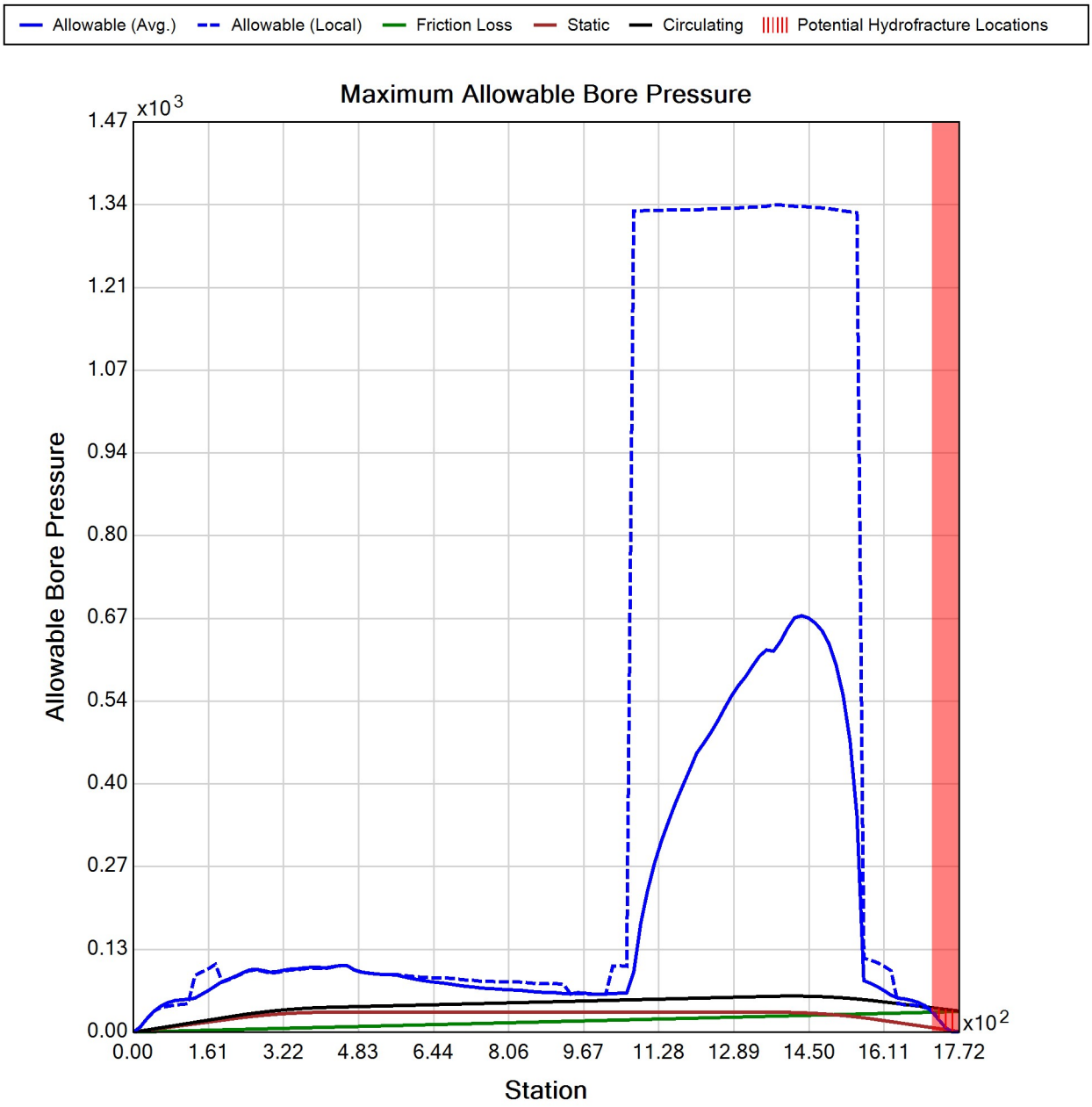

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Input Summary

Start Coordinate	(0.00, 0.00, 152.20) ft
End Coordinate	(1754.60, 0.00, 147.00) ft
Project Length	1754.60 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

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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 2" (2.375")
Pipe DR: 9
Pipe Length: 1785.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	11.1	24.7
Water Pressure	17.5	17.5
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	28.6	42.2
Deflection		
Earth Load Deflection	3.018	6.729
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	3.047	6.758
Compressive Stress [psi]		
Compressive Wall Stress	128.7	189.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1592.5	1592.5
Pullback Stress [psi]	909.9	909.9
Pullback Strain	1.582E-2	1.582E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	909.9	912.0
Tensile Strain	1.582E-2	1.596E-2

Net External Pressure = 38.4 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.047	7.5	2.5	OK
Unconstrained Collapse [psi]	44.0	105.1	2.4	OK
Compressive Wall Stress [psi]	128.7	1150.0	8.9	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	53.8	200.1	3.7	OK
Tensile Stress [psi]	912.0	1200.0	1.3	OK

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Project Summary

General:	CHPE HDD 25 Conduit 2
	P3
	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 25 10-inch DR 9 Conduit 2

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Input Summary

Start Coordinate	(0.00, 0.00, 151.50) ft
End Coordinate	(1720.00, 0.00, 144.50) ft
Project Length	1720.00 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

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Soil Summary

Number of Layers: 6

Soil Layer #1 USCS, Sand (S), SP
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, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 7.30 [psi]

Soil Layer #3 USCS, Clay (C), CL
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 7.30 [psi]

Soil Layer #4 USCS, Sand (S), SW
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 #5 USCS, Sand (S), SW
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 #6 Rock, Geological Classification, Sedimentary Rocks
From Assistant
Unit Weight: 107.8272 (dry), 177.6384 (sat) [lb/ft3]
Phi: 35.00, S.M.: 1450.40, Coh: 2900.80 [psi]

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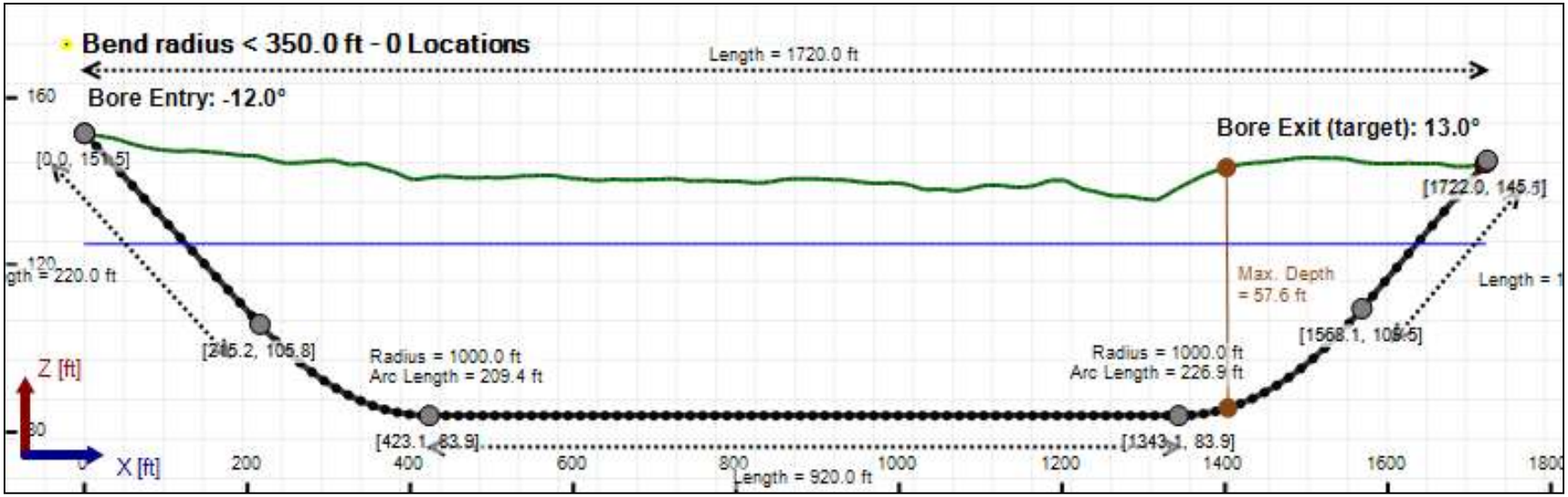
Bore Cross-Section View



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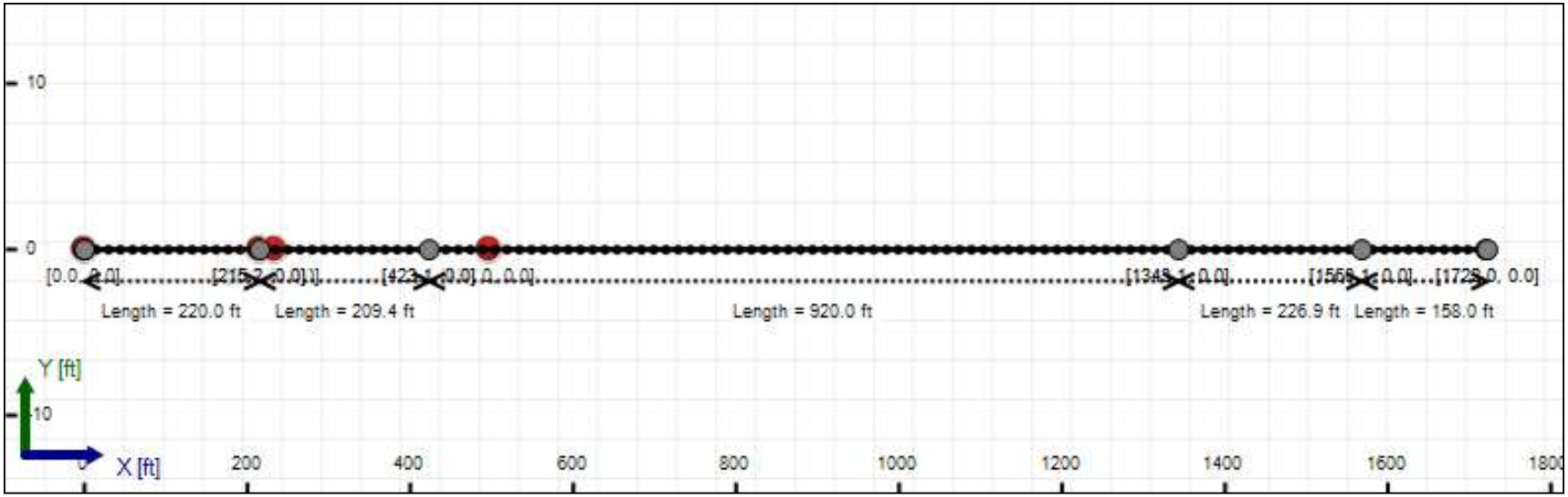
Bore Plan View



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Load Verifier Input Summary:

Pipe Application: Electrical Cable
Pipe Type: HDPE
Classification: IPS
Pipe OD: 10" (10.75")
Pipe DR: 9
Pipe Length: 1740.00 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

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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	7.1	29.2
Water Pressure	17.8	17.4
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	24.9	46.6
Deflection		
Earth Load Deflection	1.941	8.051
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	2.073	8.183
Compressive Stress [psi]		
Compressive Wall Stress	112.2	209.6

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	29462.3	29462.3
Pullback Stress [psi]	821.7	821.7
Pullback Strain	1.429E-2	1.429E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	821.7	844.0
Tensile Strain	1.429E-2	1.513E-2

Net External Pressure = 38.4 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	2.073	7.5	3.6	OK
Unconstrained Collapse [psi]	44.0	114.7	2.6	OK
Compressive Wall Stress [psi]	112.2	1150.0	10.2	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	53.9	205.0	3.8	OK
Tensile Stress [psi]	844.0	1200.0	1.4	OK

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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	546.811 psi	1344.285 psi
1	8.00 in	12.00 in	546.765 psi	1344.171 psi
2	12.00 in	16.13 in	546.697 psi	1344.006 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

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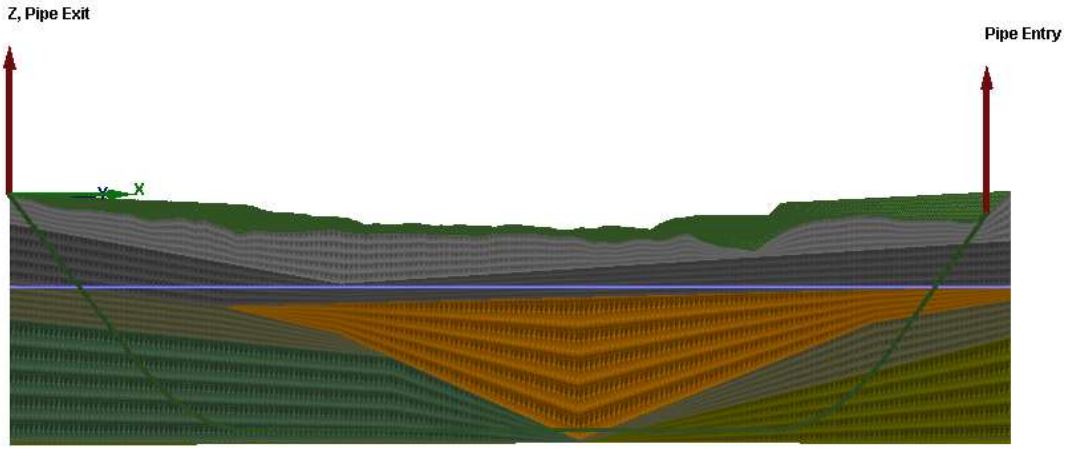
Virtual Site



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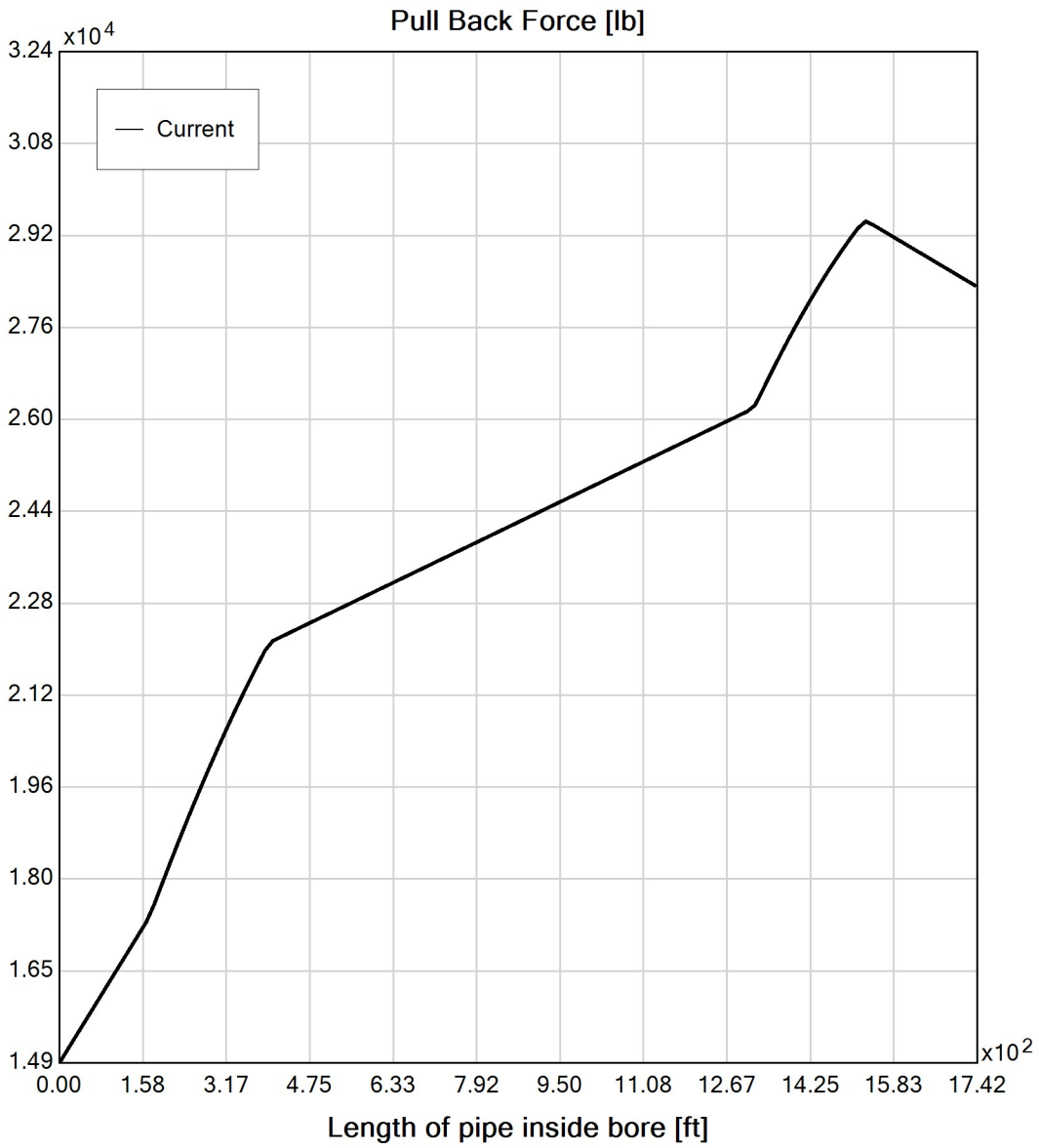

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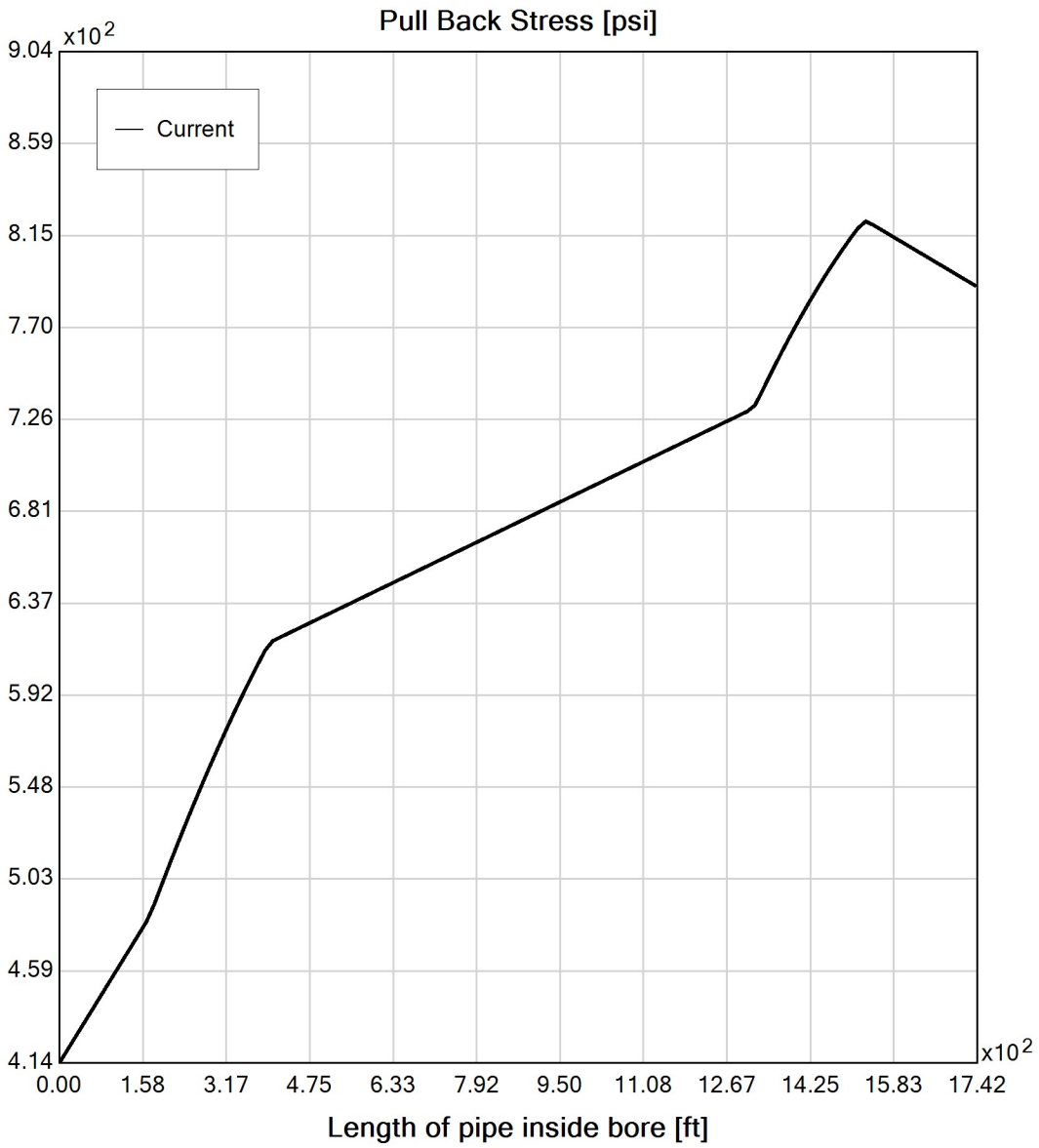

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