Inadvertent Release Contingency Plan For Horizontal Directional Drilling in Segment 3 – Package 1C

Whitehall to Fort Ann
Washington County, New York

CHA Project Number: 066076

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1.0 INTRODUCTION

CHA Consulting, Inc. (CHA) and the Kiewit Team, with the support of Boscardin Consulting Engineers (BCE), proposes to design and construct approximately 170 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 Segment 3 – Package 1C which includes seven HDD crossings: HDD #3 through HDD #8.

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

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

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

It is important to note that the plan in this document serves as the guiding framework for confirming that the HDD Construction Subcontractor (HDD Subcontractor) is adhering to the specifications and provisions to be protective of the environment. Since there are a variety of potential measures listed in this document available for preventing inadvertent releases and mitigating the effects of a release should one occur. The specifications require that each HDD Subcontractor submit to the project design team, for its review and acceptance, a supplemental site and HDD Subcontractor specific means and methods plan for each HDD crossing reaffirming and detailing how the HDD Subcontractor will conform with the requirements of this plan and the project specifications to prevent inadvertent releases and to mitigate any effects of a release should one occur. The supplemental plan by the HDD Subcontractor shall be consistent with the site conditions and constraints, and the Subcontractor's selected means, methods and equipment. The selected HDD Subcontractor will be responsible for incorporating specific permit conditions, applicable regulatory requirements, site specific environmental features and geotechnical information not available at this time into its submittal. The submittal shall be reviewed and approved by the design team and the Environmental Inspector prior to the start of construction of a specific HDD location.

2.0 DESCRIPTION OF THE HDD PROCESS

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

A guidance system is mounted immediately behind the drilling head to allow the crew to track and steer the path of the drilling so that it follows the preplanned alignment within the specification's permitted tolerances. The drilling fluid holds the cuttings in suspension and carries the drill cuttings back through the annular space between the drill rods and the bore hole wall to the entry pit where it is collected and processed for re-used by a recycling system. The cuttings are separated from the bentonite, using screens, centrifuges, and desanding units which prepares the bentonite for re-use. Once the pilot bore reaches the exit pit, a larger diameter, back-reaming head is then attached to the drill string and pulled back through the pilot hole to enlarge the hole. Depending on the size of the conduit to be installed and the ground conditions, several successively larger reaming passes may be needed. Again, a bentonite and water slurry is pumped into the bore hole during reaming to remove cuttings and to stabilize the bore hole. Lastly, the drill string is pulled back through the bore hole with the new, preassembled conduit attached to it in one continuous process until the lead end of the conduit emerges at the entry pit. Final reaming or swabbing and conduit pull back may be combined.

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

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

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

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

3.0 ORGANIZATION AND STAFFING RESPONSIBILITIES

The organizational chart shown below 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 Holders	Name, Title TDI Phone Email
Construction Manager	TBD
HDD Design Engineer Team	TDB - CHA contact
HDD Construction Subcontractor	 TBD
Environmental Inspector	TBD
U.S. Army Corps of Engineers, New York District Office	**USACE** New York District Upstate Regulatory Field Office ATTN; CENAN-OP-UR, Bldg. 10, 3rd Floor North 1 Buffington Street Watervliet, NY 12189-4000 518-266-6350 cenan.rfo@usace.army.mil
New York State Department of Public Service	Matthew Smith Department of Public Service Empire State Plz 3 Albany, NY 12223 (518) 402-5141 matthew.smith@dps.ny.gov
New York State Department of Environmental Conservation	Regional Office(s) Information **NYSDEC** REGION 5 Sub-Office Regional Permit Administrator 232 Golf Course Rd Warrensburg, NY 12885-1172 518-623-1281 dep.r5@dec.ny.gov
New York State Department of Environmental Conservation (Spills)	NYS Spill Hotline: 1-800-457-7362

3.1 RESPONSIBILITIES OF VARIOUS ORGANIZATIONS

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

3.2 REGULATORY AGENCIES

The Certificate of Conditions issued by the NY Public Service Commission is the primary regulatory agency for the requirements associated with the project. The Champlain Hudson Power Express (CHPE) Route Project also has permits from the Department of Energy, and the US Army Corps of Engineers, and the New York Water Quality Certification. Various HDDs within this package take place within or adjacent to wetlands, underneath or adjacent to bodies of water, and underneath or adjacent to 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 HOLDERS

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

3.4 DESIGN ENGINEER

The Front End Engineering and Design (FEED) Design Engineer for the HDD Design is CHA and Kiewit in collaboration with BCE. During construction, the yet to be confirmed Design Engineer during construction will be responsible for reviewing and approving required Subcontractor submittals, shop drawings, and material certificates. Power Engineers 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, chosen Third Party engineer will be assisting Transmission Developers Inc. with the review of the HDD Subcontractors Inadvertent Release Plan and providing technical assistance as needed with the HDD installation.

3.6 CONSTRUCTION MANAGER

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

3.7 HDD CONSTRUCTION SUBCONTRACTOR

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

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

3.8 ENVIRONMENTAL INSPECTOR

The Environmental Inspector for this project has not yet been determined. In general, the

Environmental Inspector will perform full-time observation and documentation during the HDD activities at a specific site. The Environmental Inspector will be responsible for coordination with all county, state and federal resource agencies, compliance with and changes to any environmental permits.

The Environmental Inspector shall have the authority to stop work when the environmental permit conditions are not being followed or when appropriate environmental precautions are being disregarded by the HDD 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 cement or cement/bentonite grout, and located off the planned bore path, to limit the risk of a release through an abandoned bore hole during the HDD construction.

4.2 HDD Design

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

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

steel;

- Requiring drilling fluid composition, flow rates, and drilling procedures that minimize drilling fluid pressures;
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment;
- 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 slurry additives (Article VII: General Condition No. 114 [m]) and, in the event of a detected release of fluid, implement the procedures specified in the approved EM&CP. For any release occurring in a waterbody, the Certificate Holders shall immediately notify DPS Staff and NYSDEC Region 5 Staff of details of the release and the course of action they recommend taking.

4.3 CONTINGENCY PLAN

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

- Work plan and detailed description of the drilling program (details for executing pilot hole, reaming, pull-back operations, and schedule), this plan shall include necessary procedures for addressing problems that are typically encountered during HDD installations through the anticipated subsurface for each drill location and to prevent inadvertent releases of drilling slurry;
- Drilling fluid composition design and on-hand amendments to alter fluid properties to reduce pressures, potential for plugging, and seepage losses;
- Description of the planned drilling equipment and drill site layout;
- SDS information for all drilling fluid products proposed for use;
- Procedures for drilling fluid pressure control, and fluid and pressure loss monitoring and management to aid in prevention and the detection of an inadvertent release (i.e.,

metering of makeup water, recording of drilling fluid product quantities utilized, fluid return volumes, fluid and cuttings disposal quantities, turbidity of river water, etc.);

- Contingency plans for addressing inadvertent releases into wetlands, or other sensitive areas, which includes the specific procedures used to halt the release and then contain, clean-up, and remove materials from the release site;
- Notification procedures and chain-of-command in the event of a release;
- Criteria for evaluating the need for a drill hole abandonment and the associated plan for sealing the drill hole if abandoned;
- Drilling fluid management and disposal procedures;
- The work plan and detailed drilling program description should include documentation regarding site restoration, vegetation management, sedimentation and erosion control, and hazardous material usage (if applicable). The intended approach will be in compliance with those measures presented in the Project EM&CP.
- Notice shall be provided to residents, businesses, and building, structure, and facility (including underground, above ground and underwater facilities) owners and operators within one hundred (100) feet of any HDD staging area or trenching activity with an offer to inspect foundations before, during, and after construction. Additional detail regarding this notice, associated inspections, intended benefits, proof of notice, cost reimbursements and associated construction initiation schedule is included in General Condition 154.

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

The workspace layout for HDD materials and equipment will be configured to reduce the likelihood of a release. Final dimensions and equipment 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 subcontractor performing the HDD. However, the drilling fluid management system and subsequent disposal will adhere to the following requirements:

- Drilling fluid will be processed through an initial cleaning that separates the solid materials from the fluid;
- Solids will be sifted out by a screening apparatus/system and the solids deposited into a rolloff or a dump truck and periodically transported off-site and disposed of at an approved disposal facility determined by the HDD construction subcontractor;
- Drilling fluid that is deemed unacceptable to be reused during construction or left over at the end of drilling will be collected and transferred into a tanker truck for disposal at an approved disposal facility determined by the HDD construction subcontractor;
- Petroleum-based fluids and other potentially hazardous materials associated with drilling operations that are spilled during HDD construction will be contained following the mitigation measures described in the SPCC (Appendix K of the EM&CP) and disposed of at an approved disposal facility as determined by the HDD construction subcontractor and included in the EM&CP;
- 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 as 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 or anthropogenic features such as, existing wells, piles and culverts, in close proximity to the HDD bore that may provide a preferential path for the drilling slurry to escape from the bore path.

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

An experienced drill crew is the most effective approach to detecting reaction to drilling fluid seepage prior to a surface release. They can promptly stop the drilling, modifying 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 a 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 immediately, then the Subcontractor can trip the drill steel back a selected distance and attempt to clear cuttings from the annulus to re-establish circulation.

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

If a release is identified in an upland area, the Subcontractor will be required to respond immediately as described above to limit the extent 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 together 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 NSF certified and approved drilling solution and, in the event of a detected release of fluid, implement the procedures specified in the approved EM&CP. If an inadvertent release occurs when working beneath the waterway, wetland, or railroad the HDD Subcontractor will be required to cease drilling operations and reduce pressures in borehole immediately, and notify the Environmental Inspector, the Railroad (if within railroad property), the construction management team and the Certificate Holders. The Environmental Inspector, with input from the Drill Operator, will evaluate the potential impact of the release on a site-specific basis and will determine the appropriate course of action. Prior to construction, the 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 HDD Subcontractor must abandon the drilled hole, a plan to fill the abandoned hole will be implemented as detailed in the HDD Subcontractor's supplemental Inadvertent Release Contingency Plan and an alternative plan/alignment for crossing shall be evaluated. If it becomes necessary to abandon a partially completed hole, the abandoned hole will be filled with a mixture of high-yield bentonite, water, and drill spoil. The first ten feet of the bore path will be compacted and filled with soil or a cement-bentonite mix to prevent future settlement. The Subcontractor submitted site-specific abandonment plan shall be approved by the Design Engineer and the Construction Manager prior to being performed in the field.

After the abandoned hole has been filled, an alternative entry and exit hole and bore path alignment will be evaluated by the HDD Subcontractor, Construction Manager, and the Design Engineer. The new alignment shall be offset from the abandoned hole by at least 10 feet (except at the ends where a 5- foot offset may be used) to help limit the risk 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 #3

HDD #3 consists of two, straight (in plan view) HDD bores, approximately 1893 and 1894 feet long as shown in Appendix B. The HDD bores will pass approximately 35 feet below the estimated mudline (assuming a 5' water depth) to the east of CP Rail railroad tracks at the CP Whitehall yard. The approximate center of the HDD bores located under the open water is at latitude 43.5342°N and longitude -73.4078°W, in Whitehall, NY (see Appendix B). The ground surface elevations along the HDD path gently slope down from North to South starting at El. 127 and reaching El. 121. About 100' north of the entry, the drill passes underneath open water in a wetland with standing water at about El. 116 (reference datum NAVD 1988).

The bores will have both horizontal and vertical curves, but no segments of the bore path are designed with compound curves (segments with compound curves would have both horizontal and vertical curves). Given the presence of wetlands near/in the work areas, we recommend the use of barriers to contain potential releases to the ground surface near the exit pits and work area. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

<u>Ground conditions at HDD #3</u> Based on the borings drilled for this project, the soil profile for the HDD #3 BoreAid analyses will be divided into three [3] layers: Medium dense poorly graded sand, medium stiff fat clay, and very soft to soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix A.

Specific design considerations for HDD #3 include:

- General depth of soil cover beneath the estimated mudline of the open water body hovers around 35 feet. Preliminary analysis of the bores, assuming typical drilling methods, indicates that the lowest maximum allowable pressure capacity in the middle of the bore is approximately 58 psi. The total circulating pressure estimated to occur in the bore in the middle portion is approximately 40 psi assumed standard HDD drilling methods. In the remainder of the bore the maximum allowable pressure ranges from approximately 0 to 78 psi and the approximate applied slurry pressure during drilling ranges from 0 to 50 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 releases 10 to 30 feet at either end of the bore path. These should be relatively easily controlled through the use of conductive conduit, straw bales, silt fences, erosion control measures and vacuum trucks.
- The entry pits and entry work area have been located at the south end of the alignment as there appears to be more space for the assembly of the conduits.
- 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.

9.2 HDD CROSSING #4

HDD #4 consists of two, straight bores, approximately 628 and 650 feet long, located at the CP Railway east of Old Route 4 and west of the Champlain Hudson Canal. The bores pass underneath an 84” RCP with approximately a 16 to 17 foot clearance at approximately 43.5198°N and longitude -73.4116°W (approximately Sta. 15141+91), in Whitehall, NY (see Appendix B). The ground surface elevations along the HDD path gently undulates between El. 124 and El. 121 for the majority of the run before taking a dip to El. 114 at the southern end, approximately 70% through the alignment (reference datum NAVD 1988).

Given the presence of wetlands near/in the work areas, we recommend the use of barriers to contain potential releases to the ground surface near the exit pits and work area. The proposed work for HDD 4 must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #4 –Based on the borings drilled for this project, the soil profile for the HDD #4 BoreAid analyses will be divided into five [5] layers: Gravel, loose silt, medium stiff clay, and two layers of lower soft clays. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix A.

Specific design considerations for HDD #4 currently 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 84" RCP is approximately 16 to 17 feet. Preliminary analyses of the bore indicate the lowest maximum allowable pressure capacity in the middle of the bores to be approximately 51 psi. 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 74 psi and the approximate applied slurry pressure during drilling ranges from 0 to 29 psi. Sketches showing the maximum allowable pressure and the applied pressure is provided in the summary BoreAid analyses in the attached Appendix A.
- 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.
- It appears that there is a potential for releases 0 to 10 feet at the exit of the bore path. This should be relatively easily controlled through the use of conductive conduit, straw bales, silt fences, erosion control measures and vacuum trucks.
- Due to the work zones being located within 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.
- 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.

9.3 HDD CROSSING #4A

HDD #4A consists of two straight HDD bores, approximately 755 feet long, that cross from the west side of the CP Rail railroad tracks, under two sets of tracks, and to the east side approximately 500 feet east of the Champlain Canal. The bores cross underneath the tracks at a depth range between 33 to 34 feet at approximately latitude 43.5131°N and longitude -73.4135°W in Whitehall, NY (see Appendix B). The ground surface elevations along the HDD path gently builds from around El. 116 to El. 124 under the tracks and then gently back down to around El. 113 on the south end of the alignment (reference datum NAVD 1988). Given the presence of wetlands near/in the work areas, we recommend the use of barriers to contain potential releases to the ground surface near the exit pits and work area. The proposed work for HDD 4Amust be constructed in accordance with the Article VII Certificate and associated EM&CP.

<u>Ground conditions at HDD #4A</u> – The soil conditions at this location were estimated based on nearby borings since no subsurface investigations were conducted along the alignment. It is recommended that the HDD subcontractor drill a test boring at the start of construction at the HDD 4A site before starting the HDD to confirm the ground conditions. Based on the adjacent borings, the soil profile for HDD #4A BoreAid analysis was divided into three [3] layers: gravel, medium stiff lean clay, and very soft to soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix A.

Specific design considerations for HDD #4A currently include:

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water bodies, rail, road, wetlands, or ground surface. General depths of cover under the rail are between 33 and 34 feet for both bore paths. Preliminary analyses of the bore indicate the lowest maximum allowable pressure capacity in the middle of the bore to be approximately 49 psi. The total circulating pressure estimated to occur in the middle portion of the bore is approximately 19 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 49 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 a potential for releases in the starting and ending 0 to 35 feet of each bore near the entry and exit pits exists. These should be relatively easily controlled through the use of conductive conduit, straw bales, silt fences, erosion control measures and vacuum trucks.
- Due to the work zones being located within 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, and
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

9.4 HDD CROSSING #5

HDD #5 consists of two, straight, HDD bores, approximately 735 and 760 feet long, both located on the East side of CP Rail railroad tracks in Whitehall, NY. The middle of both bores cross underneath an arm of the Champlain canal, using an assumed 5 foot water depth, between 21 to 22 feet below the estimated mudline between approximately latitude 43.5100°N and longitude -73.4140°W in Whitehall, NY (see Appendix B). The ground surface elevations along the HDD path gently undulates around El. 117 to El. 124 aside from an El. drop to approximately El. 111 at the canal edges (reference datum NAVD 1988). The culverts have inverts at a range of El. 107.7 to El. 109.2 (reference datum NAVD 1988). The proposed work for HDD5 must be constructed in accordance with the Article VII Certificate and associated EM&CP.

<u>Ground conditions at HDD #5</u> –Based on the borings drilled for the project and the elevation and location of that bore, the soil profile for the HDD #5 BoreAid analyses will be divided into three [3] layers: gravel, medium stiff lean clay, and soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix A.

Specific design considerations for HDD #5 currently 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 depths of cover under the estimated mudline are 21 to 22 feet for both bore paths. Preliminary analyses of the bore indicate the lowest maximum allowable pressure capacity in the middle of the bore to be approximately 54 psi. The total circulating pressure estimated to occur in the bore in the middle portion of the bore is approximately 25 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 58 psi 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 the ending 0 to 10 feet of each bore exists. This should be relatively easily controlled through the use of conductive conduit, 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.

9.5 HDD CROSSING #6

HDD #6 consists of two horizontally curved HDD bores, approximately 1339 and 1453 feet long. Both bores ross CP Rail railroad tracks diagonally, curve, and then cross underneath a water way at an 84” RCP in Whitehall, NY. The bores pass underneath the tracks at a depth between 30 and 39 feet. The clearance underneath the estimated mudline at the 84” RCP is 20 feet at approximately latitude 43.4975°N and longitude -73.4207°W in Whitehall, NY (see Appendix B). The ground surface elevations along the HDD path ends hover around El. 120 with the tracks at the center of the path reaching a peak at El. 127 (reference datum NAVD 1988). The culvert invert ranges El. 112.3 (on the west side of the tracks) to El. 109.4 (on the east) (reference datum NAVD 1988).

The bores will have both horizontal and vertical curves, but no segments of the bore path are designed with compound curves (segments with compound curves would have both horizontal and vertical curves). Given the presence of wetlands near/in the work areas, we recommend the use of barriers to contain potential releases to the ground surface near the exit pits and work area. The proposed work for HDD 6 must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #6 –Based on the borings drilled for the project, the soil profile for the HDD #6 BoreAid analyses will be divided into five [5] layers: Loose silt, medium stiff lean clay, second layer of loose silt, poorly graded medium dense sand, and soft clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix A.

Specific design considerations for HDD #6 currently 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 depths of cover under the CP Rail railroad tracks are 39 feet. Both bores cross underneath the waterway at the 84" RCP with a clearance of 20 feet under estimated mudline. Preliminary analyses of the bore indicate the lowest maximum allowable pressure capacity in the middle of bores to be approximately 53 psi. The total circulating pressure estimated to occur in the bore 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 76 psi and the approximate applied slurry pressure during drilling ranges from 0 to 38 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 the starting 5 to 10 feet of each bore and the ending 60 feet exists. This should be relatively easily controlled through the use of conductive conduit, straw bales, silt fences, erosion control measures and vacuum trucks.
- Due to the work zones being located within 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, and

- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

9.6 HDD CROSSING #7

HDD #7 consists of two, straight, HDD bores, approximately 1305 feet long, passing approximately 40 feet below estimated mudlines of standing water/wetlands located approximately 55 to 74 feet west of CP Rail railroad tracks in Whitehall, NY. The bores run from approximately latitude 43.4903°N and longitude 73.4248°W to latitude 43.4869°N and longitude 73.4262°W, see Appendix B. The ground surface elevations along the HDD path gently undulates between El. 121 and El. 119 (reference datum NAVD 1988). The depth of water at this crossing is not known, a water depth of 5 feet was assumed for design purposes and analysis. Given the presence of wetlands in the work areas, we recommend the use of barriers to contain potential releases to the ground surface near the entry and exit pits and work area. The proposed work for HDD #7 must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #7 –Based on the borings drilled for the project and the elevation and location of that bore, the soil profile for the HDD #7 BoreAid analyses will be divided into three [3] layers: poorly graded medium dense sand, stiff lean clay, and soft to very soft fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix A.

Specific design considerations for HDD #7 currently 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 depths of cover under the estimated mudline are 40 feet. Preliminary analyses of the bore indicate the lowest maximum allowable pressure capacity in the middle of the bore to be approximately 50 psi. The total circulating pressure estimated to occur in the middle portion of the bore is approximately 40 psi assuming standard HDD drilling methods. In the remainder of the bores the maximum allowable pressure ranges from approximately 0 to 60 psi and the approximate applied slurry pressure during drilling ranges from 0 to 47 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 the starting and ending 5 to 30 feet of each bore at the entry and exit pits exists. These should be relatively easy to control through the use of conductive conduits, strawbales, silt fences, erosion control measures and vacuum trucks.
- Due to the work zones being located within 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, and
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

9.7 HDD CROSSING #8

HDD #8 consists of two straight HDD bores, approximately 655 and 838 feet long, both crossing from the western side of the CP Rail railroad tracks to the east side, located east of State Route 4 and west of N. Old Route 4. They will be passing approximately 29 feet (El 104) below the top of rail of the CP Railway and 17 feet below a 28"x48" box culvert in Whitehall, Washington County, New York. The bores run from approximately latitude 43.2847°N and longtidue 73.25451°W to latitude 43.2839°N and longitude 73.2547°W, see Appendix B. The ground surface elevations along the HDD path gently undulates between El. 133 and El. 129, with the largest change in elevation occurring within the first 20% of the bores (reference datum NAVD 1988). The proposed work for HDD #8 must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #*8* –Based on the borings drilled for this project, the soil profile for the HDD #8 BoreAid analyses will be divided into two [2] layers: Poorly graded sand and medium stiff fat clay. The soil profiles used for BoreAid analyses of the HDDs in this segment are presented in Appendix A.

Specific design considerations for HDD #8 currently 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 railway is 29 feet near the centers of the bore paths. Preliminary analyses of the bore indicate the lowest maximum allowable pressure capacity in the middle of the bore to be approximately 52 psi. The total circulating pressure estimated to occur in the bore 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 65 psi and the approximate applied slurry pressure during drilling ranges from 0 to 25 psi. Sketches showing the maximum allowable pressure and the applied pressures for each conduit is provided in the summary BoreAid analyses in the attached Appendix A.
- It appears that a potential for releases in the starting and ending 5 to 20 feet of each bore near entry and exit pit exists. This should be relatively easily controlled through the use of conductive conduit, 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.
- Due to the work zones being located within 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.

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:	HDD #3 - Conduit 1 Start Date: 12-10-2021 End Date: 12-10-2021
Designer:	TAR CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1894.40, 0.00, 127.20) ft
Project Length	1894.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

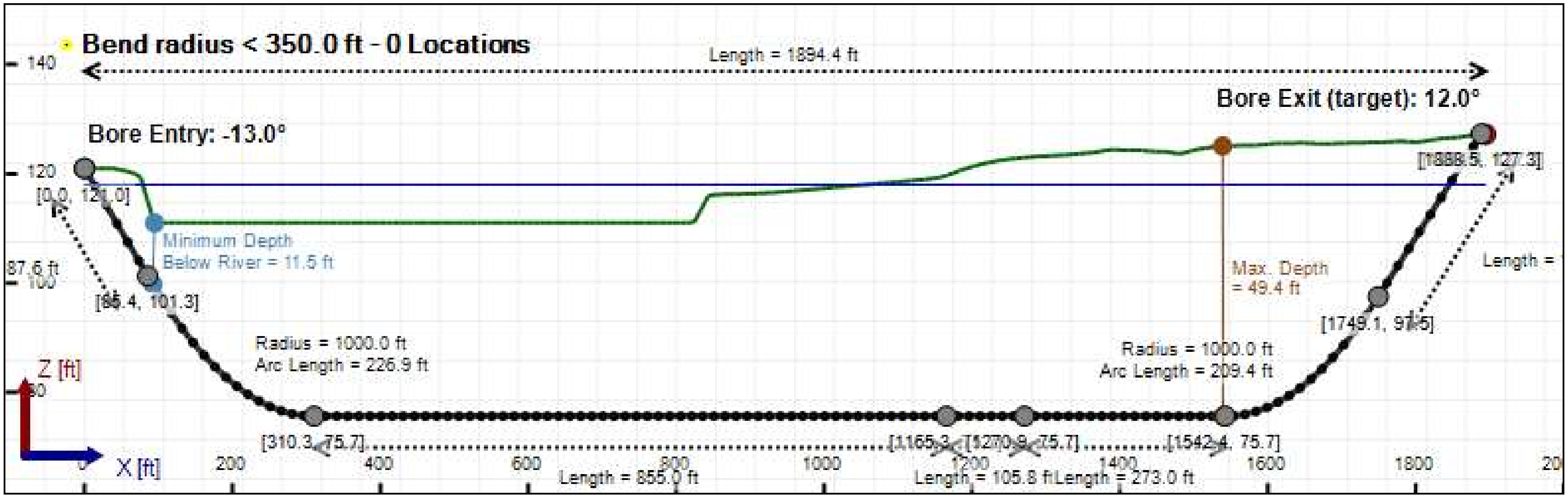
Number of Layers: 3

Soil Layer #1 USCS, Sand (S), SM
Depth: 11.60 ft
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, Clay (C), CH
Depth: 15.60 ft
Unit Weight: 90.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 350.00, Coh: 6.90 [psi]

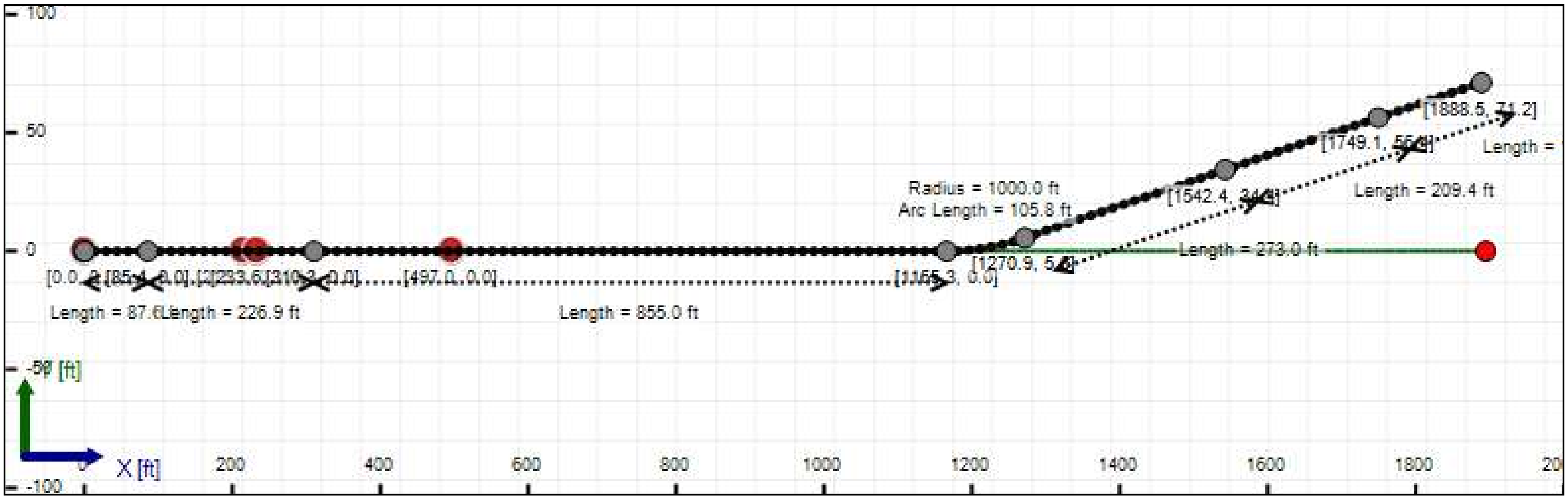
Soil Layer #3 USCS, Clay (C), CH
Depth: 35.00 ft
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Bore Cross-Section View



Powered by BoreAid

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: 1904.99 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term):   1200 psi

Allowable Tensile Stress (Long Term):   1100 psi

Allowable Compressive Stress (Short Term):   1150 psi

Allowable Compressive Stress (Long Term):   1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	10.8	22.1
Water Pressure	18.4	18.4
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	29.2	40.4
Deflection		
Earth Load Deflection	2.944	6.018
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	3.076	6.150
Compressive Stress [psi]		
Compressive Wall Stress	131.2	181.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	32831.0	32831.0
Pullback Stress [psi]	915.6	915.6
Pullback Strain	1.592E-2	1.592E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	915.6	938.8
Tensile Strain	1.592E-2	1.678E-2

Net External Pressure = 25.6 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.076	7.5	2.4	OK
Unconstrained Collapse [psi]	34.1	104.9	3.1	OK
Compressive Wall Stress [psi]	131.2	1150.0	8.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	44.1	198.5	4.5	OK
Tensile Stress [psi]	938.8	1200.0	1.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	78.802 psi	61.984 psi
1	8.00 in	12.00 in	78.754 psi	61.797 psi
2	12.00 in	16.13 in	78.685 psi	61.535 psi

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

Estimated Circulating Pressure Summary

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

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

Drill Fluid Density: 68.700 lb/ft3

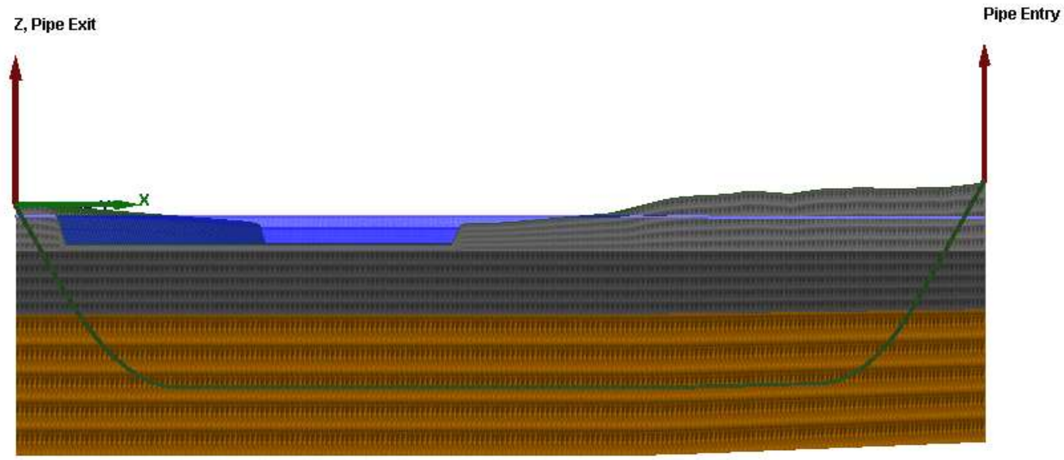
Rheological model: Power-Law

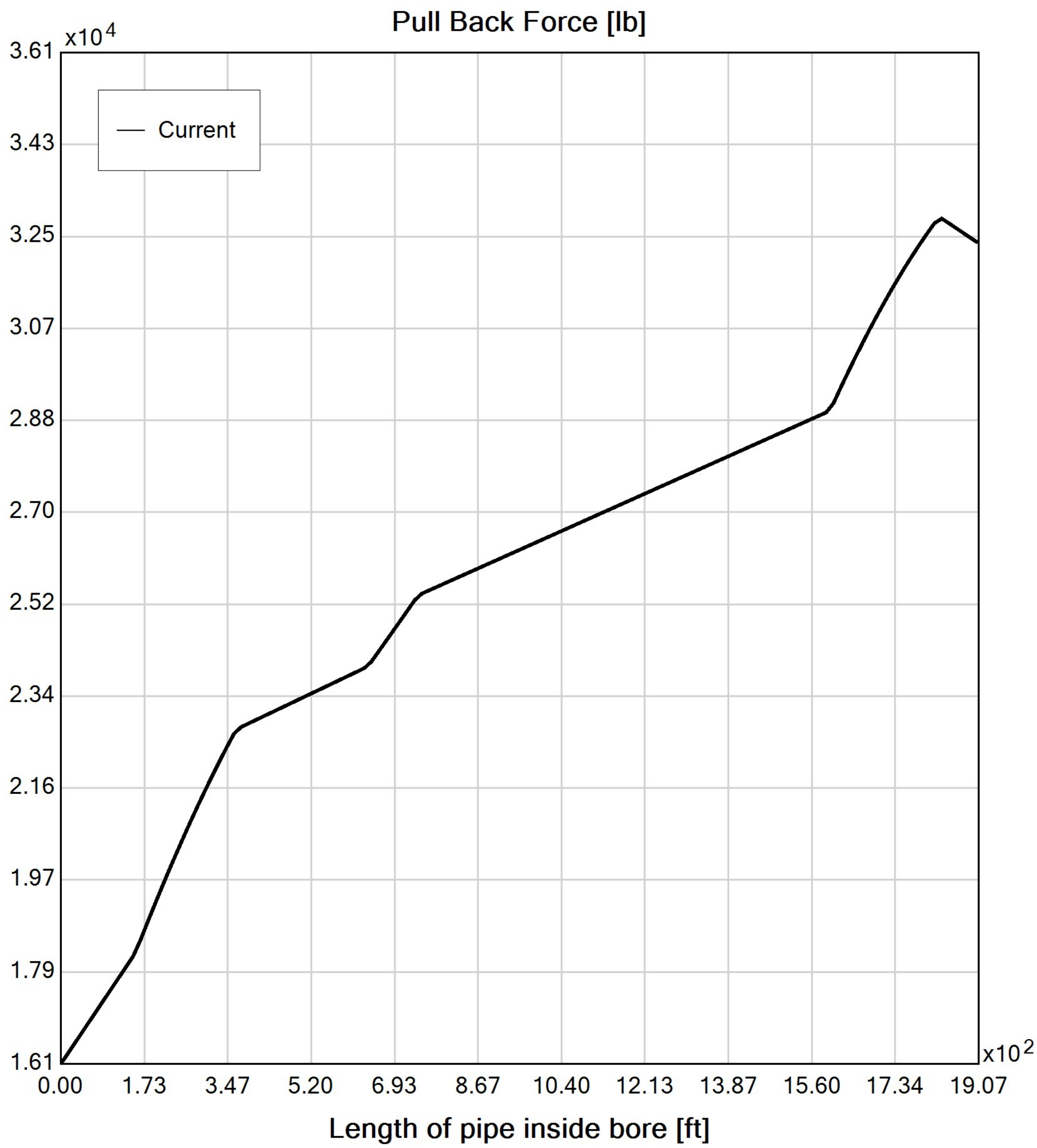
Fluid Consistency Index (K): 63.17

Power Law Exponent (n): 0.14

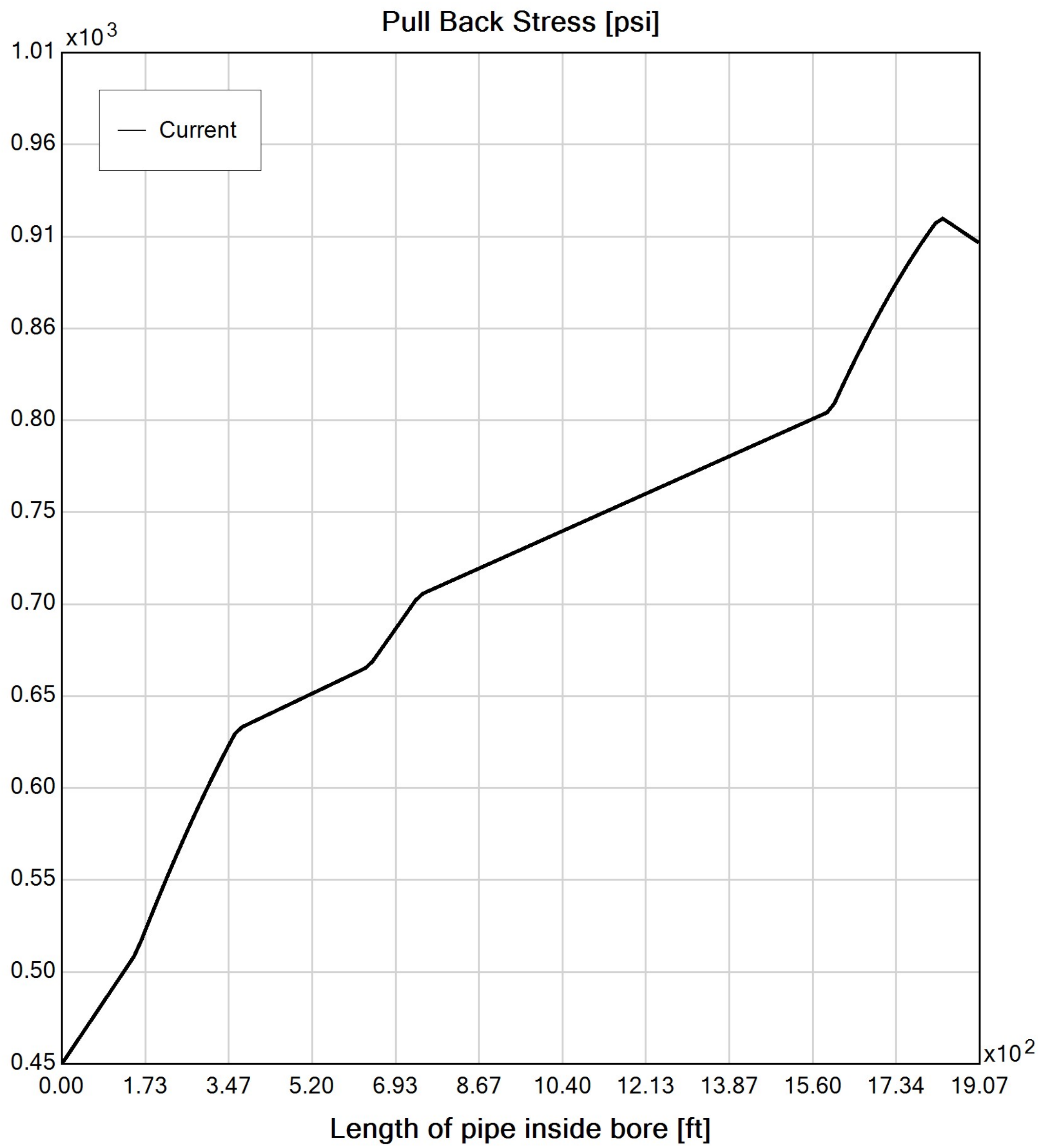
Effective Viscosity (cP): 859.3

Virtual Site





Pull Back Force [lb]
x10⁴
3.61
3.43
3.25
3.07
2.88
2.70
2.52
2.34
2.16
1.97
1.79
1.61
Current
x10²
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]



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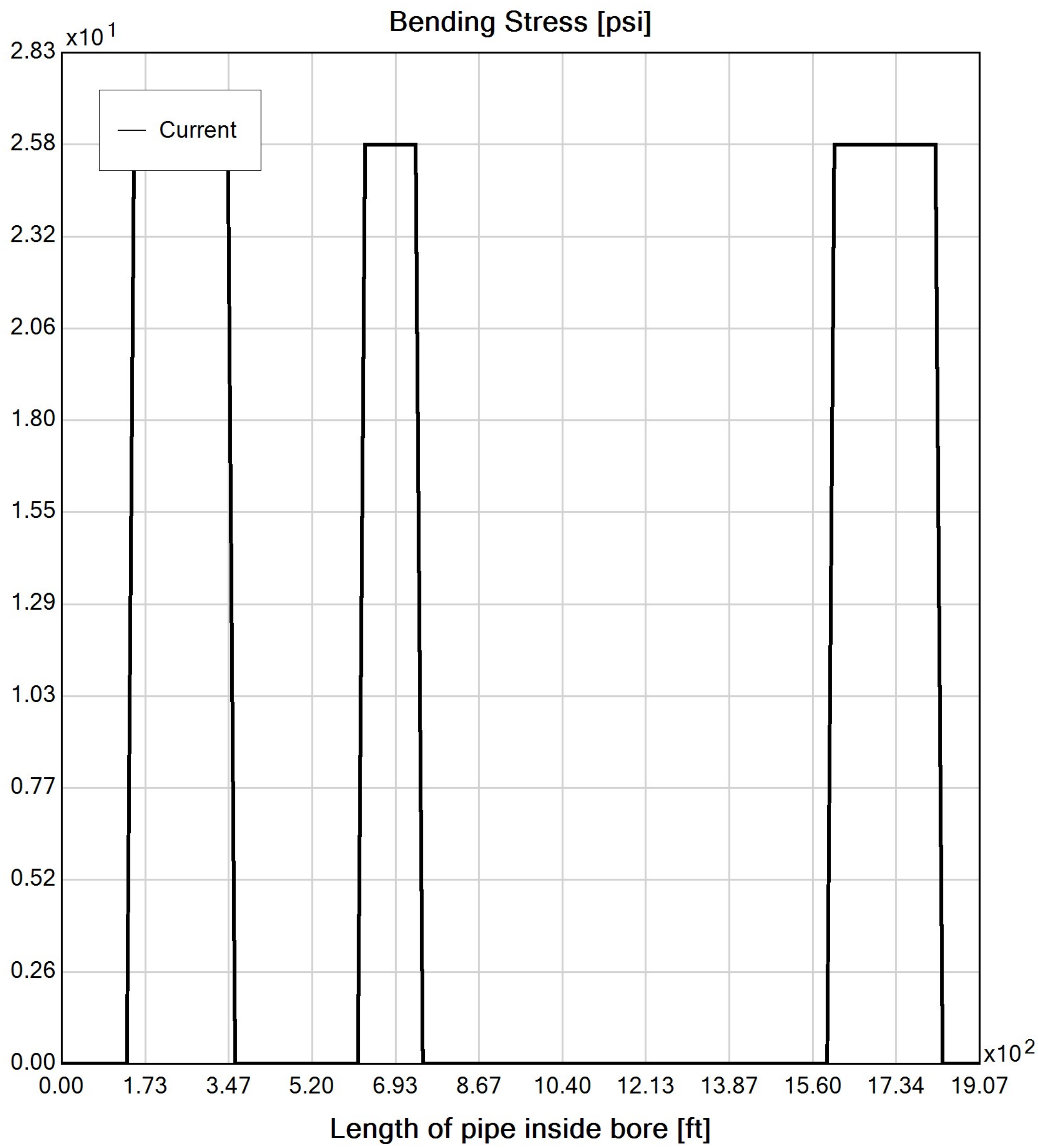

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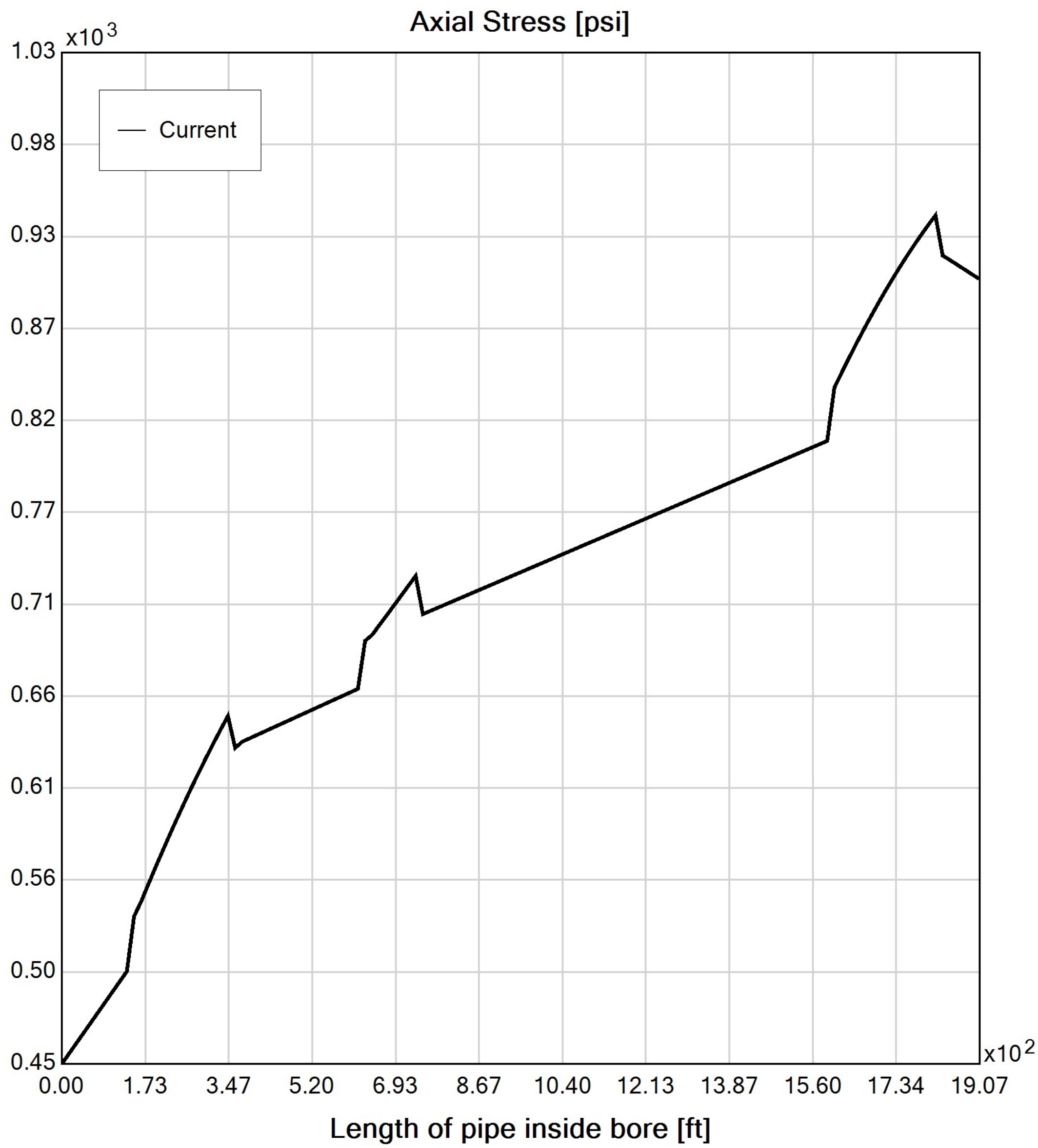
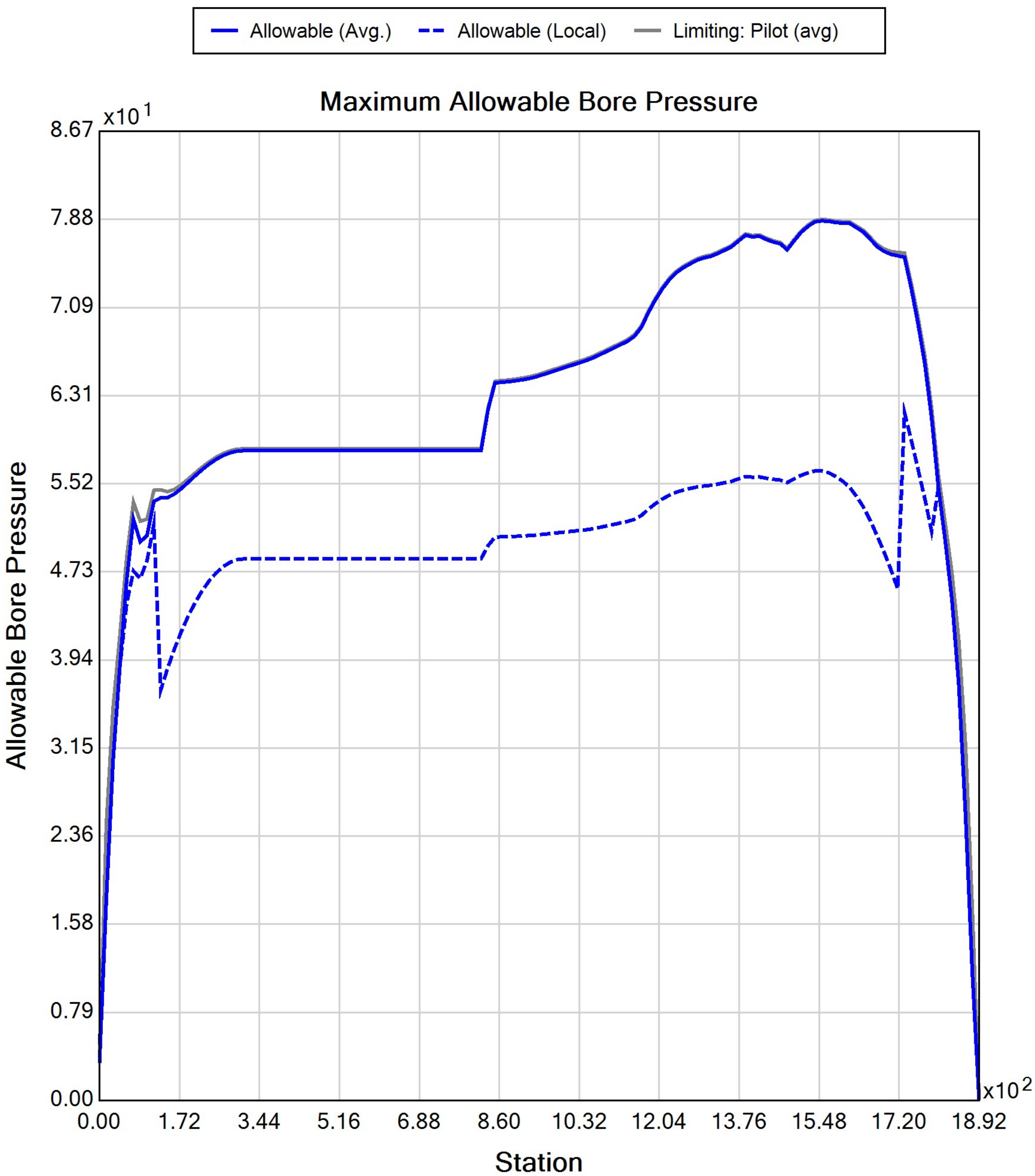
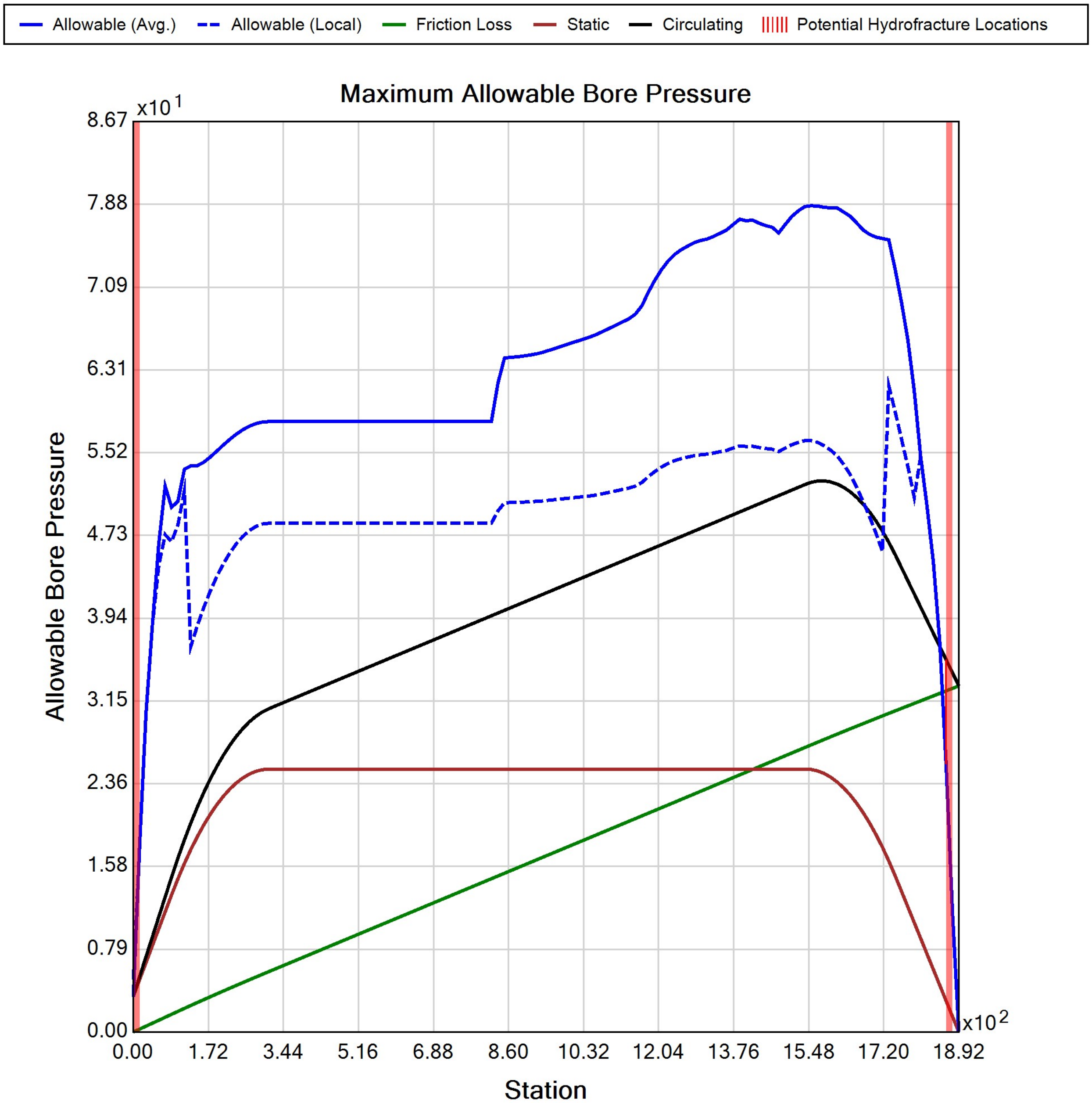

Axial Stress [psi]
x10 3
1.03
0.98
0.93
0.87
0.82
0.77
0.71
0.66
0.61
0.56
0.50
0.45
Current
x10 2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
8.67
7.88
7.09
6.31
5.52
4.73
3.94
3.15
2.36
1.58
0.79
0.00
Allowable Bore Pressure
x10 2
0.00
1.72
3.44
5.16
6.88
8.60
10.32
12.04
13.76
15.48
17.20
18.92
Station



Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10 1
8.67
7.88
7.09
6.31
5.52
4.73
3.94
3.15
2.36
1.58
0.79
0.00
Allowable Bore Pressure
0.00
1.72
3.44
5.16
6.88
8.60
10.32
12.04
13.76
15.48
17.20
18.92
x10 2
Station

Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1894.40, 0.00, 127.20) ft
Project Length	1894.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1904.99 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	7.4	22.1
Water Pressure	18.4	18.4
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	25.8	40.4
Deflection		
Earth Load Deflection	2.019	6.018
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	2.048	6.047
Compressive Stress [psi]		
Compressive Wall Stress	116.0	181.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1712.1	1712.1
Pullback Stress [psi]	978.2	978.2
Pullback Strain	1.701E-2	1.701E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	978.2	981.4
Tensile Strain	1.701E-2	1.717E-2

Net External Pressure = 25.6 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	2.048	7.5	3.7	OK
Unconstrained Collapse [psi]	34.1	114.9	3.4	OK
Compressive Wall Stress [psi]	116.0	1150.0	9.9	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	44.1	195.9	4.4	OK
Tensile Stress [psi]	981.4	1200.0	1.2	OK

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Project Summary

General:	HDD #3 - Conduit 2 Start Date: 12-10-2021 End Date: 12-10-2021
Designer:	TAR CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1894.40, 0.00, 127.50) ft
Project Length	1894.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

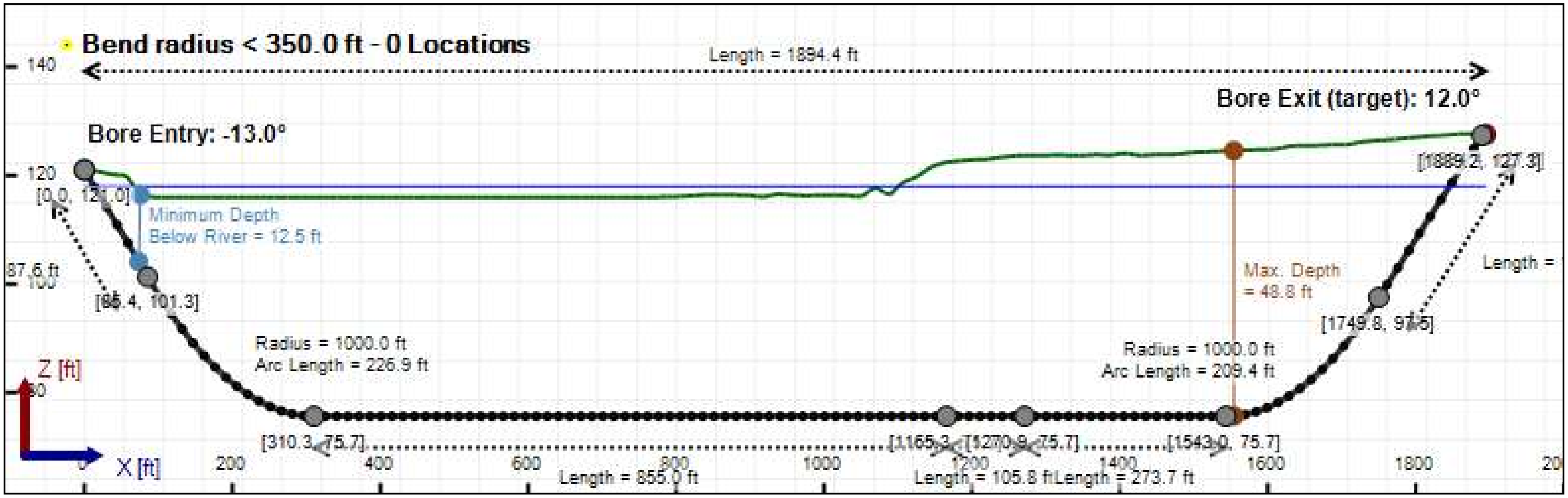
Number of Layers: 3

Soil Layer #1 USCS, Sand (S), SM
Depth: 11.60 ft
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, Clay (C), CH
Depth: 15.60 ft
Unit Weight: 90.0000 (dry), 115.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 350.00, Coh: 6.90 [psi]

Soil Layer #3 USCS, Clay (C), CH
Depth: 35.00 ft
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Bore Cross-Section View



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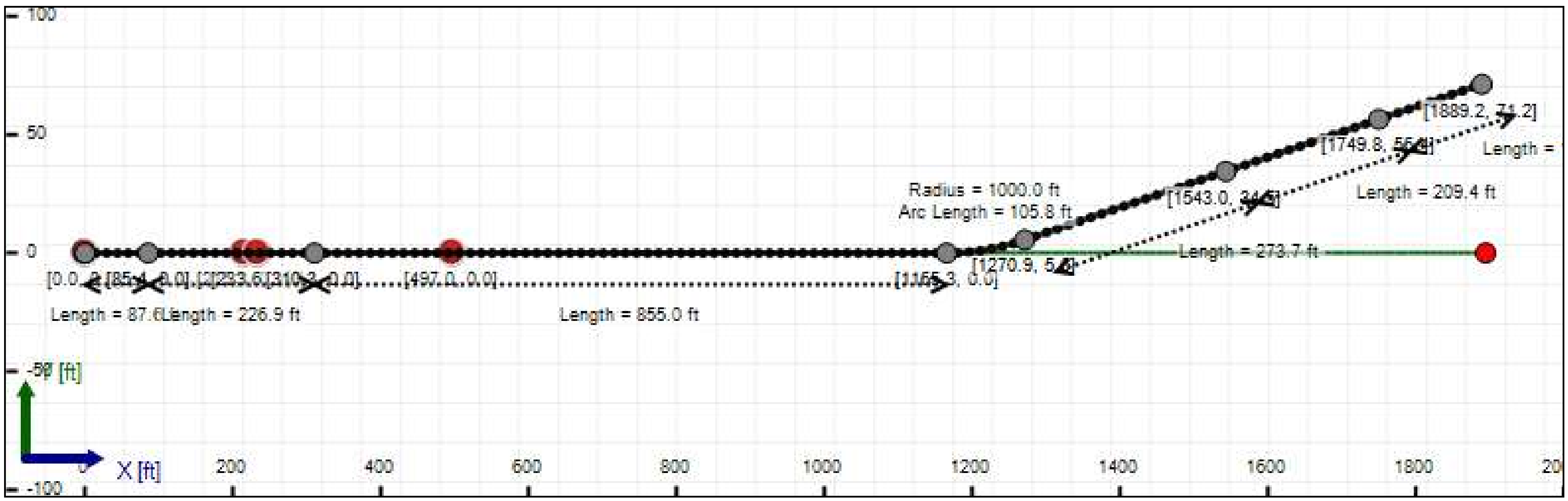
Bore Plan View



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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: 1904.99 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.6	21.6
Water Pressure	18.4	18.3
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	25.0	40.0
Deflection		
Earth Load Deflection	1.799	5.890
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.931	6.022
Compressive Stress [psi]		
Compressive Wall Stress	112.3	179.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	32821.6	32821.6
Pullback Stress [psi]	915.4	915.4
Pullback Strain	1.592E-2	1.592E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	915.4	938.5
Tensile Strain	1.592E-2	1.677E-2

Net External Pressure = 25.5 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.931	7.5	3.9	OK
Unconstrained Collapse [psi]	34.0	116.2	3.4	OK
Compressive Wall Stress [psi]	112.3	1150.0	10.2	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	44.0	198.5	4.5	OK
Tensile Stress [psi]	938.5	1200.0	1.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	77.758 psi	62.450 psi
1	8.00 in	12.00 in	77.700 psi	62.270 psi
2	12.00 in	16.13 in	77.616 psi	62.017 psi

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

Estimated Circulating Pressure Summary

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

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

Drill Fluid Density: 68.700 lb/ft3

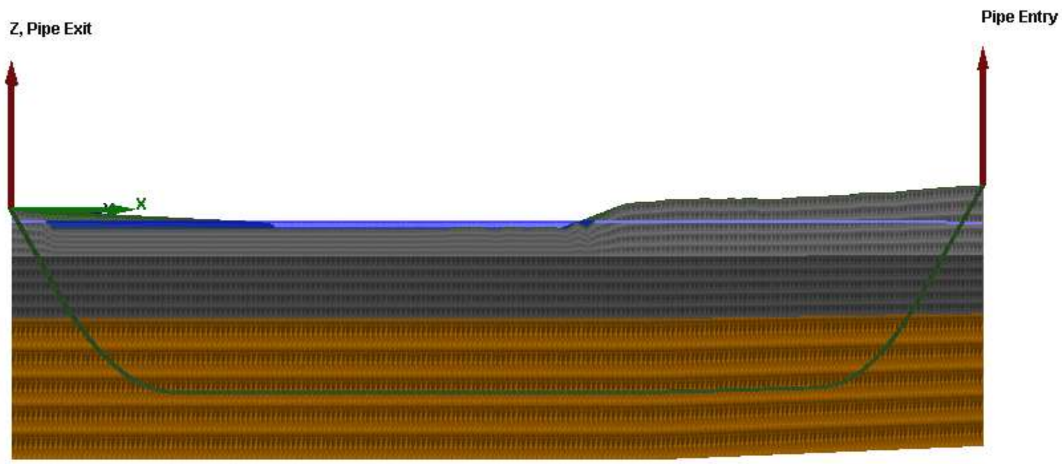
Rheological model: Bingham-Plastic

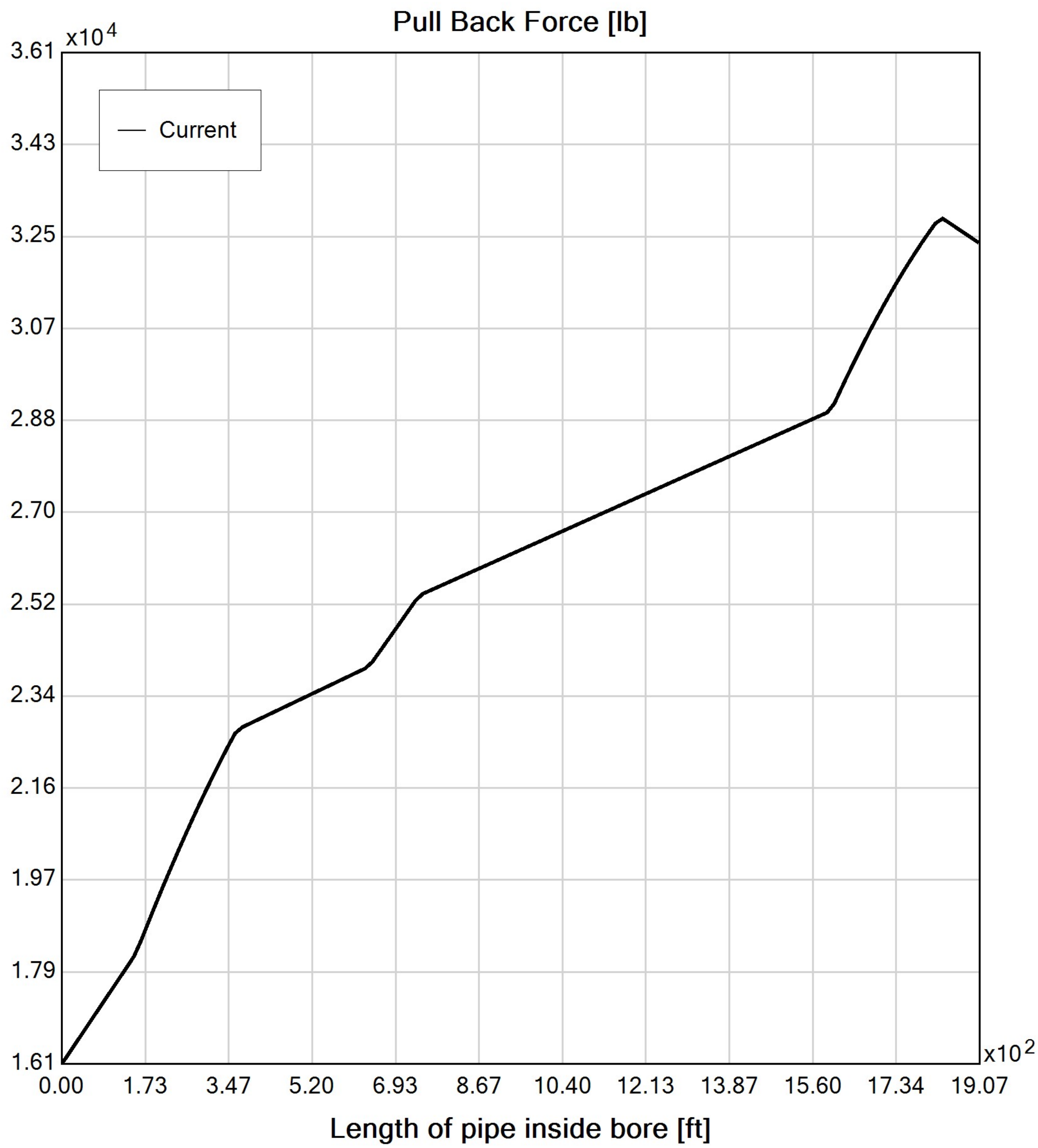
Plastic Viscosity (PV): 25.53

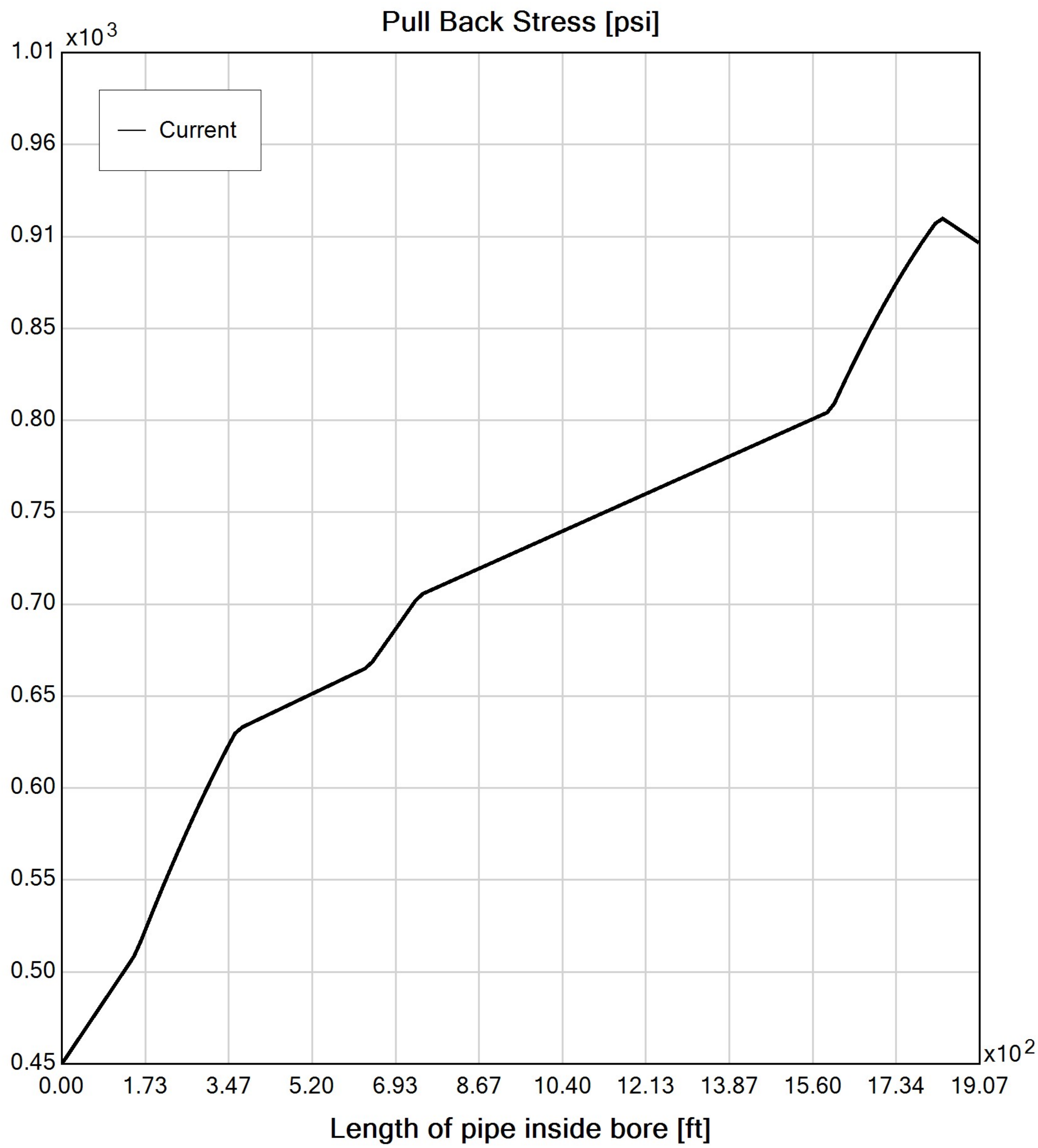
Yield Point (YP): 16.49

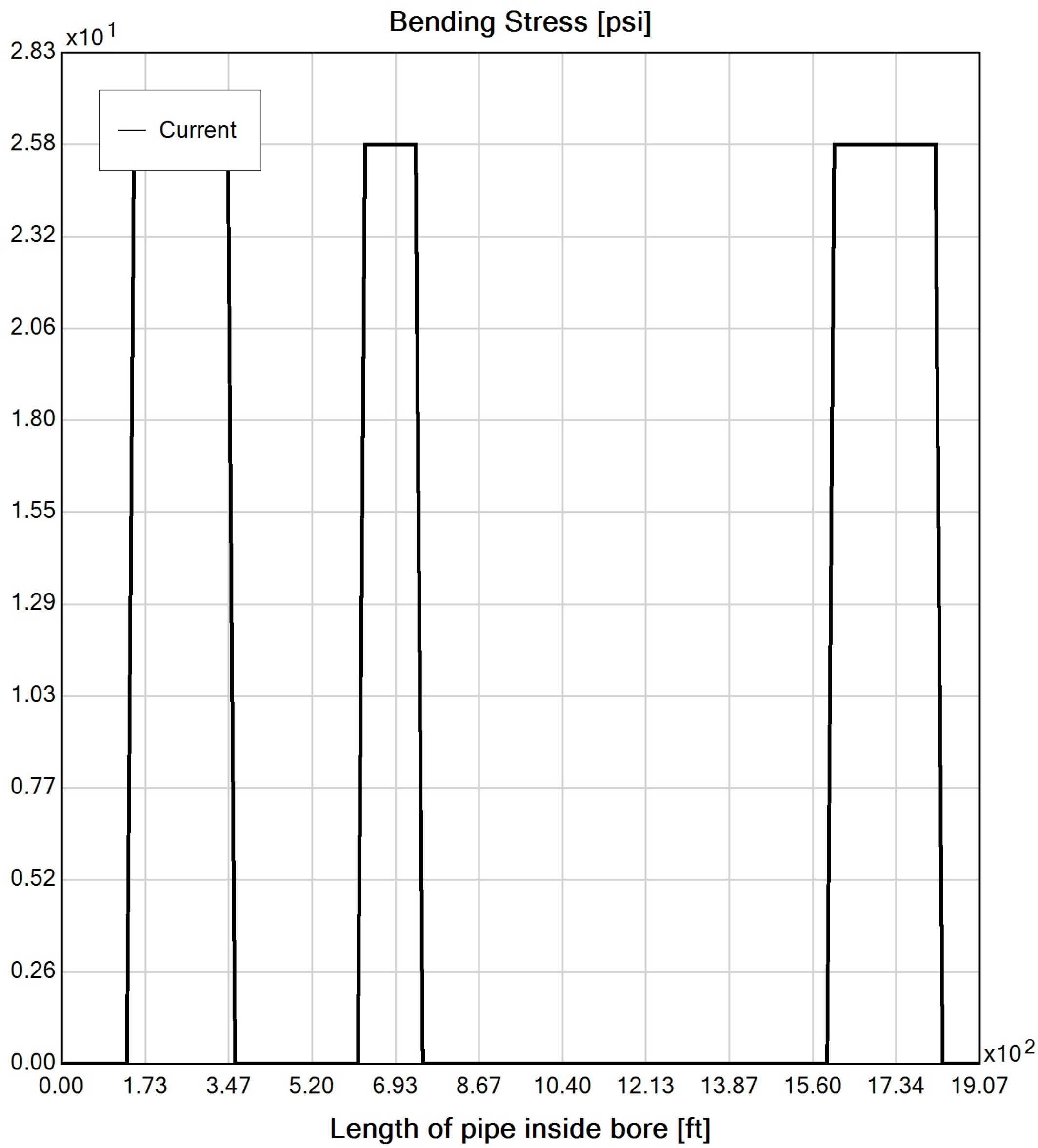
Effective Viscosity (cP): 1202.0

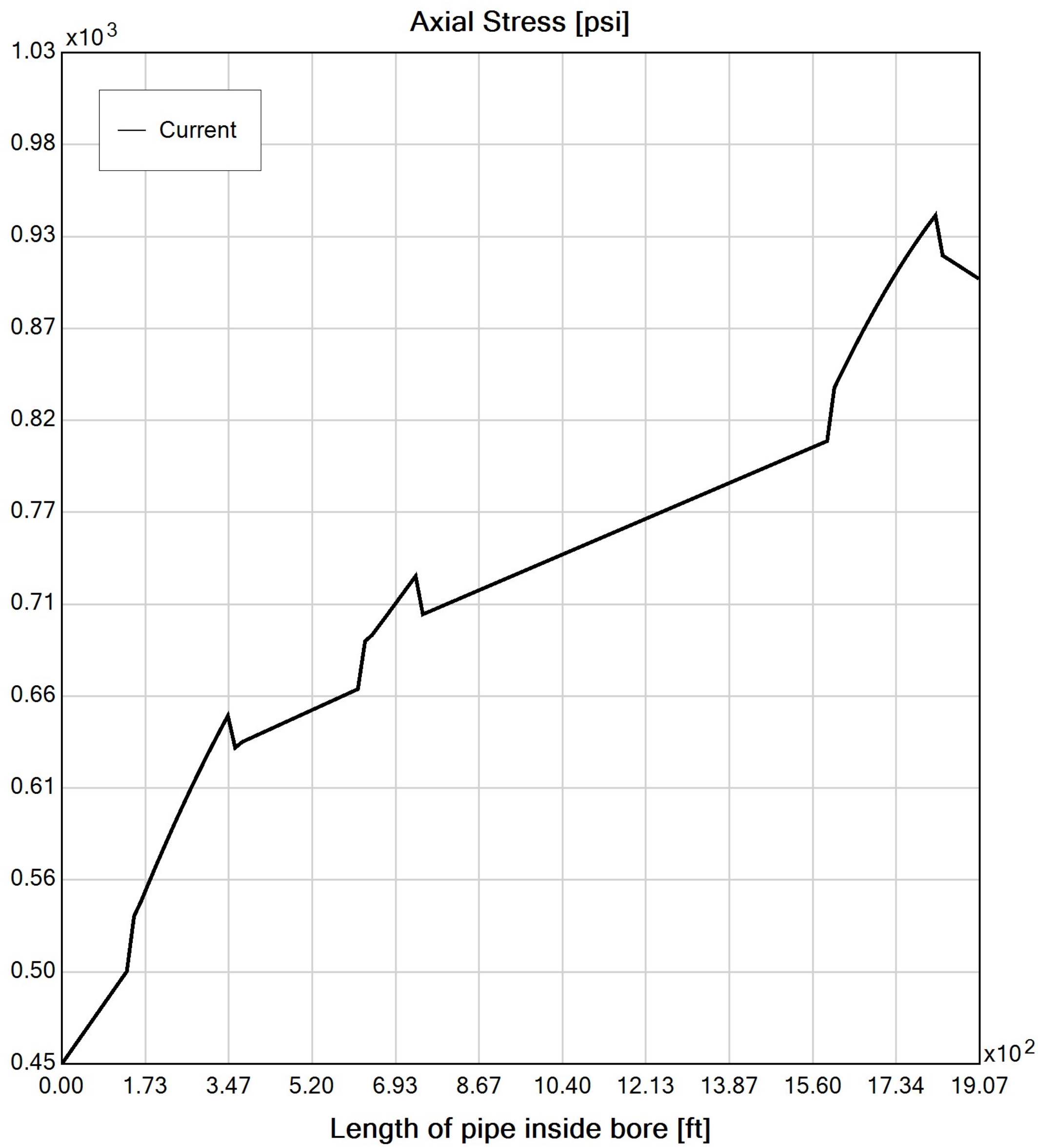
Virtual Site



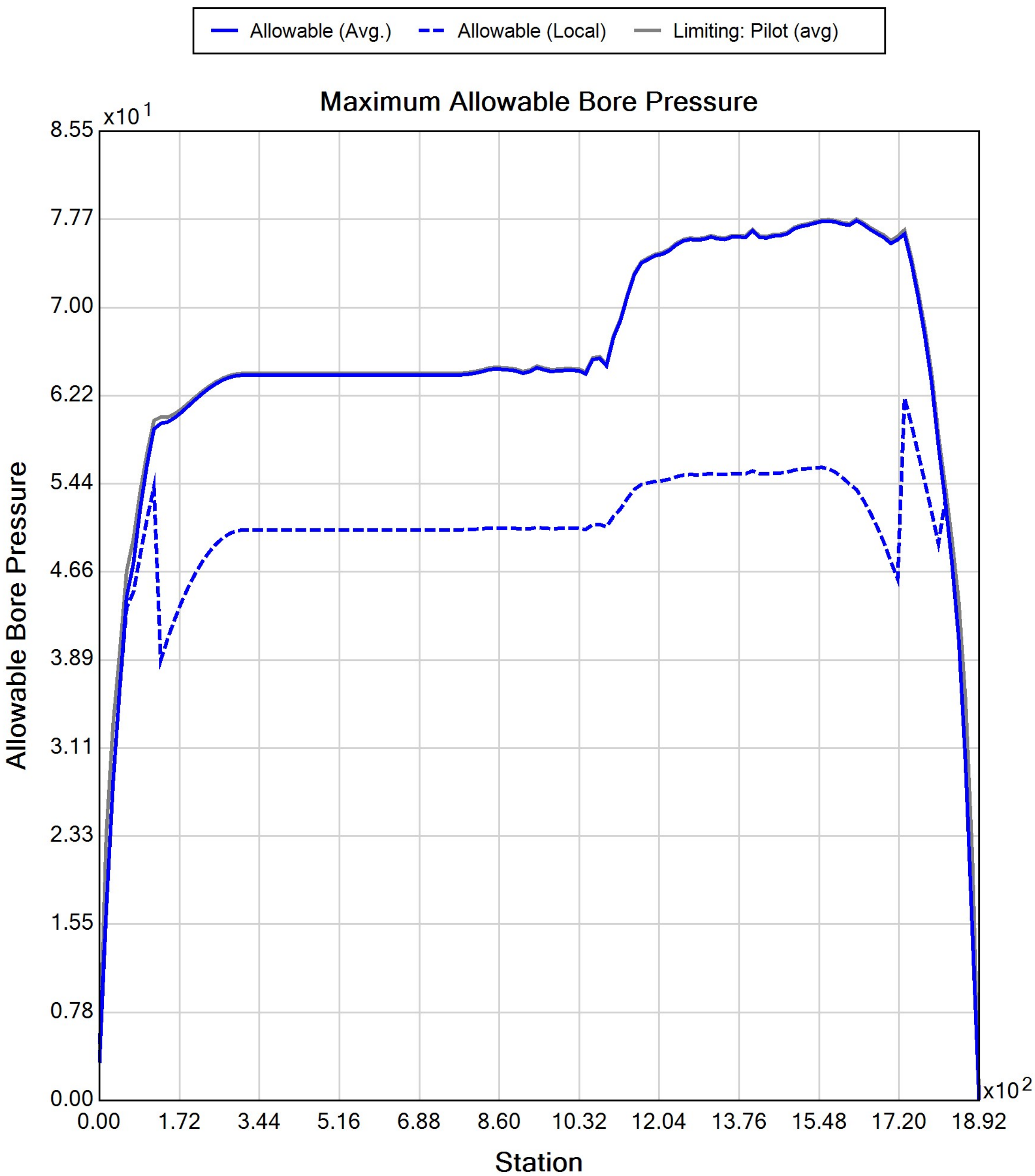

Pull Back Force [lb]
x10^4
3.61
3.43
3.25
3.07
2.88
2.70
2.52
2.34
2.16
1.97
1.79
1.61
Current
x10^2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]


Pull Back Stress [psi]
x10 3
1.01
0.96
0.91
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
Current
x10 2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]

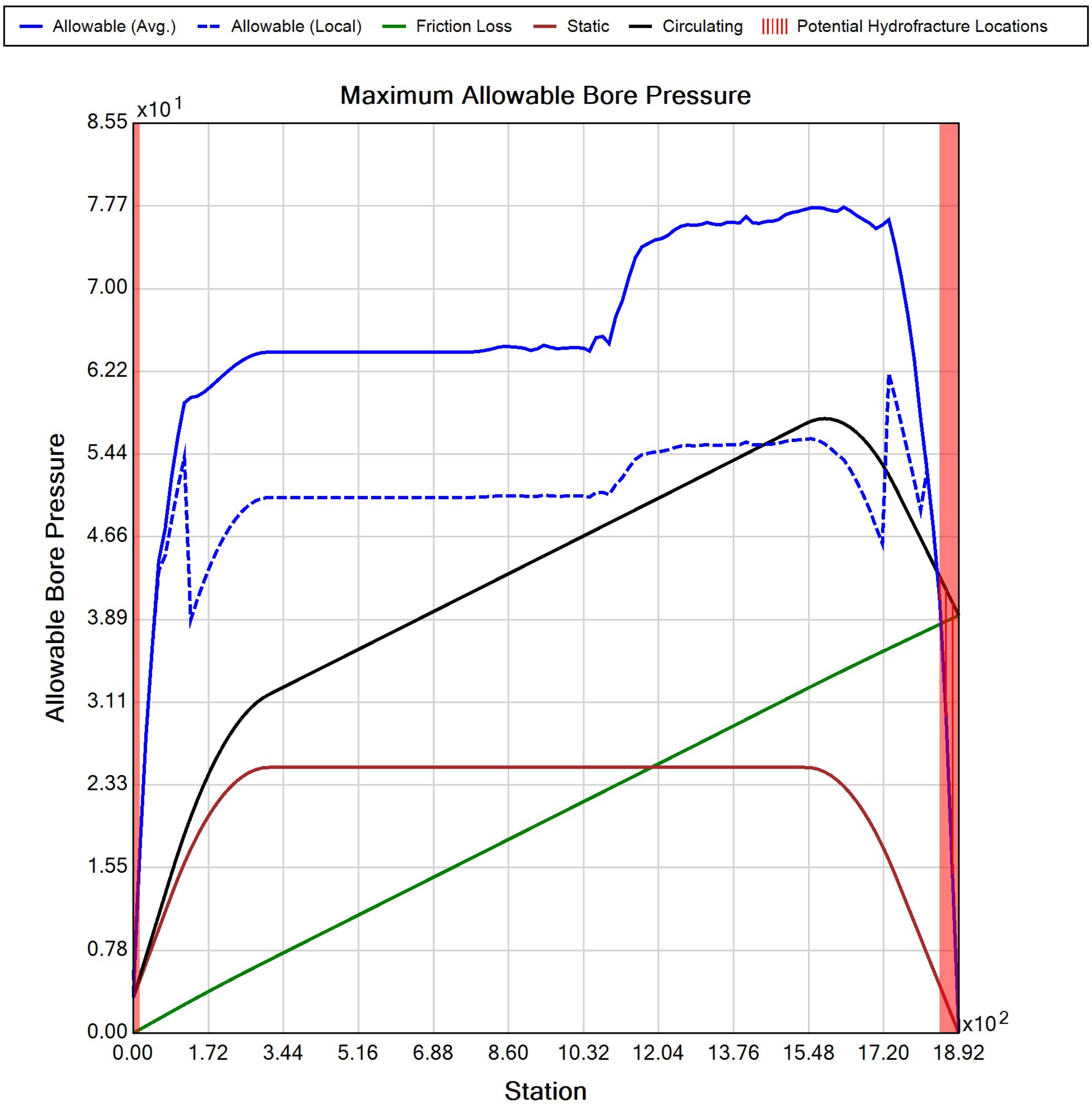

Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]



Axial Stress [psi]
x10 3
1.03
0.98
0.93
0.87
0.82
0.77
0.71
0.66
0.61
0.56
0.50
0.45
Current
x10 2
0.00
1.73
3.47
5.20
6.93
8.67
10.40
12.13
13.87
15.60
17.34
19.07
Length of pipe inside bore [ft]



Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
8.55
7.77
7.00
6.22
5.44
4.66
3.89
3.11
2.33
1.55
0.78
0.00
Allowable Bore Pressure
x10 2
0.00
1.72
3.44
5.16
6.88
8.60
10.32
12.04
13.76
15.48
17.20
18.92
Station



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Input Summary

Start Coordinate	(0.00, 0.00, 121.00) ft
End Coordinate	(1894.40, 0.00, 127.50) ft
Project Length	1894.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1904.99 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 3.32999992370605 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	2.9	21.6
Water Pressure	18.4	18.3
Surface Surcharge	3.3	3.3
Internal Pressure	0.0	0.0
Net Pressure	21.3	40.0
Deflection		
Earth Load Deflection	0.948	5.890
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	0.977	5.919
Compressive Stress [psi]		
Compressive Wall Stress	95.8	179.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1711.6	1711.6
Pullback Stress [psi]	978.0	978.0
Pullback Strain	1.701E-2	1.701E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	978.0	981.1
Tensile Strain	1.701E-2	1.716E-2

Net External Pressure = 25.5 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.977	7.5	7.7	OK
Unconstrained Collapse [psi]	34.0	128.2	3.8	OK
Compressive Wall Stress [psi]	95.8	1150.0	12.0	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	44.0	195.9	4.5	OK
Tensile Stress [psi]	981.1	1200.0	1.2	OK

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Project Summary

General:	HDD #4
	Ref: BLANK
	BLANK
	Start Date: 03-01-2022
	End Date: 03-01-2022
Project Owner:	BLANK
Project Contractor:	BLANK
Project Consultant:	BLANK
Designer:	BLANK
	CHA
	BLANK
	BLANK, BLANK
	BLANK BLANK
	Phone: BLANK
	Fax: BLANK
	BLANK
Description:	BLANK

Input Summary

Start Coordinate	(0.00, 0.00, 122.36) ft
End Coordinate	(631.40, 0.00, 121.70) ft
Project Length	631.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 5

Soil Layer #1 USCS, Gravel (G), GM
Depth: 6.00 ft
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 37.00, S.M.: 1000.00, Coh: 0.00 [psi]

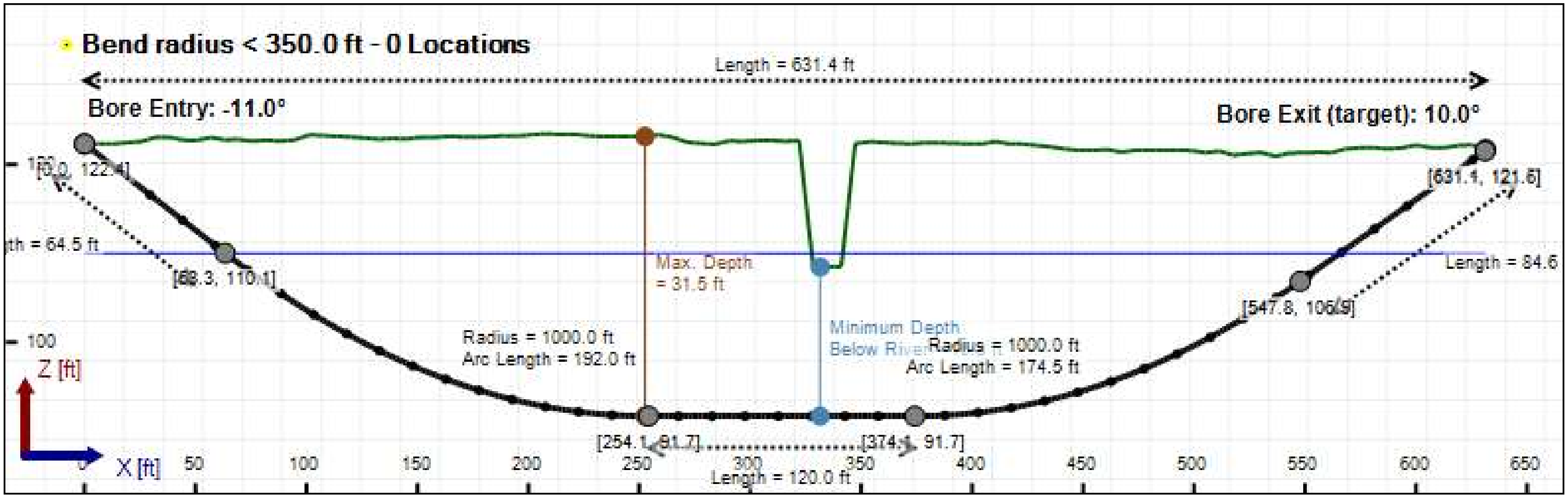
Soil Layer #2 USCS, Silt (M), ML
Depth: 2.00 ft
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 50.00, Coh: 4.40 [psi]

Soil Layer #3 USCS, Clay (C), CH
Depth: 15.50 ft
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 5.50 [psi]

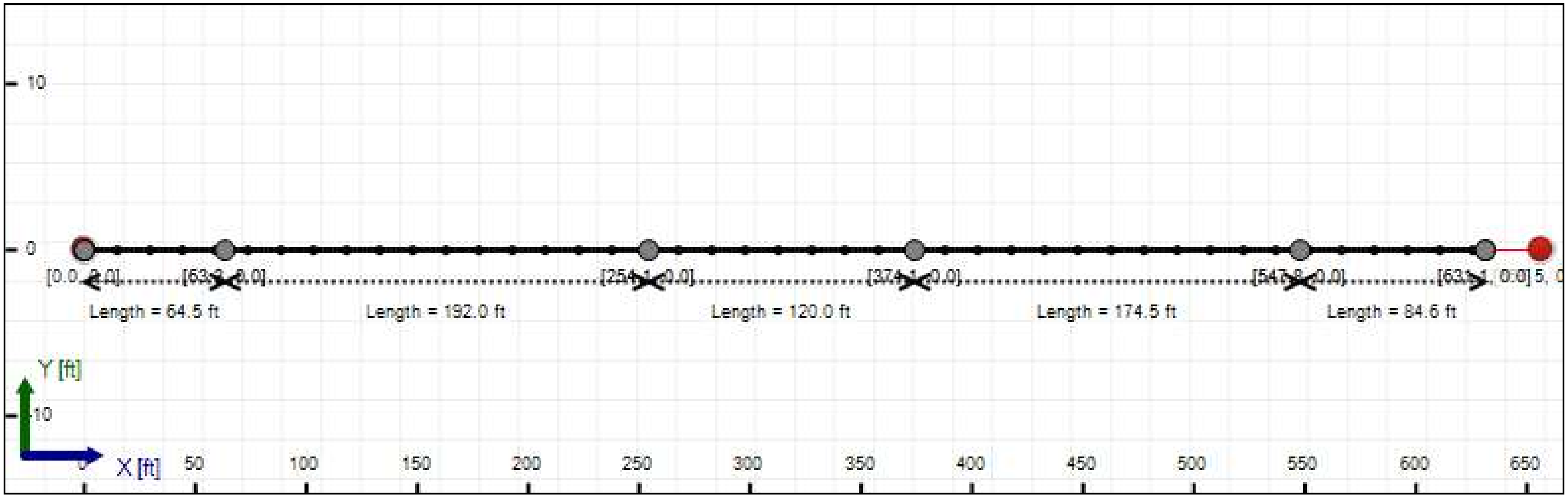
Soil Layer #4 USCS, Clay (C), CH
Depth: 6.50 ft
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Soil Layer #5 USCS, Clay (C), CH
Depth: 10.00 ft
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 645.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.8	14.8
Water Pressure	7.9	7.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.7	22.7
Deflection		
Earth Load Deflection	1.845	4.036
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.978	4.168
Compressive Stress [psi]		
Compressive Wall Stress	66.2	102.3

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	11031.9	11031.9
Pullback Stress [psi]	307.7	307.7
Pullback Strain	5.351E-3	5.351E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	307.7	332.6
Tensile Strain	5.351E-3	6.232E-3

Net External Pressure = 18.0 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

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	61.383 psi	48.194 psi
1	8.00 in	12.00 in	61.145 psi	44.345 psi
2	12.00 in	16.13 in	60.810 psi	43.969 psi

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

Estimated Circulating Pressure Summary

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

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

Drill Fluid Density: 68.700 lb/ft3

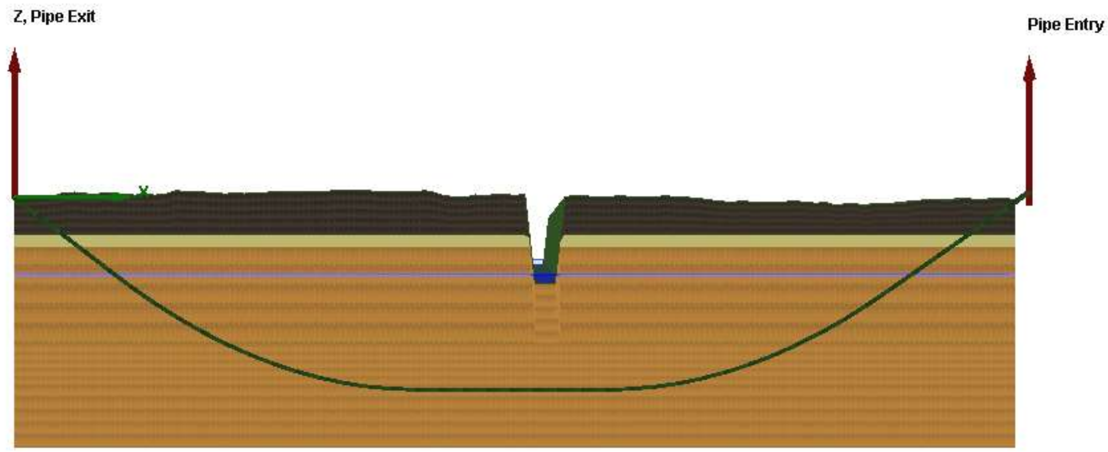
Rheological model: Bingham-Plastic

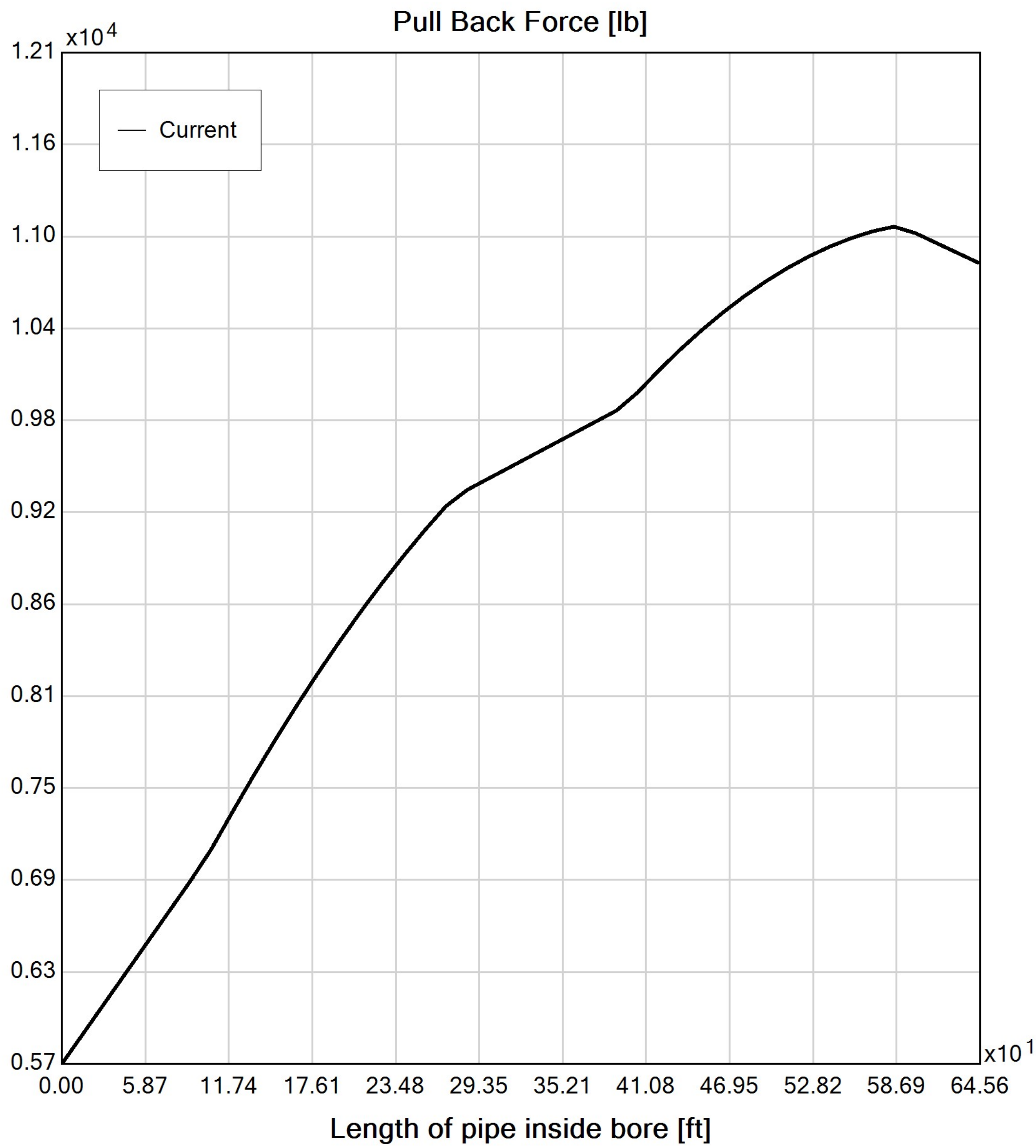
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

Virtual Site





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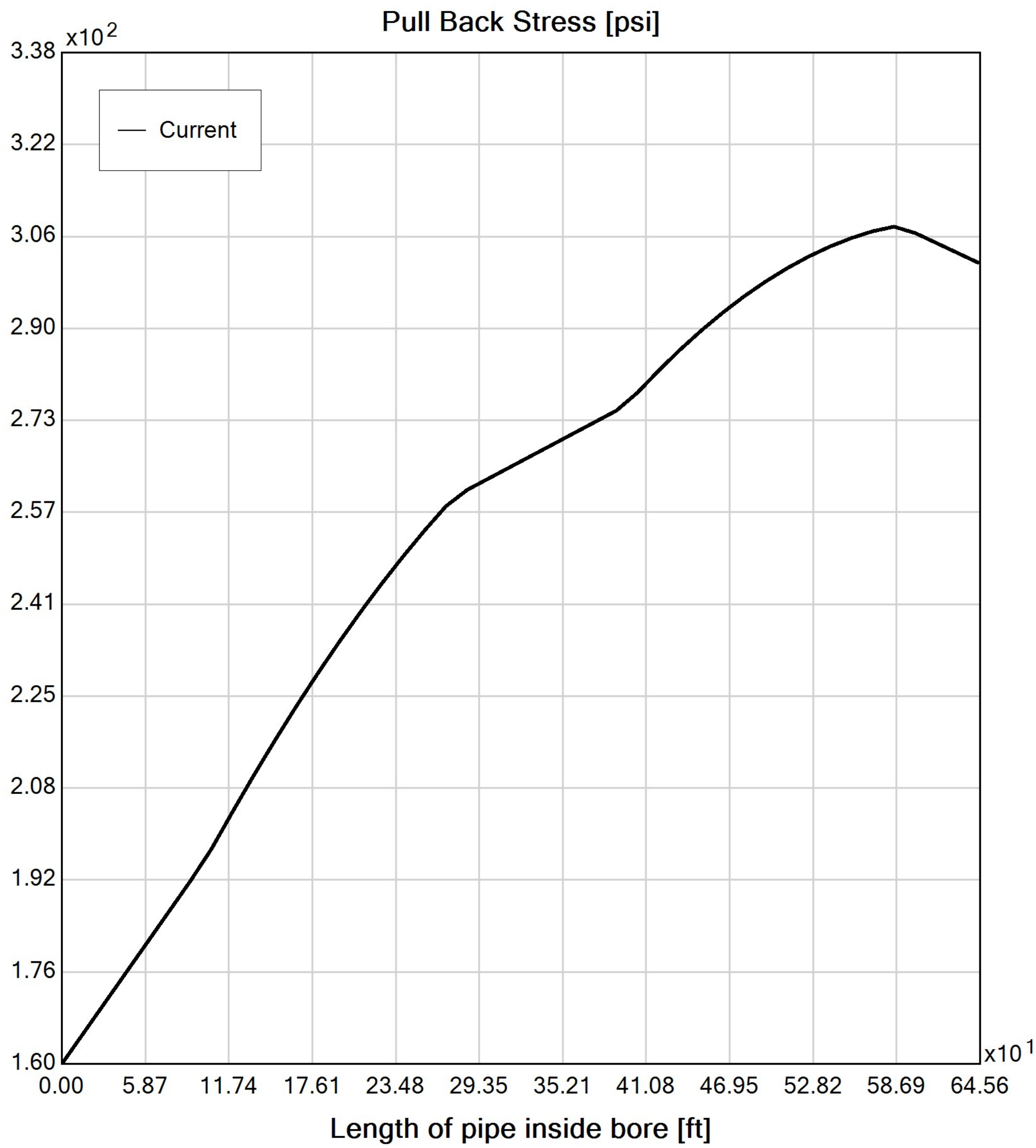
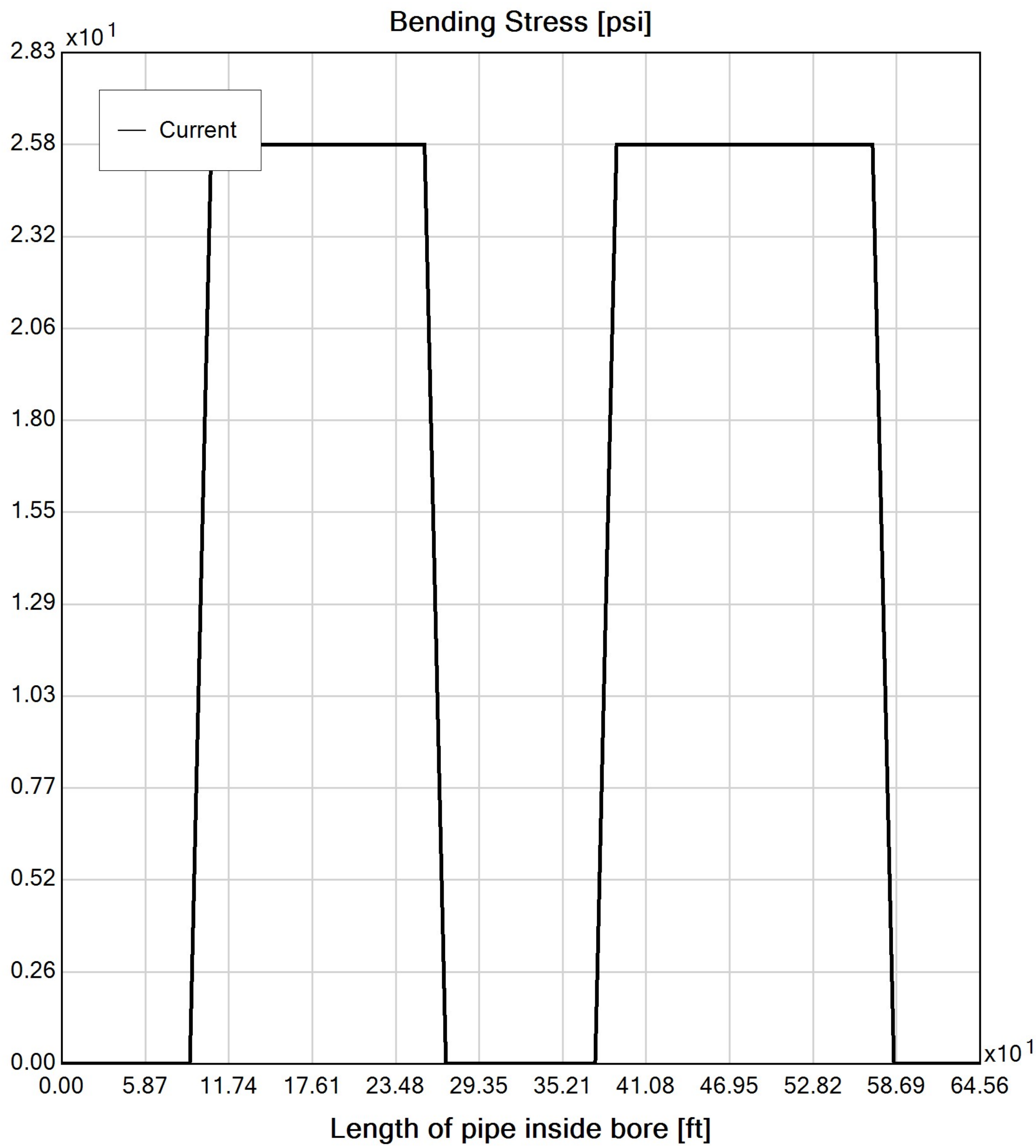
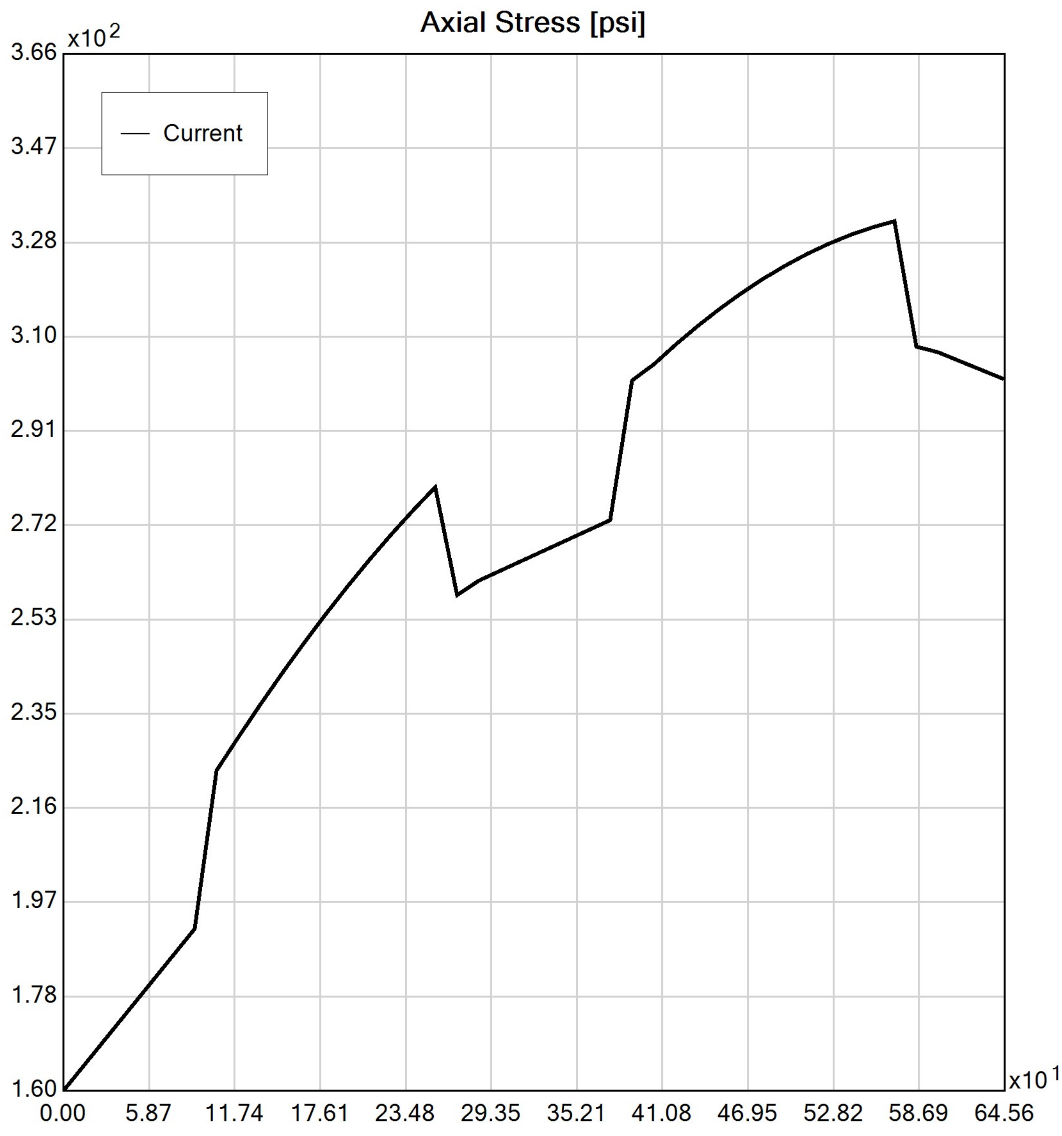


Powered by Vermeer | BoreAid


Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00
5.87
11.74
17.61
23.48
29.35
35.21
41.08
46.95
52.82
58.69
64.56
Length of pipe inside bore [ft]



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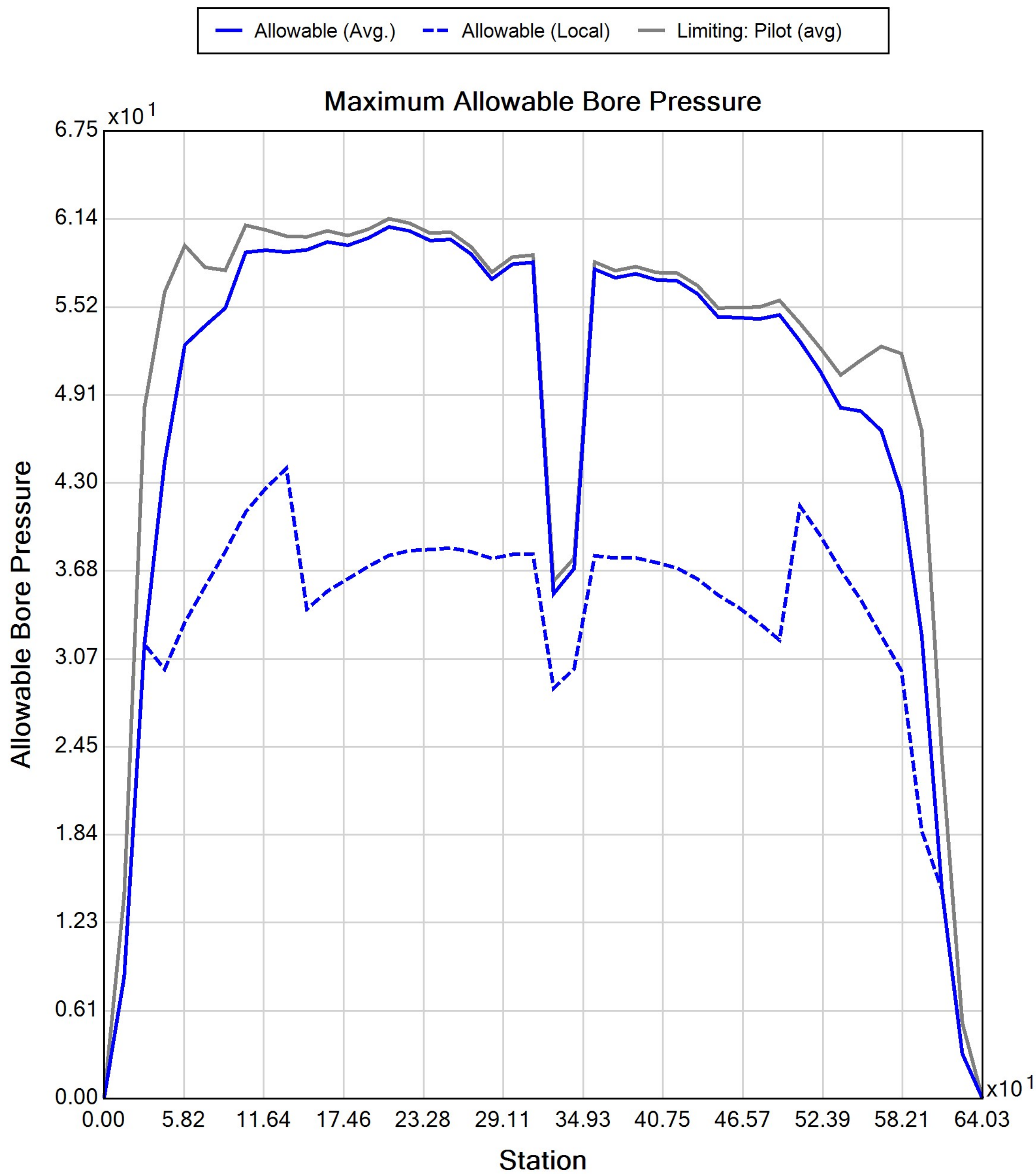
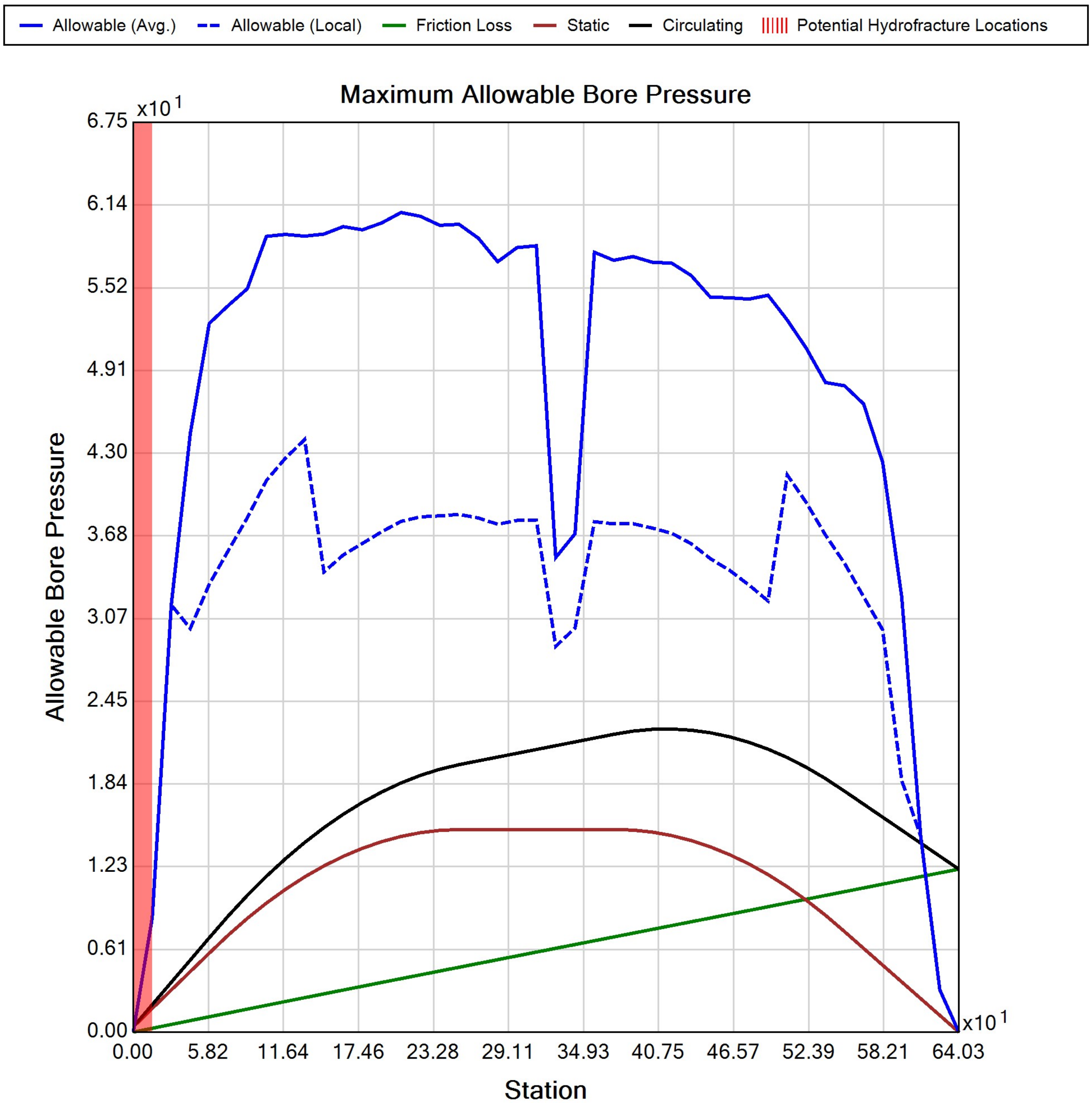


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
6.75
6.14
5.52
4.91
4.30
3.68
3.07
2.45
1.84
1.23
0.61
0.00
Allowable Bore Pressure
0.00
5.82
11.64
17.46
23.28
29.11
34.93
40.75
46.57
52.39
58.21
64.03
x10 1
Station



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In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.8	14.8
Water Pressure	7.9	7.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.7	22.7
Deflection		
Earth Load Deflection	1.845	4.036
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.978	4.168
Compressive Stress [psi]		
Compressive Wall Stress	66.2	102.3

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	11031.9	11031.9
Pullback Stress [psi]	307.7	307.7
Pullback Strain	5.351E-3	5.351E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	307.7	332.6
Tensile Strain	5.351E-3	6.232E-3

Net External Pressure = 18.0 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.978	7.5	3.8	OK
Unconstrained Collapse [psi]	20.5	115.7	5.6	OK
Compressive Wall Stress [psi]	66.2	1150.0	17.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	30.5	237.4	7.8	OK
Tensile Stress [psi]	332.6	1200.0	3.6	OK

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.

Input Summary

Start Coordinate	(0.00, 0.00, 122.36) ft
End Coordinate	(631.40, 0.00, 121.70) ft
Project Length	631.40 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 645.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.8	14.8
Water Pressure	7.9	7.9
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.7	22.7
Deflection		
Earth Load Deflection	1.845	4.036
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.875	4.065
Compressive Stress [psi]		
Compressive Wall Stress	66.2	102.3

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	648.1	648.1
Pullback Stress [psi]	370.3	370.3
Pullback Strain	6.440E-3	6.440E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	370.3	375.2
Tensile Strain	6.440E-3	6.623E-3

Net External Pressure = 18.0 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.875	7.5	4.0	OK
Unconstrained Collapse [psi]	20.5	116.7	5.7	OK
Compressive Wall Stress [psi]	66.2	1150.0	17.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	30.5	235.8	7.7	OK
Tensile Stress [psi]	375.2	1200.0	3.2	OK

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:	HDD#4A
	Ref: Washington County, NY
	Whitehall
	Start Date: 02-28-2022
	End Date: 02-28-2022
Project Owner:	TDI
Project Contractor:	KIEWIT
Project Consultant:	CHA
Designer:	MCS
	CHA
	BLANK
	BLANK, BLANK
	BLANK BLANK
	Phone: BLANK
	Fax: BLANK
	BLANK
Description:	BLANK

Input Summary

Start Coordinate	(0.00, 0.00, 115.42) ft
End Coordinate	(766.00, 0.00, 155.33) ft
Project Length	766.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

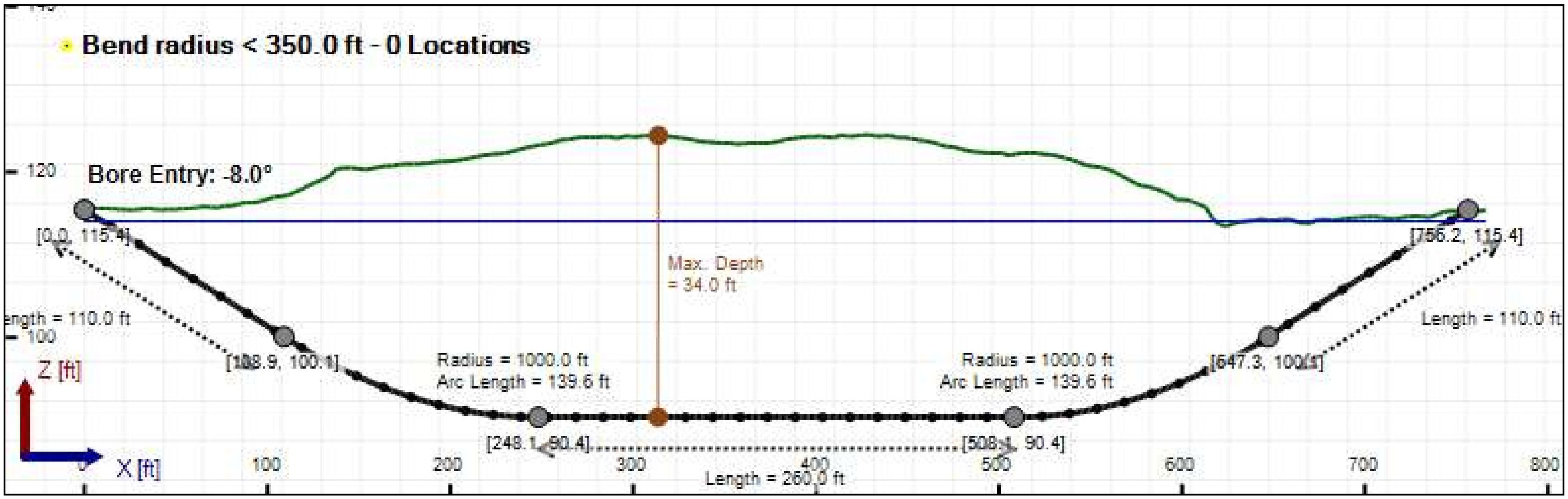
Number of Layers: 3

Soil Layer #1 USCS, Gravel (G), GM
Depth: 4.00 ft
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 100.00, Coh: 0.00 [psi]

Soil Layer #2 USCS, Clay (C), CL
Depth: 8.00 ft
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 7.30 [psi]

Soil Layer #3 USCS, Clay (C), CH
Depth: 30.00 ft
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 8.70 [psi]

Bore Cross-Section View



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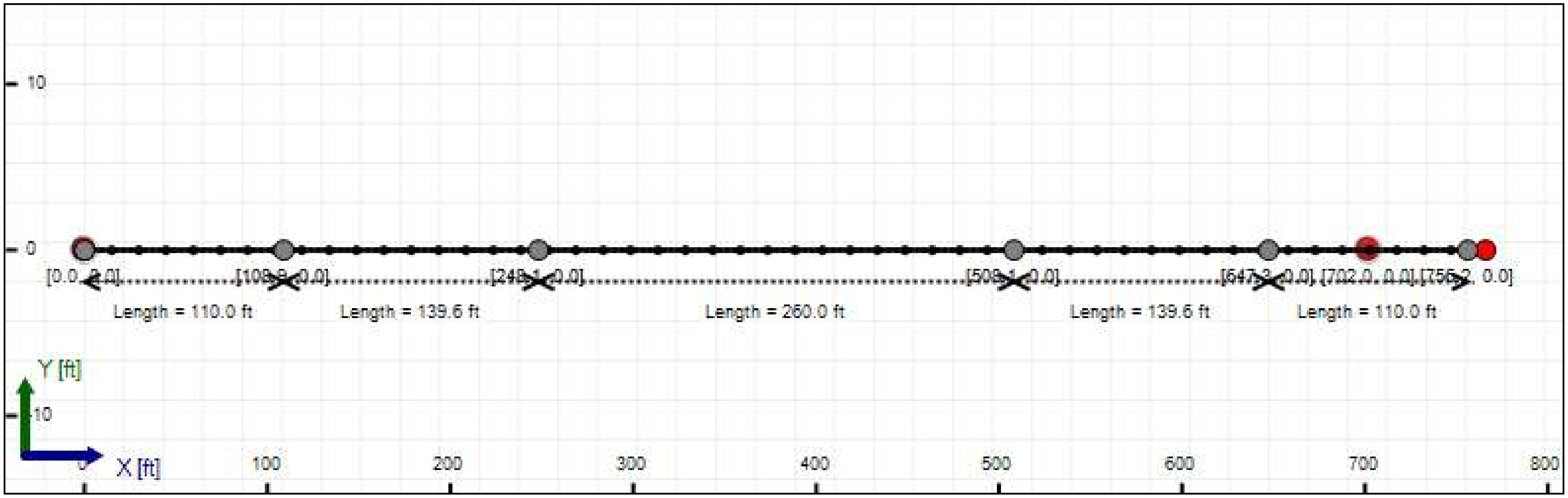
Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 765.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.1	16.1
Water Pressure	10.2	10.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	26.3	26.3
Deflection		
Earth Load Deflection	4.378	4.378
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	4.510	4.510
Compressive Stress [psi]		
Compressive Wall Stress	118.4	118.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	12249.6	12249.6
Pullback Stress [psi]	341.6	341.6
Pullback Strain	5.941E-3	5.941E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	341.6	365.2
Tensile Strain	5.941E-3	6.799E-3

Net External Pressure = 18.7 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.510	7.5	1.7	OK
Unconstrained Collapse [psi]	26.3	92.3	3.5	OK
Compressive Wall Stress [psi]	118.4	1150.0	9.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	26.8	235.1	8.8	OK
Tensile Stress [psi]	365.2	1200.0	3.3	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	48.852 psi	62.230 psi
1	8.00 in	12.00 in	48.776 psi	62.135 psi
2	12.00 in	16.13 in	48.667 psi	61.999 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): 20.00 US (liquid) gallon/min

Drill Fluid Density: 68.700 lb/ft3

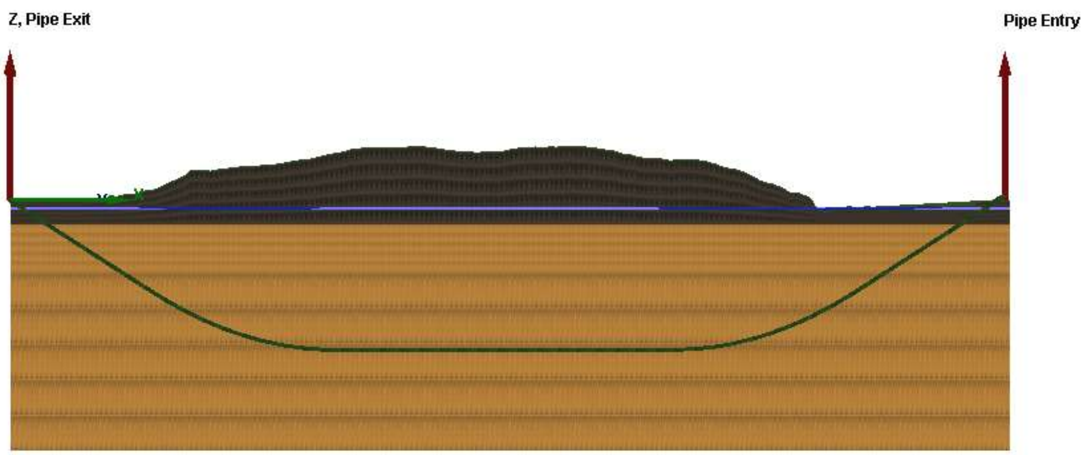
Rheological model: Bingham-Plastic

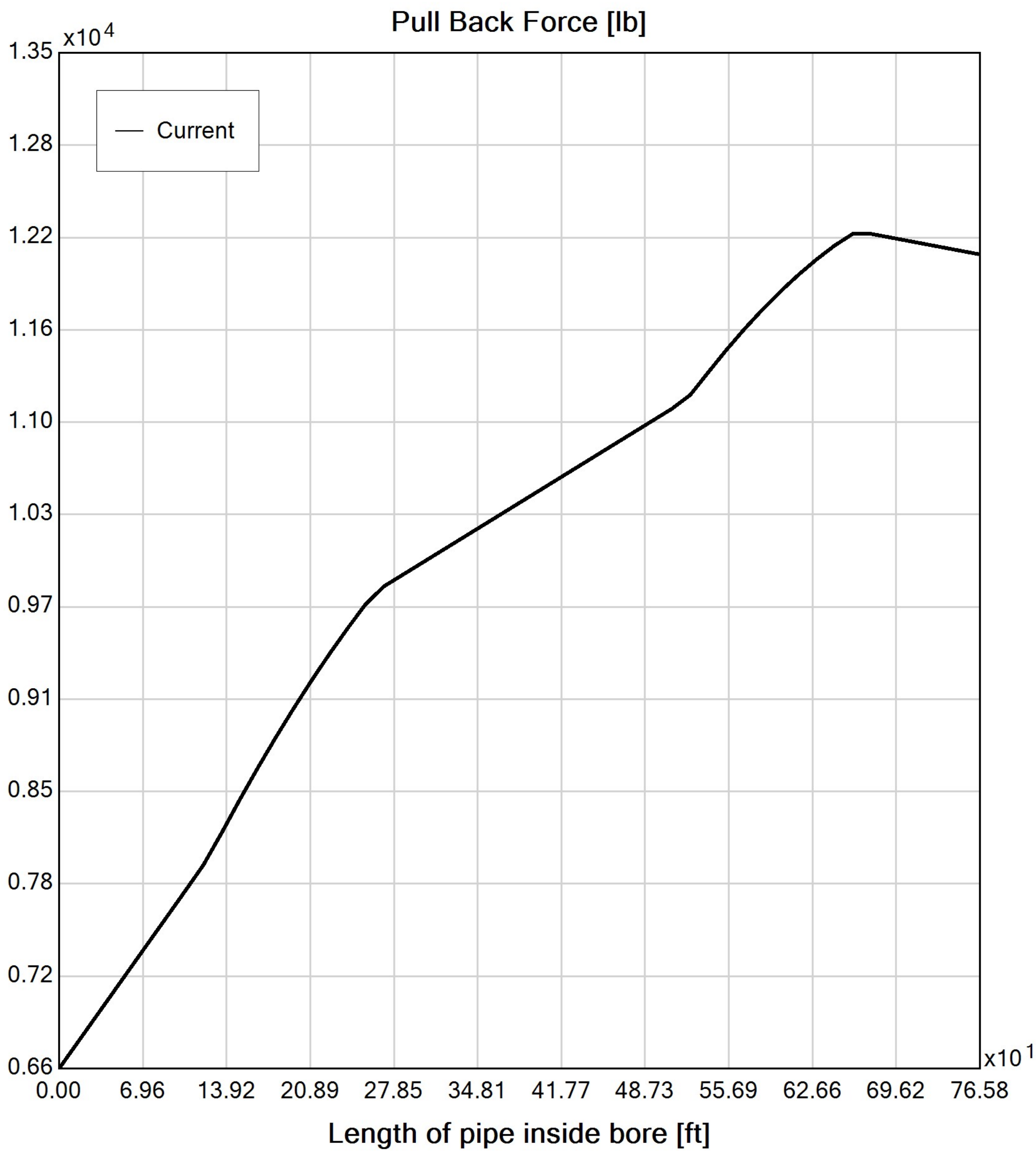
Plastic Viscosity (PV): 25.53

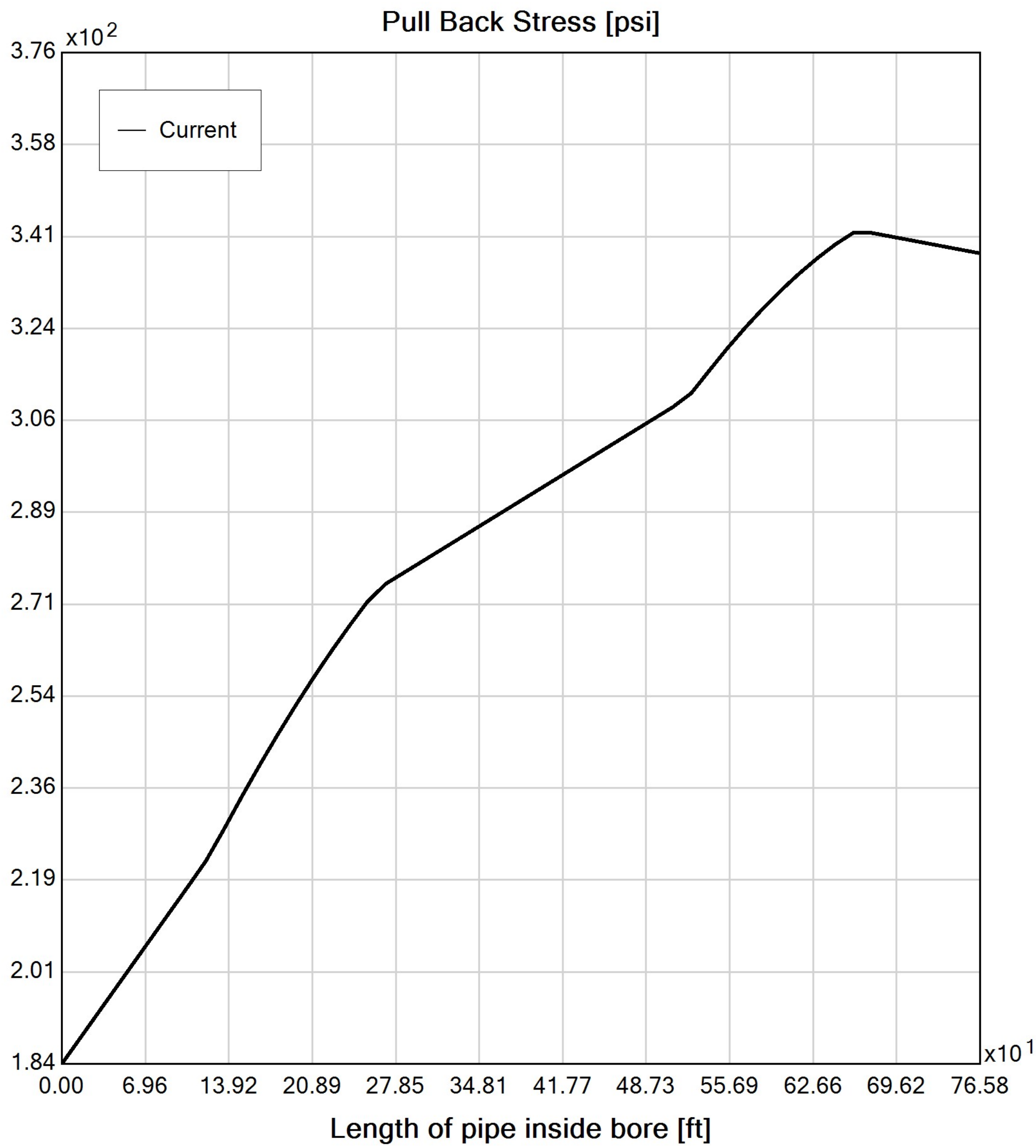
Yield Point (YP): 16.49

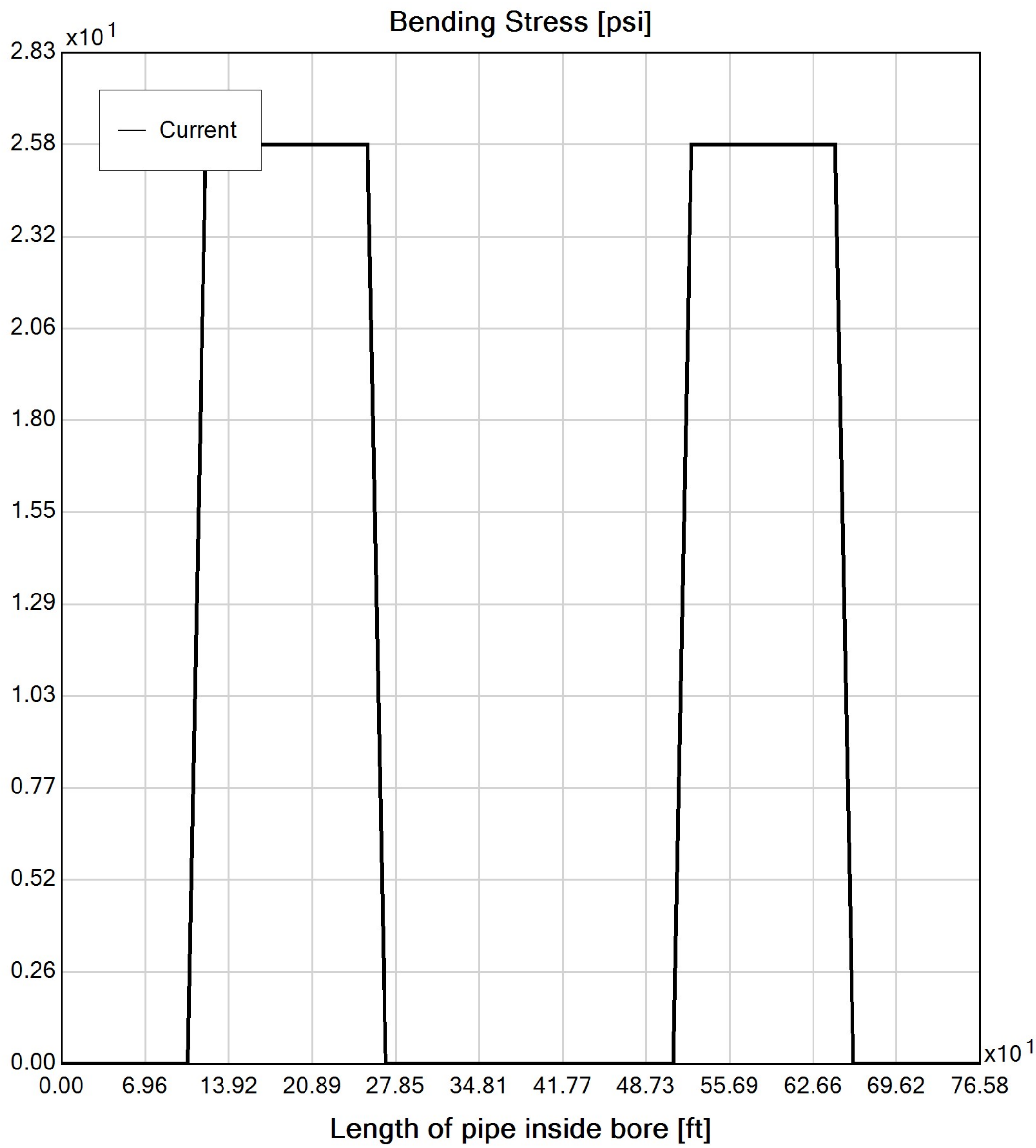
Effective Viscosity (cP): 2378.4

Virtual Site

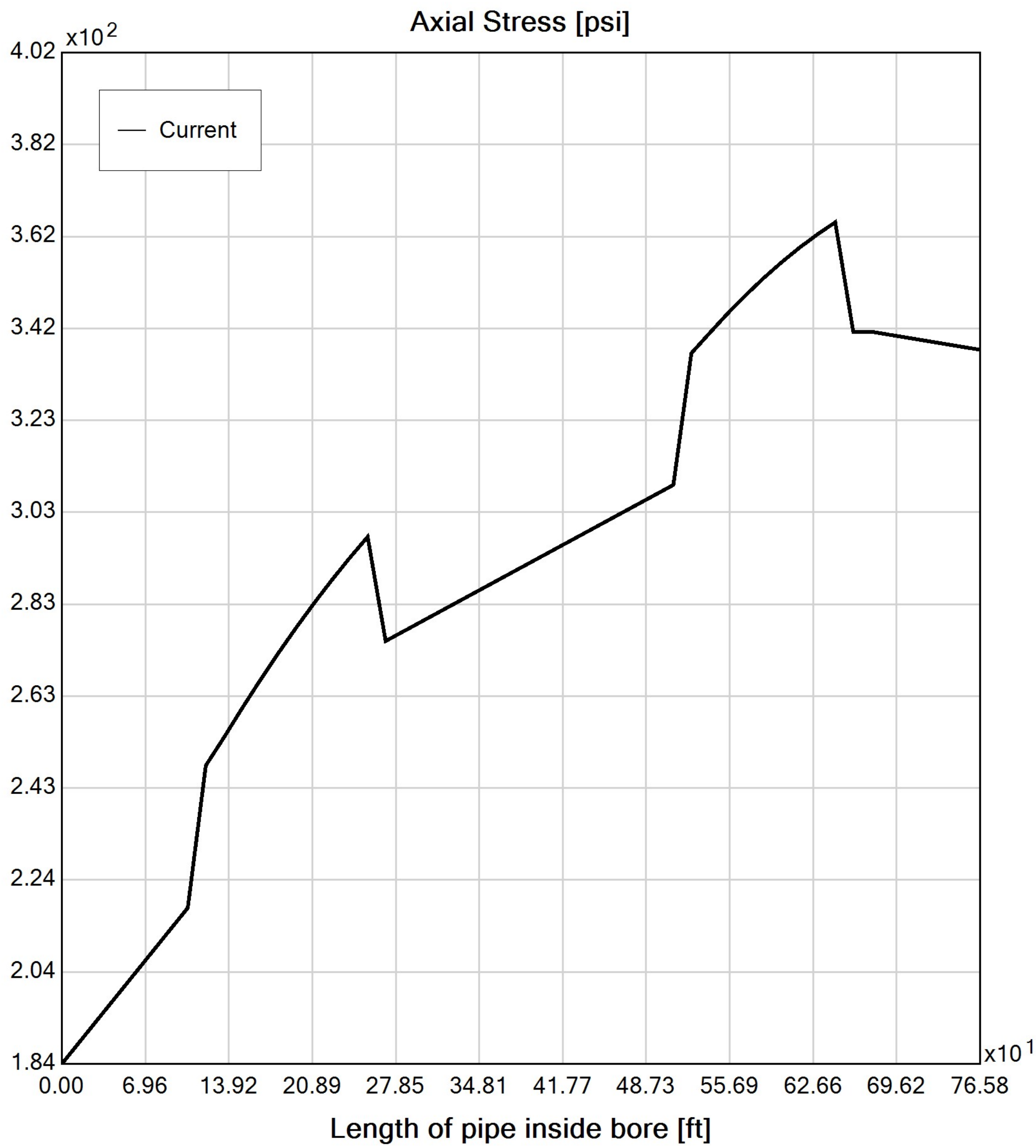


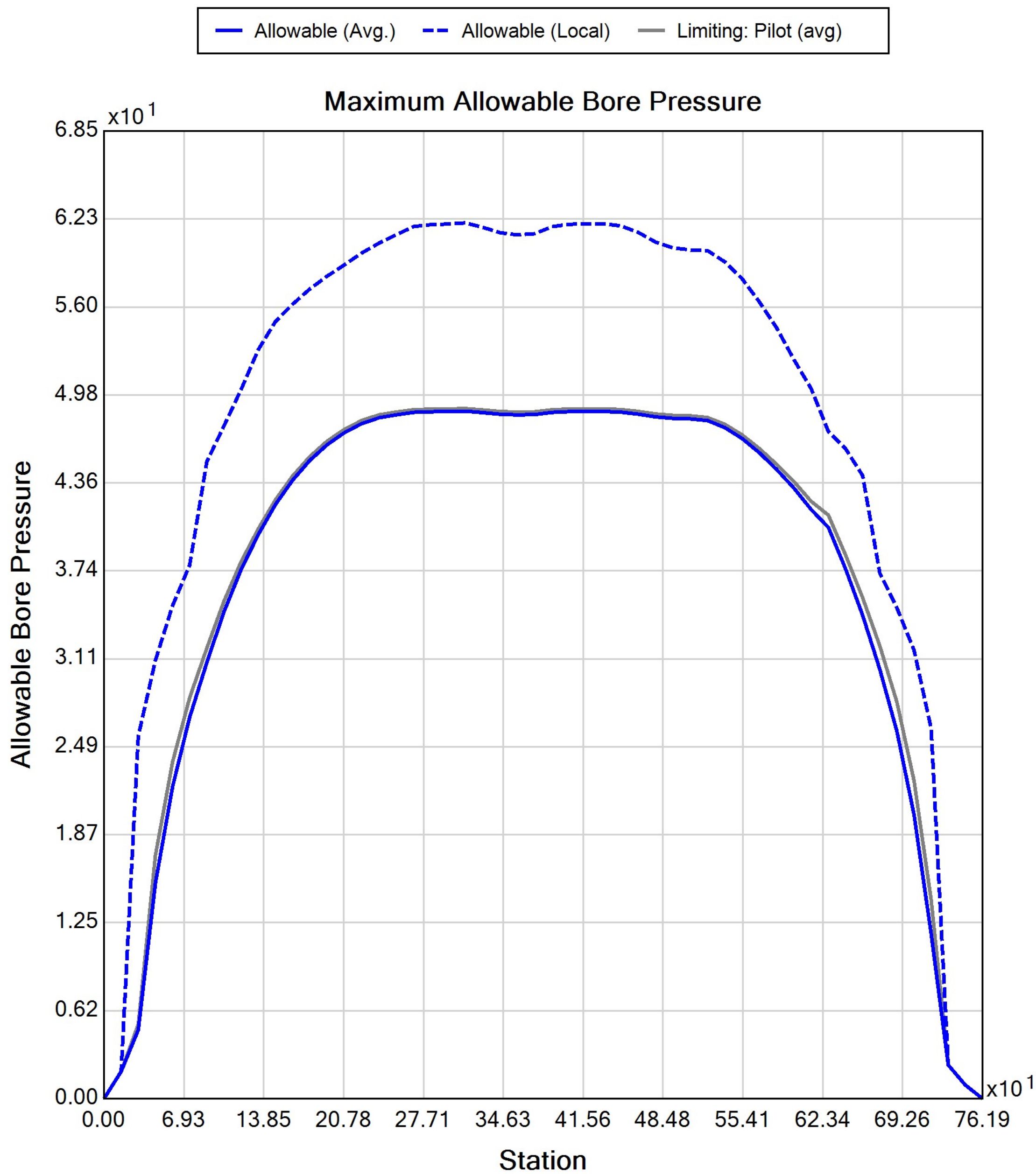

Pull Back Force [lb]
x10^4
1.35
1.28
1.22
1.16
1.10
1.03
0.97
0.91
0.85
0.78
0.72
0.66
Current
x10^1
0.00
6.96
13.92
20.89
27.85
34.81
41.77
48.73
55.69
62.66
69.62
76.58
Length of pipe inside bore [ft]


Pull Back Stress [psi]
x10^2
3.76
3.58
3.41
3.24
3.06
2.89
2.71
2.54
2.36
2.19
2.01
1.84
Current
x10^1
0.00
6.96
13.92
20.89
27.85
34.81
41.77
48.73
55.69
62.66
69.62
76.58
Length of pipe inside bore [ft]



Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00
6.96
13.92
20.89
27.85
34.81
41.77
48.73
55.69
62.66
69.62
76.58
Length of pipe inside bore [ft]


Axial Stress [psi]
x10 2
4.02
3.82
3.62
3.42
3.23
3.03
2.83
2.63
2.43
2.24
2.04
1.84
Current
x10 1
0.00
6.96
13.92
20.89
27.85
34.81
41.77
48.73
55.69
62.66
69.62
76.58
Length of pipe inside bore [ft]



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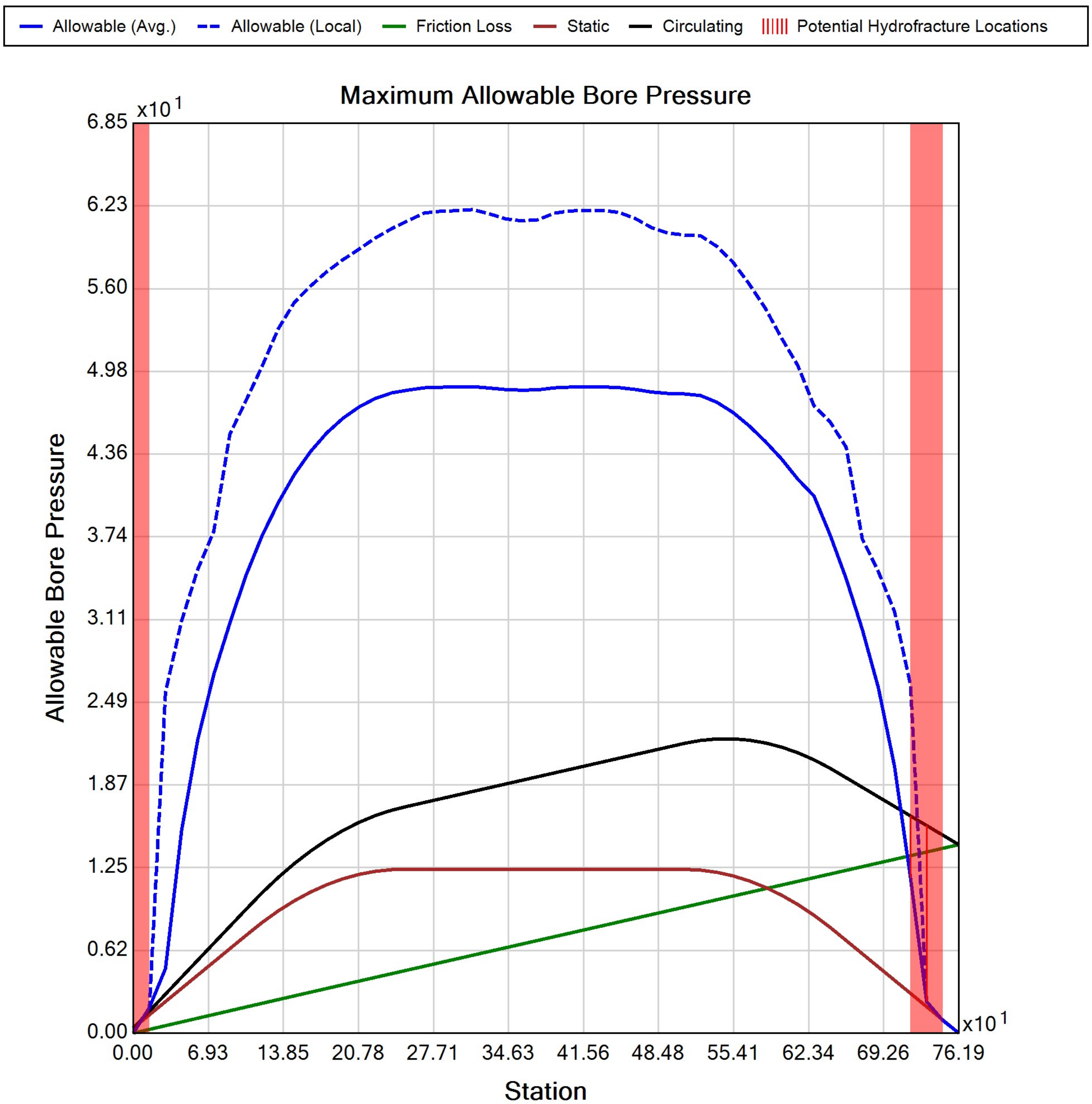
Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10 1
6.85
6.23
5.60
4.98
4.36
3.74
3.11
2.49
1.87
1.25
0.62
0.00
Allowable Bore Pressure
0.00
6.93
13.85
20.78
27.71
34.63
41.56
48.48
55.41
62.34
69.26
76.19
x10 1
Station

Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 115.42) ft
End Coordinate	(766.00, 0.00, 155.33) ft
Project Length	766.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 765.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	16.1	16.1
Water Pressure	10.2	10.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	26.3	26.3
Deflection		
Earth Load Deflection	4.378	4.378
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	4.407	4.407
Compressive Stress [psi]		
Compressive Wall Stress	118.4	118.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	707.5	707.5
Pullback Stress [psi]	404.2	404.2
Pullback Strain	7.030E-3	7.030E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	404.2	407.7
Tensile Strain	7.030E-3	7.190E-3

Net External Pressure = 18.7 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	4.407	7.5	1.7	OK
Unconstrained Collapse [psi]	26.3	93.1	3.5	OK
Compressive Wall Stress [psi]	118.4	1150.0	9.7	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	26.8	233.4	8.7	OK
Tensile Stress [psi]	407.7	1200.0	2.9	OK

Generated Output

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Project Summary

General:	HDD #5 Start Date: 02-28-2022 End Date: 02-28-2022
Designer:	MCS CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 123.02) ft
End Coordinate	(710.00, 0.00, 122.00) ft
Project Length	710.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

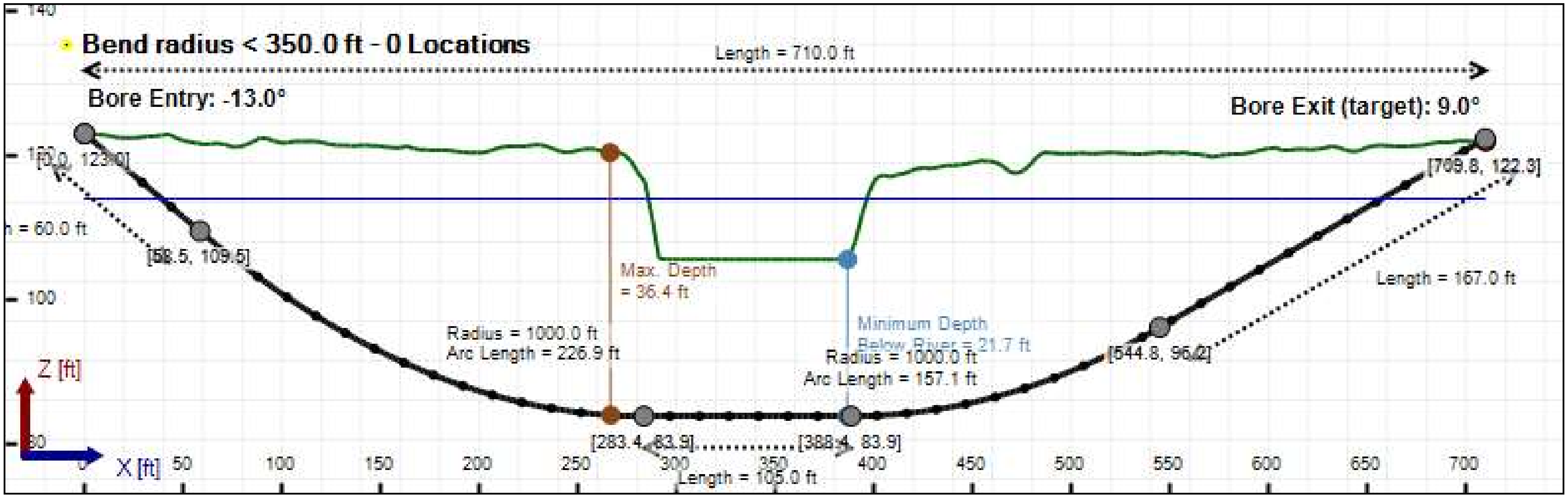
Number of Layers: 3

Soil Layer #1 USCS, Gravel (G), GM
Depth: 4.00 ft
Unit Weight: 120.0000 (dry), 140.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 100.00, Coh: 0.00 [psi]

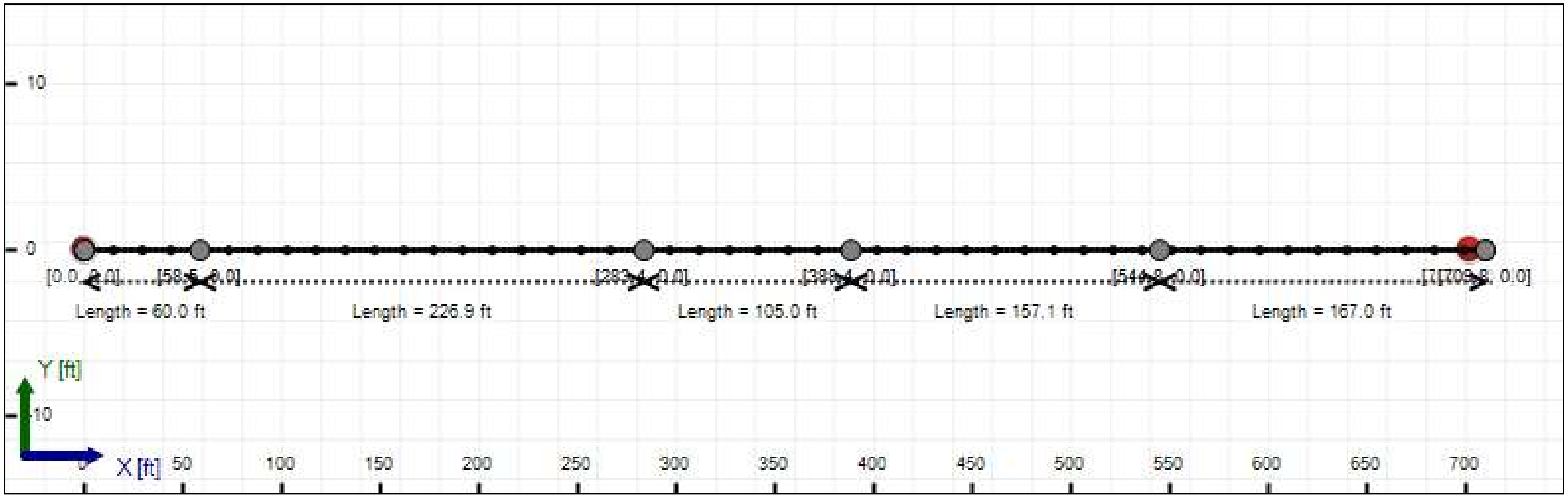
Soil Layer #2 USCS, Clay (C), CL
Depth: 8.00 ft
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 7.30 [psi]

Soil Layer #3 USCS, Clay (C), CH
Depth: 30.00 ft
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 8.70 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 720.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	11.6	11.6
Water Pressure	12.8	12.8
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	24.5	24.5
Deflection		
Earth Load Deflection	3.183	3.183
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	3.315	3.315
Compressive Stress [psi]		
Compressive Wall Stress	110.1	110.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	12466.7	12466.7
Pullback Stress [psi]	347.7	347.7
Pullback Strain	6.047E-3	6.047E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	347.7	372.7
Tensile Strain	6.047E-3	6.930E-3

Net External Pressure = 18.8 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.315	7.5	2.3	OK
Unconstrained Collapse [psi]	25.4	103.3	4.1	OK
Compressive Wall Stress [psi]	110.1	1150.0	10.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	35.4	235.3	6.6	OK
Tensile Stress [psi]	372.7	1200.0	3.2	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	58.142 psi	60.390 psi
1	8.00 in	12.00 in	58.061 psi	60.307 psi
2	12.00 in	16.13 in	57.944 psi	60.188 psi

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

Estimated Circulating Pressure Summary

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

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

Drill Fluid Density: 68.700 lb/ft3

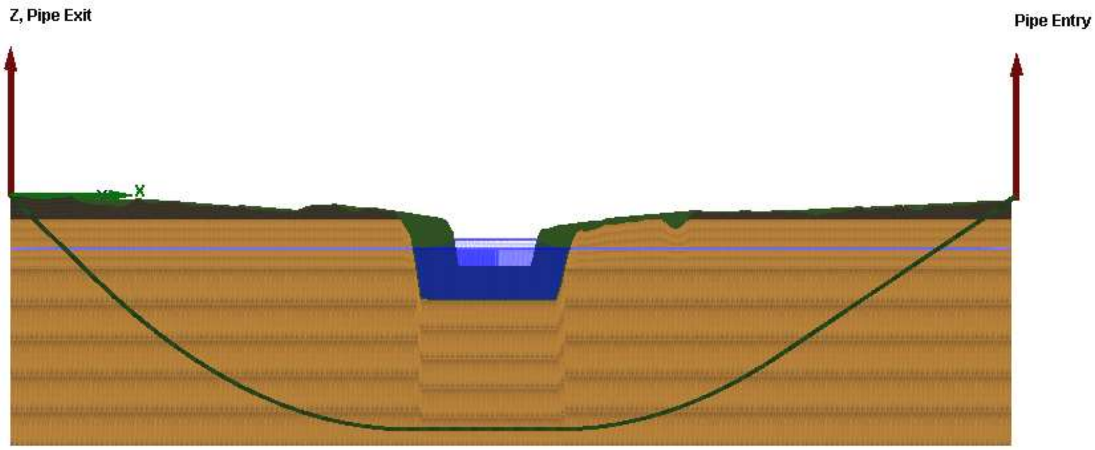
Rheological model: Bingham-Plastic

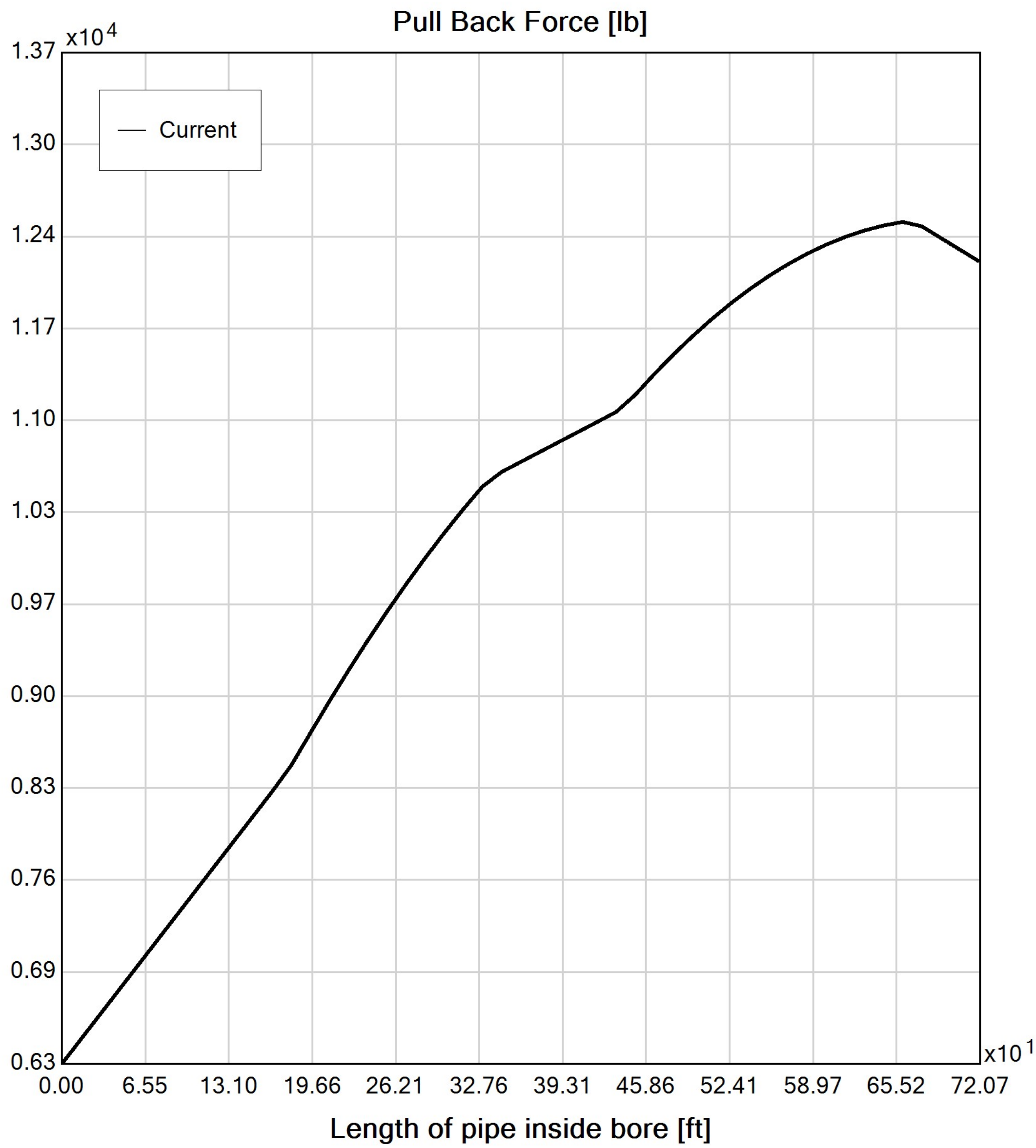
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

Virtual Site





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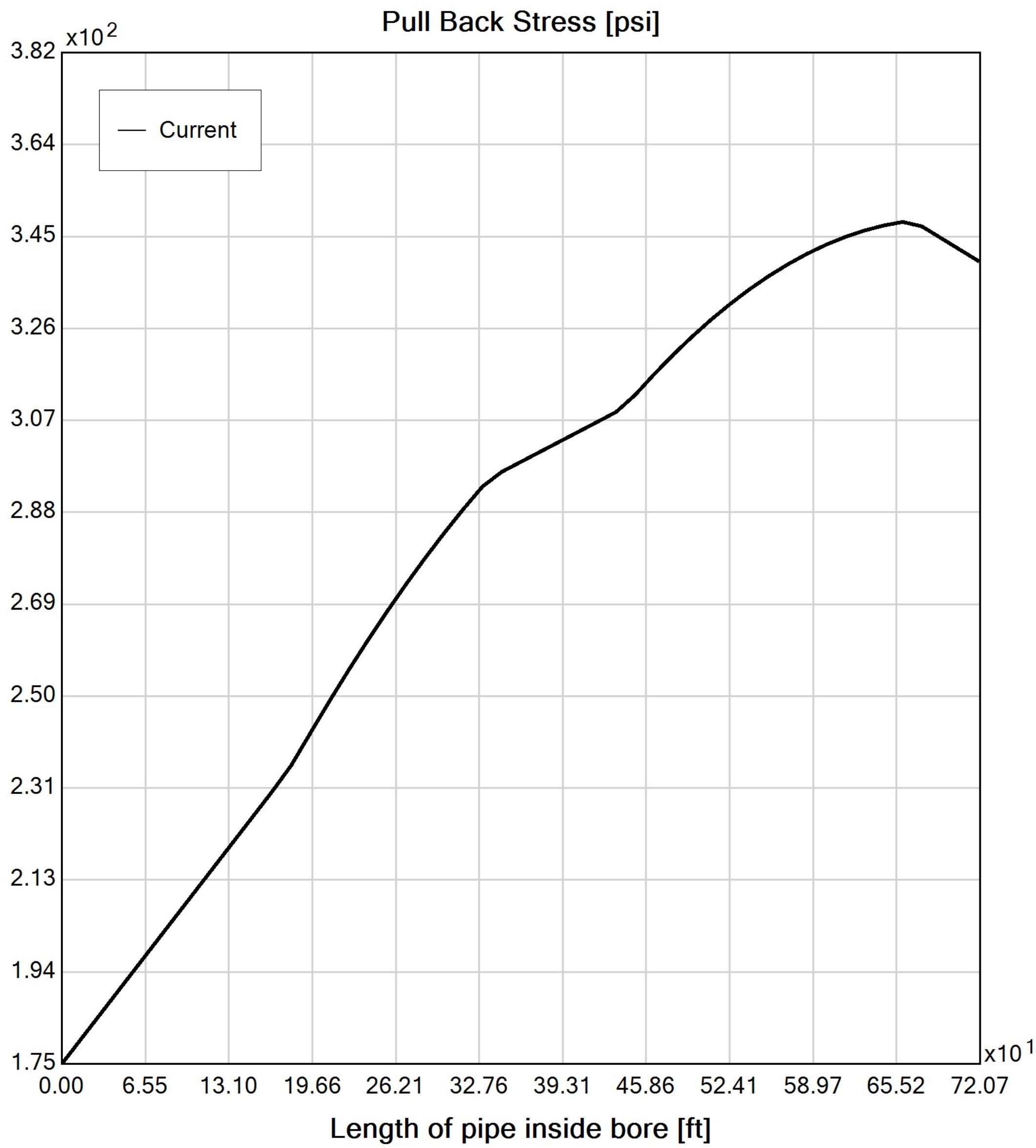
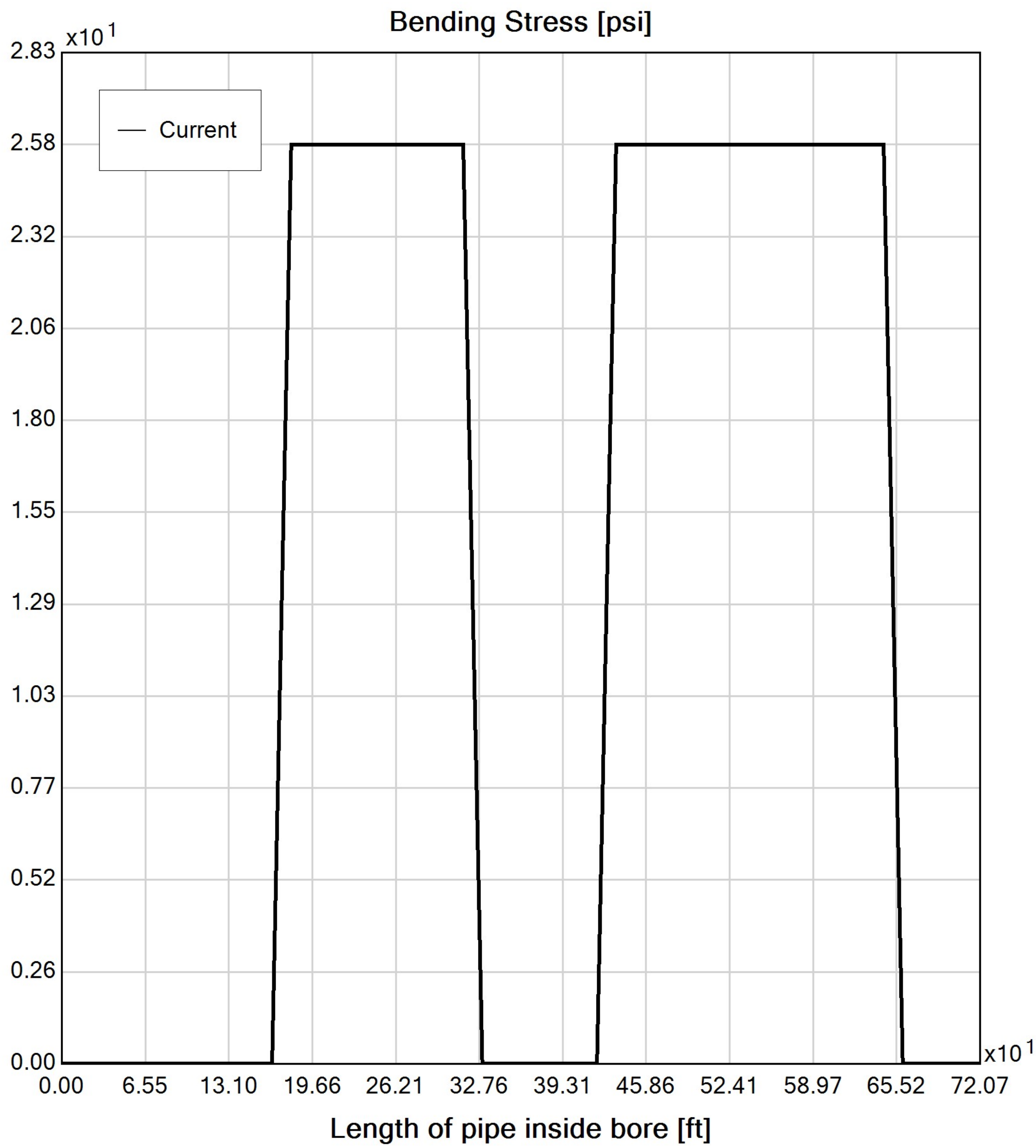
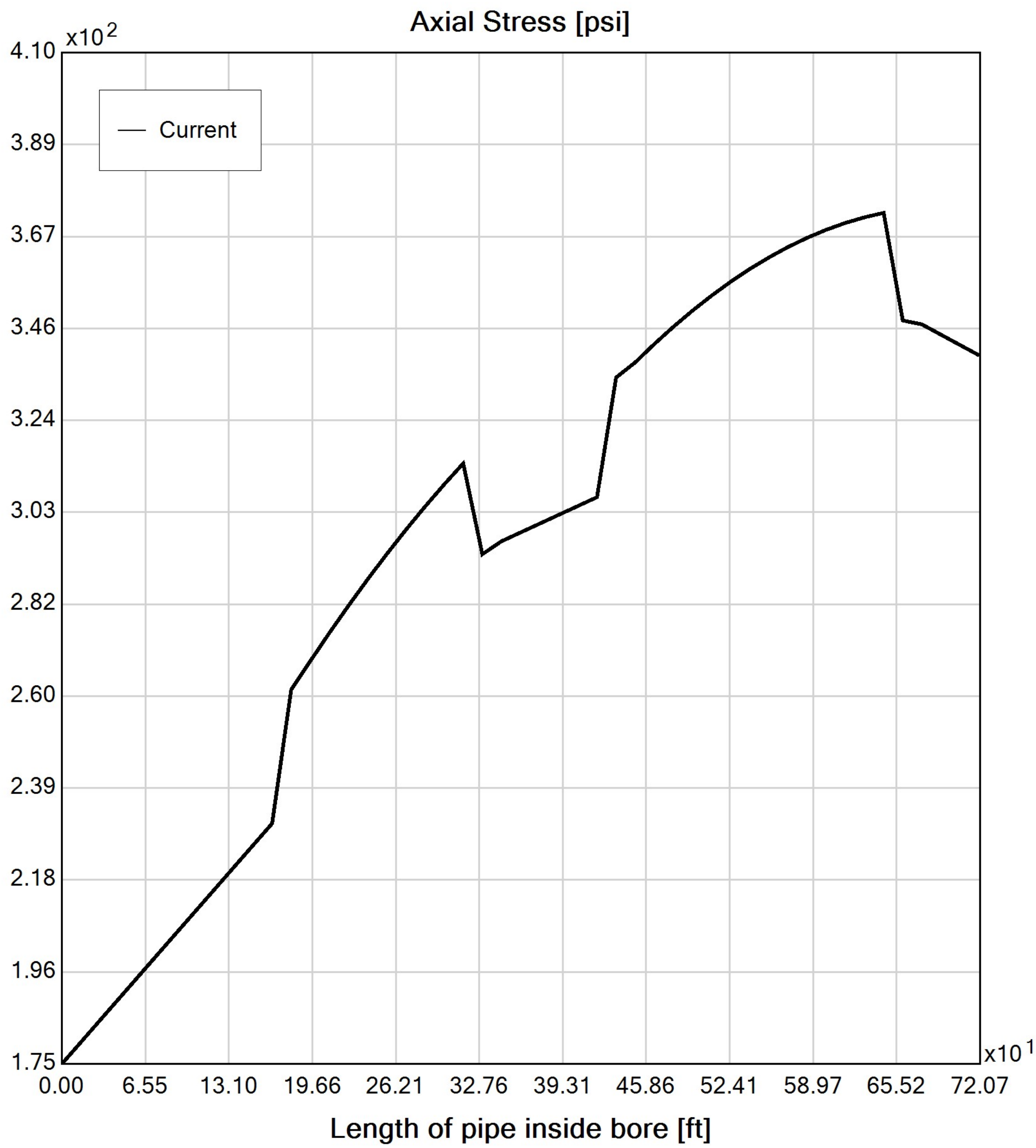


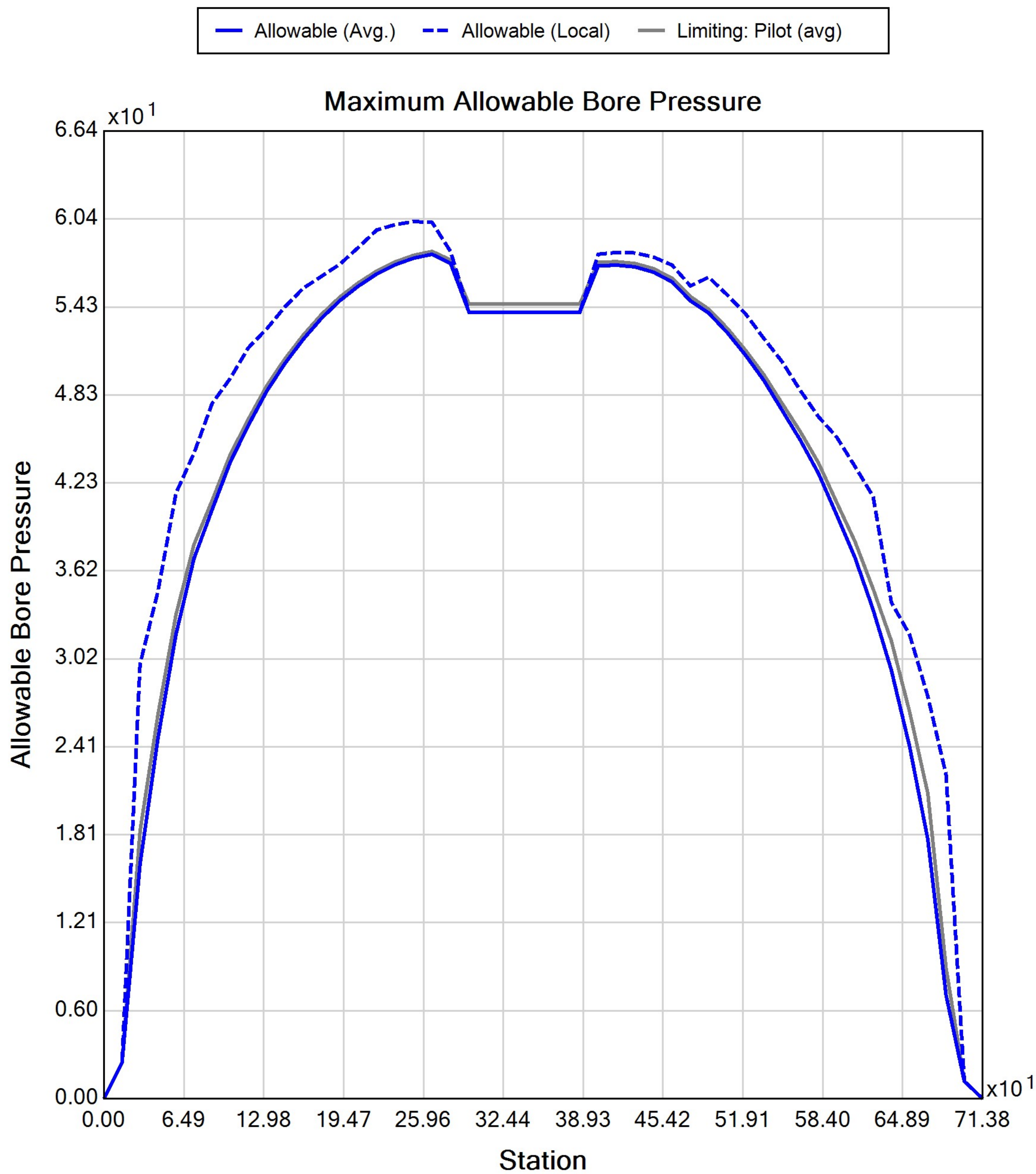
Pull Back Stress [psi]
x10 2
3.82
3.64
3.45
3.26
3.07
2.88
2.69
2.50
2.31
2.13
1.94
1.75
Current
x10 1
0.00
6.55
13.10
19.66
26.21
32.76
39.31
45.86
52.41
58.97
65.52
72.07
Length of pipe inside bore [ft]



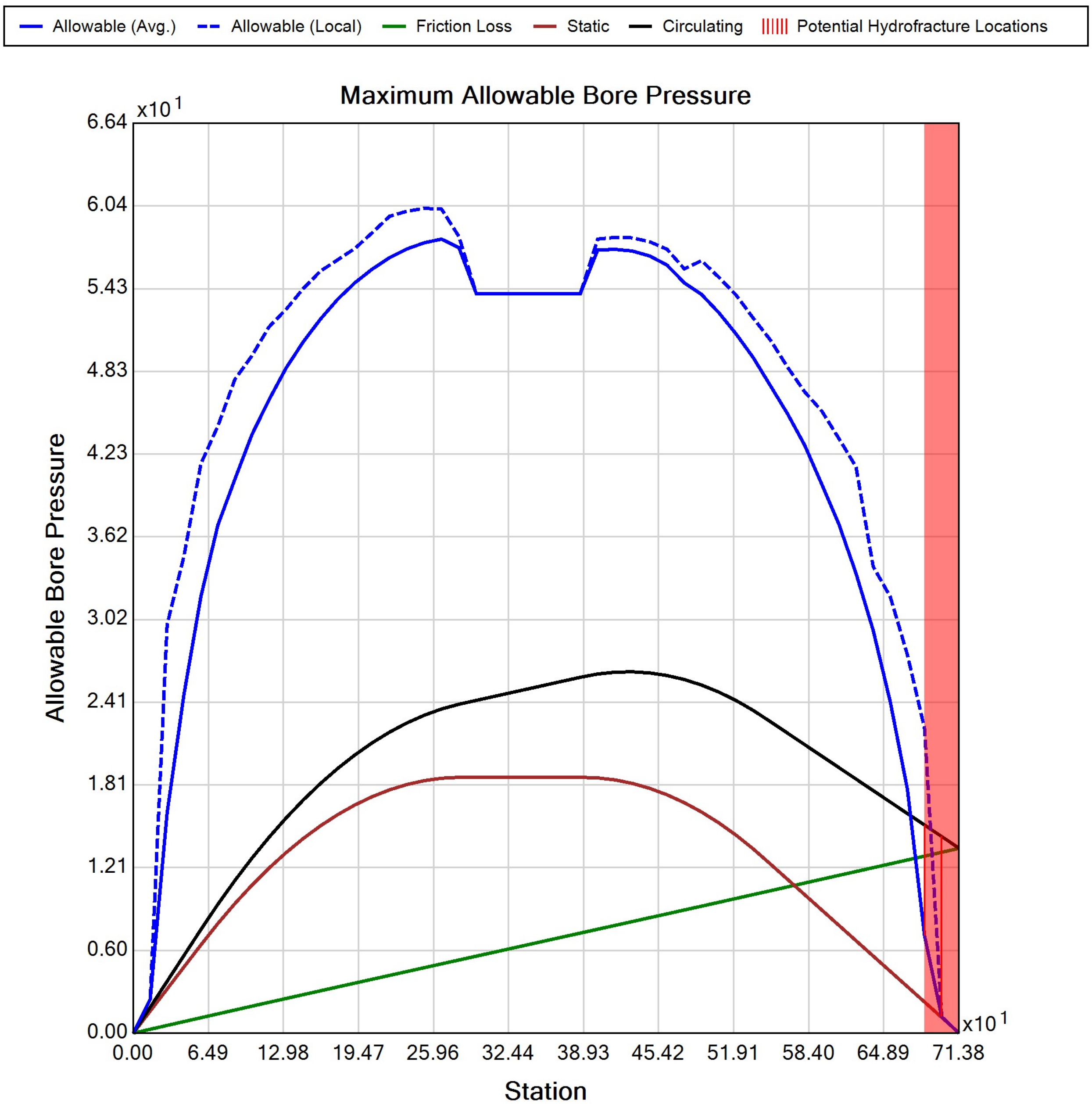
Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00
6.55
13.10
19.66
26.21
32.76
39.31
45.86
52.41
58.97
65.52
72.07
Length of pipe inside bore [ft]



Axial Stress [psi]
x10 2
4.10
3.89
3.67
3.46
3.24
3.03
2.82
2.60
2.39
2.18
1.96
1.75
Current
x10 1
0.00
6.55
13.10
19.66
26.21
32.76
39.31
45.86
52.41
58.97
65.52
72.07
Length of pipe inside bore [ft]



Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
6.64
6.04
5.43
4.83
4.23
3.62
3.02
2.41
1.81
1.21
0.60
0.00
Allowable Bore Pressure
0.00
6.49
12.98
19.47
25.96
32.44
38.93
45.42
51.91
58.40
64.89
71.38
x10 1
Station



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Input Summary

Start Coordinate	(0.00, 0.00, 123.02) ft
End Coordinate	(710.00, 0.00, 122.00) ft
Project Length	710.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 720.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	11.6	11.6
Water Pressure	12.8	12.8
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	24.5	24.5
Deflection		
Earth Load Deflection	3.183	3.183
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	3.212	3.212
Compressive Stress [psi]		
Compressive Wall Stress	110.1	110.1

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	718.1	718.1
Pullback Stress [psi]	410.3	410.3
Pullback Strain	7.136E-3	7.136E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	410.3	415.2
Tensile Strain	7.136E-3	7.321E-3

Net External Pressure = 18.8 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.212	7.5	2.3	OK
Unconstrained Collapse [psi]	25.4	104.3	4.1	OK
Compressive Wall Stress [psi]	110.1	1150.0	10.4	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	35.4	233.6	6.6	OK
Tensile Stress [psi]	415.2	1200.0	2.9	OK

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Project Summary

General:	HDD #6 Start Date: 02-24-2022 End Date: 02-24-2022
Designer:	MCS/mdb CHA
Description:	Noth to south

Input Summary

Start Coordinate	(0.00, 0.00, 120.32) ft
End Coordinate	(1451.00, 0.00, 116.43) ft
Project Length	1451.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 5

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

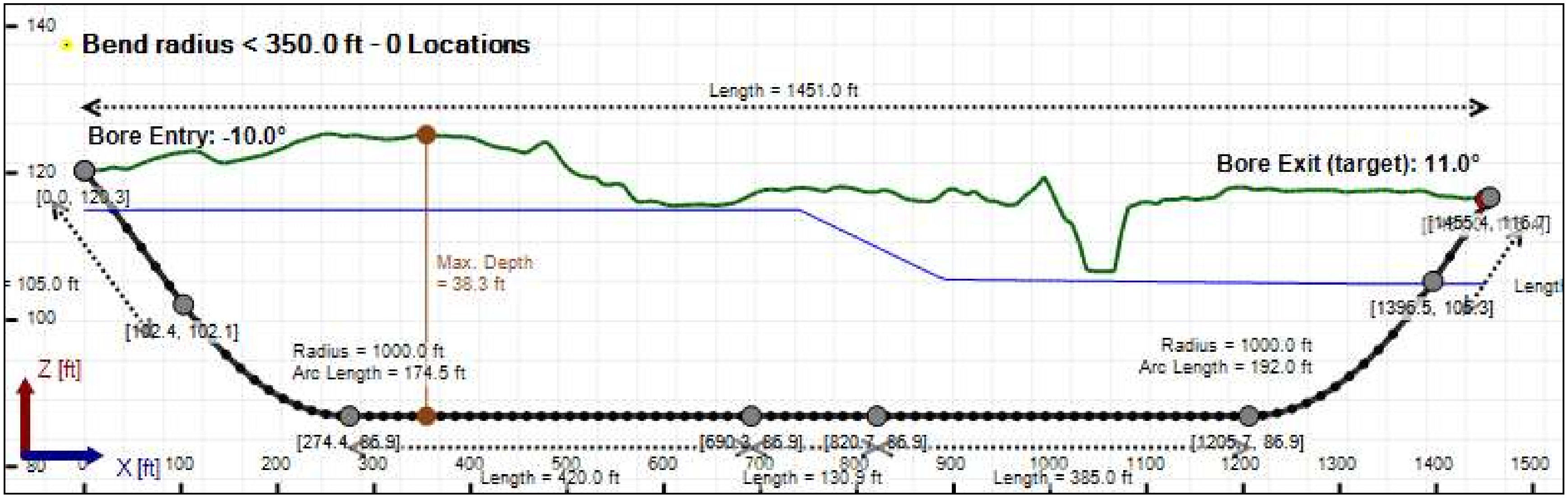
Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 5.50 [psi]

Soil Layer #3 USCS, Silt (M), ML
From Assistant
Unit Weight: 80.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 28.00, S.M.: 50.00, Coh: 0.00 [psi]

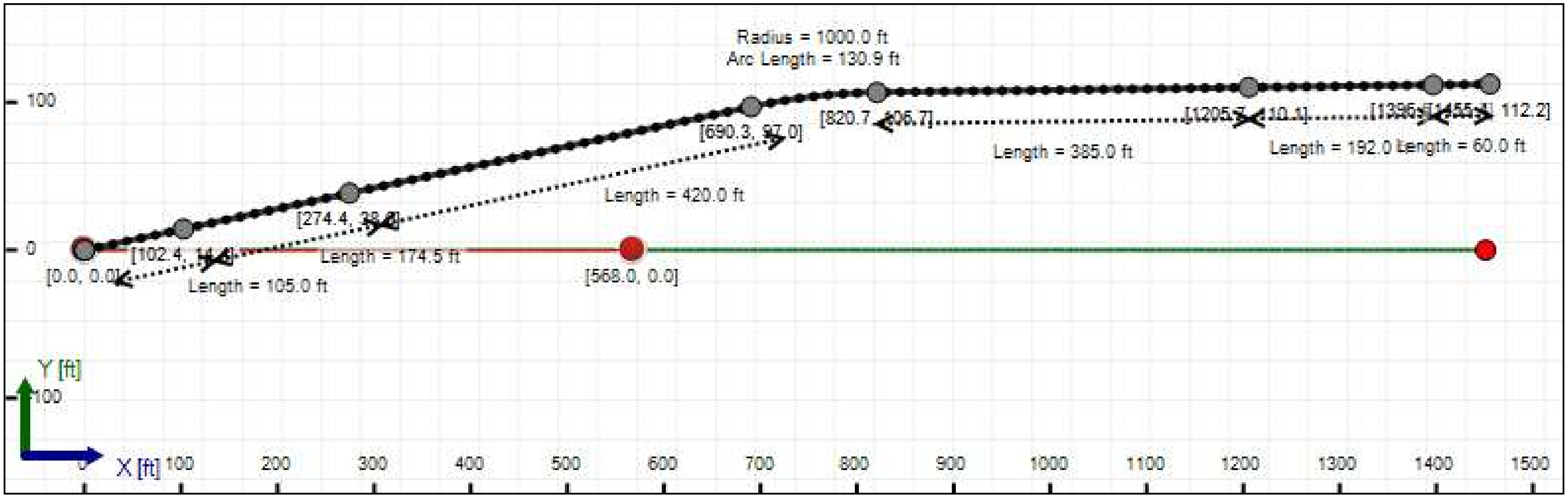
Soil Layer #4 USCS, Sand (S), SP
From Assistant
Unit Weight: 110.0000 (dry), 125.0000 (sat) [lb/ft3]
Phi: 34.00, S.M.: 500.00, Coh: 0.00 [psi]

Soil Layer #5 USCS, Clay (C), CL
From Assistant
Unit Weight: 75.0000 (dry), 105.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 250.00, Coh: 4.30 [psi]

Bore Cross-Section View



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: 1470.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	3.2	14.7
Water Pressure	12.2	12.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	15.4	26.9
Deflection		
Earth Load Deflection	1.694	4.199
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.826	4.331
Compressive Stress [psi]		
Compressive Wall Stress	69.1	120.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	24196.2	24196.2
Pullback Stress [psi]	674.8	674.8
Pullback Strain	1.174E-2	1.174E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	674.8	694.8
Tensile Strain	1.174E-2	1.253E-2

Net External Pressure = 20.2 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.826	7.5	4.1	OK
Unconstrained Collapse [psi]	21.7	123.0	5.7	OK
Compressive Wall Stress [psi]	69.1	1150.0	16.6	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	31.7	214.3	6.8	OK
Tensile Stress [psi]	694.8	1200.0	1.7	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	75.791 psi	85.829 psi
1	8.00 in	12.00 in	75.449 psi	84.758 psi
2	12.00 in	16.13 in	74.968 psi	83.299 psi

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

Estimated Circulating Pressure Summary

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

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

Drill Fluid Density: 68.700 lb/ft3

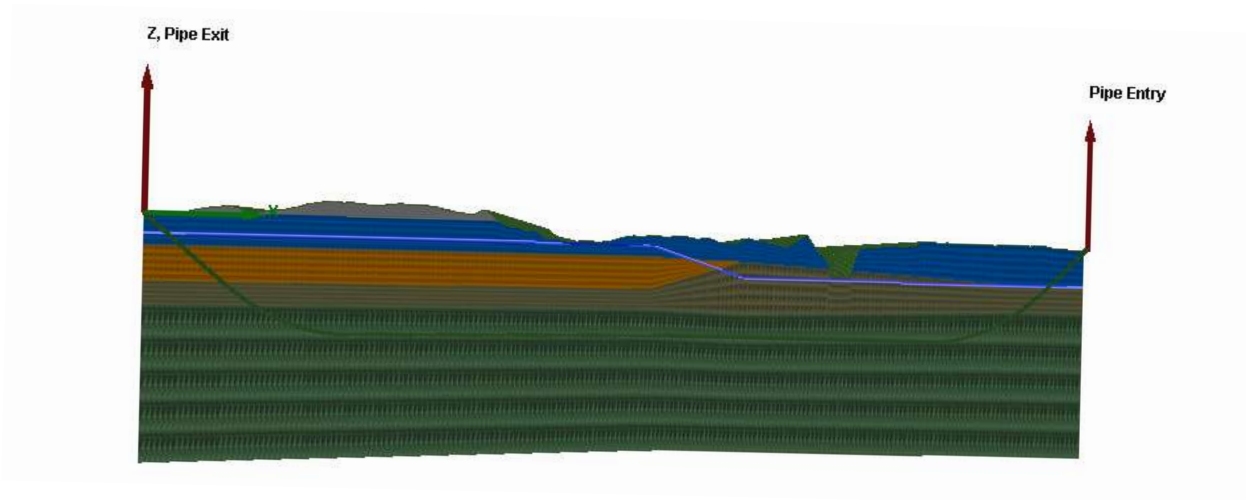
Rheological model: Bingham-Plastic

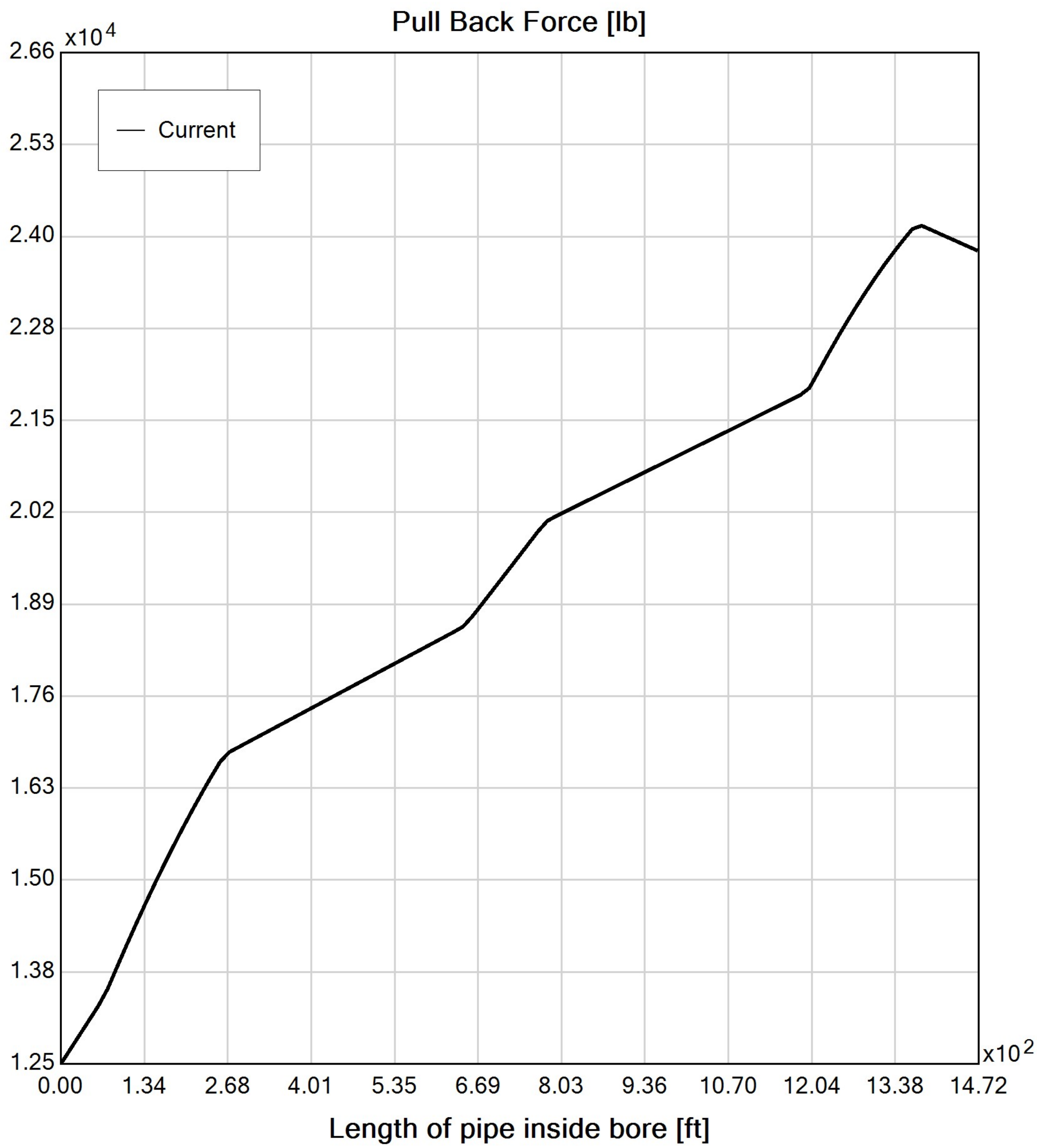
Plastic Viscosity (PV): 25.53

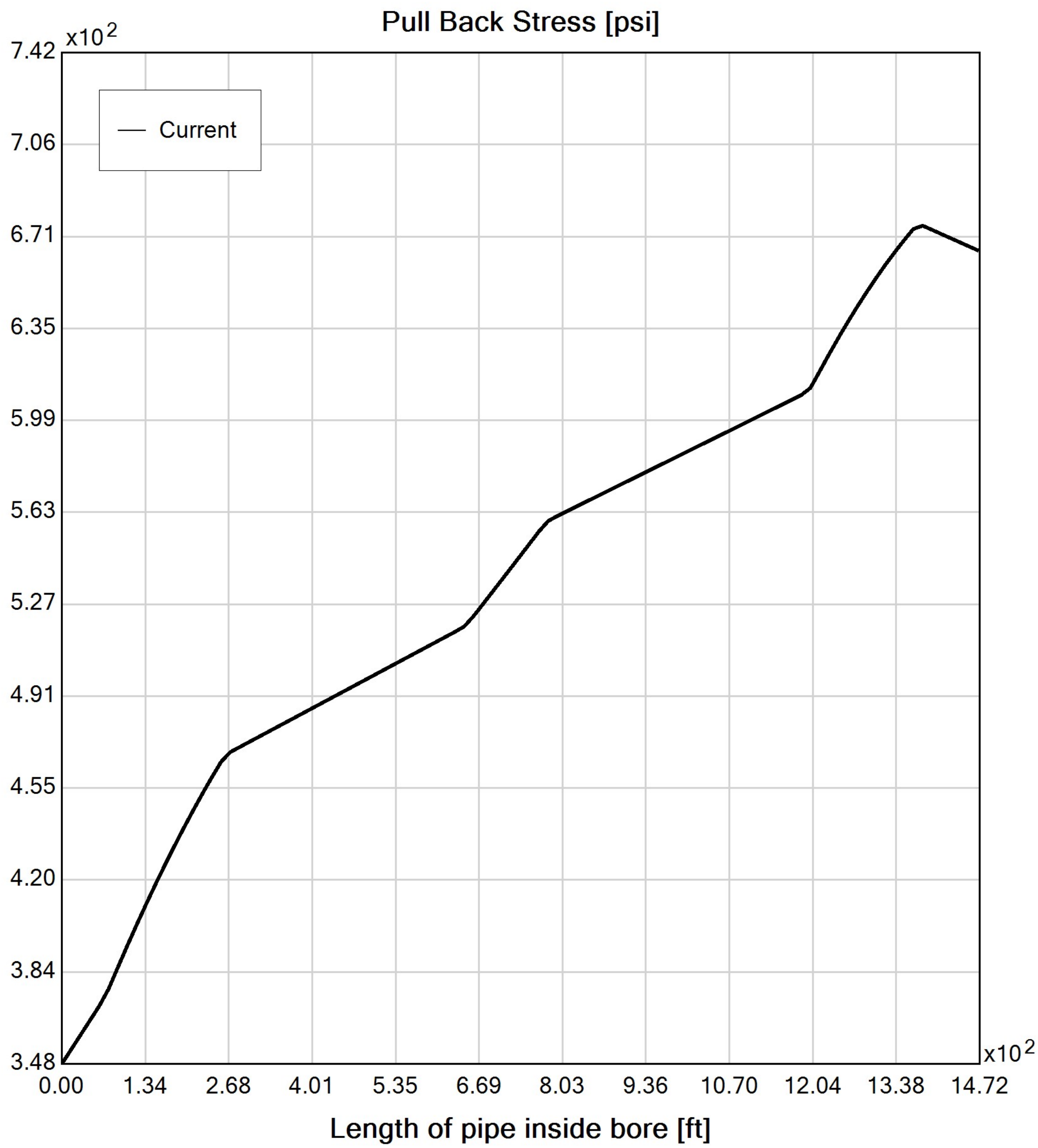
Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

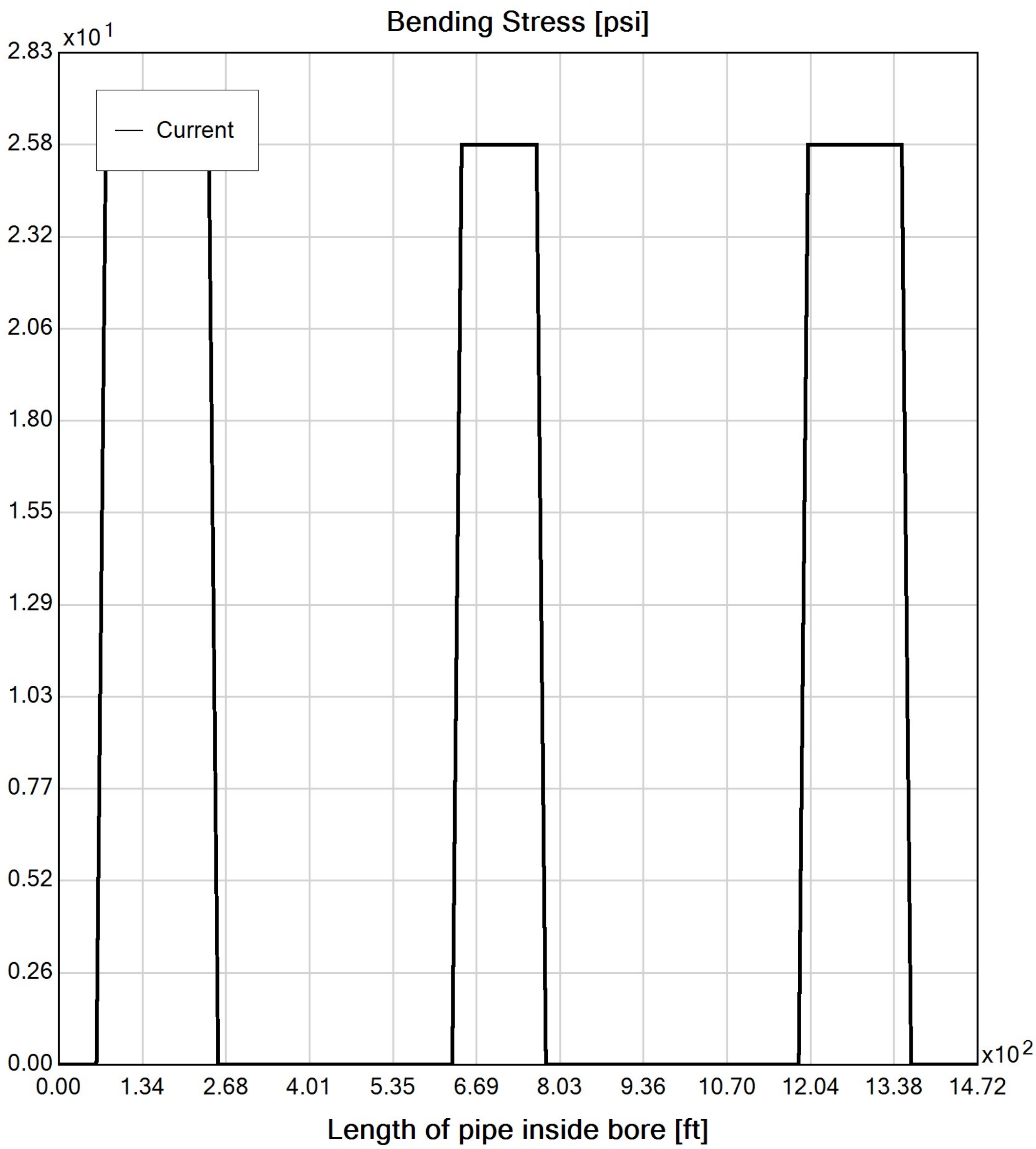
Virtual Site

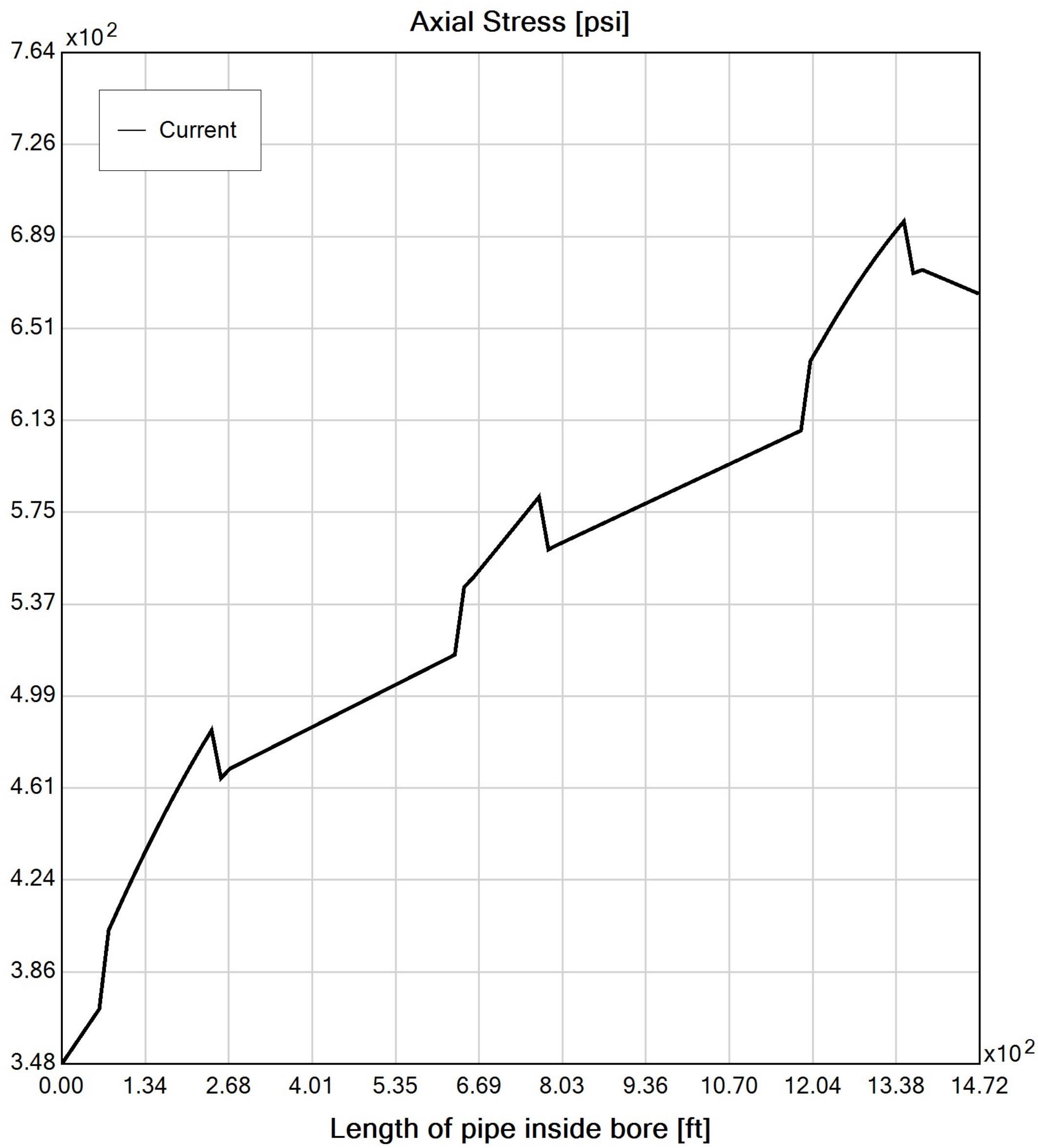



Pull Back Force [lb]
x10^4
2.66
2.53
2.40
2.28
2.15
2.02
1.89
1.76
1.63
1.50
1.38
1.25
Current
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
x10^2
Length of pipe inside bore [ft]

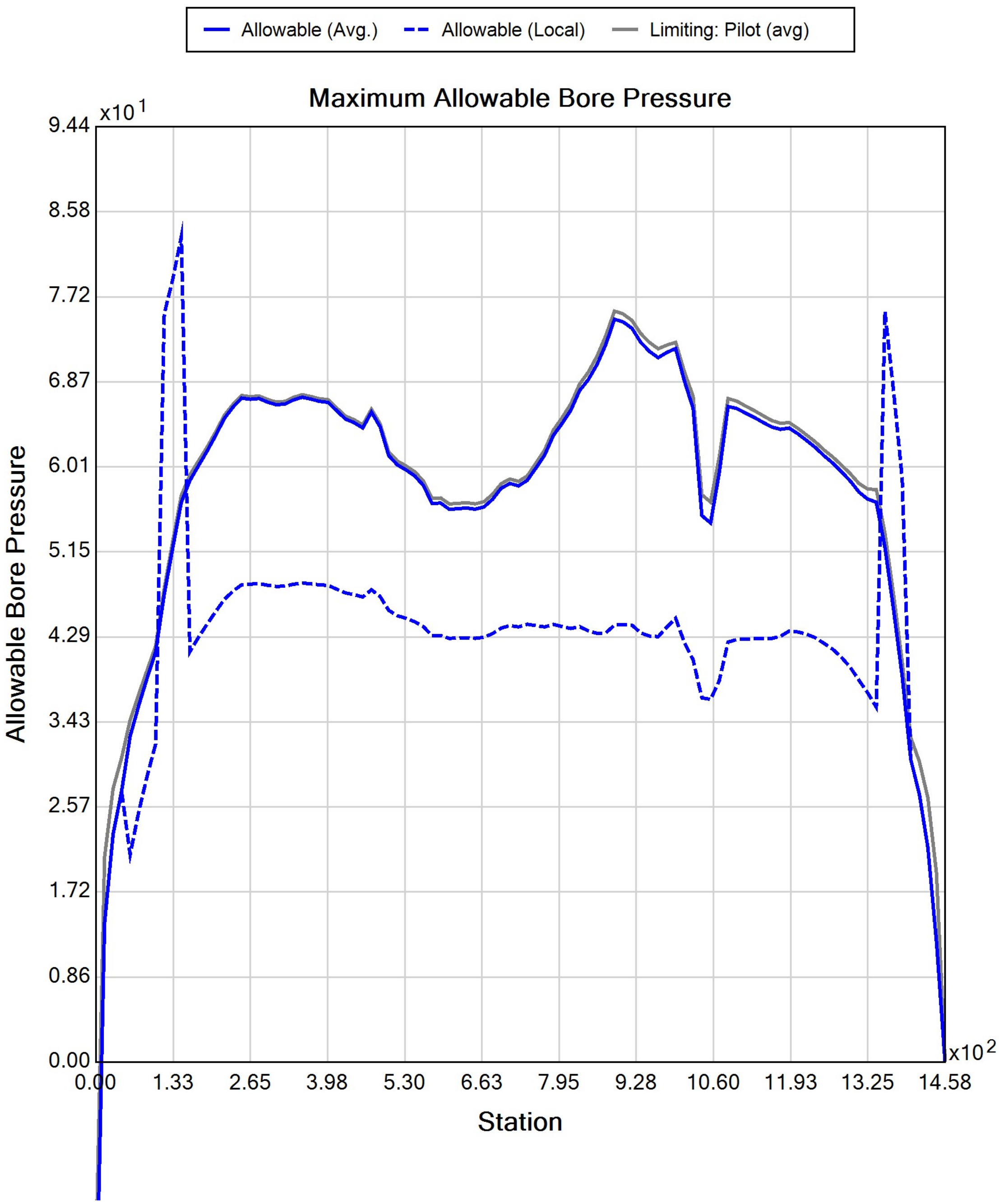


Pull Back Stress [psi]
x10 2
7.42
7.06
6.71
6.35
5.99
5.63
5.27
4.91
4.55
4.20
3.84
3.48
Current
x10 2
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
Length of pipe inside bore [ft]


Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 2
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
Length of pipe inside bore [ft]



Axial Stress [psi]
x10 2
7.64
7.26
6.89
6.51
6.13
5.75
5.37
4.99
4.61
4.24
3.86
3.48
Current
x10 2
0.00
1.34
2.68
4.01
5.35
6.69
8.03
9.36
10.70
12.04
13.38
14.72
Length of pipe inside bore [ft]



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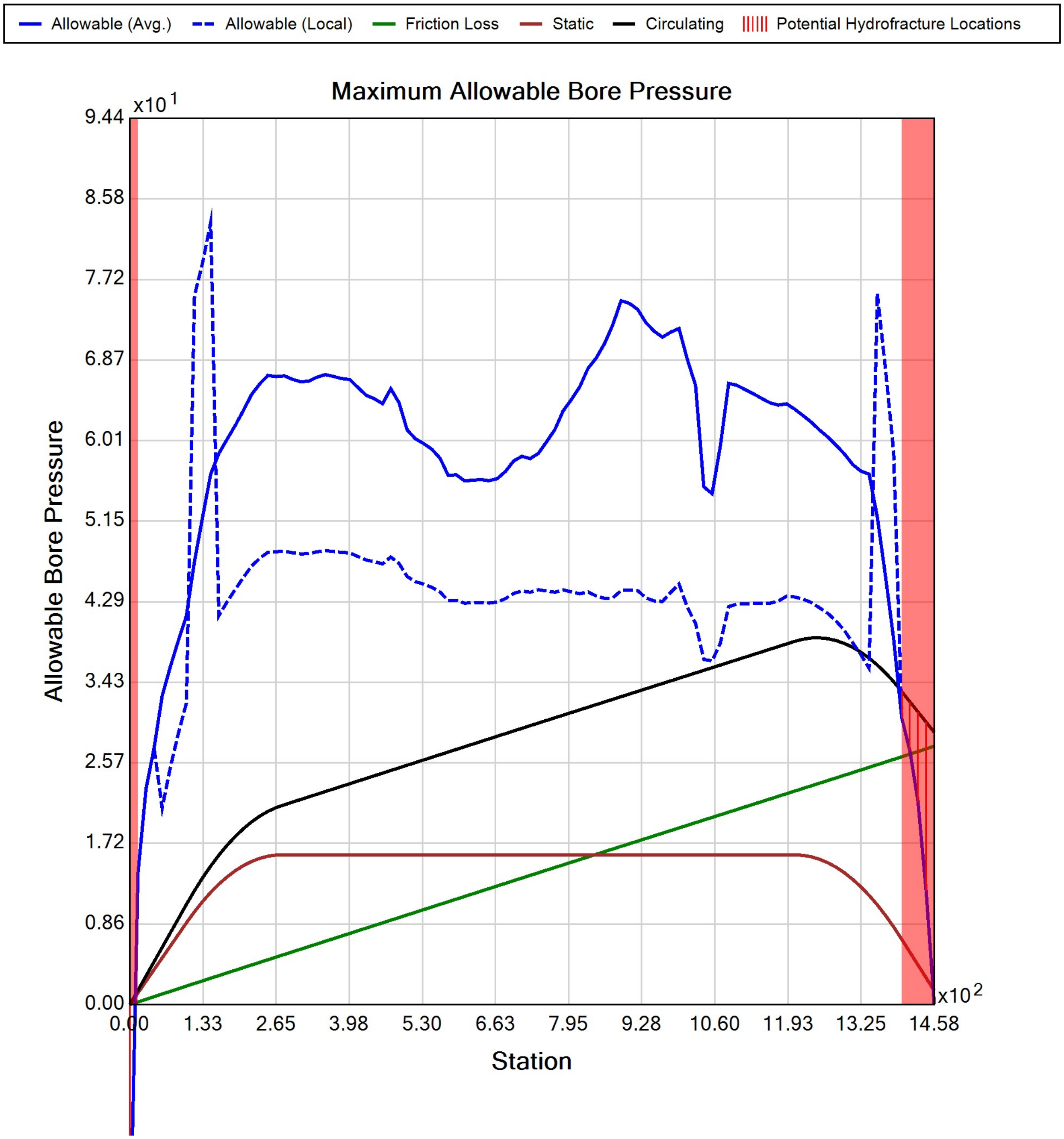

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Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 120.32) ft
End Coordinate	(1451.00, 0.00, 116.43) ft
Project Length	1451.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1470.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	1.3	14.7
Water Pressure	12.2	12.2
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	13.5	26.9
Deflection		
Earth Load Deflection	1.694	4.199
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.723	4.229
Compressive Stress [psi]		
Compressive Wall Stress	60.5	120.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1290.6	1290.6
Pullback Stress [psi]	737.4	737.4
Pullback Strain	1.282E-2	1.282E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	737.4	737.4
Tensile Strain	1.282E-2	1.292E-2

Net External Pressure = 20.2 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.723	7.5	4.4	OK
Unconstrained Collapse [psi]	21.7	132.0	6.1	OK
Compressive Wall Stress [psi]	60.5	1150.0	19.0	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	31.7	212.0	6.7	OK
Tensile Stress [psi]	737.4	1200.0	1.6	OK

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Generated Output

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Project Summary

General:	HDD #7
	Start Date: 02-23-2022
	End Date: 02-23-2022
Designer:	MCS
	CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 118.40) ft
End Coordinate	(1305.00, 0.00, 124.40) ft
Project Length	1305.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

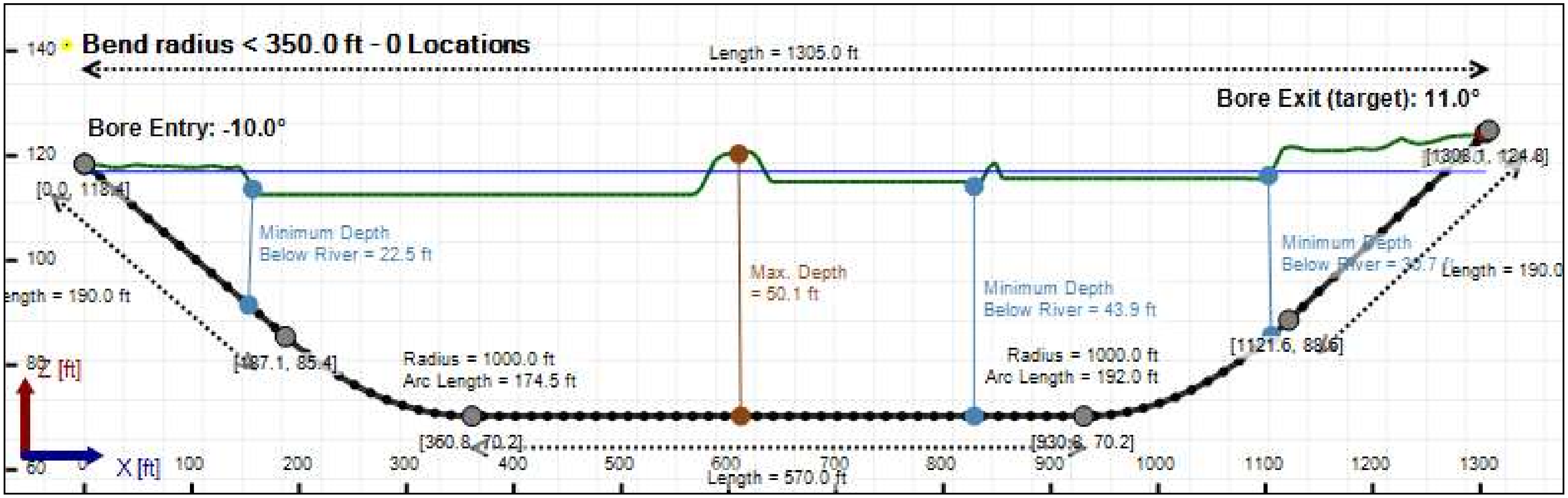
Number of Layers: 3

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

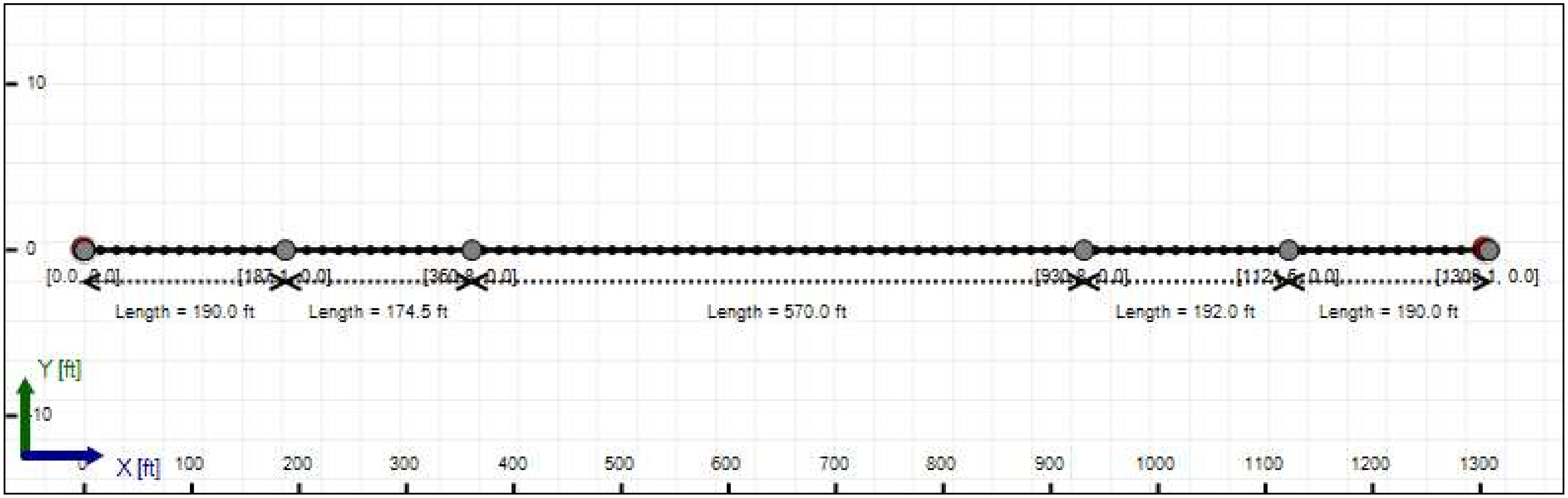
Soil Layer #2 USCS, Clay (C), CL
From Assistant
Unit Weight: 100.0000 (dry), 120.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 400.00, Coh: 5.60 [psi]

Soil Layer #3 USCS, Clay (C), CH
From Assistant
Unit Weight: 70.0000 (dry), 100.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 200.00, Coh: 3.10 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 1320.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	13.7	16.8
Water Pressure	20.3	20.3
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	34.0	37.1
Deflection		
Earth Load Deflection	3.740	4.571
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	3.872	4.703
Compressive Stress [psi]		
Compressive Wall Stress	153.1	166.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	22225.7	22225.7
Pullback Stress [psi]	619.8	619.8
Pullback Strain	1.078E-2	1.078E-2
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	619.8	642.8
Tensile Strain	1.078E-2	1.163E-2

Net External Pressure = 34.9 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.872	7.5	1.9	OK
Unconstrained Collapse [psi]	36.0	97.7	2.7	OK
Compressive Wall Stress [psi]	153.1	1150.0	7.5	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	45.9	218.1	4.7	OK
Tensile Stress [psi]	642.8	1200.0	1.9	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	59.964 psi	53.067 psi
1	8.00 in	12.00 in	59.926 psi	53.023 psi
2	12.00 in	16.13 in	59.871 psi	52.961 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

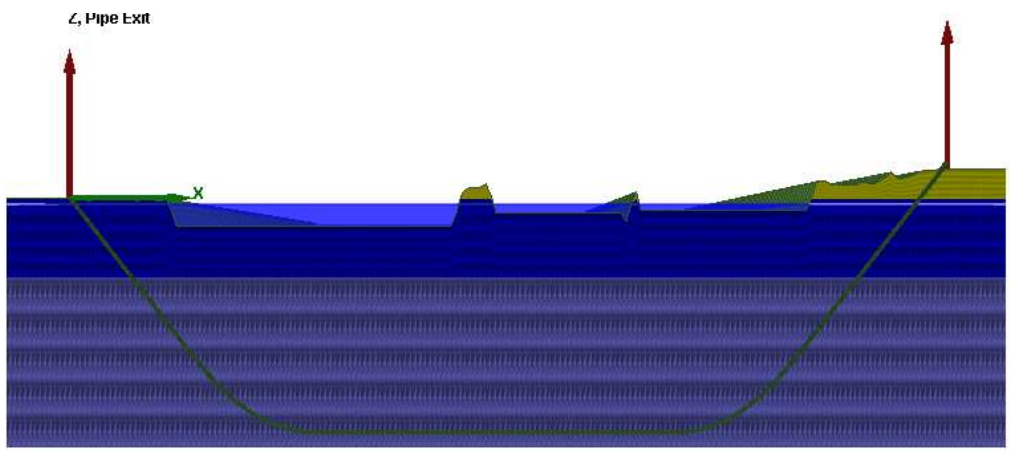
Rheological model: Bingham-Plastic

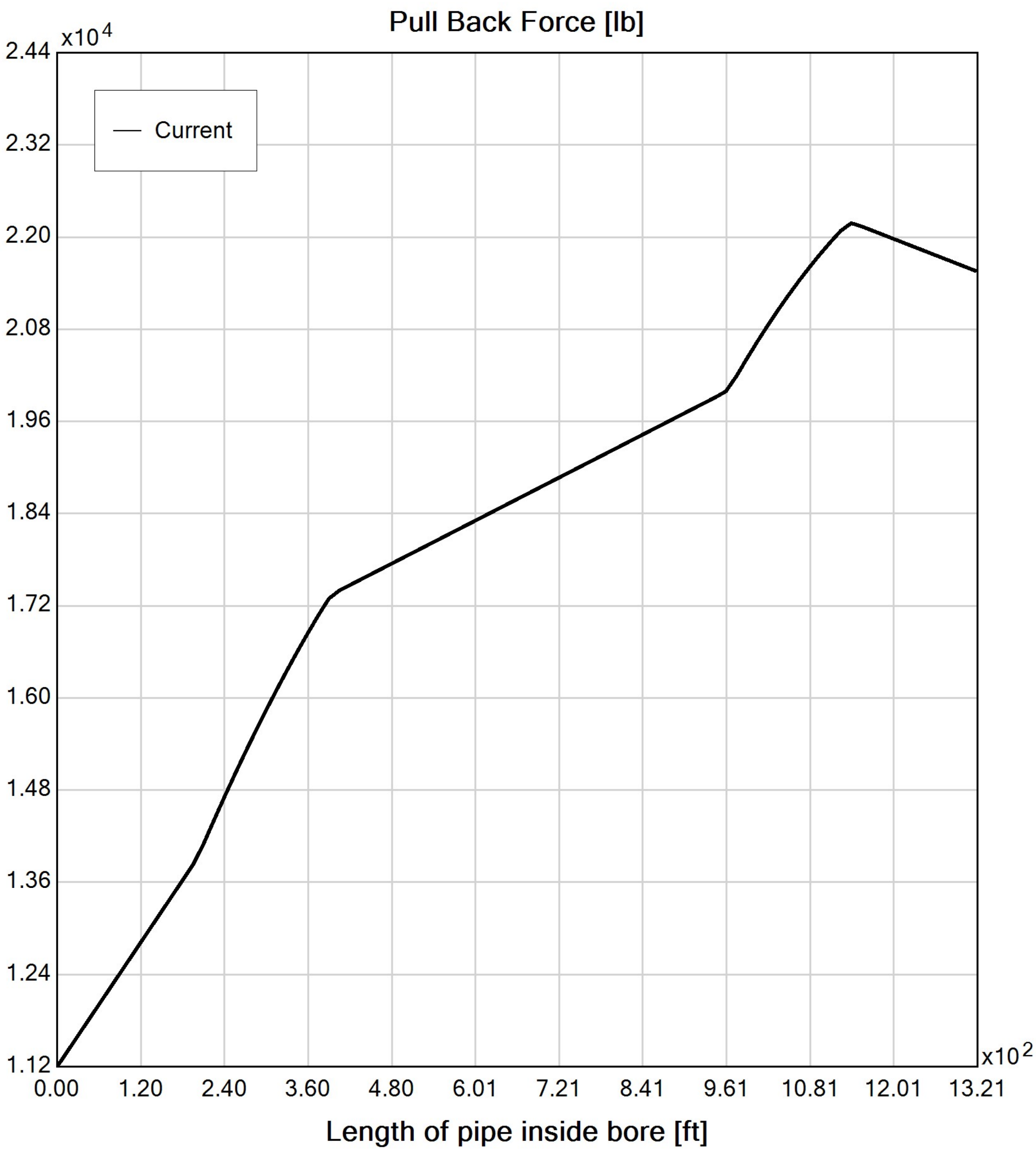
Plastic Viscosity (PV): 25.53

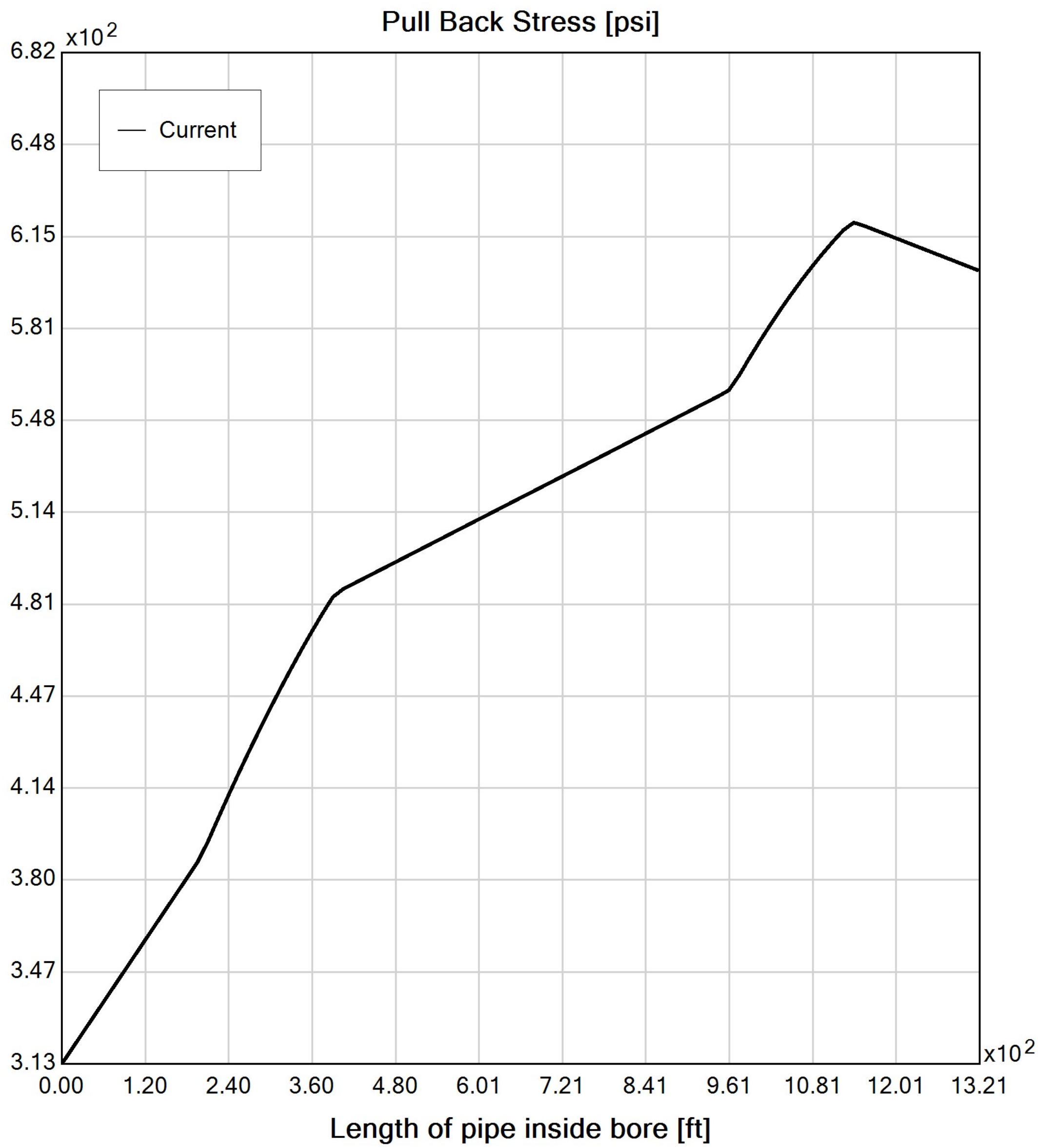
Yield Point (YP): 16.49

Effective Viscosity (cP): 1202.0

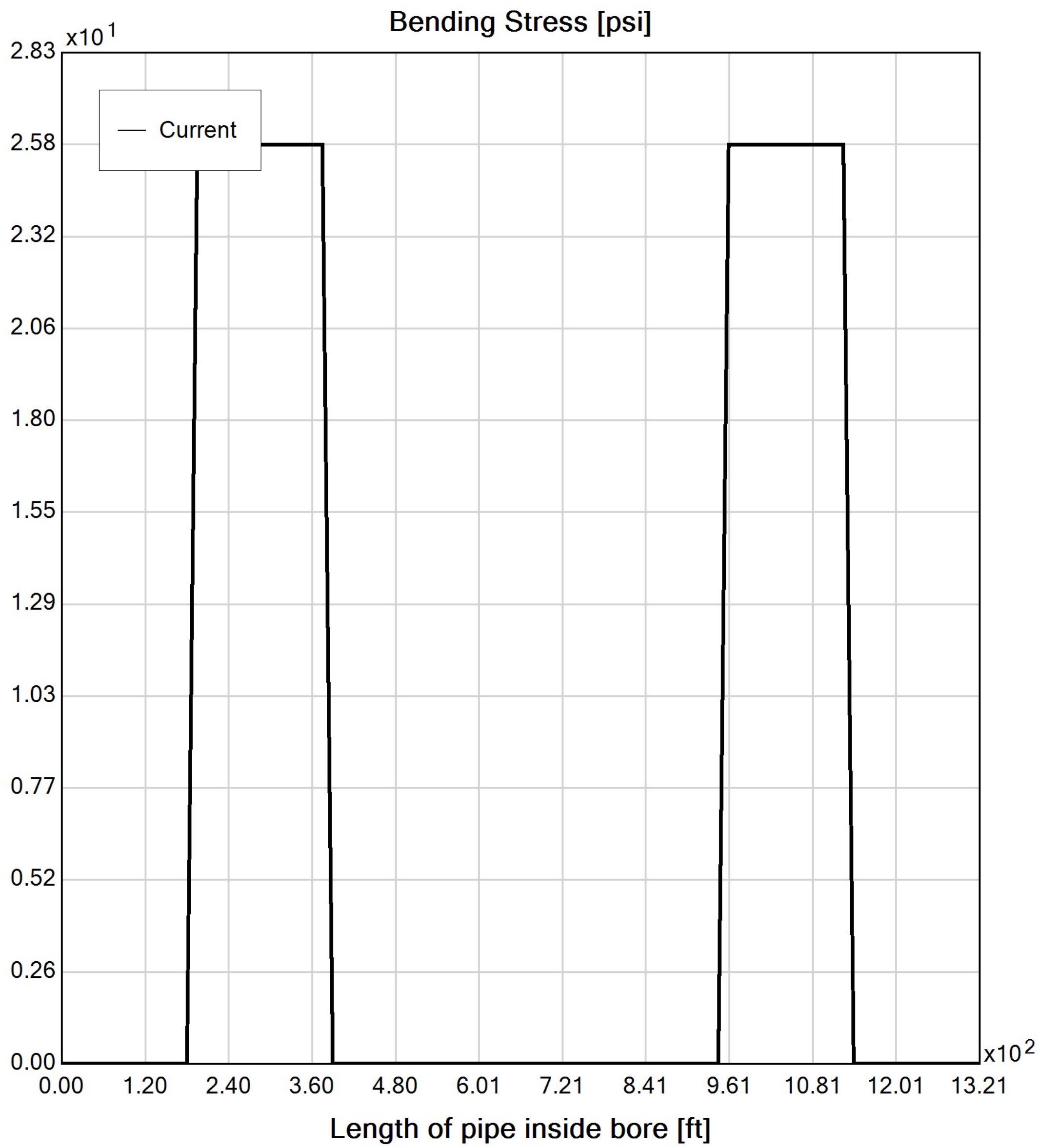
Virtual Site




Pull Back Force [lb]
x10^4
2.44
2.32
2.20
2.08
1.96
1.84
1.72
1.60
1.48
1.36
1.24
1.12
Current
x10^2
0.00
1.20
2.40
3.60
4.80
6.01
7.21
8.41
9.61
10.81
12.01
13.21
Length of pipe inside bore [ft]



Pull Back Stress [psi]
x10 2
6.82
6.48
6.15
5.81
5.48
5.14
4.81
4.47
4.14
3.80
3.47
3.13
Current
x10 2
0.00
1.20
2.40
3.60
4.80
6.01
7.21
8.41
9.61
10.81
12.01
13.21
Length of pipe inside bore [ft]



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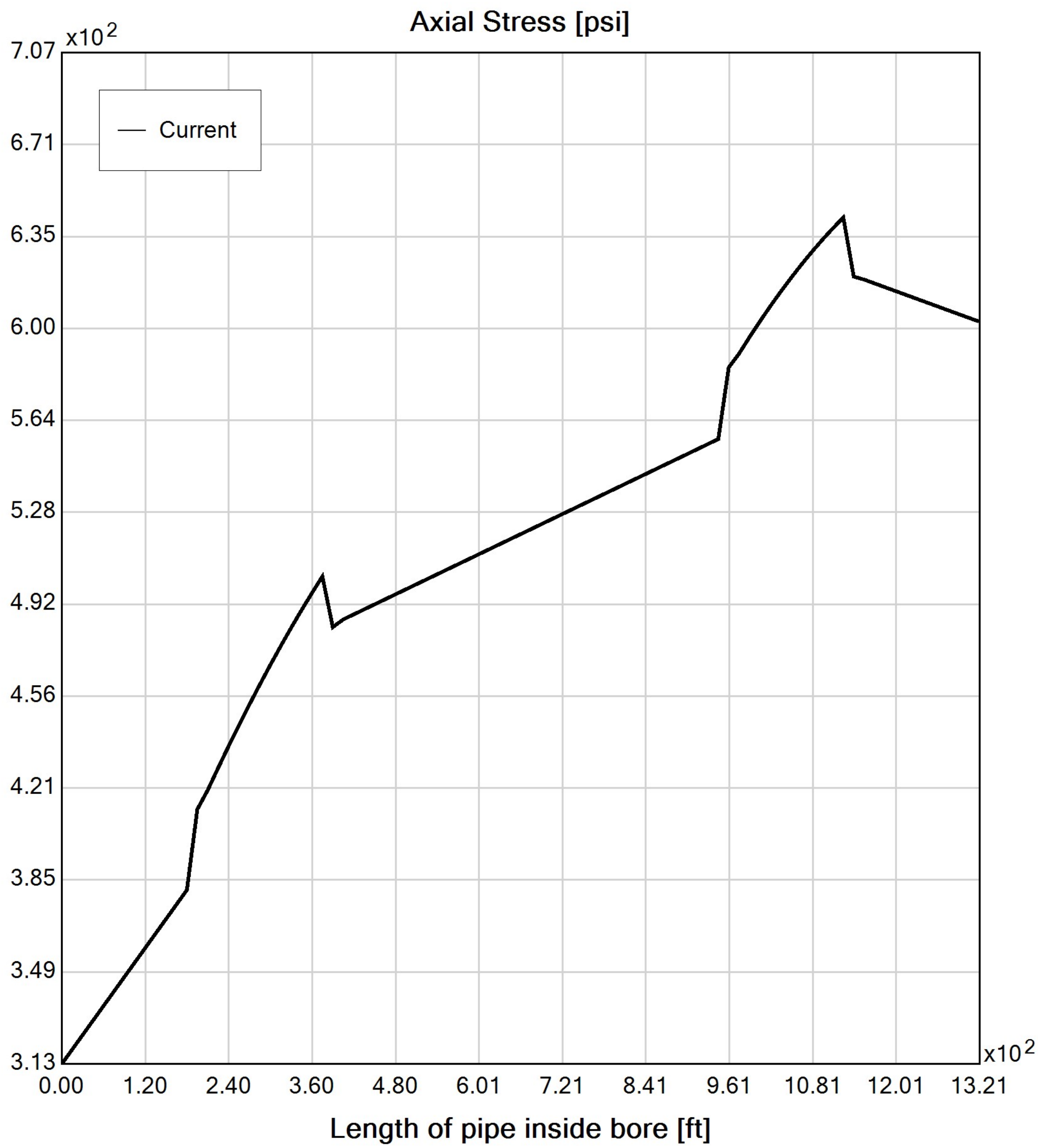
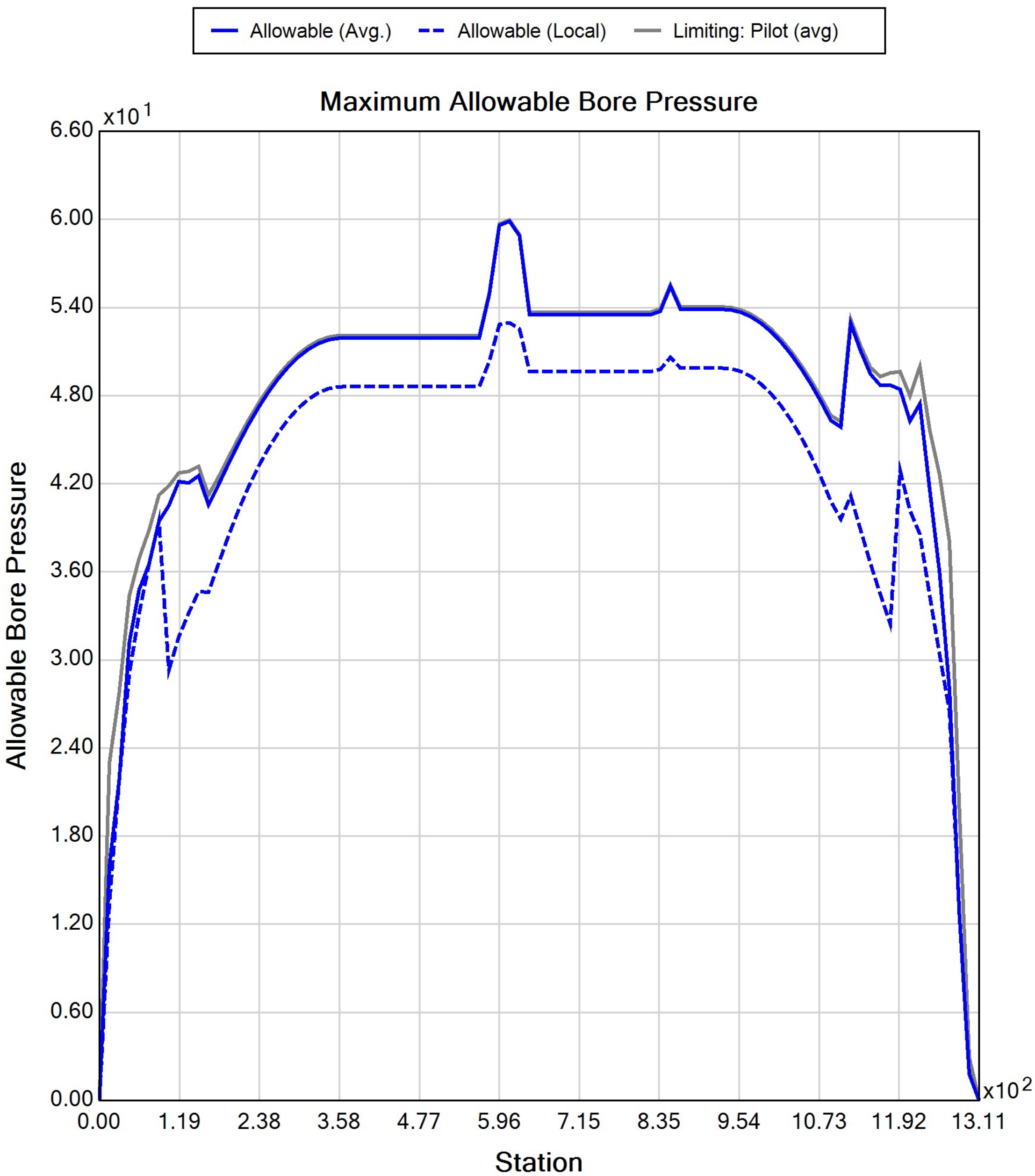

Axial Stress [psi]
x10 2
7.07
6.71
6.35
6.00
5.64
5.28
4.92
4.56
4.21
3.85
3.49
3.13
Current
x10 2
0.00
1.20
2.40
3.60
4.80
6.01
7.21
8.41
9.61
10.81
12.01
13.21
Length of pipe inside bore [ft]



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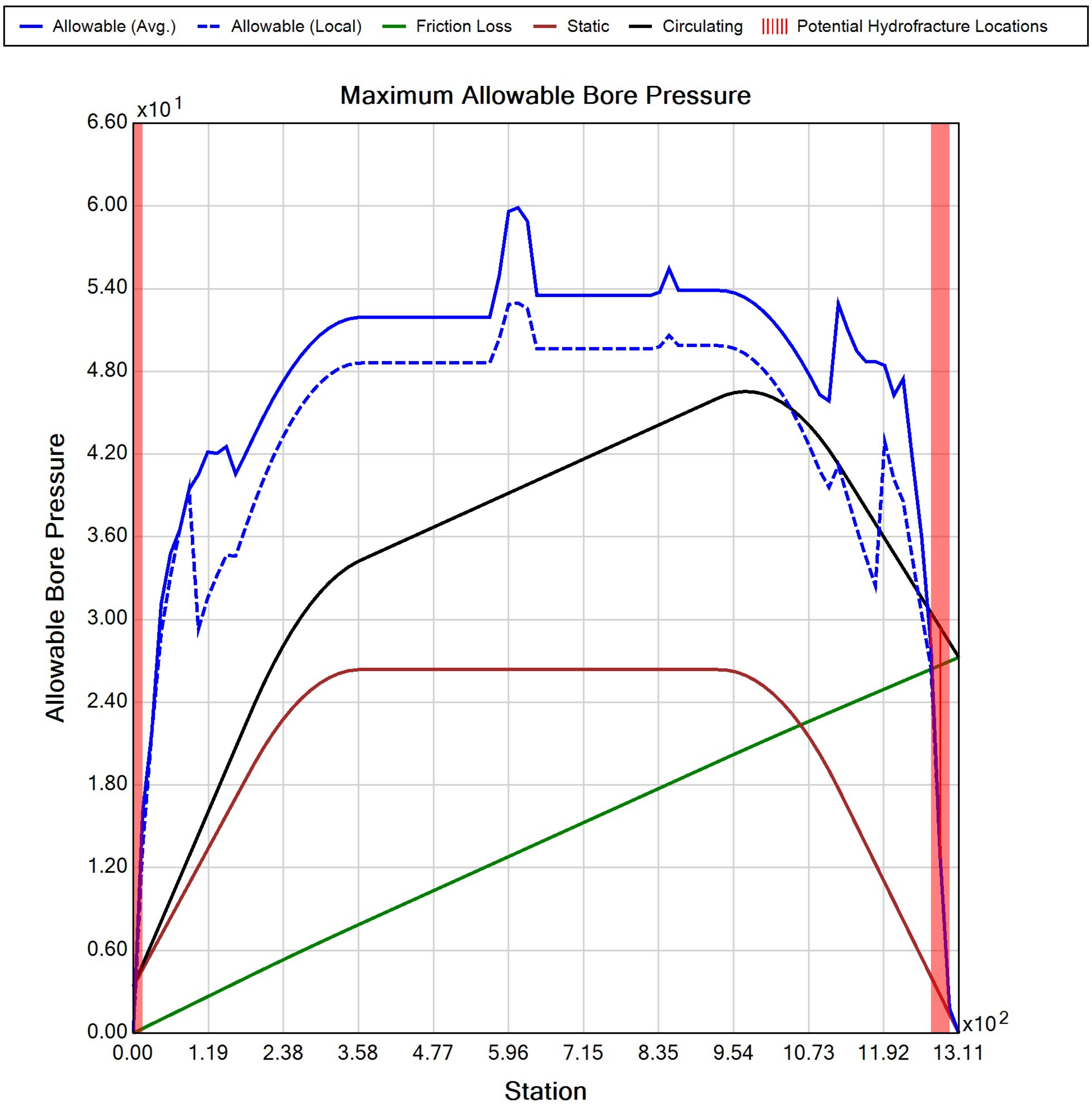

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Input Summary

Start Coordinate	(0.00, 0.00, 118.40) ft
End Coordinate	(1305.00, 0.00, 124.40) ft
Project Length	1305.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 1320.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	13.7	16.8
Water Pressure	20.3	20.3
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	34.0	37.1
Deflection		
Earth Load Deflection	3.740	4.571
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	3.769	4.600
Compressive Stress [psi]		
Compressive Wall Stress	153.1	166.8

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	1194.4	1194.4
Pullback Stress [psi]	682.5	682.5
Pullback Strain	1.187E-2	1.187E-2
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	682.5	685.4
Tensile Strain	1.187E-2	1.202E-2

Net External Pressure = 34.9 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	3.769	7.5	2.0	OK
Unconstrained Collapse [psi]	36.0	98.6	2.7	OK
Compressive Wall Stress [psi]	153.1	1150.0	7.5	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	45.9	216.0	4.7	OK
Tensile Stress [psi]	685.4	1200.0	1.8	OK

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:	HDD #8 - Conduit 1 Start Date: 12-10-2021 End Date: 12-10-2021
Designer:	TAR CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 130.11) ft
End Coordinate	(800.00, 0.00, 130.00) ft
Project Length	800.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

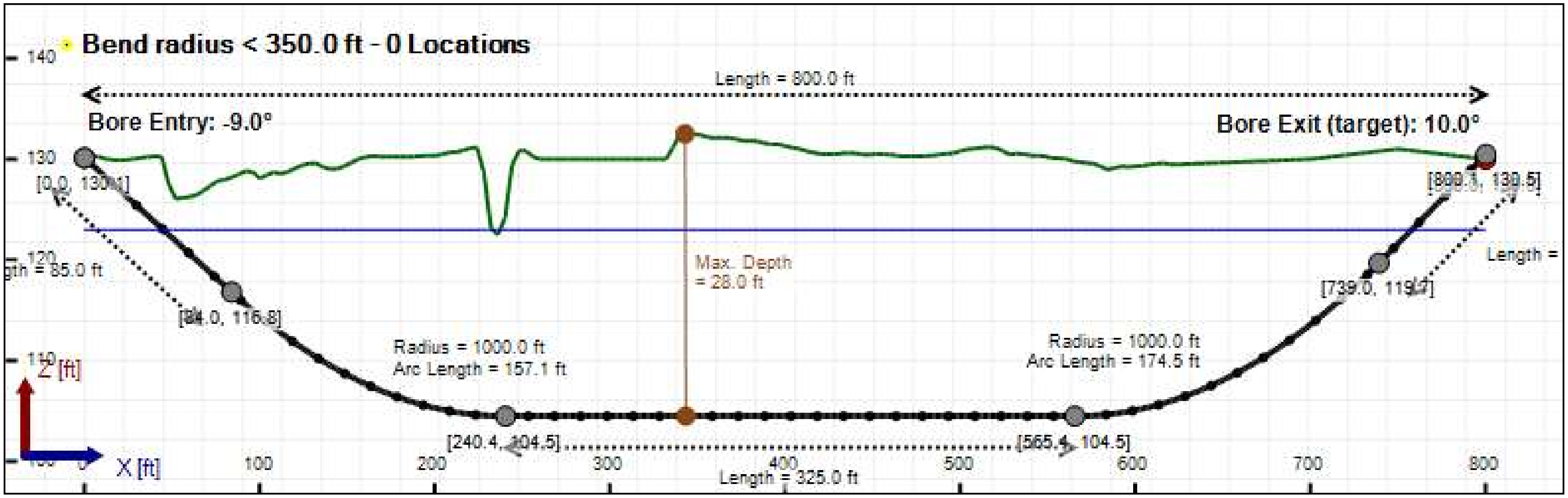
Soil Summary

Number of Layers: 2

Soil Layer #1 USCS, Sand (S), SP
Depth: 6.00 ft
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), CH
Depth: 25.00 ft
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]
Phi: 0.00, S.M.: 300.00, Coh: 8.70 [psi]

Bore Cross-Section View



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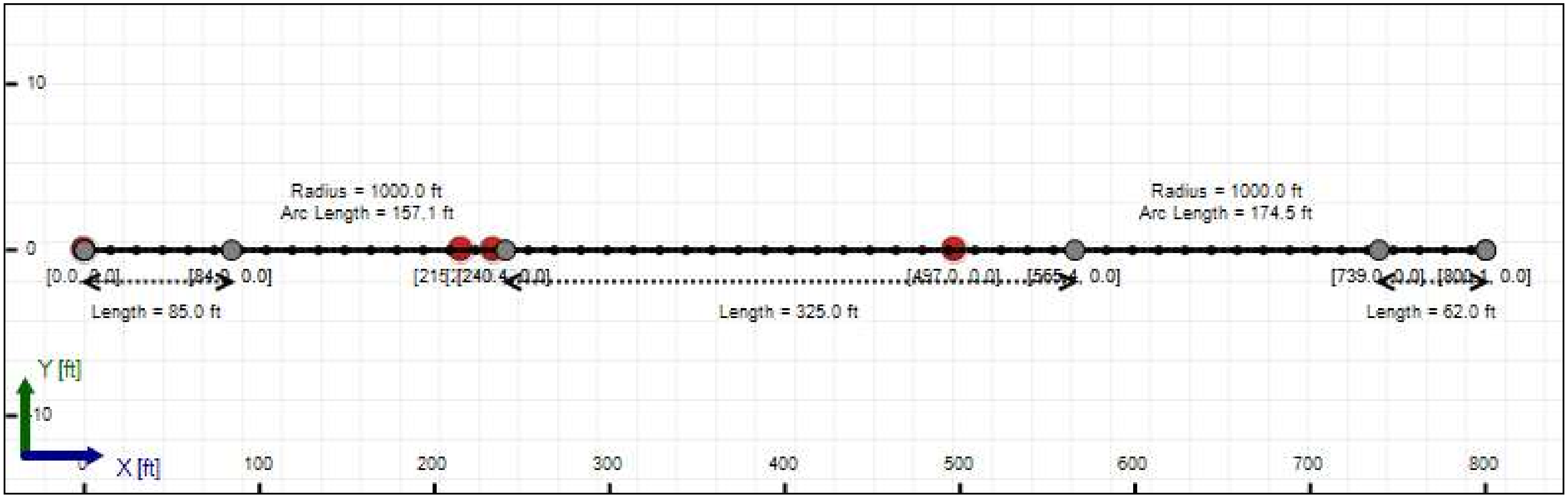
Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 810.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.3	12.8
Water Pressure	8.0	8.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.4	20.9
Deflection		
Earth Load Deflection	1.728	3.499
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.860	3.631
Compressive Stress [psi]		
Compressive Wall Stress	64.6	93.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	13251.4	13251.4
Pullback Stress [psi]	369.6	369.6
Pullback Strain	6.427E-3	6.427E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	369.6	393.9
Tensile Strain	6.427E-3	7.298E-3

Net External Pressure = 18.6 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.860	7.5	4.0	OK
Unconstrained Collapse [psi]	17.6	116.9	6.6	OK
Compressive Wall Stress [psi]	64.6	1150.0	17.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	27.6	233.7	8.5	OK
Tensile Stress [psi]	393.9	1200.0	3.0	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	64.880 psi	60.219 psi
1	8.00 in	12.00 in	64.710 psi	60.013 psi
2	12.00 in	16.13 in	64.468 psi	59.722 psi

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

Estimated Circulating Pressure Summary

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

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

Drill Fluid Density: 68.700 lb/ft3

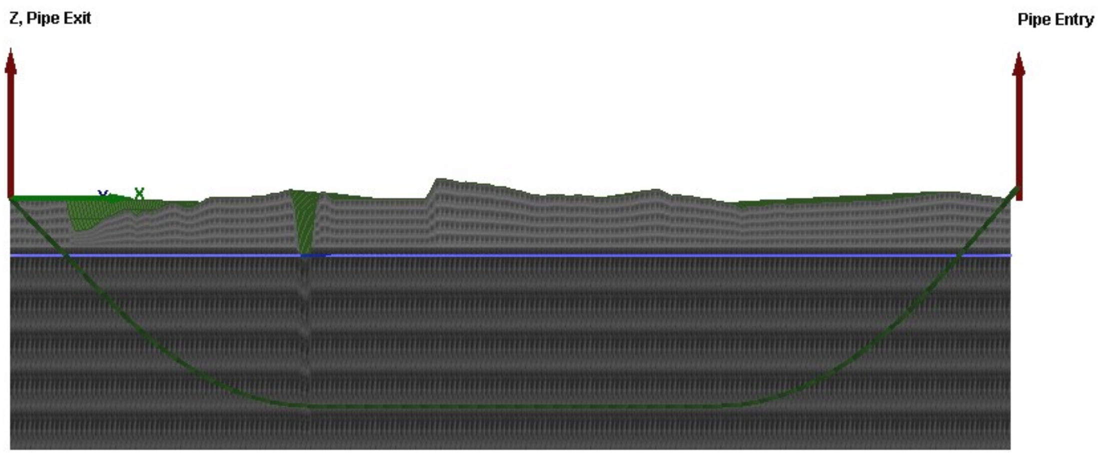
Rheological model: Bingham-Plastic

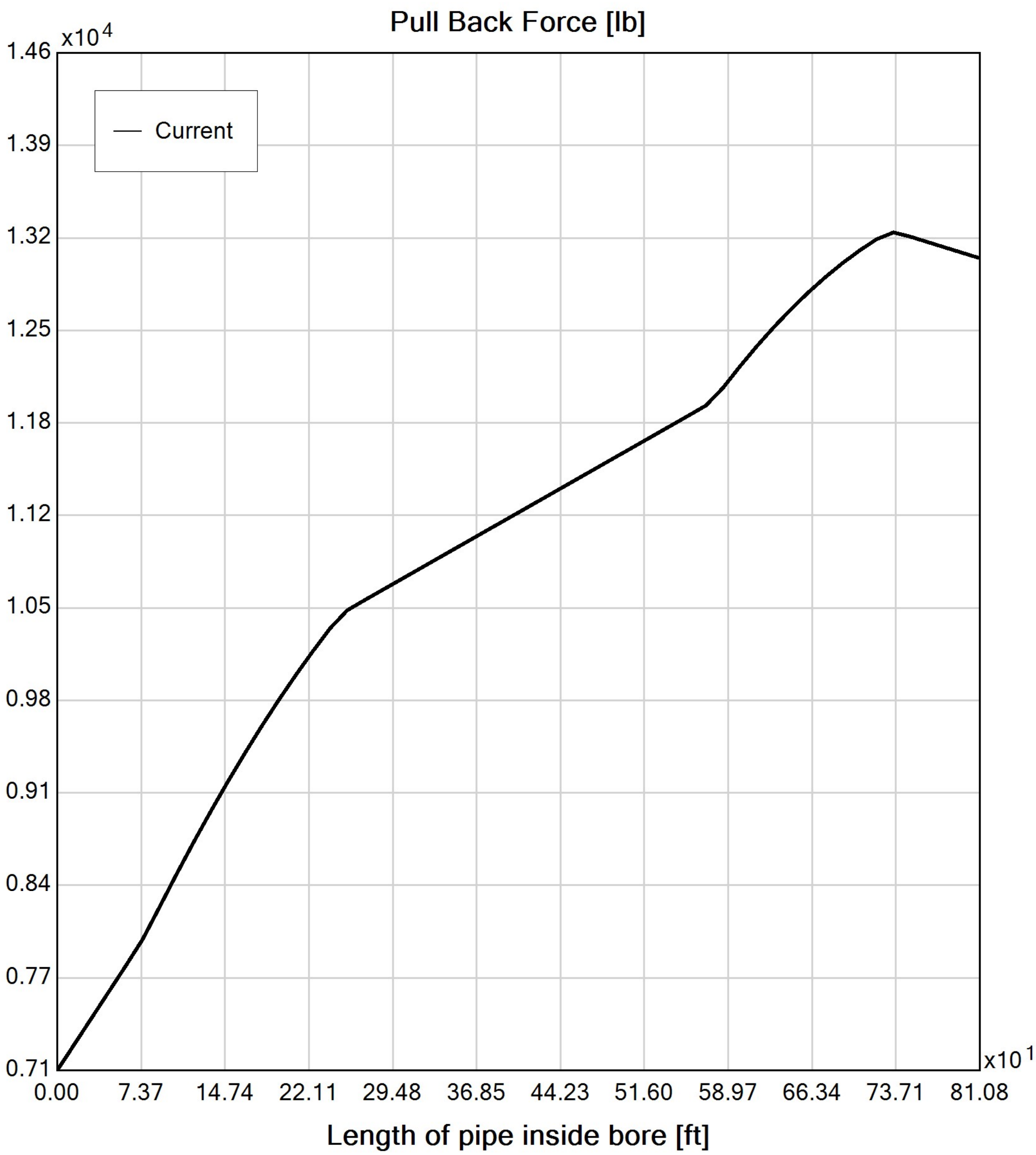
Plastic Viscosity (PV): 25.53

Yield Point (YP): 16.49

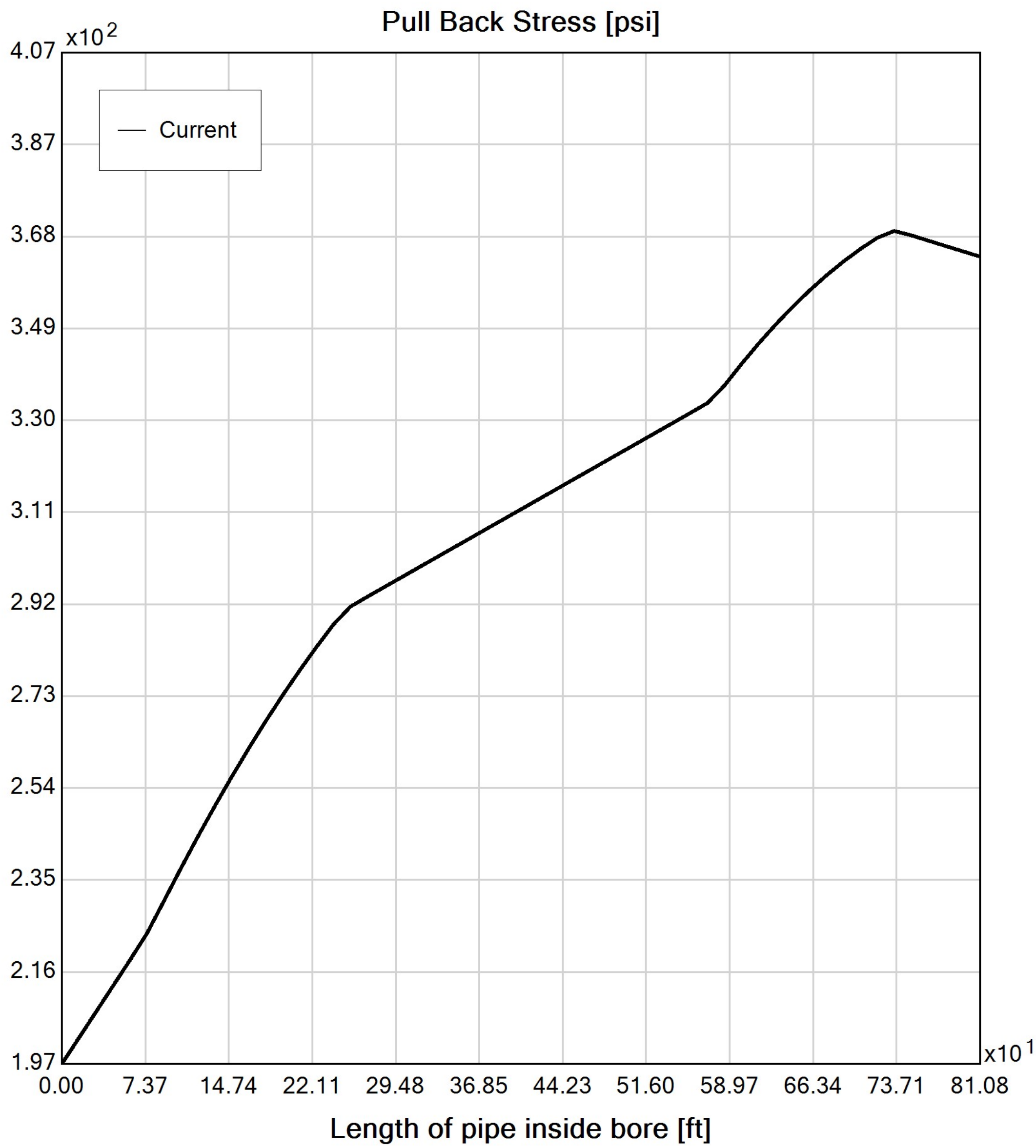
Effective Viscosity (cP): 1202.0

Virtual Site





Pull Back Force [lb]
x10 4
1.46
1.39
1.32
1.25
1.18
1.12
1.05
0.98
0.91
0.84
0.77
0.71
Current
x10 1
0.00
7.37
14.74
22.11
29.48
36.85
44.23
51.60
58.97
66.34
73.71
81.08
Length of pipe inside bore [ft]



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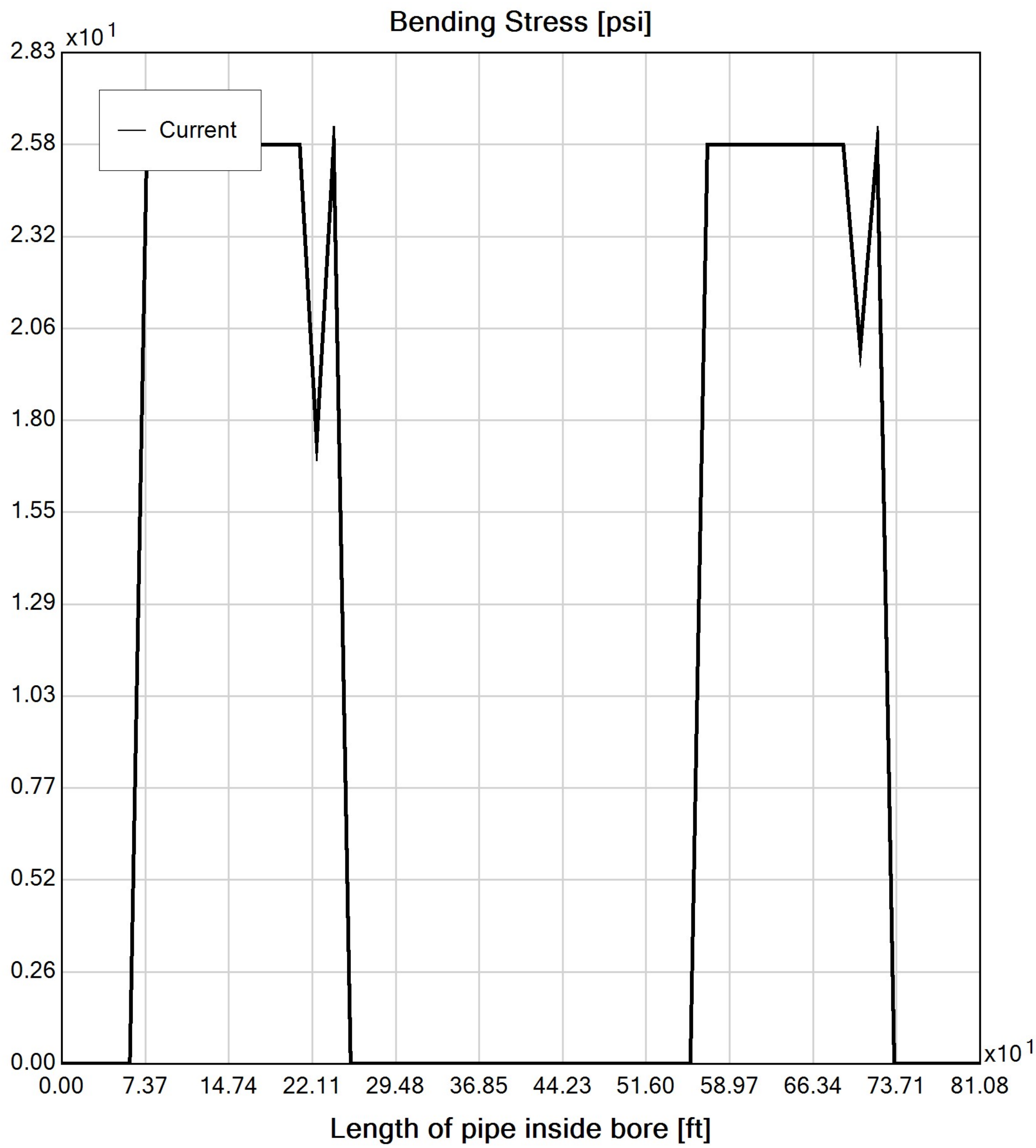
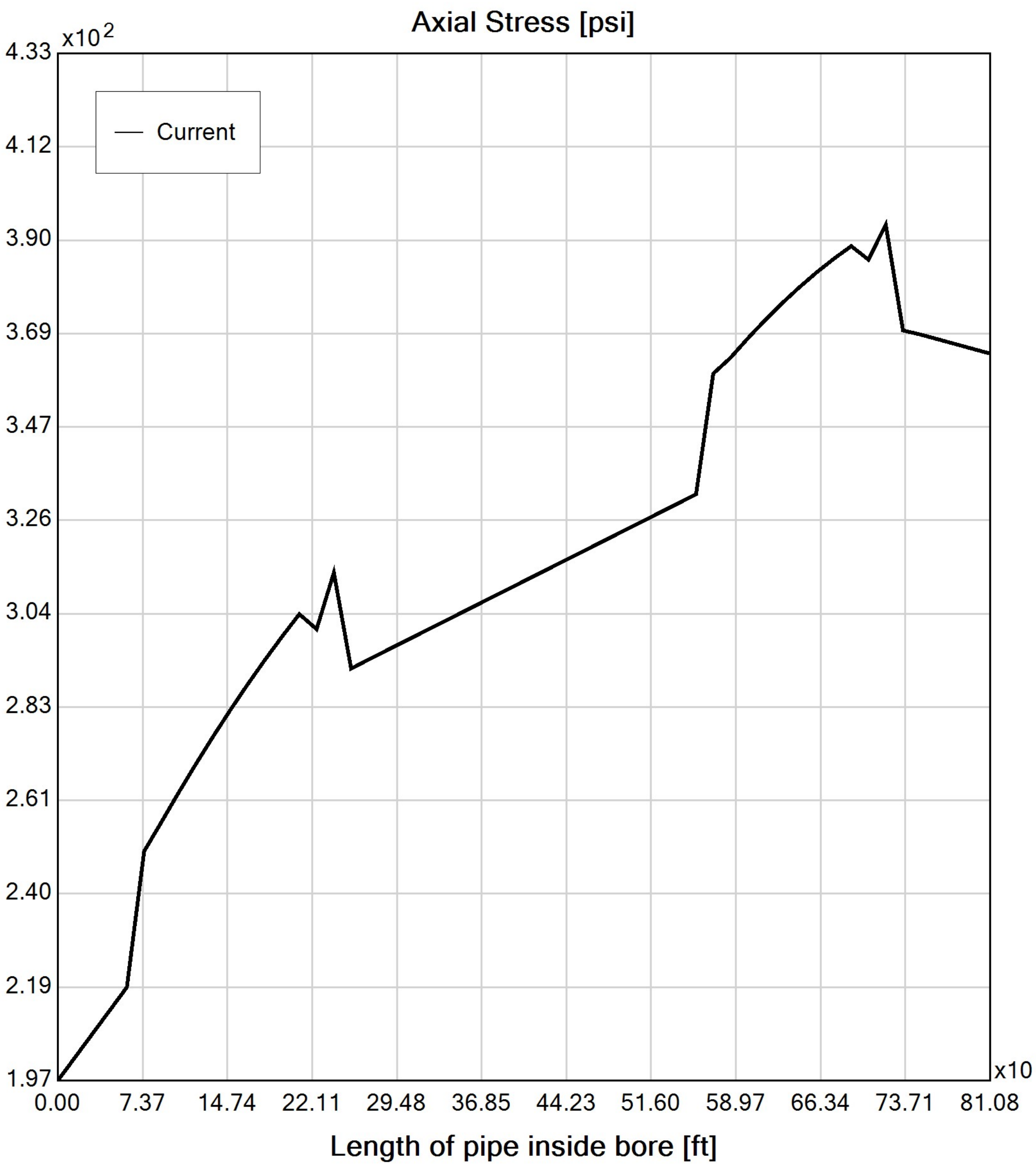
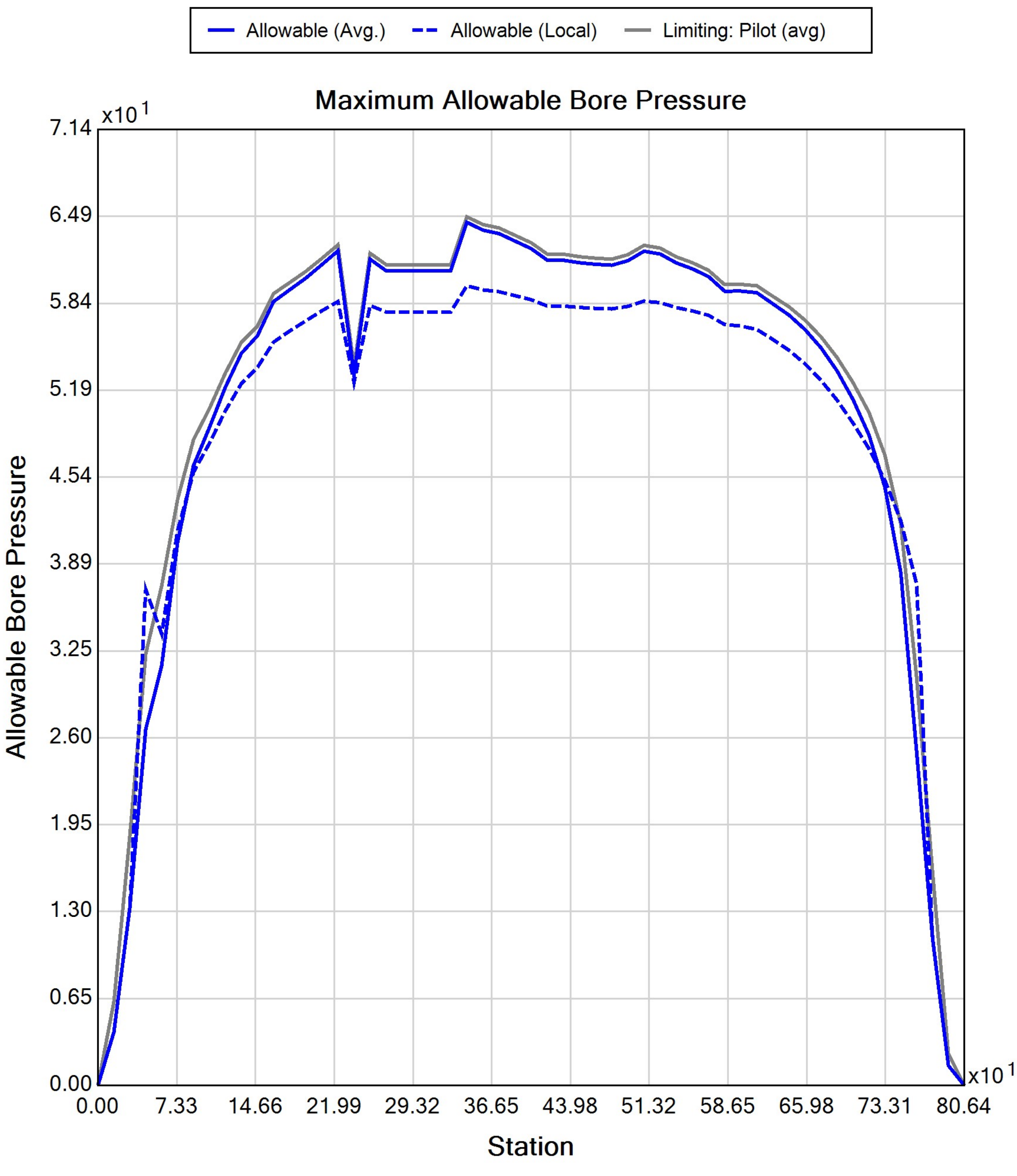
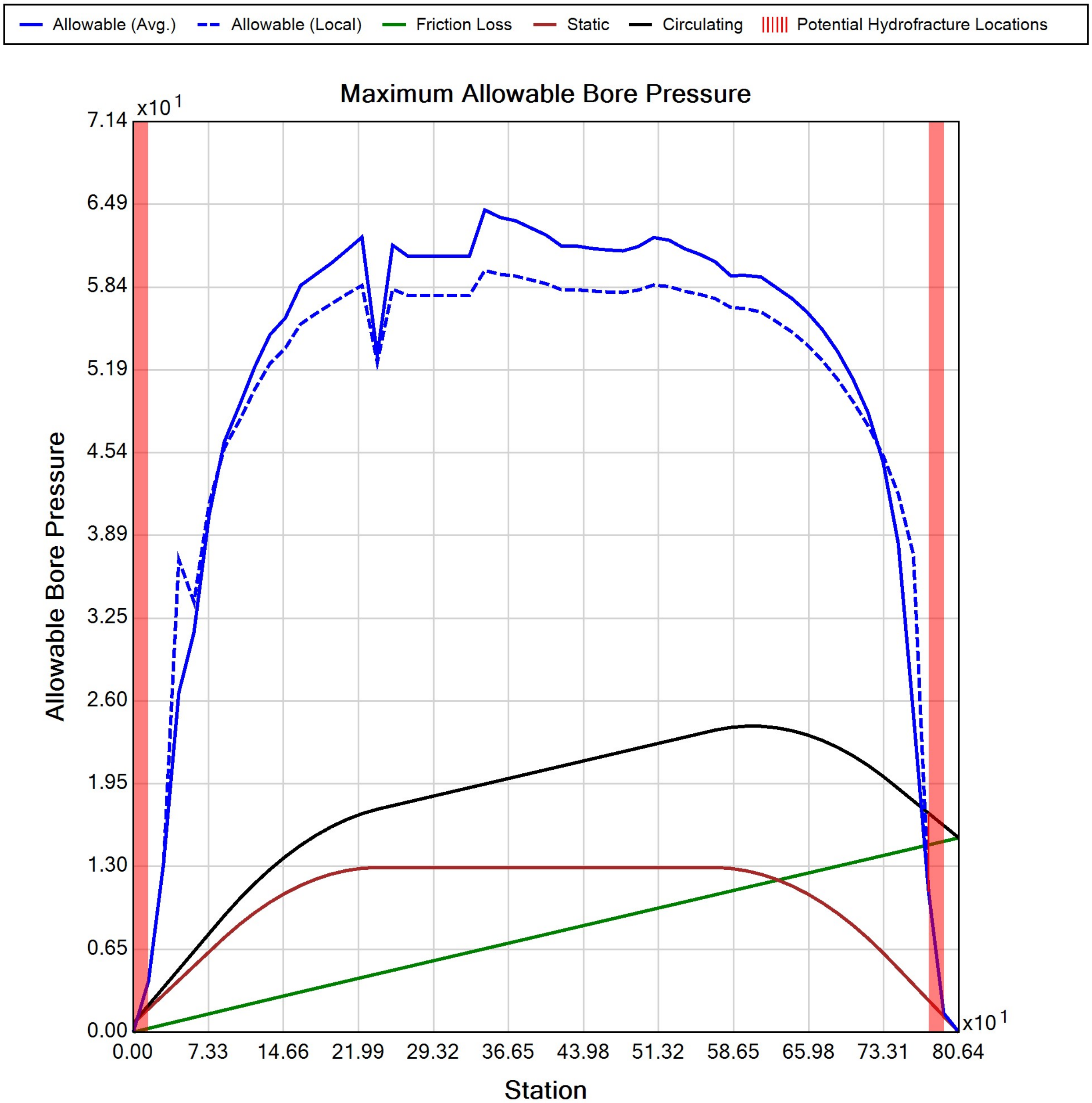

Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00
7.37
14.74
22.11
29.48
36.85
44.23
51.60
58.97
66.34
73.71
81.08
Length of pipe inside bore [ft]


Axial Stress [psi]
x10 2
4.33
4.12
3.90
3.69
3.47
3.26
3.04
2.83
2.61
2.40
2.19
1.97
Current
x10 1
0.00
7.37
14.74
22.11
29.48
36.85
44.23
51.60
58.97
66.34
73.71
81.08
Length of pipe inside bore [ft]


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
7.14
6.49
5.84
5.19
4.54
3.89
3.25
2.60
1.95
1.30
0.65
0.00
Allowable Bore Pressure
0.00
7.33
14.66
21.99
29.32
36.65
43.98
51.32
58.65
65.98
73.31
80.64
x10 1
Station


Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10 1
7.14
6.49
5.84
5.19
4.54
3.89
3.25
2.60
1.95
1.30
0.65
0.00
Allowable Bore Pressure
0.00
7.33
14.66
21.99
29.32
36.65
43.98
51.32
58.65
65.98
73.31
80.64
x10 1
Station

Generated Output

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Input Summary

Start Coordinate	(0.00, 0.00, 130.11) ft
End Coordinate	(800.00, 0.00, 130.00) ft
Project Length	800.00 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 810.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	6.3	12.8
Water Pressure	8.0	8.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.3	20.9
Deflection		
Earth Load Deflection	1.724	3.499
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.753	3.528
Compressive Stress [psi]		
Compressive Wall Stress	64.6	93.9

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	756.4	756.4
Pullback Stress [psi]	432.2	432.2
Pullback Strain	7.516E-3	7.516E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	432.2	436.5
Tensile Strain	7.516E-3	7.690E-3

Net External Pressure = 18.6 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.753	7.5	4.3	OK
Unconstrained Collapse [psi]	17.6	118.0	6.7	OK
Compressive Wall Stress [psi]	64.6	1150.0	17.8	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	27.6	231.9	8.4	OK
Tensile Stress [psi]	436.5	1200.0	2.7	OK

Generated Output

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Project Summary

General:	HDD #8 - Conduit 2 Start Date: 12-10-2021 End Date: 12-10-2021
Designer:	TAR CHA
Description:	

Input Summary

Start Coordinate	(0.00, 0.00, 130.11) ft
End Coordinate	(626.20, 0.00, 129.50) ft
Project Length	626.20 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	10.750 in
Pipe DR	9.0
Pipe Thickness	1.19 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Soil Summary

Number of Layers: 2

Soil Layer #1 USCS, Sand (S), SP

Depth: 6.00 ft

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

Phi: 30.00, S.M.: 200.00, Coh: 0.00 [psi]

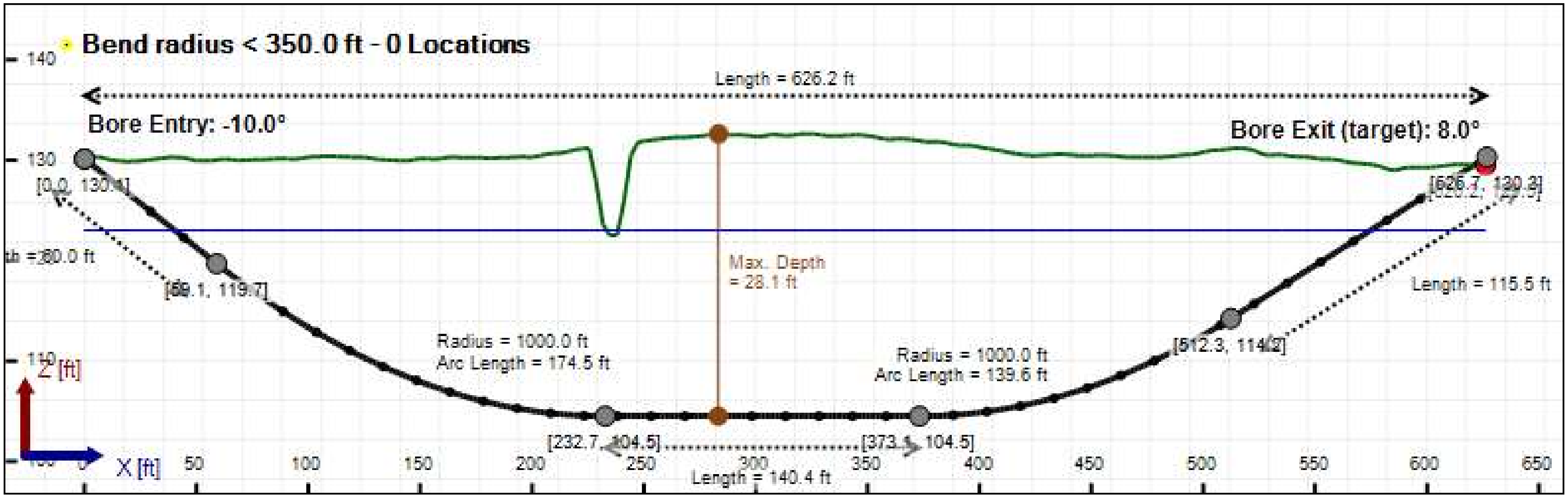
Soil Layer #2 USCS, Clay (C), CH

Depth: 25.00 ft

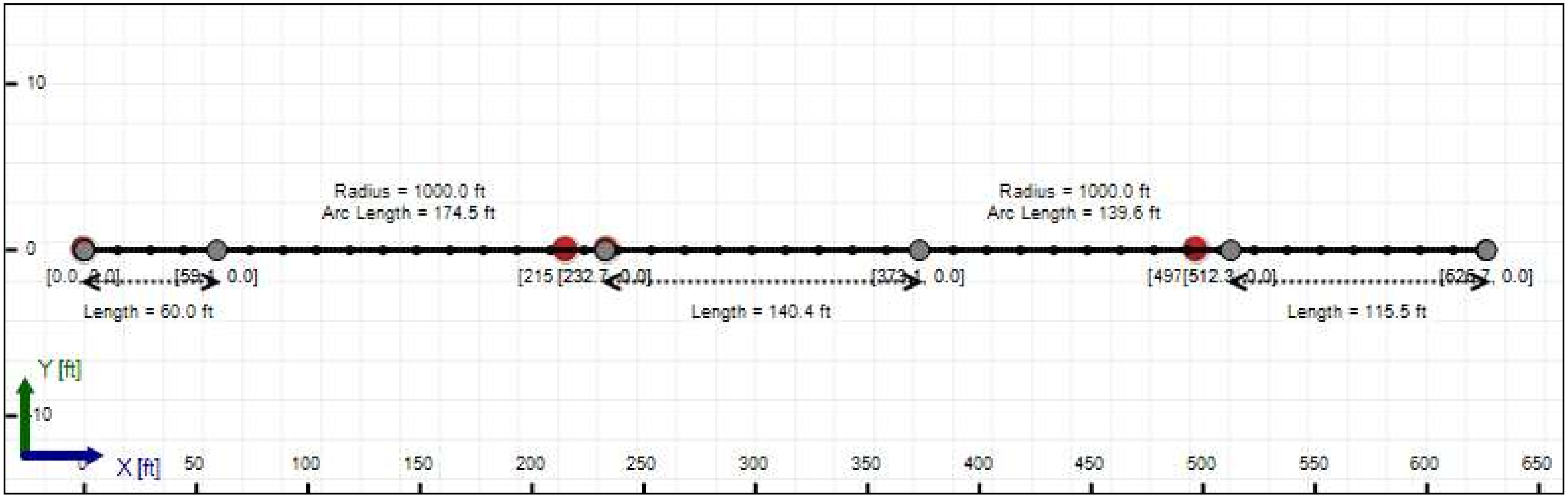
Unit Weight: 80.0000 (dry), 110.0000 (sat) [lb/ft3]

Phi: 0.00, S.M.: 300.00, Coh: 8.70 [psi]

Bore Cross-Section View



Bore Plan View



Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 10" (10.75")

Pipe DR: 9

Pipe Length: 630.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 1.34400002161662 ft

Silo Width: 1.34400002161662 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.9	13.0
Water Pressure	8.0	8.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.0	21.0
Deflection		
Earth Load Deflection	1.620	3.530
Buoyant Deflection	0.132	0.132
Reissner Effect	0	0
Net Deflection	1.752	3.662
Compressive Stress [psi]		
Compressive Wall Stress	62.9	94.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	10437.4	10437.4
Pullback Stress [psi]	291.1	291.1
Pullback Strain	5.062E-3	5.062E-3
Bending Stress [psi]	0.0	25.8
Bending Strain	0	4.479E-4
Tensile Stress [psi]	291.1	314.0
Tensile Strain	5.062E-3	5.908E-3

Net External Pressure = 16.9 [psi]

Buoyant Deflection = 0.1

Hydrokinetic Force = 567.6 lb

In-service Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.752	7.5	4.3	OK
Unconstrained Collapse [psi]	16.8	118.0	7.0	OK
Compressive Wall Stress [psi]	62.9	1150.0	18.3	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.065	7.5	115.8	OK
Unconstrained Collapse [psi]	26.7	238.3	8.9	OK
Tensile Stress [psi]	314.0	1200.0	3.8	OK

Maximum Allowable Bore Pressure Summary

Ream Number	Initial Diameter	Final Diameter	Estimated Maximum Pressure (Avg.)	Estimated Maximum Pressure (Local)
Pilot Bore	0.00 in	8.00 in	65.109 psi	60.334 psi
1	8.00 in	12.00 in	64.940 psi	60.130 psi
2	12.00 in	16.13 in	64.700 psi	59.842 psi

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

Estimated Circulating Pressure Summary

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

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

Drill Fluid Density: 68.700 lb/ft3

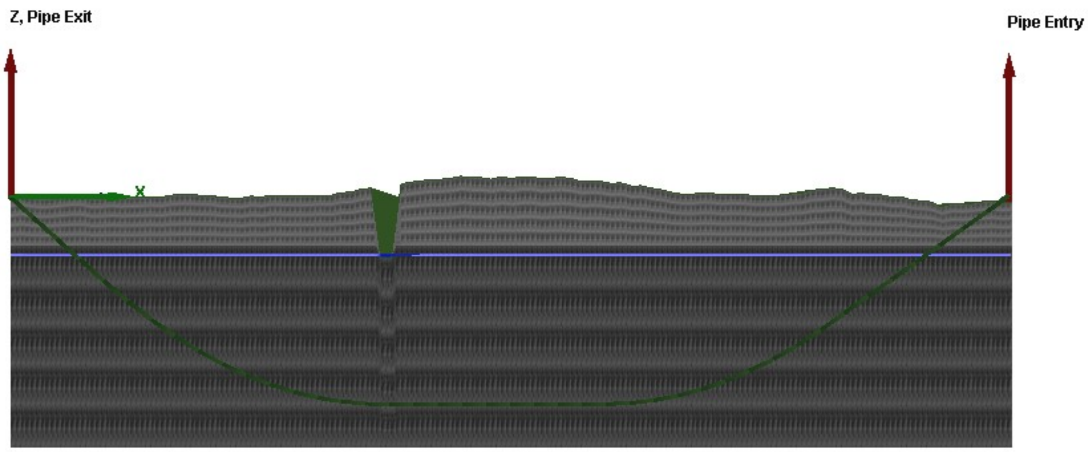
Rheological model: Bingham-Plastic

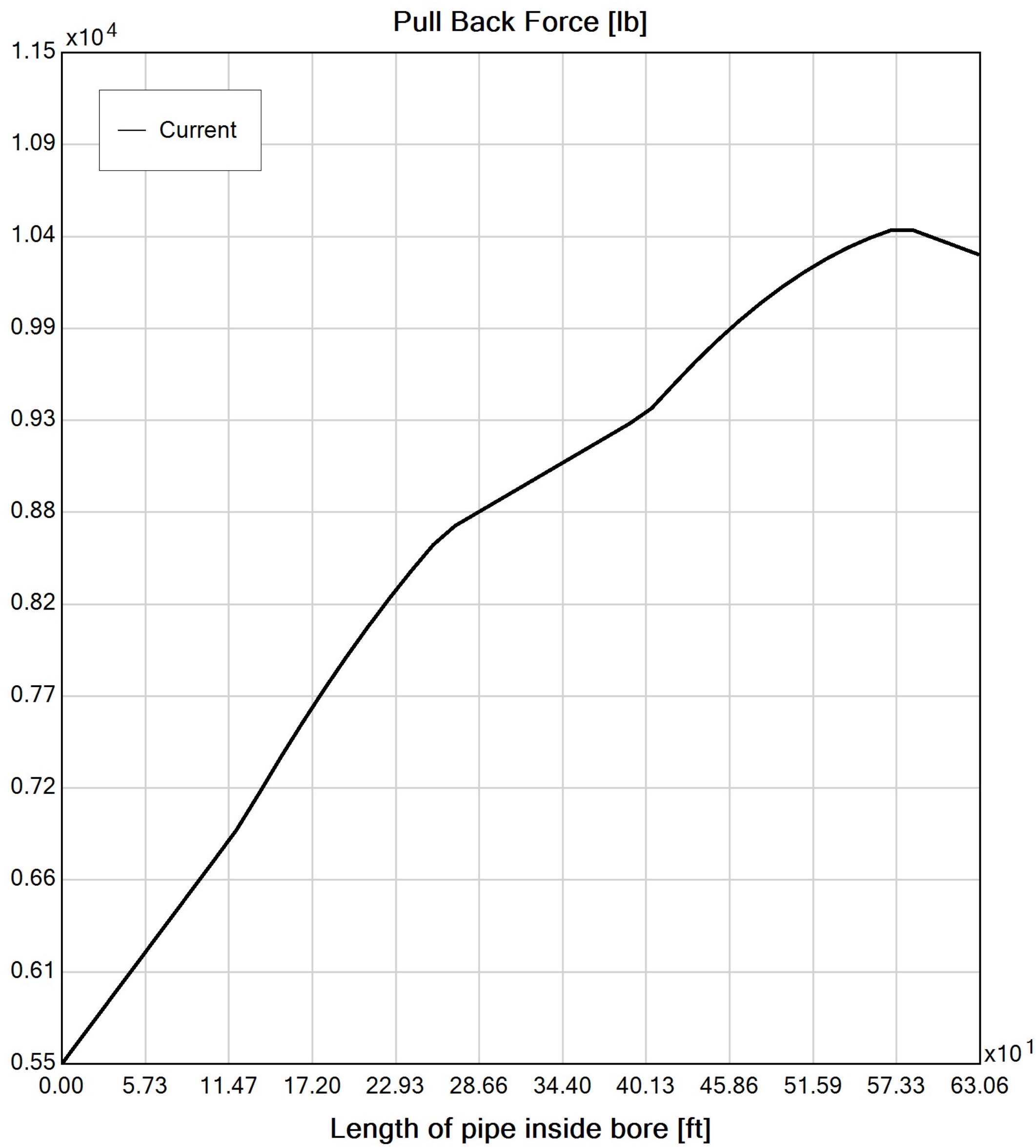
Plastic Viscosity (PV): 25.53

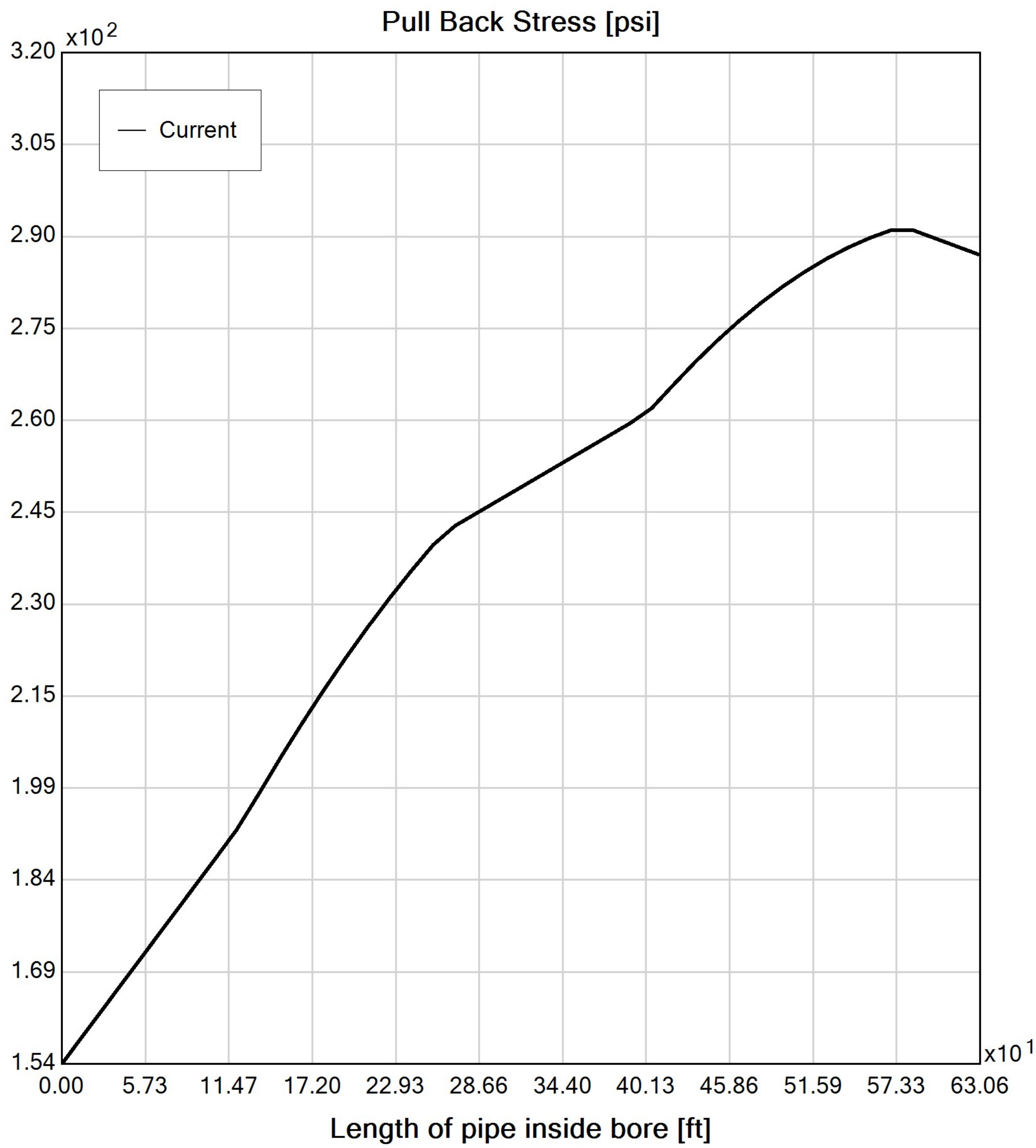
Yield Point (YP): 16.49

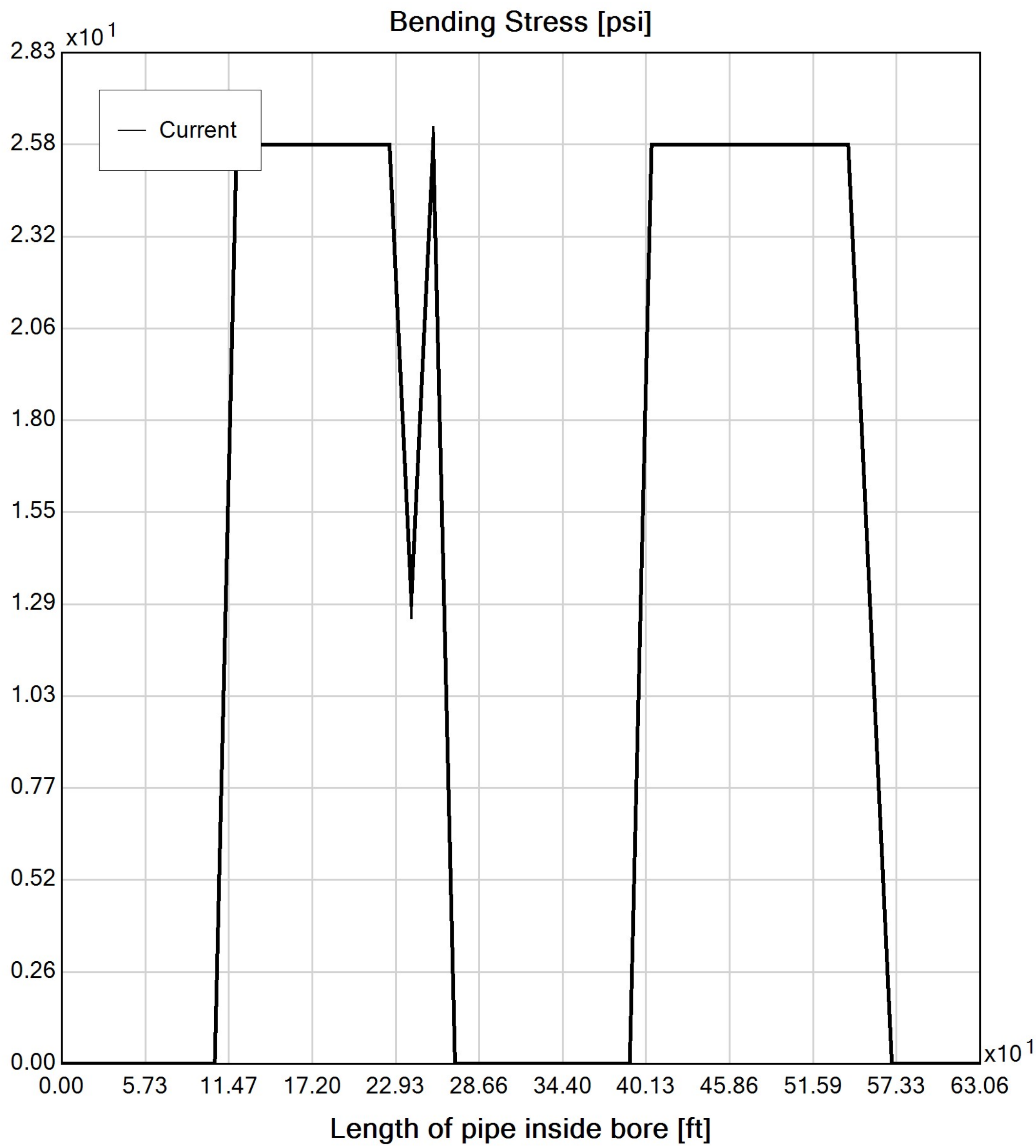
Effective Viscosity (cP): 1202.0

Virtual Site

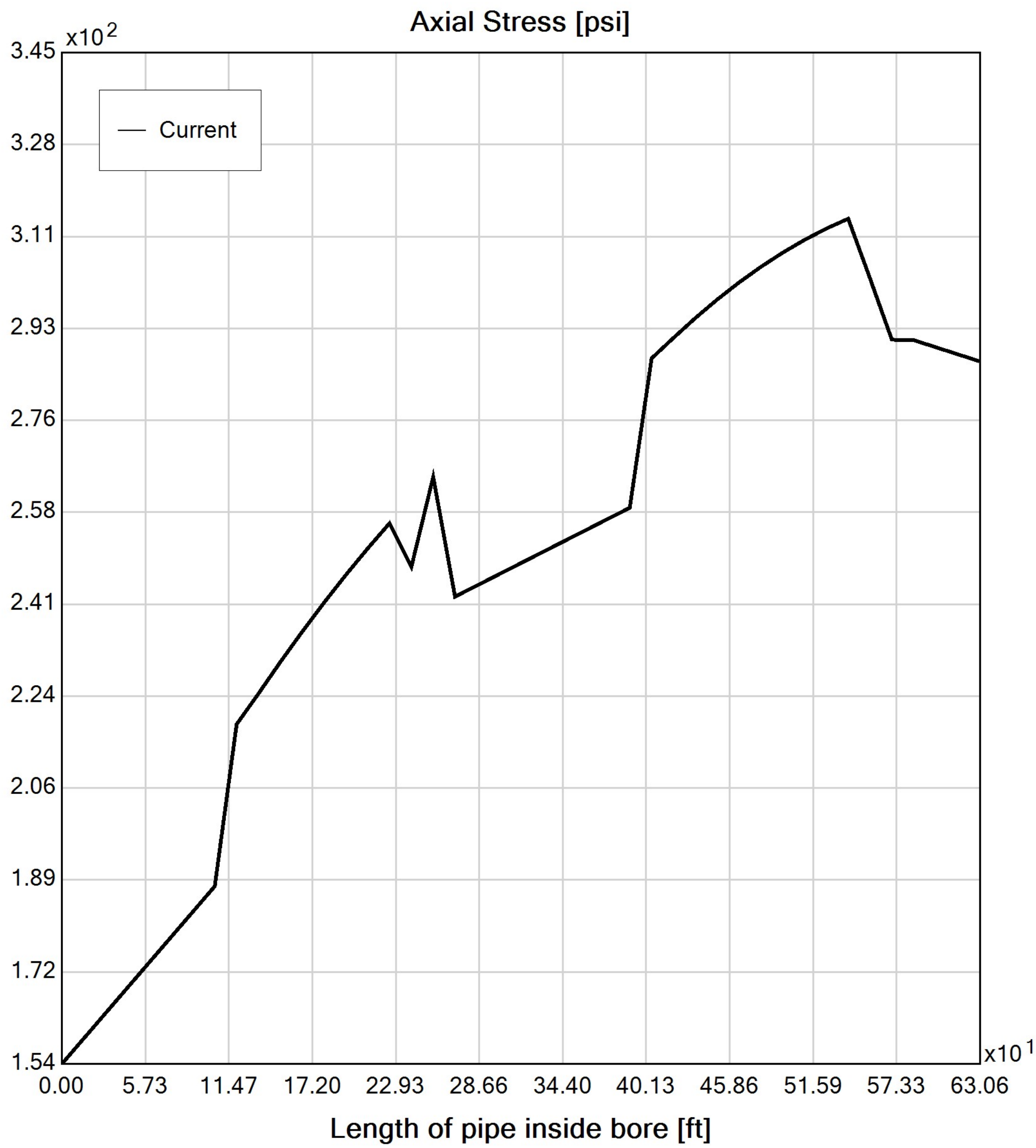



Pull Back Force [lb]
x10^4
1.15
1.09
1.04
0.99
0.93
0.88
0.82
0.77
0.72
0.66
0.61
0.55
Current
x10^1
0.00
5.73
11.47
17.20
22.93
28.66
34.40
40.13
45.86
51.59
57.33
63.06
Length of pipe inside bore [ft]


Pull Back Stress [psi]
x10 2
3.20
3.05
2.90
2.75
2.60
2.45
2.30
2.15
1.99
1.84
1.69
1.54
Current
x10 1
0.00
5.73
11.47
17.20
22.93
28.66
34.40
40.13
45.86
51.59
57.33
63.06
Length of pipe inside bore [ft]



Bending Stress [psi]
x10 1
2.83
2.58
2.32
2.06
1.80
1.55
1.29
1.03
0.77
0.52
0.26
0.00
Current
x10 1
0.00
5.73
11.47
17.20
22.93
28.66
34.40
40.13
45.86
51.59
57.33
63.06
Length of pipe inside bore [ft]



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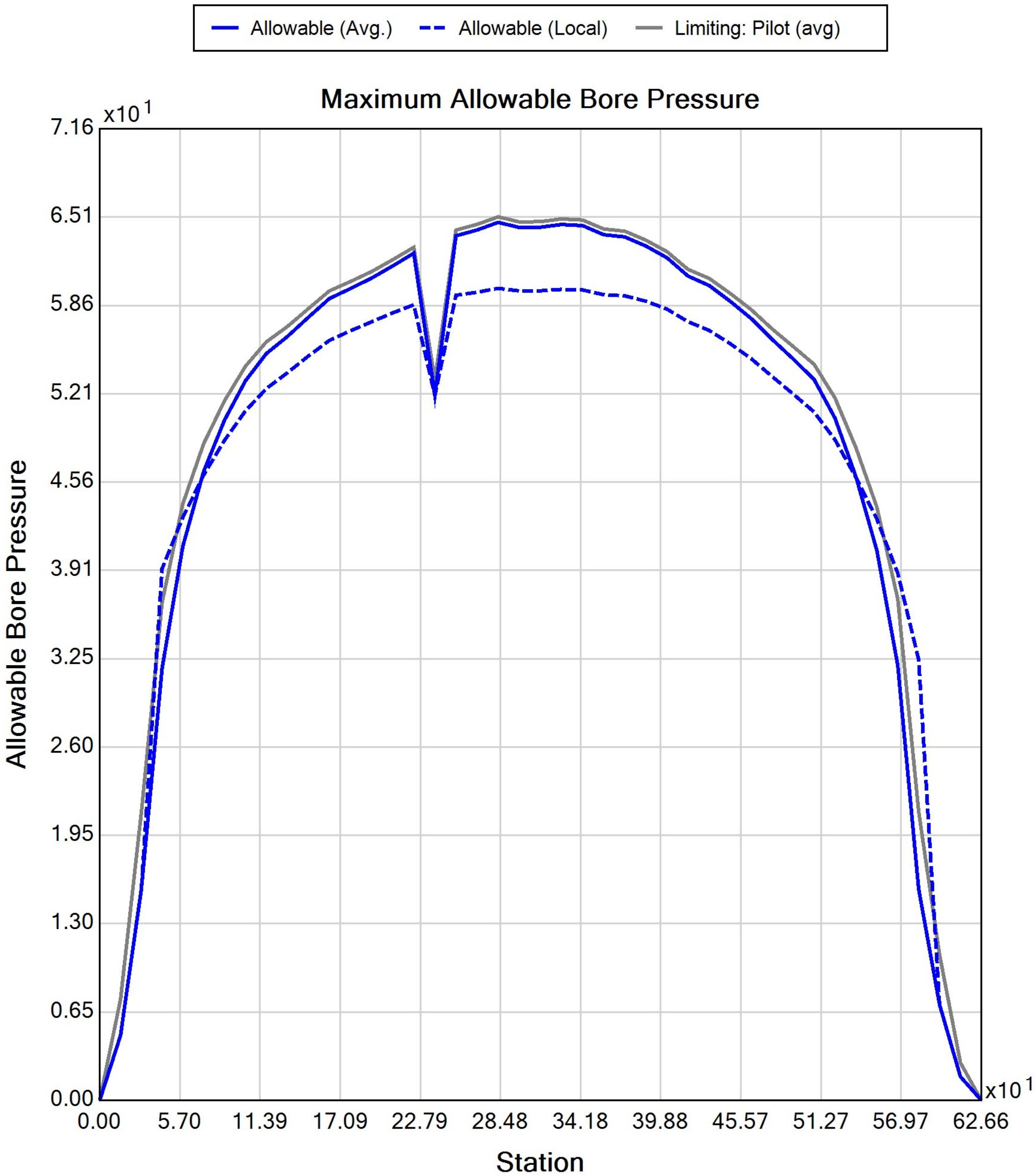
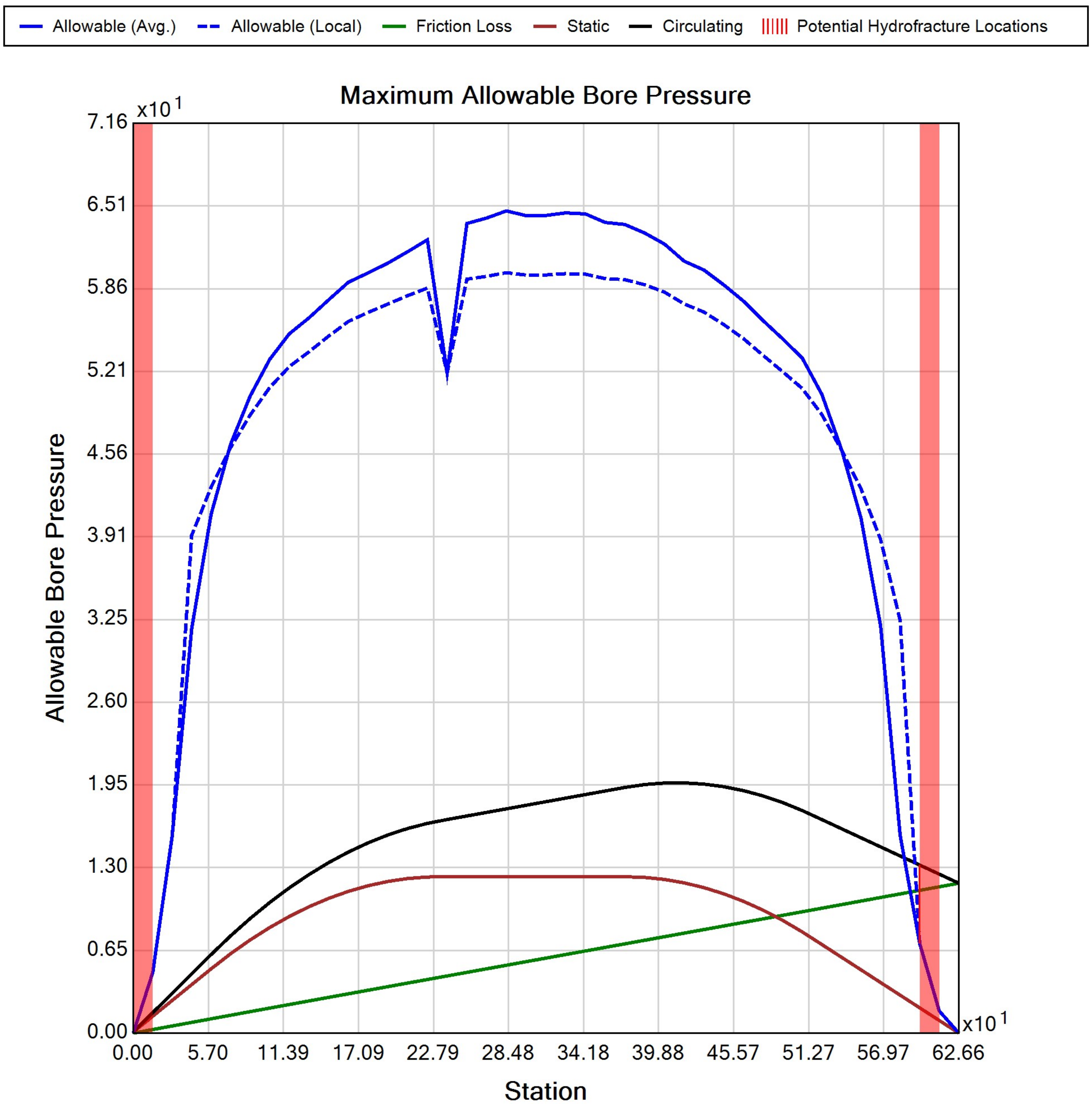


Allowable (Avg.)
Allowable (Local)
Limiting: Pilot (avg)
Maximum Allowable Bore Pressure
x10 1
7.16
6.51
5.86
5.21
4.56
3.91
3.25
2.60
1.95
1.30
0.65
0.00
Allowable Bore Pressure
0.00
5.70
11.39
17.09
22.79
28.48
34.18
39.88
45.57
51.27
56.97
62.66
x10 1
Station



Allowable (Avg.)
Allowable (Local)
Friction Loss
Static
Circulating
Potential Hydrofracture Locations
Maximum Allowable Bore Pressure
x10 1
7.16
6.51
5.86
5.21
4.56
3.91
3.25
2.60
1.95
1.30
0.65
0.00
Allowable Bore Pressure
0.00
5.70
11.39
17.09
22.79
28.48
34.18
39.88
45.57
51.27
56.97
62.66
x10 1
Station

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.

Input Summary

Start Coordinate	(0.00, 0.00, 130.11) ft
End Coordinate	(626.20, 0.00, 129.50) ft
Project Length	626.20 ft
Pipe Type	HDPE
OD Classification	IPS
Pipe OD	2.375 in
Pipe DR	9.0
Pipe Thickness	0.26 in
Rod Length	15.00 ft
Rod Diameter	3.5 in
Drill Rig Location	(0.00, 0.00, 0.00) ft

Load Verifier Input Summary:

Pipe Application: Electrical Cable

Pipe Type: HDPE

Classification: IPS

Pipe OD: 2" (2.375")

Pipe DR: 9

Pipe Length: 630.00 ft

Internal Pressure: 0 psi

Borehole Diameter: 0.531000018119812 ft

Silo Width: 0.531000018119812 ft

Surface Surcharge: 0 psi

Short Term Modulus: 57500 psi

Long Term Modulus: 28200 psi

Short Term Poisson Ratio: 0.35

Long Term Poisson Ratio: 0.45

Pipe Unit Weight: 59.30500 lb/ft3

Allowable Tensile Stress (Short Term): 1200 psi

Allowable Tensile Stress (Long Term): 1100 psi

Allowable Compressive Stress (Short Term): 1150 psi

Allowable Compressive Stress (Long Term): 1150 psi

Surface-pipe friction coefficient at entrance: 0.5

Surface-pipe friction coefficient in borehole: 0.3

Pipe-soil friction angle: 30

Slurry Unit Weight: 93.64118 lb/ft3

Hydrokinetic Pressure: 10 psi

Ballast Unit Weight: 62.42746 lb/ft3

In-service Load Summary:

Pressure [psi]	Deformed	Collapsed
Earth Pressure	5.9	13.0
Water Pressure	8.0	8.0
Surface Surcharge	0.0	0.0
Internal Pressure	0.0	0.0
Net Pressure	14.0	21.0
Deflection		
Earth Load Deflection	1.620	3.530
Buoyant Deflection	0.029	0.029
Reissner Effect	0	0
Net Deflection	1.649	3.559
Compressive Stress [psi]		
Compressive Wall Stress	62.9	94.4

Installation Load Summary:

Forces/Stresses	@Maximum Force	Absolute Maximum
Pullback Force [lb]	619.0	619.0
Pullback Stress [psi]	353.7	353.7
Pullback Strain	6.151E-3	6.151E-3
Bending Stress [psi]	0.0	5.7
Bending Strain	0	9.896E-5
Tensile Stress [psi]	353.7	356.5
Tensile Strain	6.151E-3	6.299E-3

Net External Pressure = 16.9 [psi]

Buoyant Deflection = 0.0

Hydrokinetic Force = 137.3 lb

In-service Analysis

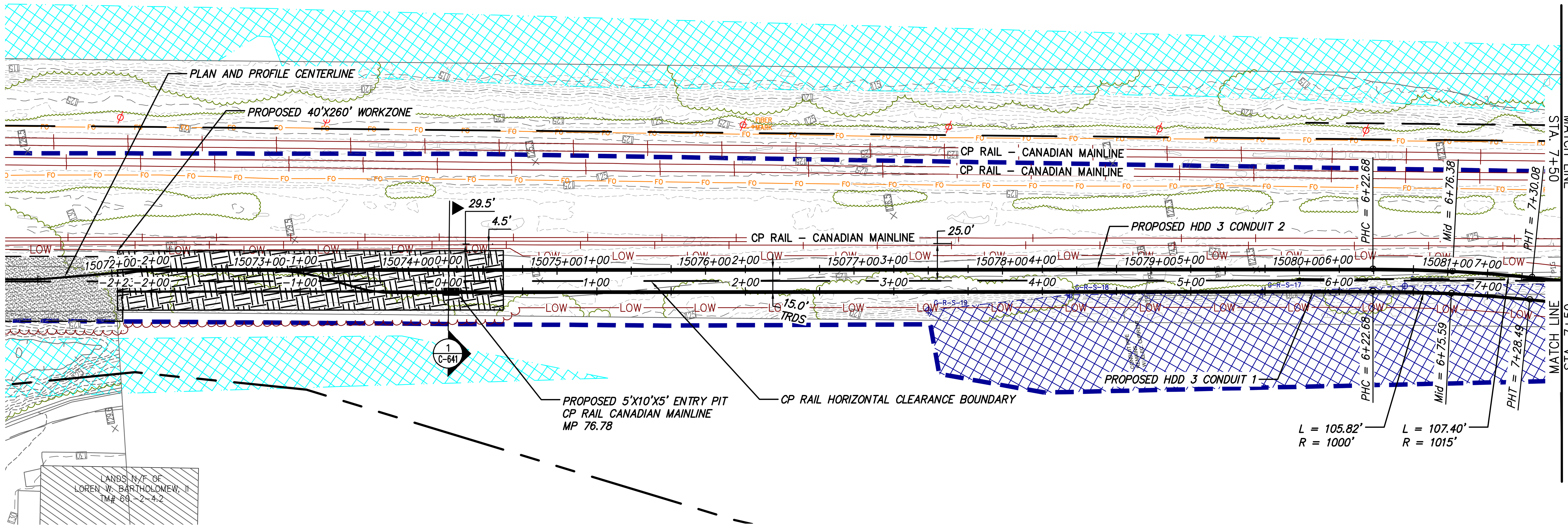
	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	1.649	7.5	4.5	OK
Unconstrained Collapse [psi]	16.8	119.1	7.1	OK
Compressive Wall Stress [psi]	62.9	1150.0	18.3	OK

Installation Analysis

	Calculated	Allowable	Factor of Safety	Check
Deflection [%]	0.014	7.5	524.3	OK
Unconstrained Collapse [psi]	26.7	236.6	8.8	OK
Tensile Stress [psi]	356.5	1200.0	3.4	OK

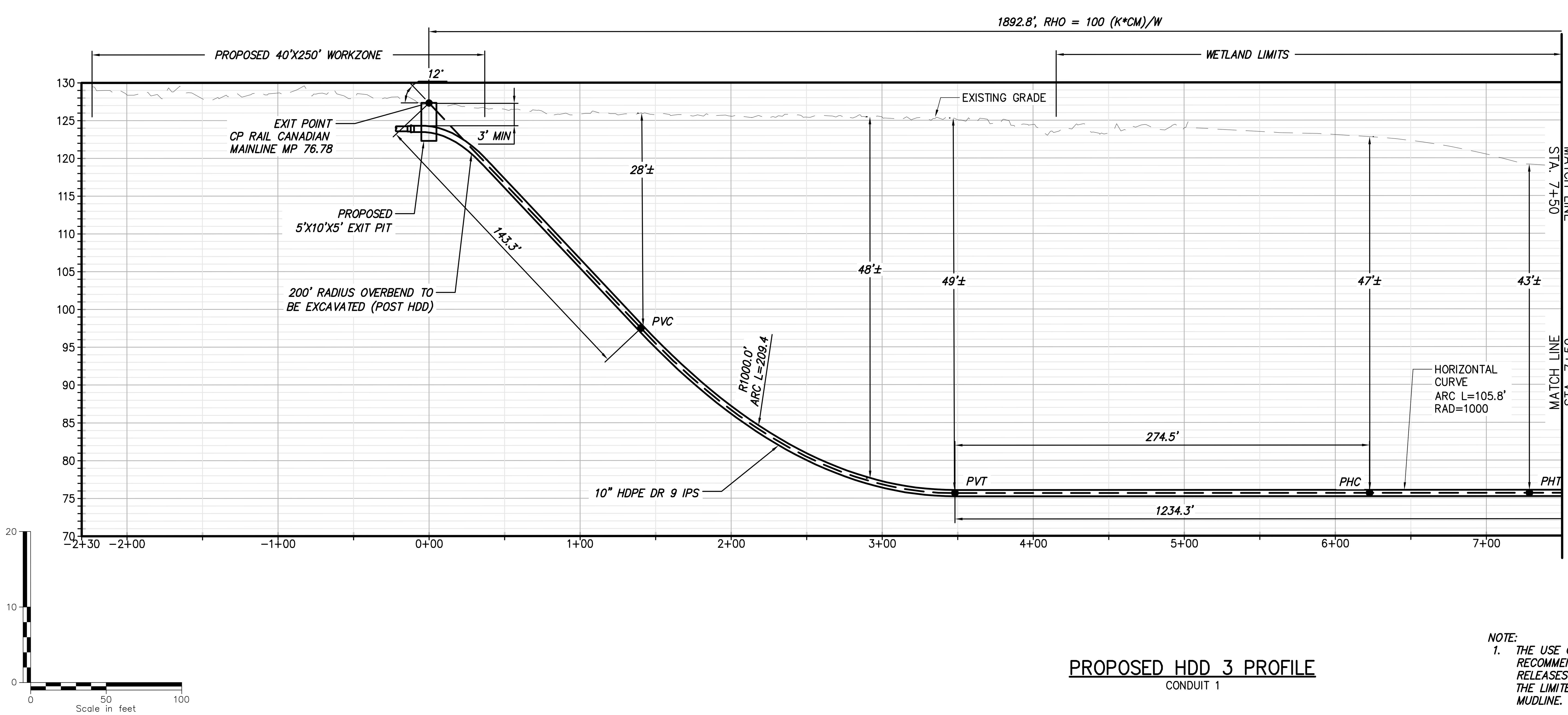
Appendix B

HDD Design Drawings



PROPOSED HDD 3 PLAN VIEW

CONDUIT 1



PROPOSED HDD 3 PROFILE

CONDUIT 1

NOTE:

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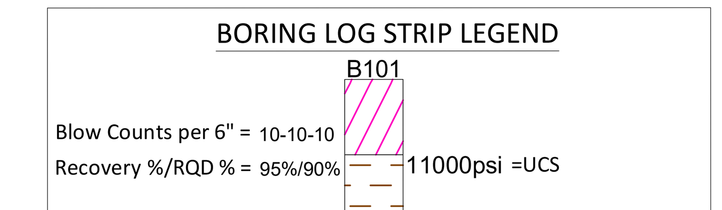
BORING LOG STRIP LEGEND



2D strip logs shown at 10x exaggeration
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Legend		
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	Boulder	Boulder
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	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
	GM	SILTY GRAVEL
	GP	Poorly Graded GRAVEL
	GP-GC	Poorly Graded Gravel with CLAY
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	GW-GM	Well Graded GRAVEL with SILT
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	ML	SILT
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	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
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	SC-SM	SILT, CLAYEY SAND
	SHALE	Shale
	SILTSTONE	Siltstone
	SM	SILTY SAND
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	SP-SC	Poorly Graded SAND with CLAY
	SP-SM	Poorly Graded SAND with SILT
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	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
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	USGS 670	Interbedded Sandstone and Shale
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	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
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CHAMPLAIN HUDSON POWER EXPRESS
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 3, CONDUIT 1

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. **C-301**

DRAWN BY: JAS | DESIGNED BY: JAS | APPROVED BY: JEO | SCALE AS NOTED | REV. NO. X | DATE 12/16/2022 | XXX

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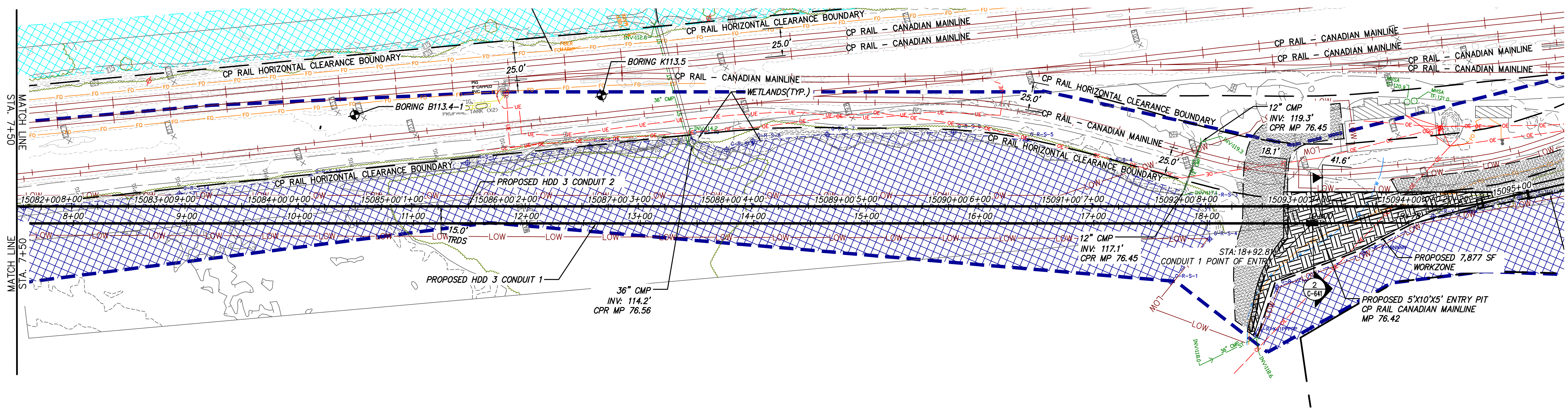
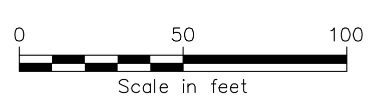
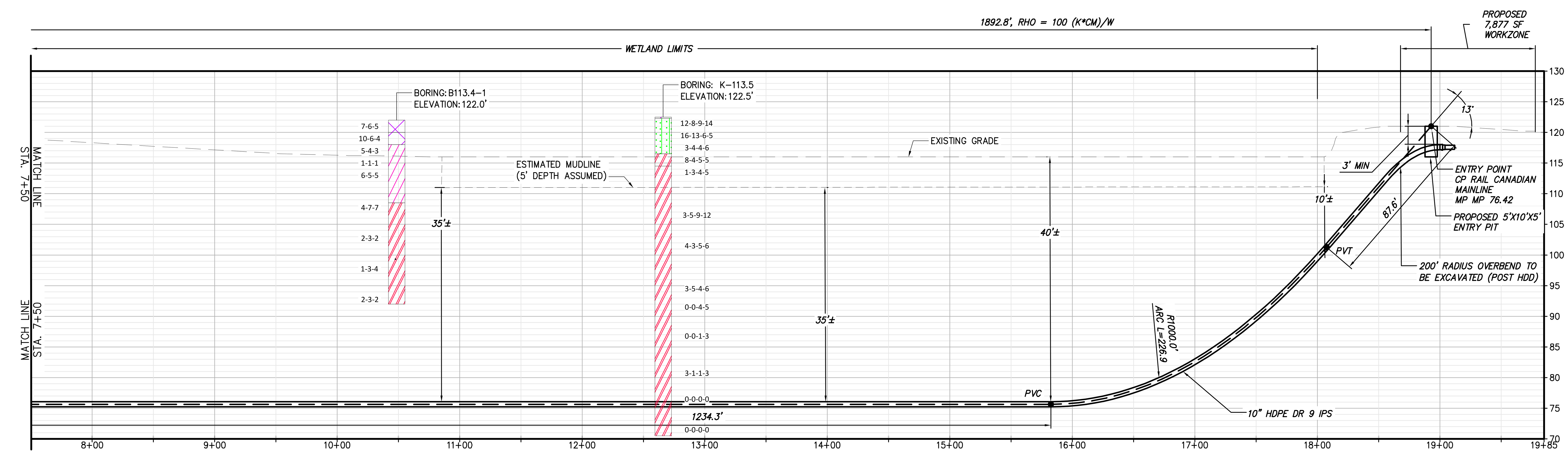
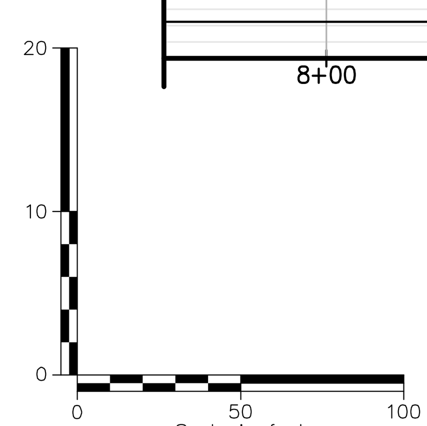




PROPOSED HDD 3 PLAN VIEW

CONDUIT 1





PROPOSED HDD 3 PROFILE

CONDUIT 1

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BORING LOG STRIP LEGEND

B101

Blow Counts per 6" = 10-10-10

Recovery %/RQD % = 95%/90%

11000psi =UCS

2D strip logs shown at 10x exaggeration

3D strip logs have no exaggeration

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
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	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
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	GC-GM	SILTY CLAYEY GRAVEL
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	ML	SILT
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	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
	Sandstone	Sandstone
	SC	CLAYEY SAND
	SC-SM	SILT, CLAYEY SAND
	SHALE	Shale
	SILTSTONE	Siltstone
	SM	SILTY SAND
	SP	Poorly Graded SAND
	SP-SC	Poorly Graded SAND with CLAY
	SP-SM	Poorly Graded SAND with SILT
	SW	Well graded SAND
	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
	USGS 654	Subgraywacke
	USGS 670	Interbedded Sandstone and Shale
	USGS 702	Quartzite
	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
▽	Delayed Water Table	Water Table after drilling

CHPE Champlain Hudson Power Express

Kiewit

CHA
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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

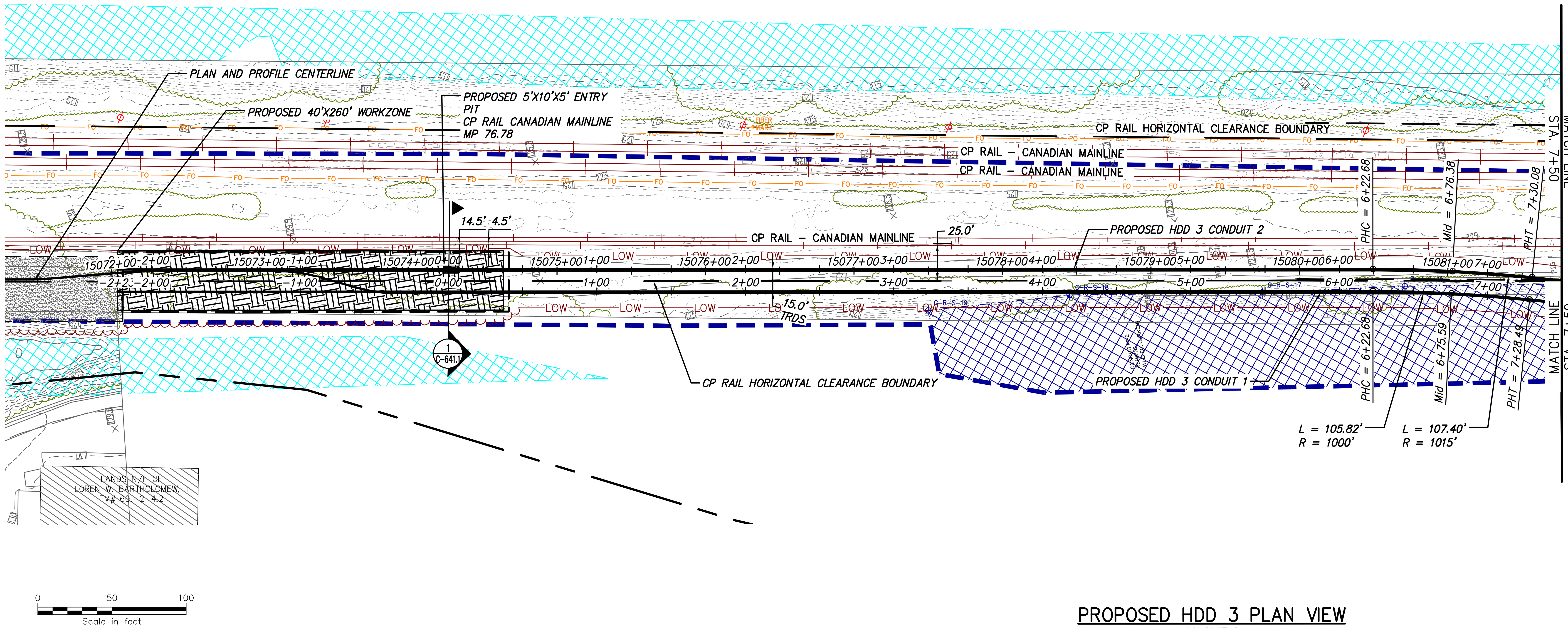
PLAN AND PROFILE - HDD 3, CONDUIT 1

KIEWIT PROJECT NO. 21162

CHA PROJECT NO. 066076

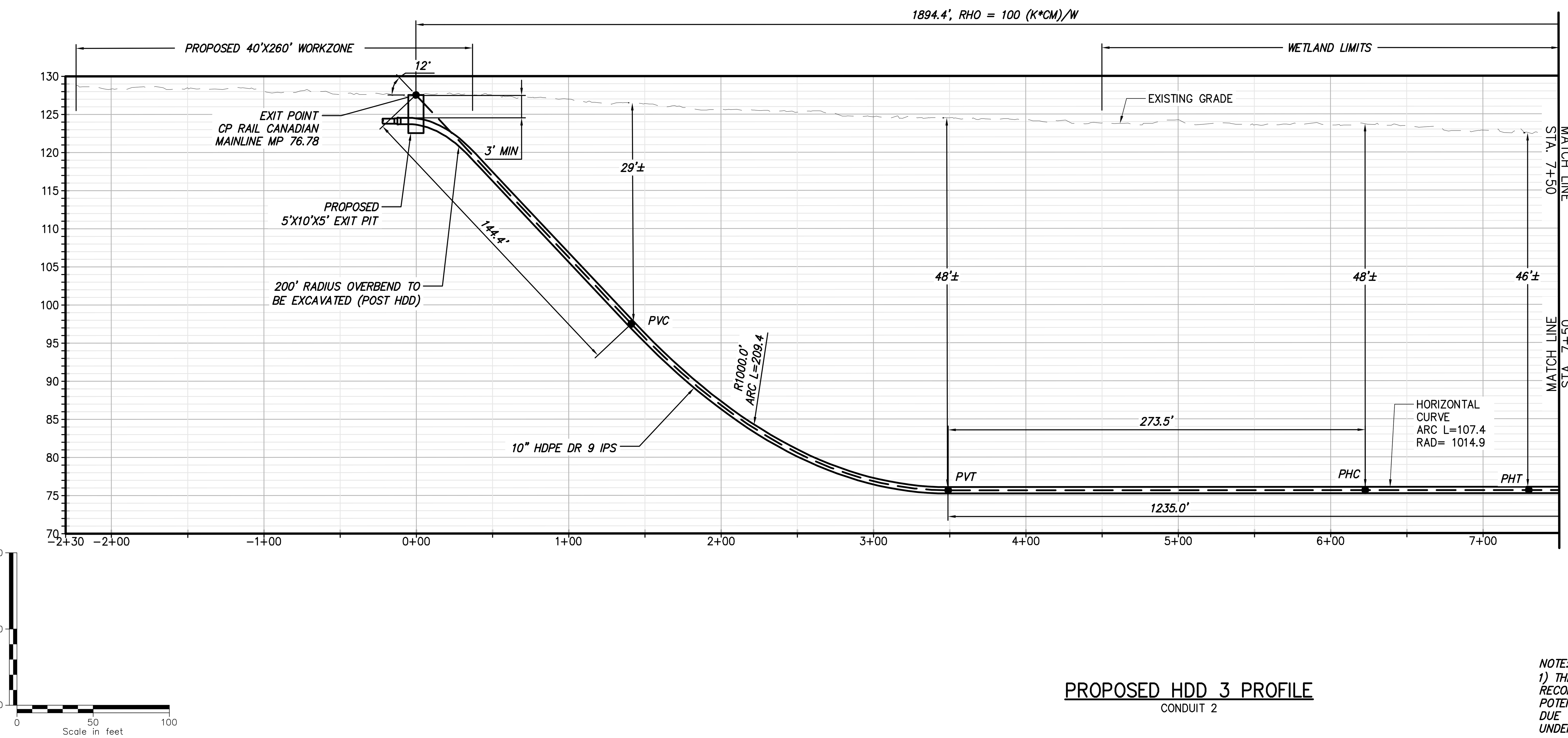
DRAWING NO. C-301.1

DRAWN BY: JAS | DESIGNED BY: JAS | APPROVED BY: JEO | SCALE AS NOTED | REV. NO. X | DATE 12/16/2022 | XXX



PROPOSED HDD 3 PLAN VIEW

CONDUIT 2



PROPOSED HDD 3 PROFILE

CONDUIT 2

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B101
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Recovery %/RQD % = 95%/90%
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Legend

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SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

PLAN AND PROFILE - HDD 3, CONDUIT 2

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CHA PROJECT NO. 066076
DRAWING NO. **C-301A**

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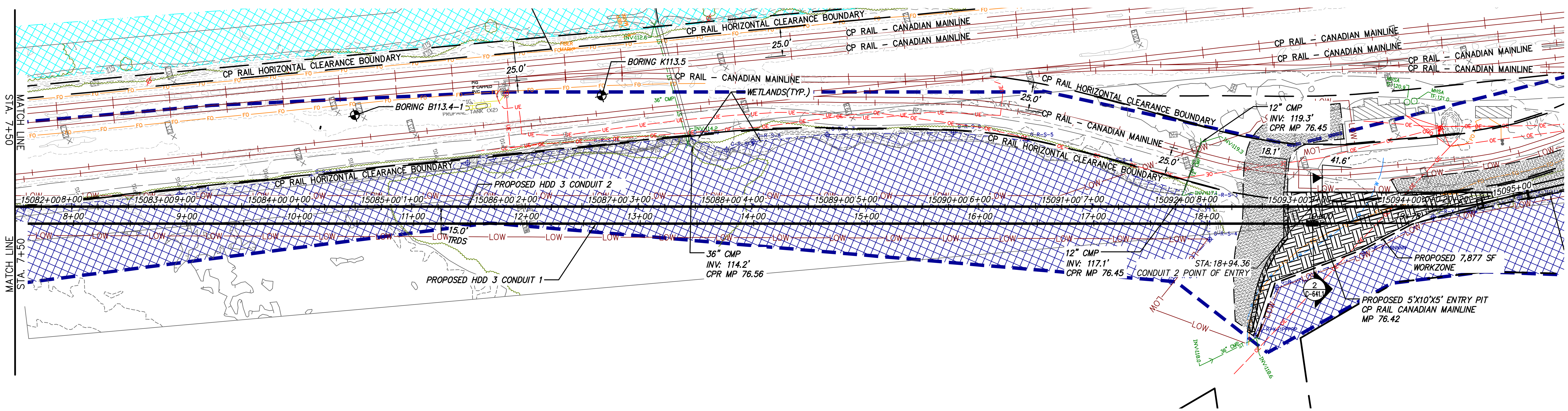
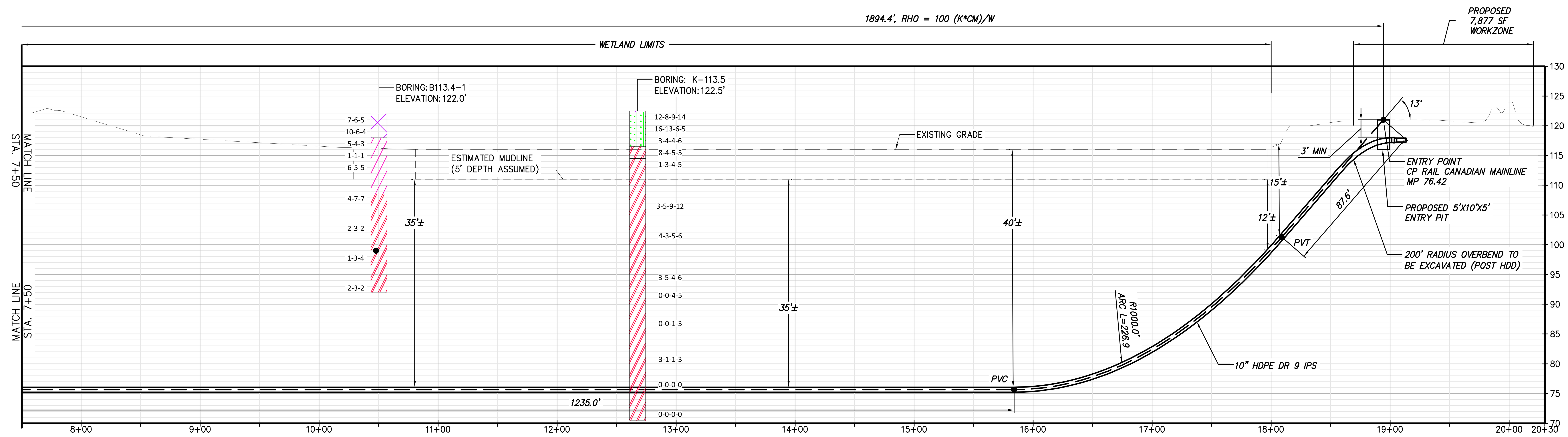


PROPOSED HDD 3 PLAN VIEW

CONDUIT 2



PROPOSED HDD 3 PROFILE

CONDUIT 2

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DRAWING NO. C-301A.1

DRAWN BY: JAS DESIGNED BY: JAS APPROVED BY: JEO

SCALE AS NOTED

REV. NO. X

DATE 12/16/2022

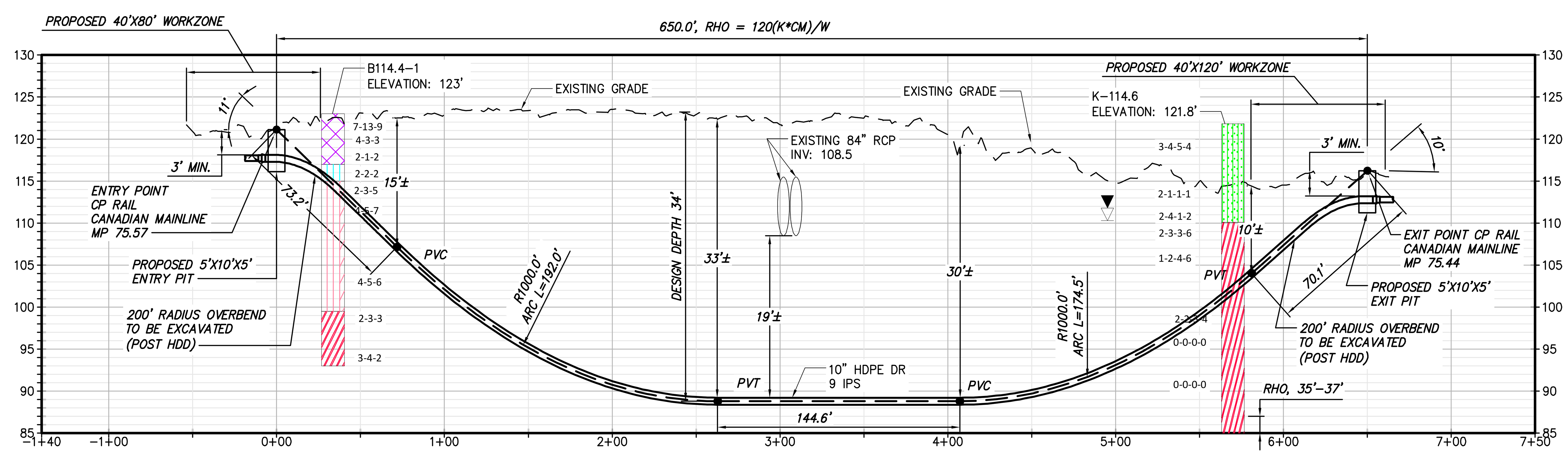
XXX

A

B

PROPOSED HDD 4 PLAN VIEW

CONDUIT 1



PROPOSED HDD 4 PROFILE

CONDUIT 1

BORING LOG STRIP LEGEND

B101

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SC-SM	SILT, CLAYEY SAND
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Champlain Hudson Power Express

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CHAMPLAIN HUDSON POWER EXPRESS
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 4, CONDUIT 1

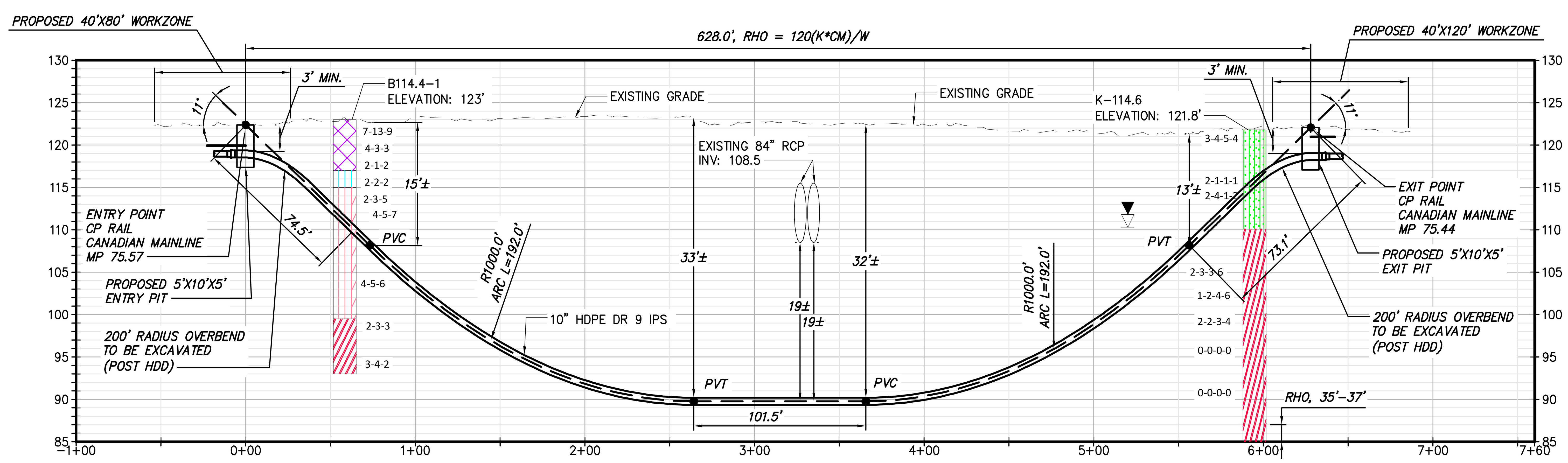
KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. **C-302**

DRAWN BY: ES | DESIGNED BY: ES | APPROVED BY: JEO | SCALE: AS NOTED | REV. NO.: X | DATE: 12/16/2022

1 2 3 4

PROPOSED HDD 4 PLAN VIEW

CONDUIT 2



PROPOSED HDD 4 PROFILE

CONDUIT 2

BORING LOG STRIP LEGEND

B101

Blow Counts per 6" = 10-10-10

Recovery %/RQD % = 95%/90%

11000psi =UCS

2D strip logs shown at 10x exaggeration

3D strip logs have no exaggeration

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
	GM	SILTY GRAVEL
	GP	Poorly Graded GRAVEL
	GP-GC	Poorly Graded Gravel with CLAY
	GP-GM	Poorly Graded GRAVEL with SILT
	GW	Well Graded GRAVEL
	GW-GC	Well Graded GRAVEL with CLAY
	GW-GM	Well Graded GRAVEL with SILT
	Limestone	Limestone
	MH	Elastic SILT
	ML	SILT
	OH	ORGANIC Fat CLAY
	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
	Sandstone	Sandstone
	SC	CLAYEY SAND
	SC-SM	SILT, CLAYEY SAND
	SHALE	Shale
	SILTSTONE	Siltstone
	SM	SILTY SAND
	SP	Poorly Graded SAND
	SP-SC	Poorly Graded SAND with CLAY
	SP-SM	Poorly Graded SAND with SILT
	SW	Well graded SAND
	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
	USGS 654	Subgraywacke
	USGS 670	Interbedded Sandstone and Shale
	USGS 702	Quartzite
	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
▽	Delayed Water Table	Water Table after drilling

CHPE Champlain Hudson Power Express

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IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED, THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE, THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

No.	DATE	SUBMITTAL / REVISION DESCRIPTION	DB	APP
0	12/16/2022	FINAL EM&CP SUBMISSION	MCS	JEO

CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

PLAN AND PROFILE - HDD 4, CONDUIT 2

KIEWIT PROJECT NO. 21162

CHA PROJECT NO. 066076

DRAWING NO. **C-302A**

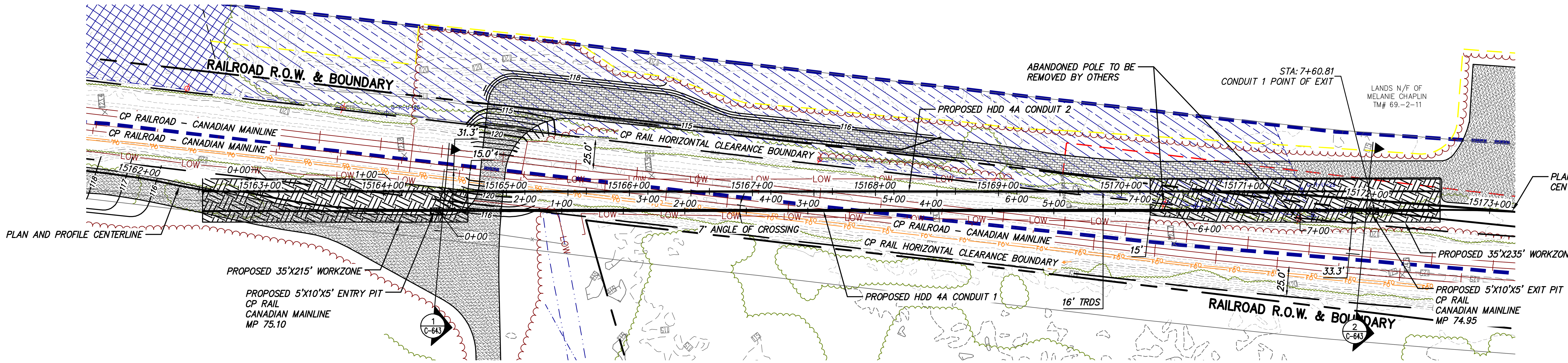
DRAWN BY: ES | DESIGNED BY: ES | APPROVED BY: JEO | SCALE: AS NOTED | DATE: 12/16/2022 | REV. NO. X

A

B

1 2 3 4

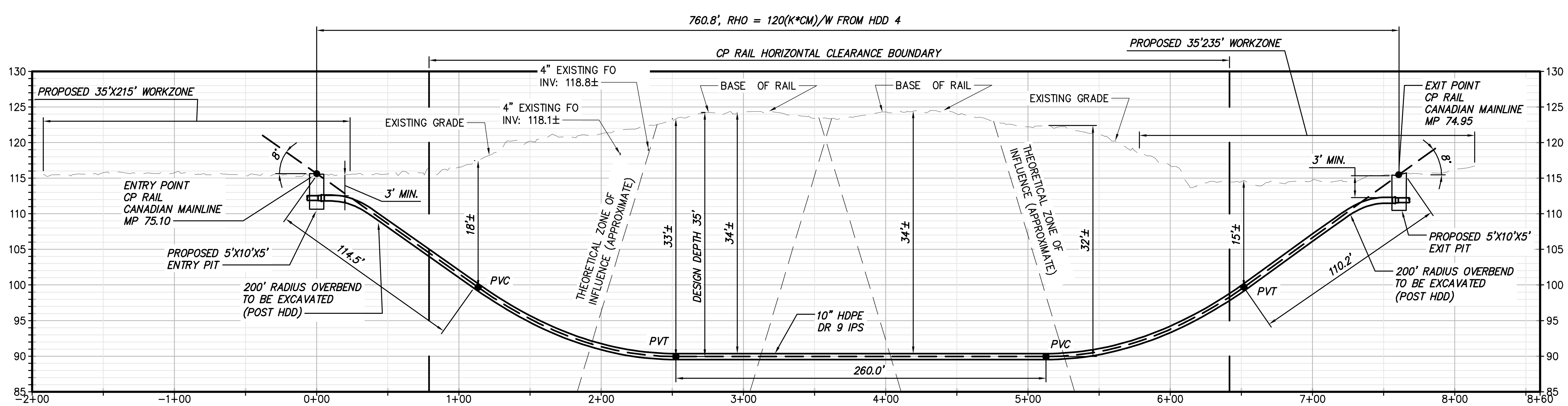
A



Scale in feet (0, 50, 100)

PROPOSED HDD 4A PLAN VIEW

CONDUIT 1



Scale in feet (0, 10, 20 vertical; 0, 50, 100 horizontal)

PROPOSED HDD 4A PROFILE

CONDUIT 1

NOTE:
1) NO SUBSURFACE INVESTIGATIONS WERE CONDUCTED AT HDD #4A. THE SOIL CONDITIONS WERE ESTIMATED BASED ON NEARBY BORINGS. IT IS RECOMMENDED THAT THE HDD SUBCONTRACTOR DRILL A TEST BORING AT THE SITE BEFORE STARTING CONSTRUCTION AT THE HDD #4A SITE BEFORE STARTING THE HDD TO CONFIRM THE GROUND CONDITIONS.

B

BORING LOG STRIP LEGEND

B101
Blow Counts per 6" = 10-10-10
Recovery %/RQD % = 95%/90%
11000psi =UCS

2D strip logs shown at 10x exaggeration
3D strip logs have no exaggeration

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
	GM	SILTY GRAVEL
	GP	Poorly Graded GRAVEL
	GP-GC	Poorly Graded Gravel with CLAY
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	GW-GC	Well Graded GRAVEL with CLAY
	GW-GM	Well Graded GRAVEL with SILT
	Limestone	Limestone
	MH	Elastic SILT
	ML	SILT
	OH	ORGANIC Fat CLAY
	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
	Sandstone	Sandstone
	SC	CLAYEY SAND
	SC-SM	SILT, CLAYEY SAND
	SHALE	Shale
	SILTSTONE	Siltstone
	SM	SILTY SAND
	SP	Poorly Graded SAND
	SP-SC	Poorly Graded SAND with CLAY
	SP-SM	Poorly Graded SAND with SILT
	SW	Well graded SAND
	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
	USGS 654	Subgraywacke
	USGS 670	Interbedded Sandstone and Shale
	USGS 702	Quartzite
	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
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	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

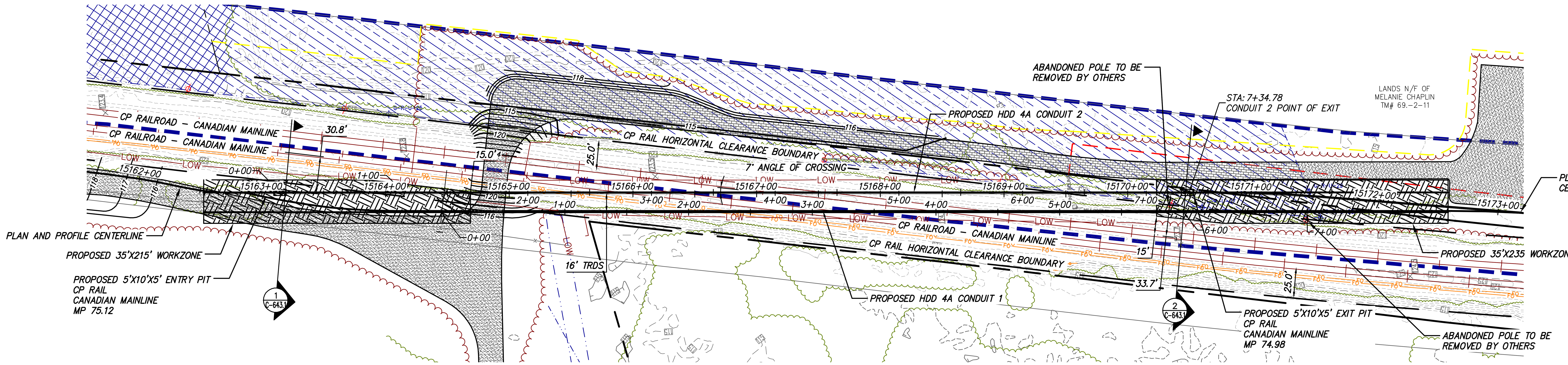
PLAN AND PROFILE - HDD 4A, CONDUIT 1

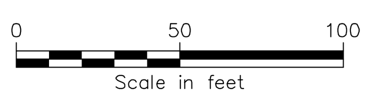
KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. C-303

DRAWN BY: ES | DESIGNED BY: ES | APPROVED BY: JEO | SCALE AS NOTED | DATE 12/16/2022 | REV. NO. X

1 2 3 4

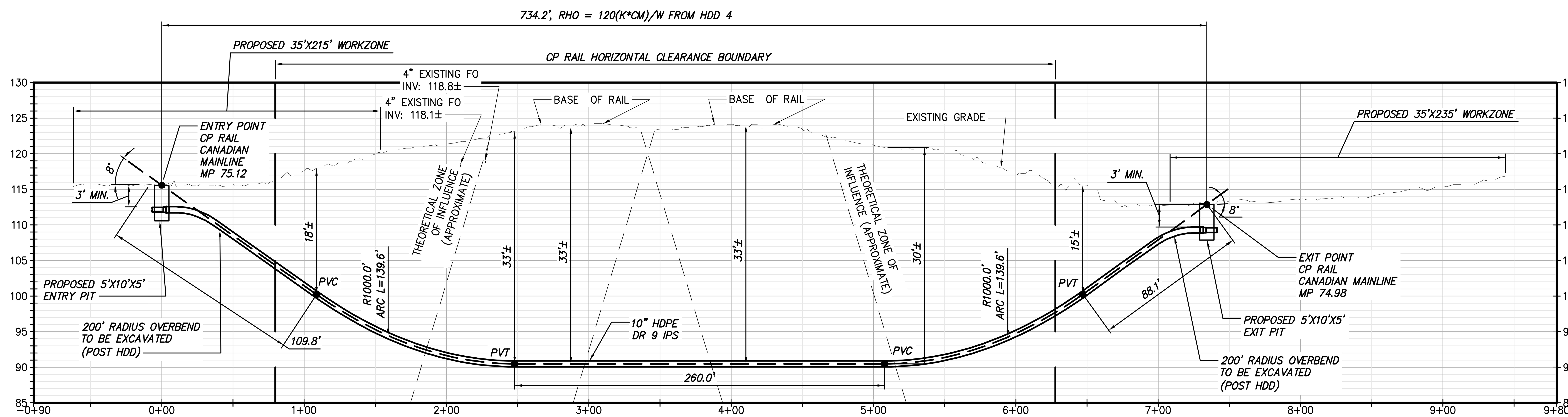
A

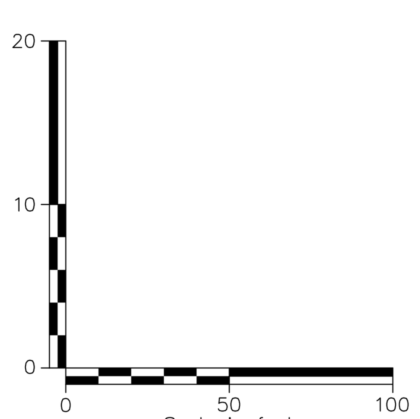




PROPOSED HDD 4A PLAN VIEW

CONDUIT 2





PROPOSED HDD 4A PROFILE

CONDUIT 2

B

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
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	USGS 705	Schist
	USGS 705	Schist
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	USGS 708	Gneiss
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	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
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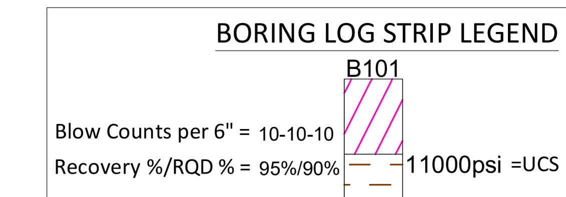
BORING LOG STRIP LEGEND



2D strip logs shown at 10x exaggeration
3D strip logs have no exaggeration

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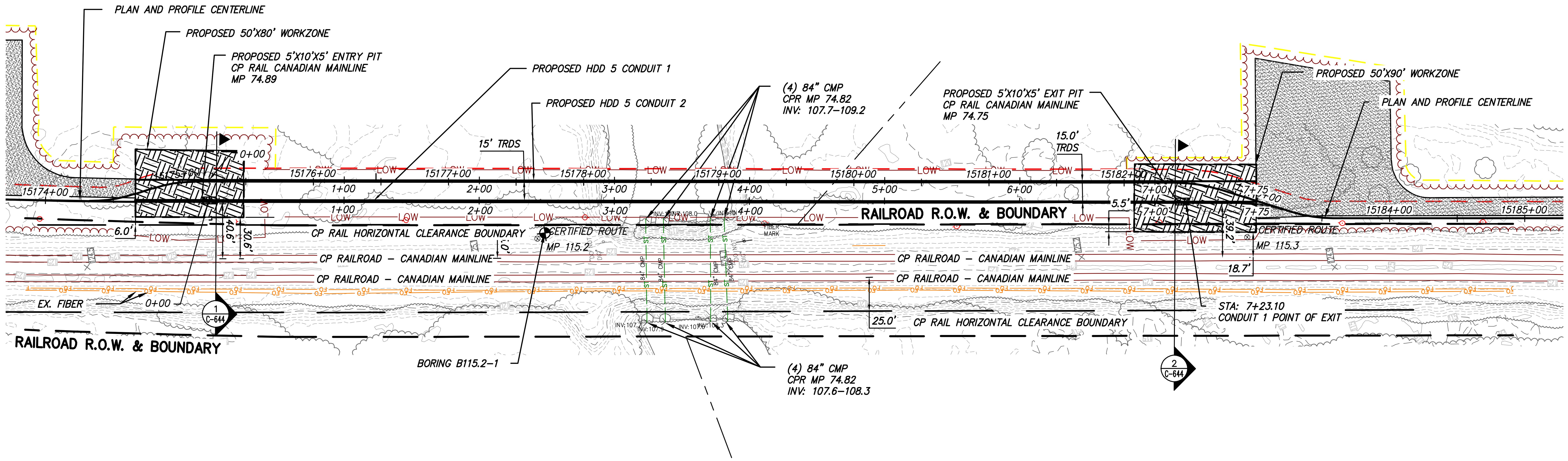
CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

PLAN AND PROFILE - HDD 4A, CONDUIT 2

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. C-303A

DRAWN BY: ES DESIGNED BY: ES APPROVED BY: JEO SCALE AS NOTED DATE 12/16/2022 REV. NO. X



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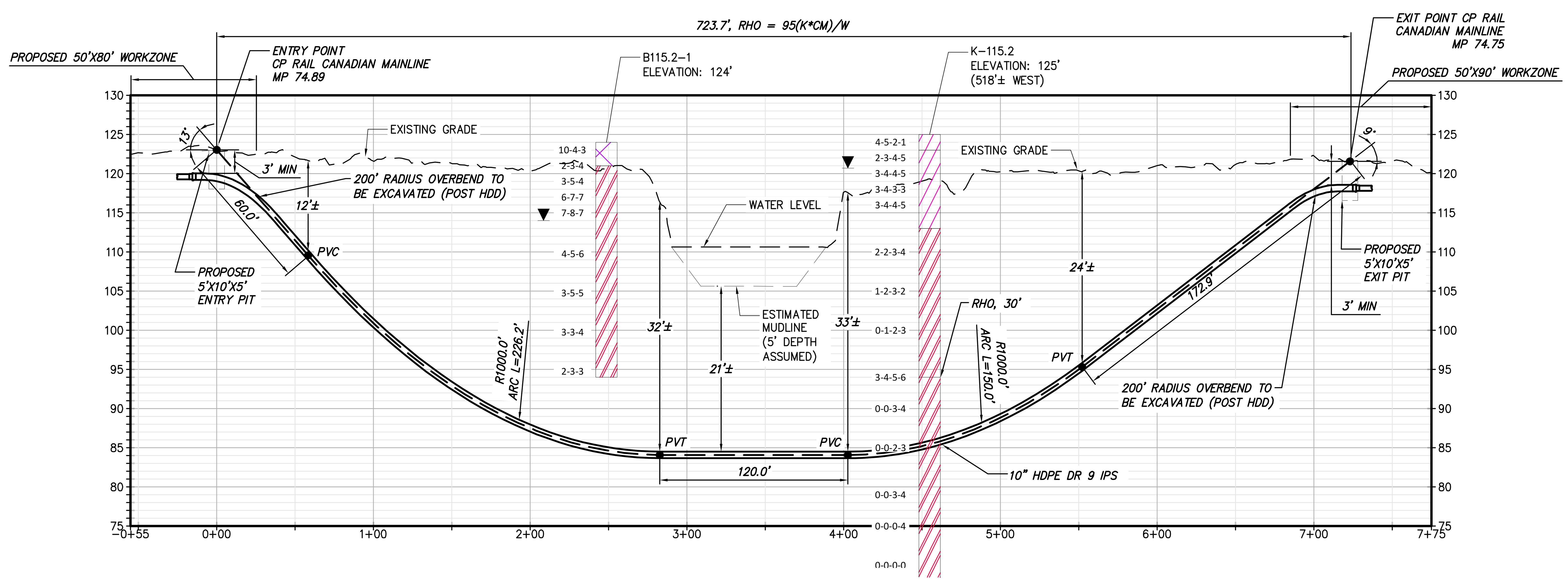
Scale in feet

PROPOSED HDD 5 PLAN VIEW
CONDUIT 1



0 50 100
Scale in feet

PROPOSED HDD 5 PROFILE
CONDUIT 1

BORING LOG STRIP LEGEND
B101
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Legend		
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	CL-ML	SILTY CLAY
	CONCRETE	Concrete
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	Limestone	Limestone
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	SHALE	Shale
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	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
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SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 5, CONDUIT 1

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. C-304

DRAWN BY: CJL DESIGNED BY: CJL APPROVED BY: JEO SCALE AS NOTED DATE 12/16/2022 REV. NO. X

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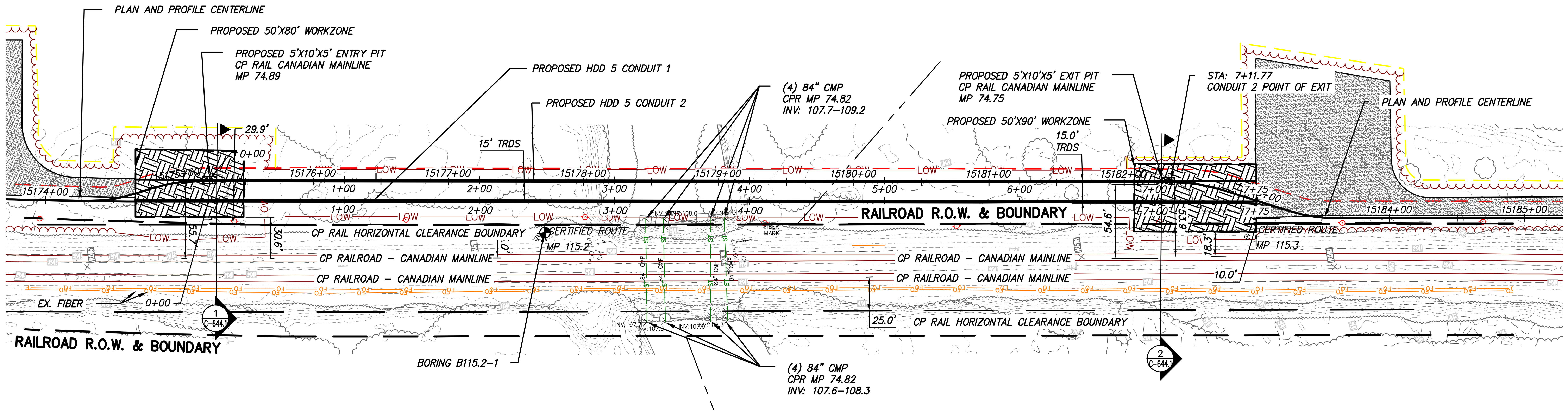
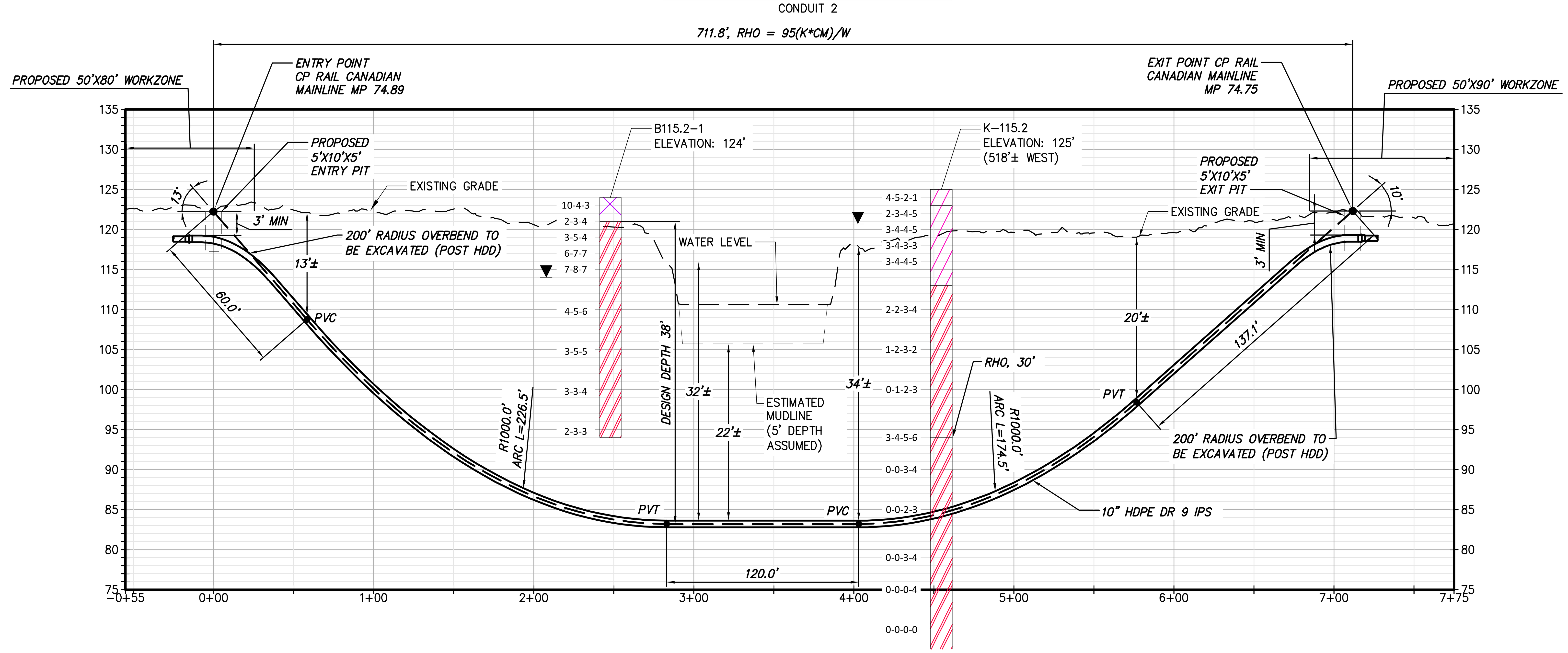


0 50 100
Scale in feet

PROPOSED HDD 5 PLAN VIEW

CONDUIT 2



0 10 20
0 50 100
Scale in feet

PROPOSED HDD 5 PROFILE

CONDUIT 2

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

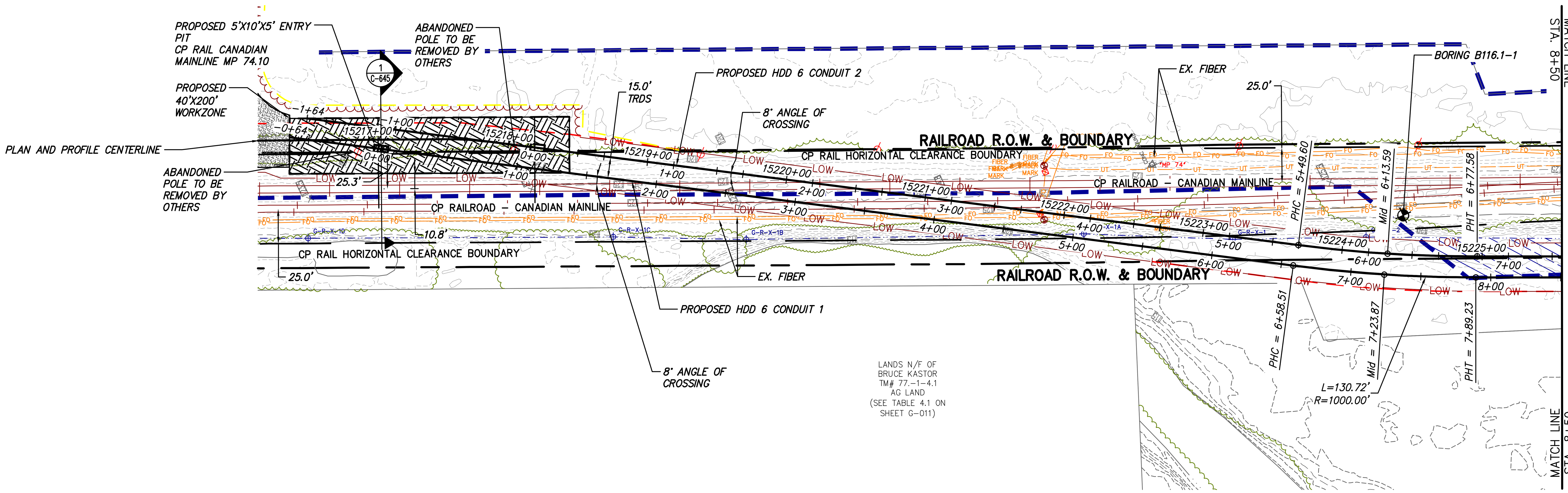
PLAN AND PROFILE - HDD 5, CONDUIT 2

KIEWIT PROJECT NO. 21162

CHA PROJECT NO. 066076

DRAWING NO. C-304A

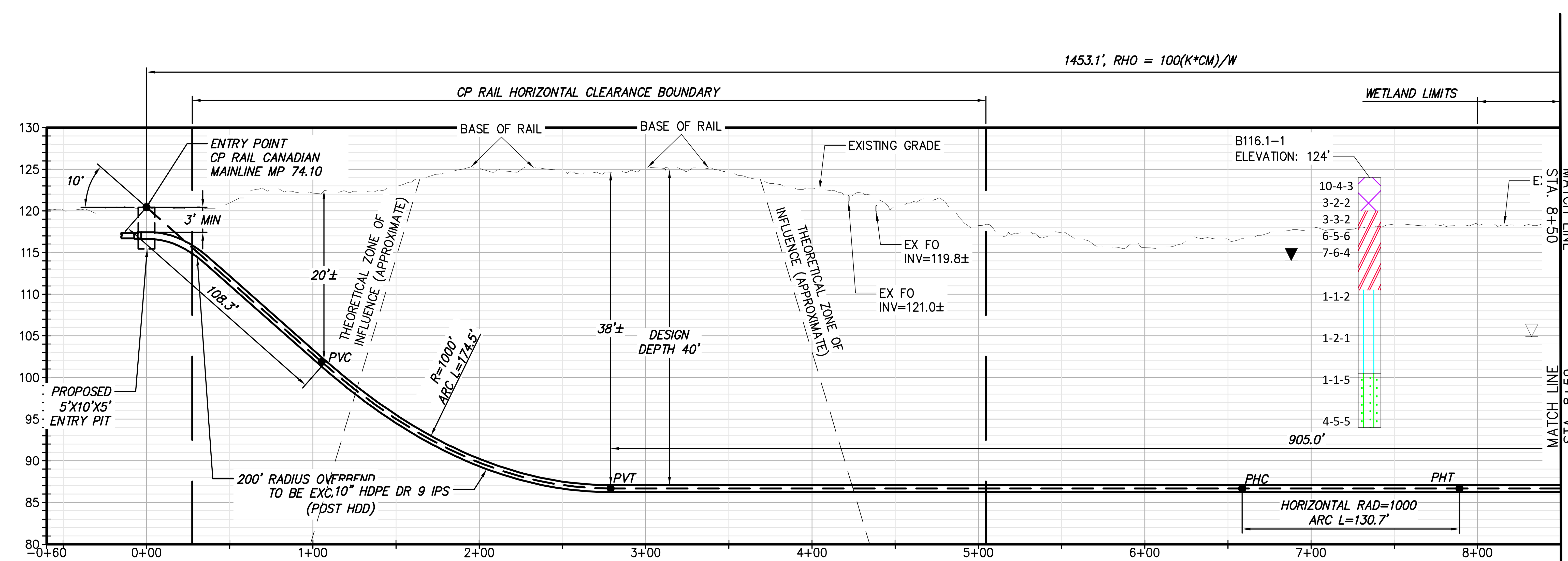
DRAWN BY: CJL DESIGNED BY: CJL APPROVED BY: JEO SCALE AS NOTED DATE 12/16/2022 REV. NO. X



PROPOSED HDD 6 PLAN VIEW

CONDUIT 1

0 50 100
Scale in feet



0 50 100
Scale in feet

PROPOSED HDD 6 PROFILE

CONDUIT 1

NOTE:
1) THE USE OF CONDUCTOR CASINGS IS RECOMMENDED TO MITIGATE THE POTENTIAL RELEASES OF FRILLING FLUIDS.

BORING LOG STRIP LEGEND

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11000psi =UCS
2D strip logs shown at 10x exaggeration
3D strip logs have no exaggeration

Legend

ASPHALT	Asphalt
Bedrock	Bedrock
Boulder	Boulder
CH	Fat CLAY
CH-MH	SILTY Fat CLAY
CL	Lean CLAY
CL-ML	SILTY CLAY
CONCRETE	Concrete
Fill	Fill
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CHAMPLAIN HUDSON POWER EXPRESS

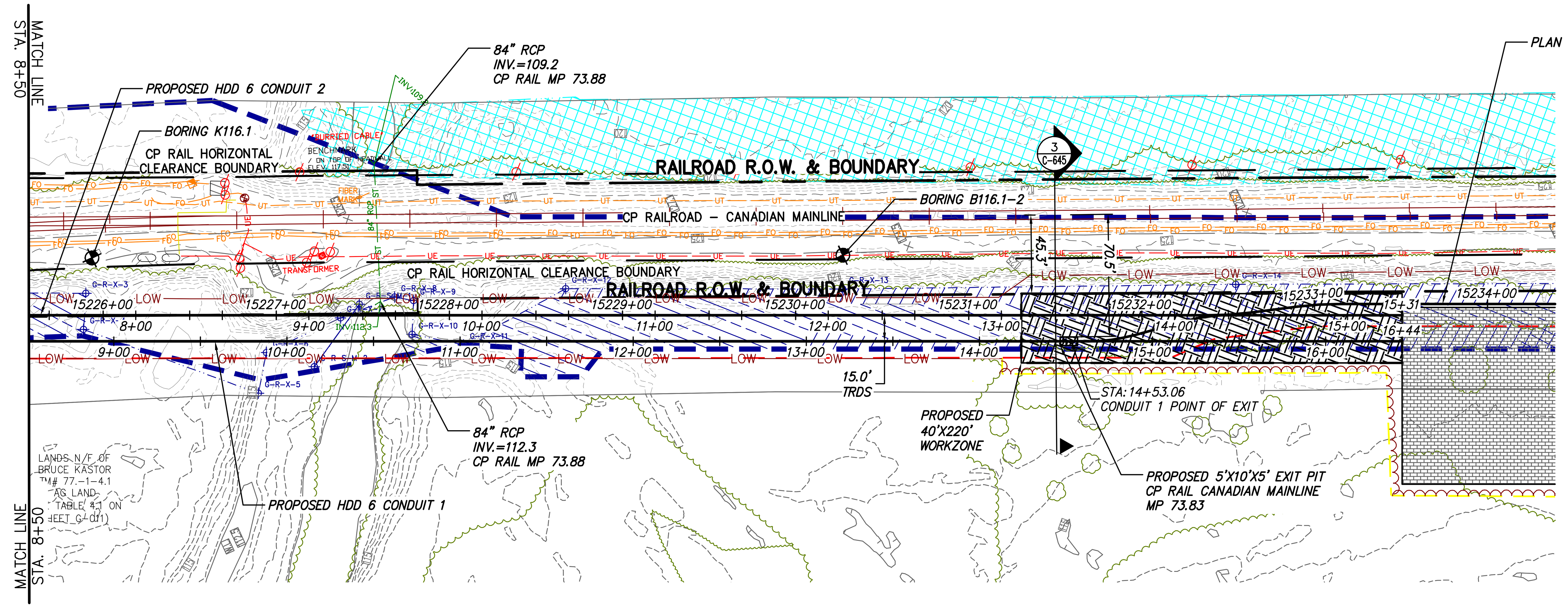
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

PLAN AND PROFILE - HDD 6, CONDUIT 1

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. **C-305**

DRAWN BY: CJL | DESIGNED BY: CJL | APPROVED BY: JEO | SCALE AS NOTED | DATE 12/16/2022 | REV. NO. X

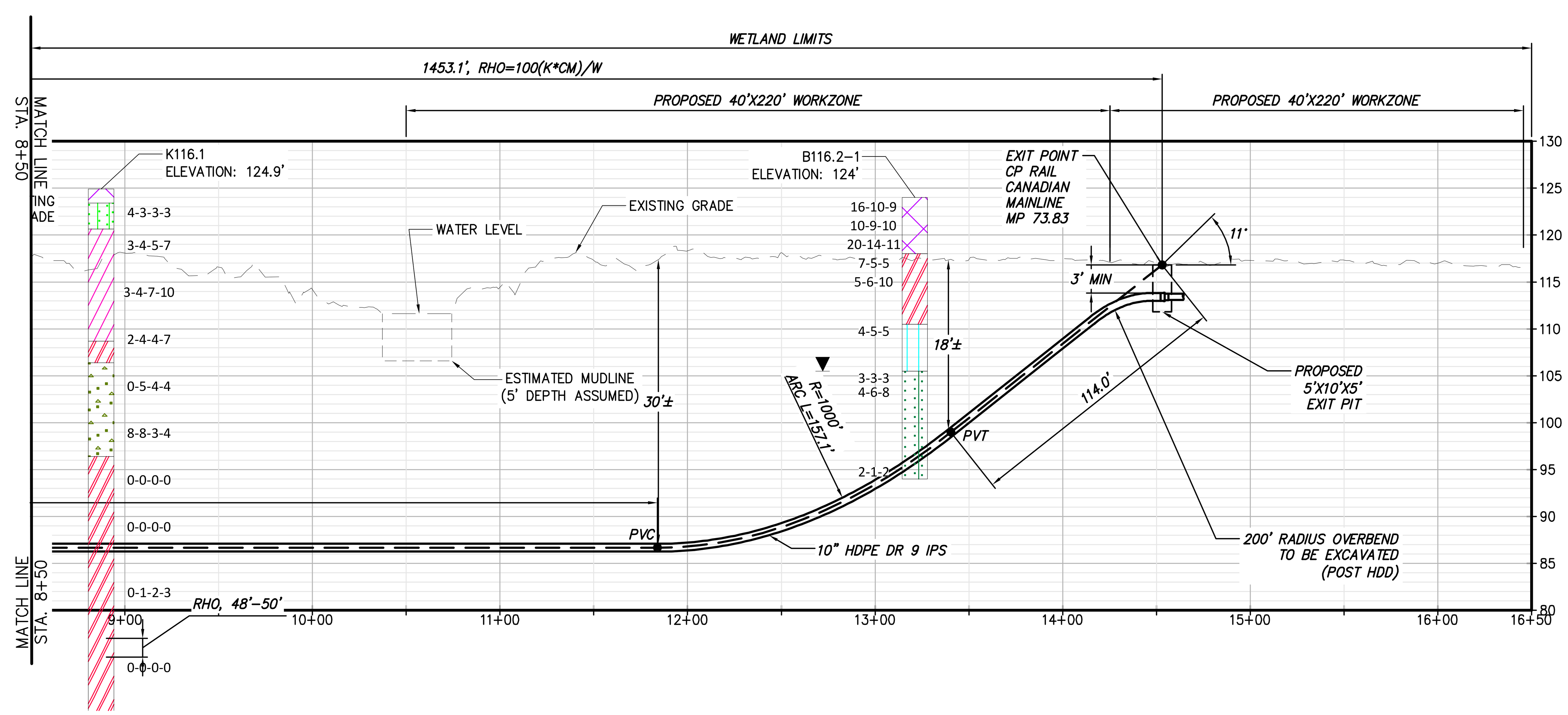
1 | 2 | 3 | 4



0 50 100
Scale in feet

PROPOSED HDD 6 PLAN VIEW

CONDUIT 1



20 10 0
0 50 100
Scale in feet

PROPOSED HDD 6 PROFILE

CONDUIT 1

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2D strip logs shown at 10x exaggeration
3D strip logs have no exaggeration

Legend

	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
	GM	SILTY GRAVEL
	GP	Poorly Graded GRAVEL
	GP-GC	Poorly Graded Gravel with CLAY
	GP-GM	Poorly Graded GRAVEL with SILT
	GW	Well Graded GRAVEL
	GW-GC	Well Graded GRAVEL with CLAY
	GW-GM	Well Graded GRAVEL with SILT
	Limestone	Limestone
	MH	Elastic SILT
	ML	SILT
	OH	ORGANIC Fat CLAY
	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
	Sandstone	Sandstone
	SC	CLAYEY SAND
	SC-SM	SILT, CLAYEY SAND
	SHALE	Shale
	SILTSTONE	Siltstone
	SM	SILTY SAND
	SP	Poorly Graded SAND
	SP-SC	Poorly Graded SAND with CLAY
	SP-SM	Poorly Graded SAND with SILT
	SW	Well graded SAND
	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
	USGS 654	Subgraywacke
	USGS 670	Interbedded Sandstone and Shale
	USGS 702	Quartzite
	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
▽	Delayed Water Table	Water Table after drilling

A

B

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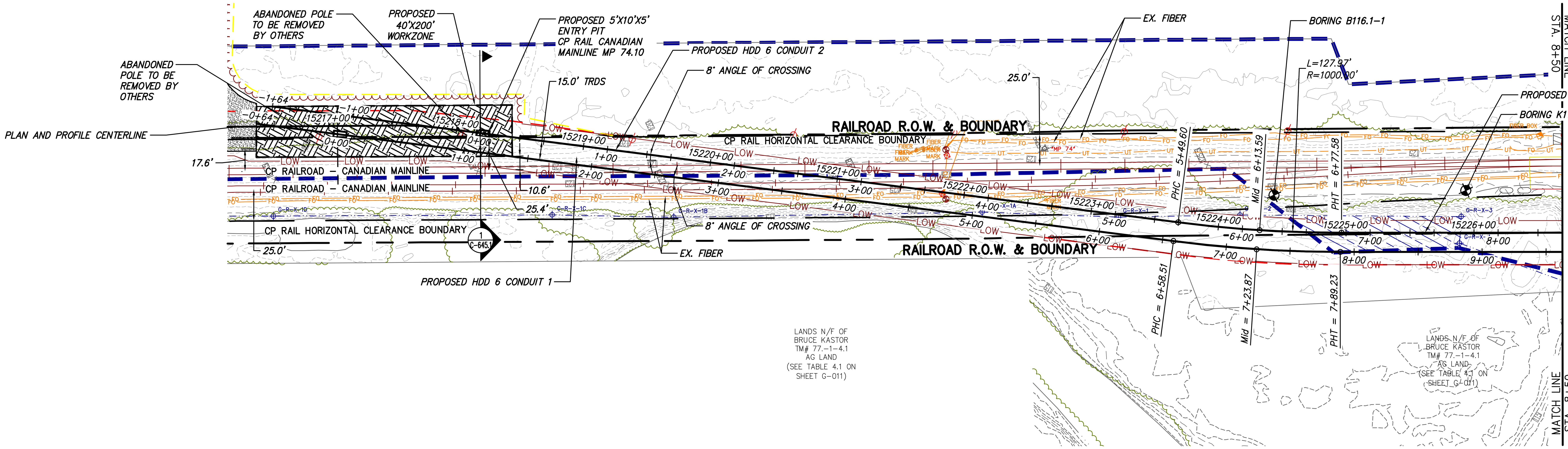
CHAMPLAIN HUDSON POWER EXPRESS
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 6, CONDUIT 1

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. C-305.1

DRAWN BY: CJL | DESIGNED BY: CJL | APPROVED BY: JEO | SCALE AS NOTED | REV. NO. X | DATE 12/16/2022

1 2 3 4

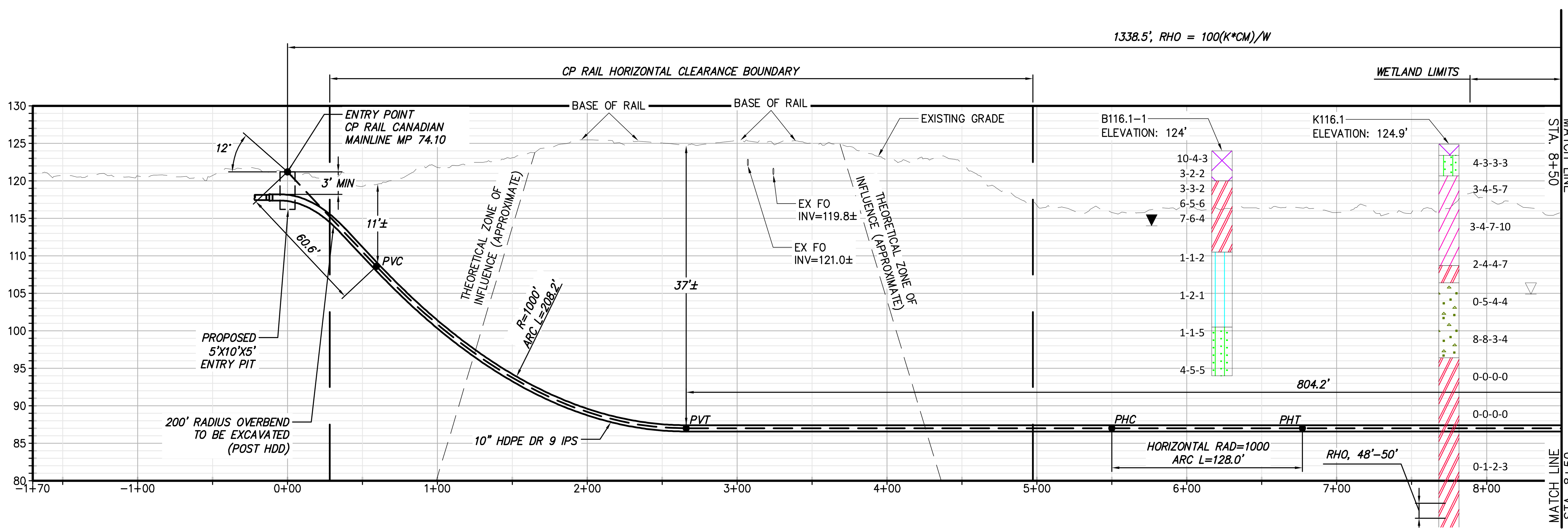


A

0 50 100
Scale in feet

PROPOSED HDD 6 PLAN VIEW

CONDUIT 2



B

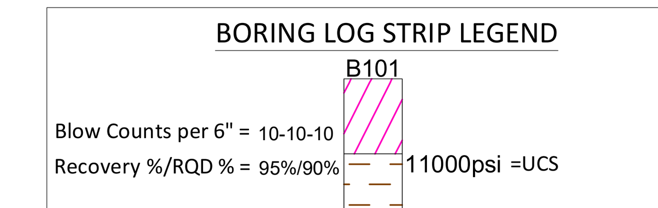
20
10
0
0 50 100
Scale in feet

PROPOSED HDD 6 PROFILE

CONDUIT 2

NOTE:
1) THE USE OF CONDUCTOR CASINGS IS RECOMMENDED TO MITIGATE THE POTENTIAL RELEASES OF FRILLING FLUIDS.

BORING LOG STRIP LEGEND



2D strip logs shown at 10x exaggeration
3D strip logs have no exaggeration

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
	GM	SILTY GRAVEL
	GP	Poorly Graded GRAVEL
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	GW-GM	Well Graded GRAVEL with SILT
	Limestone	Limestone
	MH	Elastic SILT
	ML	SILT
	OH	ORGANIC Fat CLAY
	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
	Sandstone	Sandstone
	SC	CLAYEY SAND
	SC-SM	SILT, CLAYEY SAND
	SHALE	Shale
	SILTSTONE	Siltstone
	SM	SILTY SAND
	SP	Poorly Graded SAND
	SP-SC	Poorly Graded SAND with CLAY
	SP-SM	Poorly Graded SAND with SILT
	SW	Well graded SAND
	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
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	USGS 670	Interbedded Sandstone and Shale
	USGS 702	Quartzite
	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
▽	Delayed Water Table	Water Table after drilling

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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

PLAN AND PROFILE - HDD 6, CONDUIT 2

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. C-305A

DRAWN BY: CJL DESIGNED BY: CJL APPROVED BY: JEO

SCALE AS NOTED DATE 12/16/2022
REV. NO. X

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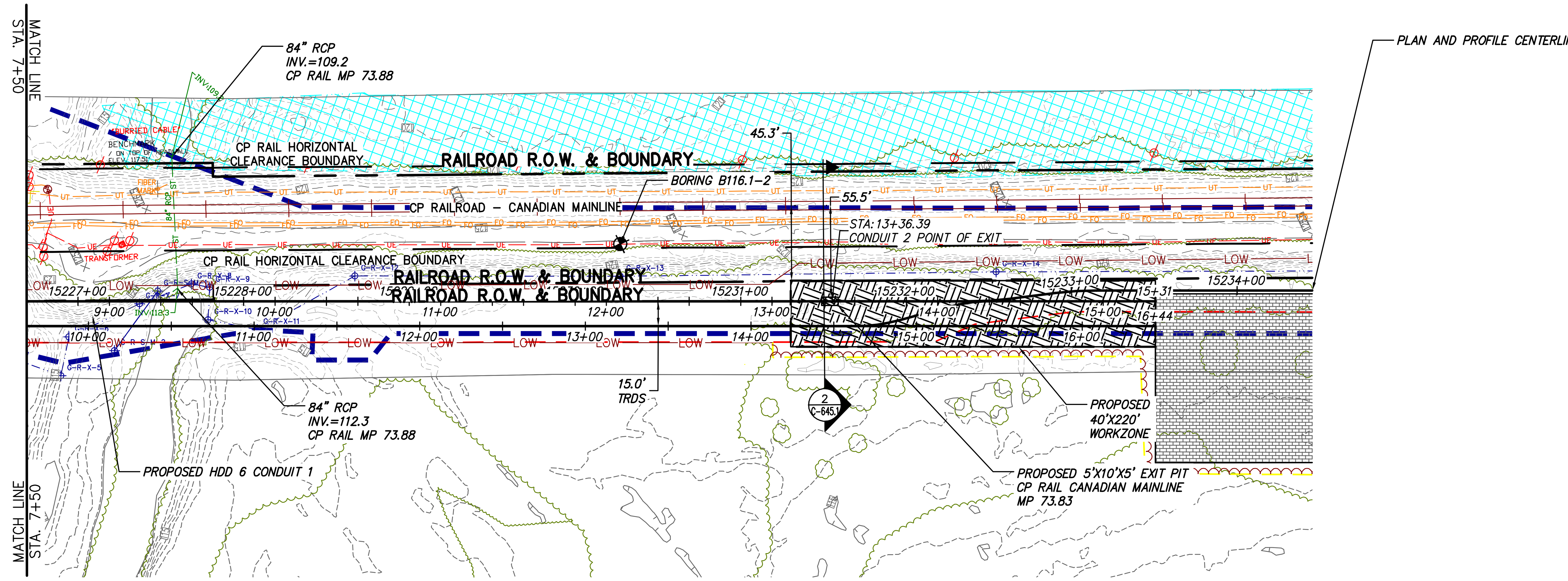
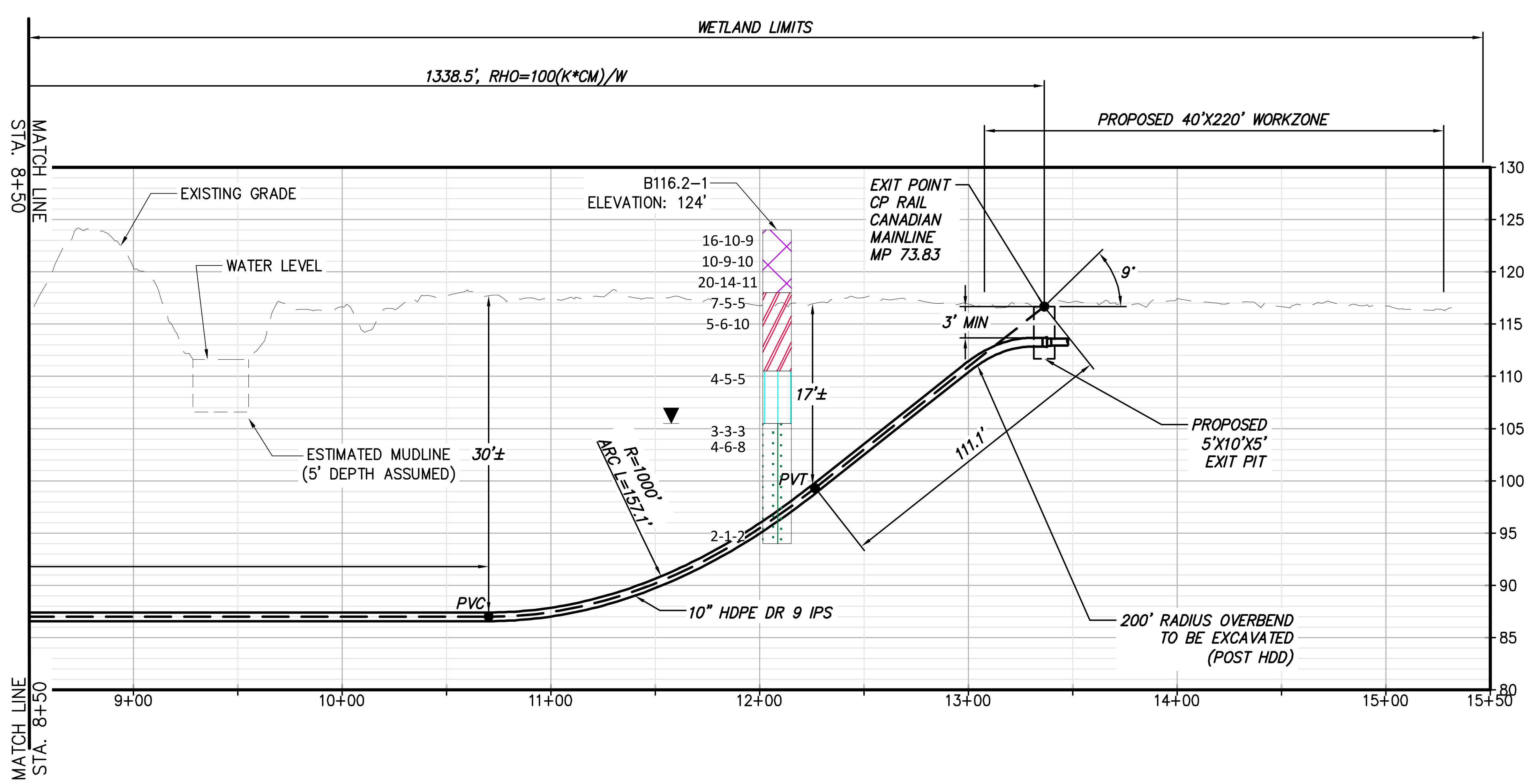


0 50 100
Scale in feet

PROPOSED HDD 6 PLAN VIEW
CONDUIT 2



20 10 0
0 50 100
Scale in feet

PROPOSED HDD 6 PROFILE
CONDUIT 2

NOTE:
1) THE USE OF CONDUCTOR CASINGS IS RECOMMENDED TO MITIGATE THE POTENTIAL RELEASES OF FRILLING FLUIDS.

BORING LOG STRIP LEGEND

B101

Blow Counts per 6" = 10-10-10
Recovery %/RQD % = 95%/90%
11000psi =UCS

2D strip logs shown at 10x exaggeration
3D strip logs have no exaggeration

Legend

ASPHALT	Asphalt
Bedrock	Bedrock
Boulder	Boulder
CH	Fat CLAY
CH-MH	SILTY Fat CLAY
CL	Lean CLAY
CL-ML	SILTY CLAY
CONCRETE	Concrete
Fill	Fill
GC	CLAYEY GRAVEL
GC-GM	SILTY CLAYEY GRAVEL
GM	SILTY GRAVEL
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GP-GC	Poorly Graded Gravel with CLAY
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GW-GC	Well Graded GRAVEL with CLAY
GW-GM	Well Graded GRAVEL with SILT
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MH	Elastic SILT
ML	SILT
OH	ORGANIC Fat CLAY
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OL/OH	ORGANIC SOIL
PT	PEAT
Rock	Rock
Sandstone	Sandstone
SC	CLAYEY SAND
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SHALE	Shale
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USGS 654	Subgraywacke
USGS 670	Interbedded Sandstone and Shale
USGS 702	Quartzite
USGS 705	Schist
USGS 705	Schist
USGS 708	Gneiss
USGS 708	Gneiss
USGS 718	Granite 1
Void	Void
Water	Water
Weathered Rock	Undefined
Water Table	Water Table during drilling
Delayed Water Table	Water Table after drilling

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IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED, THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE, THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

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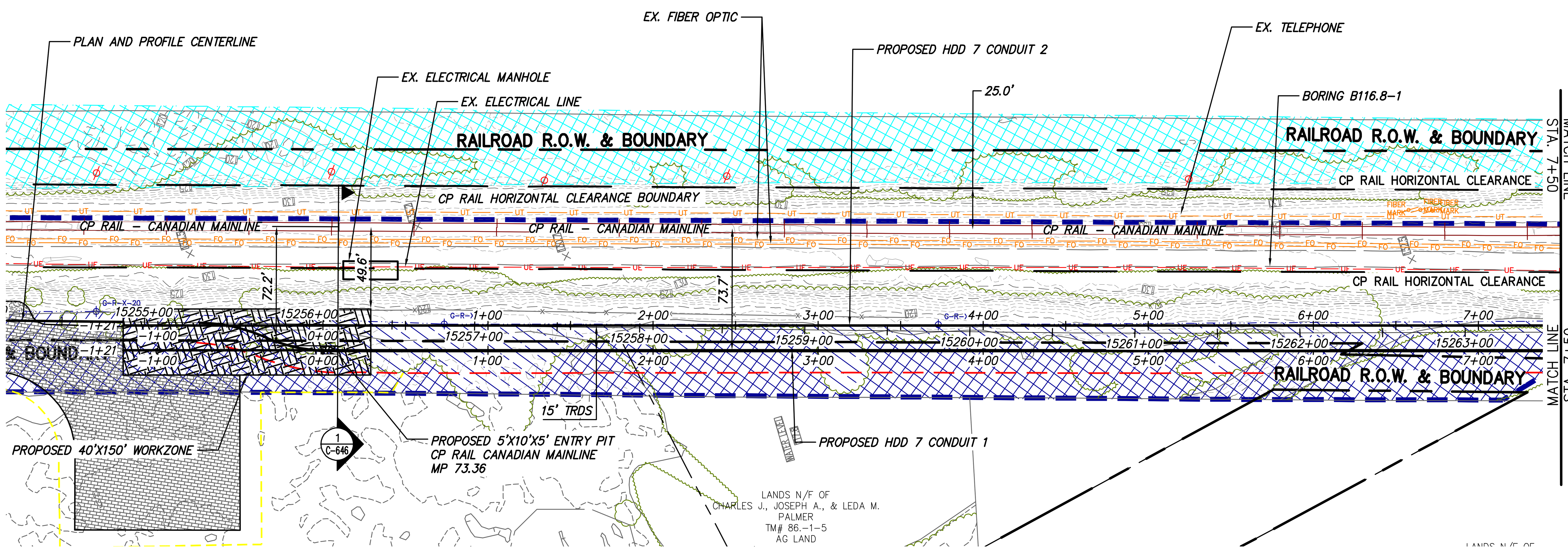
CHAMPLAIN HUDSON POWER EXPRESS
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 6, CONDUIT 2

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. **C-305A.1**

DRAWN BY: CJL DESIGNED BY: CJL APPROVED BY: JEO SCALE AS NOTED REV. NO. B DATE 12/16/2022

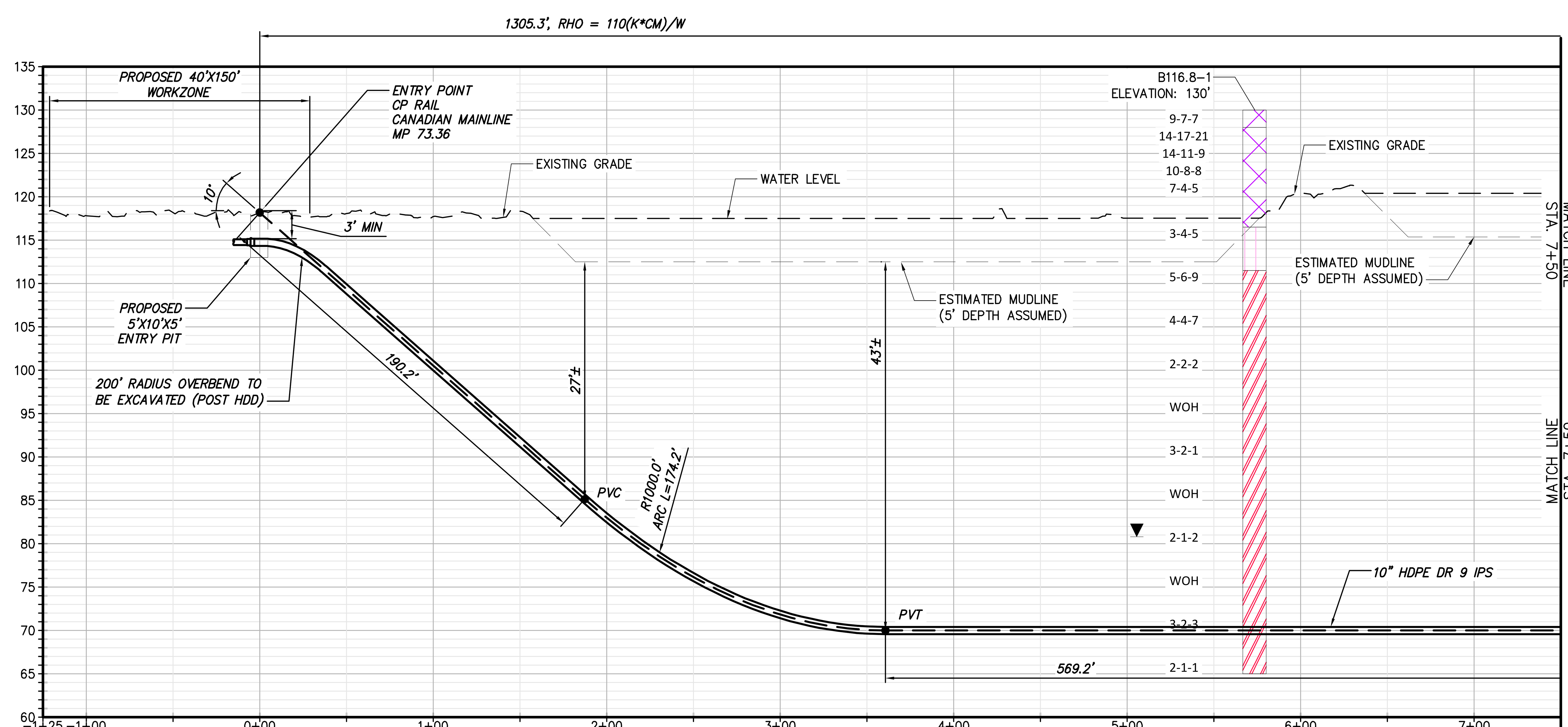
File: V:\PROJECTS\ANY\K6\066076.000\09_DESIGN\DRAWINGS\01_SHEETS\DESIGN PACKAGE 1\DESIGN PACKAGE 1C\066076_P1C_C-305 - C-305A.DWG Saved: 12/14/2022 1:25:24 PM Plotted: 12/15/2022 8:25:49 AM Current User: Snyder, Morgan LastSavedBy: 6043



Scale in feet

PROPOSED HDD 7 PLAN VIEW

CONDUIT 1



Scale in feet

PROPOSED HDD 7 PROFILE

CONDUIT 1

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
	GM	SILTY GRAVEL
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	ML	SILT
	OH	ORGANIC Fat CLAY
	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
	Sandstone	Sandstone
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	SW	Well graded SAND
	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
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	USGS 670	Interbedded Sandstone and Shale
	USGS 702	Quartzite
	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
▽	Delayed Water Table	Water Table after drilling

BORING LOG STRIP LEGEND

B101

Blow Counts per 6" = 10-10-10

Recovery %/RQD % = 95%/90%

11000psi =UCS

2D strip logs shown at 10x exaggeration

3D strip logs have no exaggeration

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SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

PLAN AND PROFILE - HDD 7, CONDUIT 1

KIEWIT PROJECT NO. 21162

CHA PROJECT NO. 066076

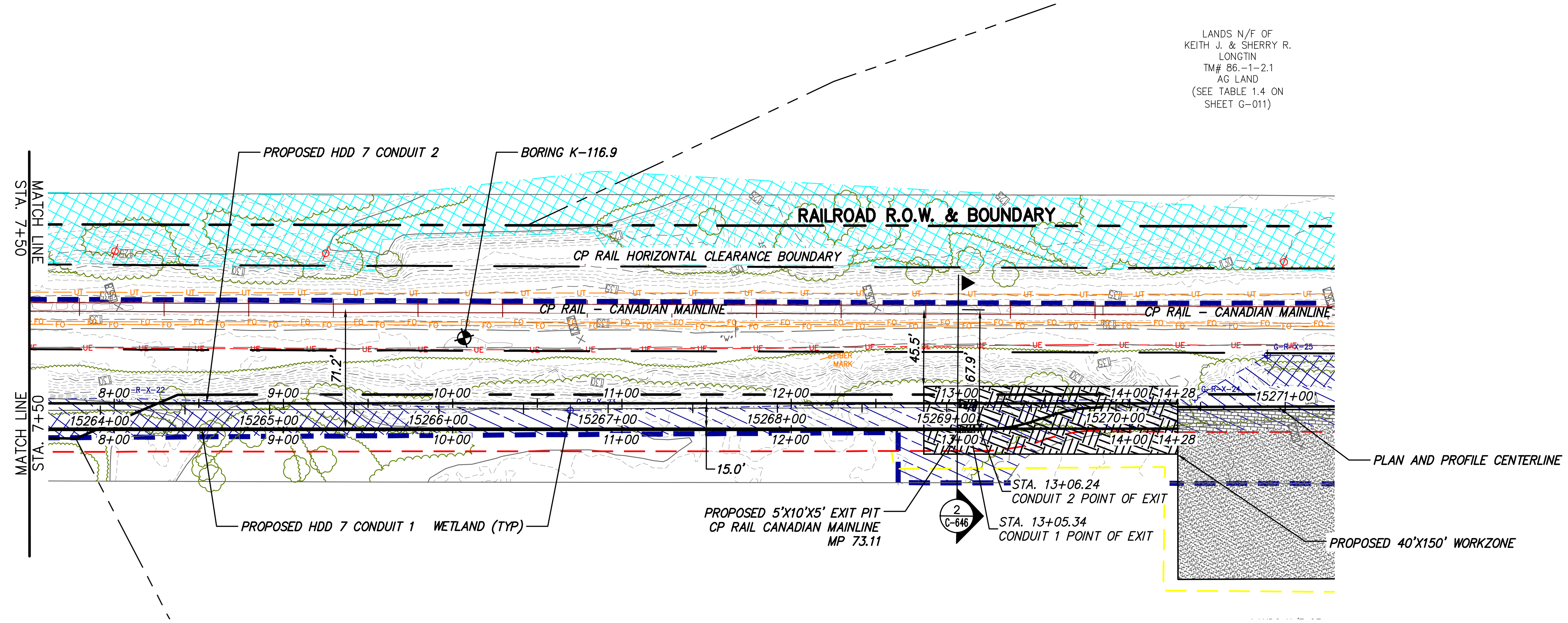
DRAWING NO. C-306

DRAWN BY: MCS DESIGNED BY: MCS APPROVED BY: JEO

SCALE AS NOTED DATE 12/16/2022

REV. NO. X

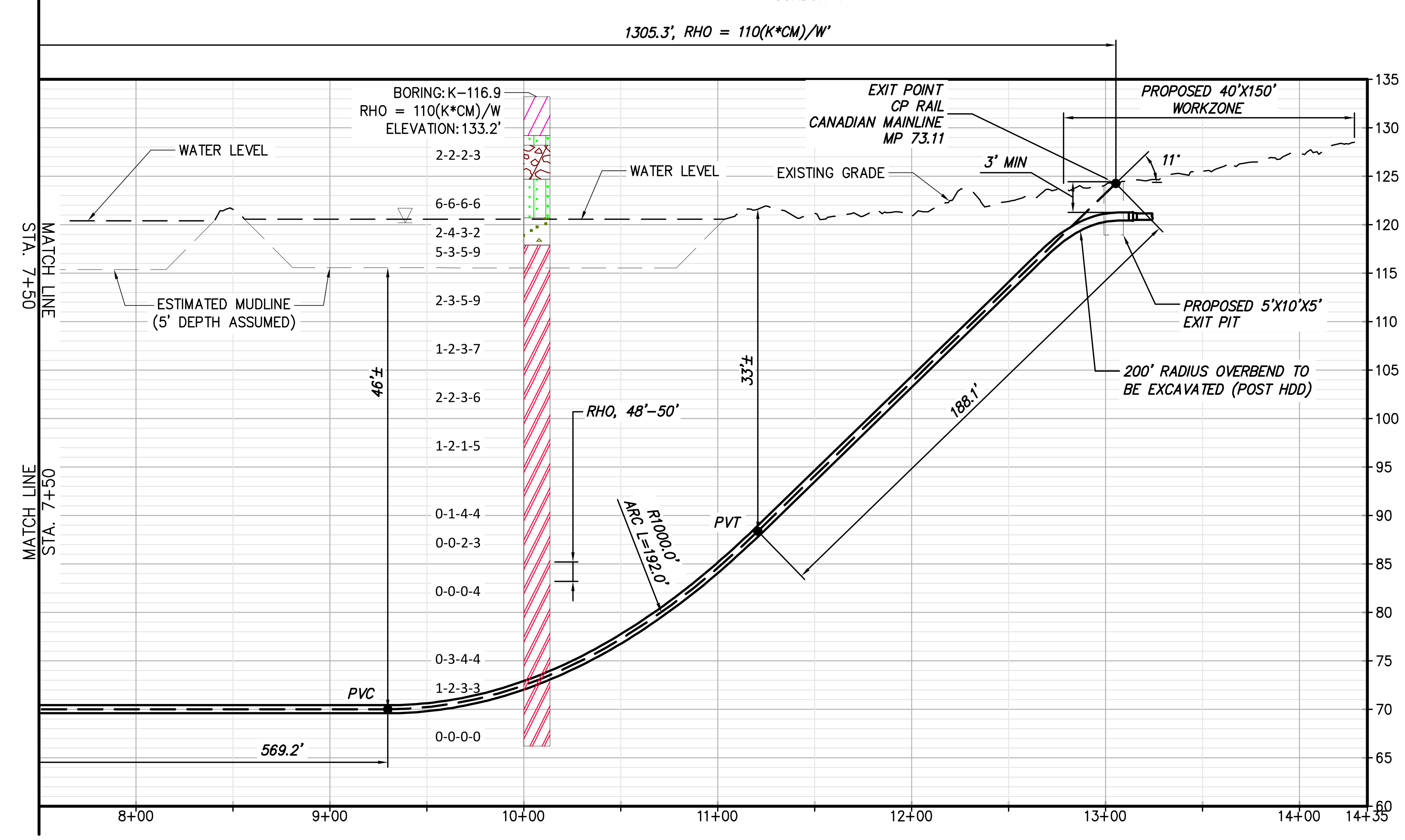
LANDS N/F OF
KEITH J. & SHERRY R.
LONGTIN
TM# 86.-1-2.1
AG LAND
(SEE TABLE 1.4 ON
SHEET G-011)



0 50 100
Scale in feet

PROPOSED HDD 7 PLAN VIEW

CONDUIT 1



0 50 100
Scale in feet

PROPOSED HDD 7 PROFILE

CONDUIT 1

BORING LOG STRIP LEGEND

B101

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3D strip logs have no exaggeration

Legend		
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	Bedrock	Bedrock
	Boulder	Boulder
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	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
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	GM	SILTY GRAVEL
	GP	Poorly Graded GRAVEL
	GP-GC	Poorly Graded Gravel with CLAY
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	GW	Well Graded GRAVEL
	GW-GC	Well Graded GRAVEL with CLAY
	GW-GM	Well Graded GRAVEL with SILT
	Limestone	Limestone
	MH	Elastic SILT
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	OH	ORGANIC Fat CLAY
	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
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	SC	CLAYEY SAND
	SC-SM	SILT, CLAYEY SAND
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	SILTSTONE	Siltstone
	SM	SILTY SAND
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	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
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	Void	Void
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	Weathered Rock	Undefined
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CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

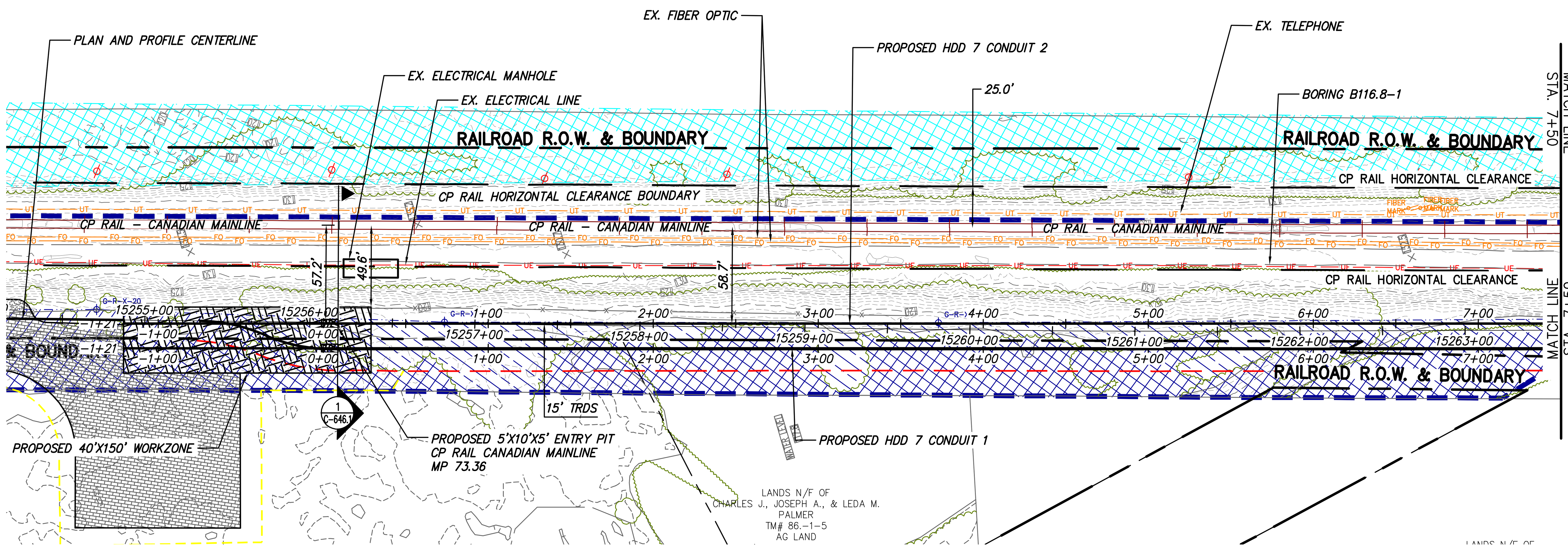
PLAN AND PROFILE - HDD 7, CONDUIT 1

KIEWIT PROJECT NO. 21162

CHA PROJECT NO. 066076

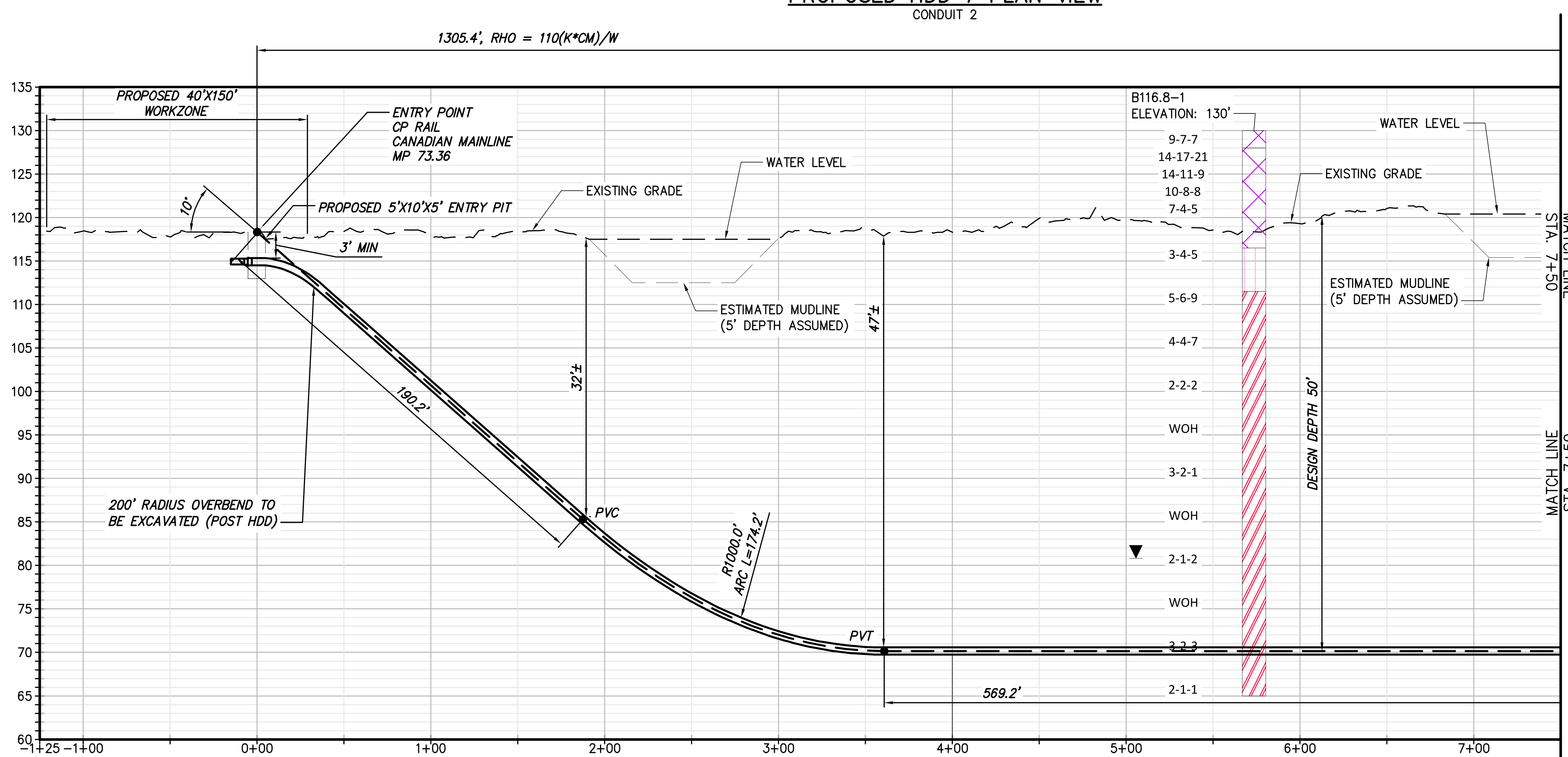
DRAWING NO. C-306.1

DRAWN BY: MCS DESIGNED BY: MCS APPROVED BY: JEO SCALE AS NOTED DATE 12/16/2022 REV. NO. X



0 50 100
Scale in feet

PROPOSED HDD 7 PLAN VIEW
CONDUIT 2



0 50 100
Scale in feet

PROPOSED HDD 7 PROFILE
CONDUIT 2

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
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BORING LOG STRIP LEGEND
B101
Blow Counts per 6" = 10-10-10
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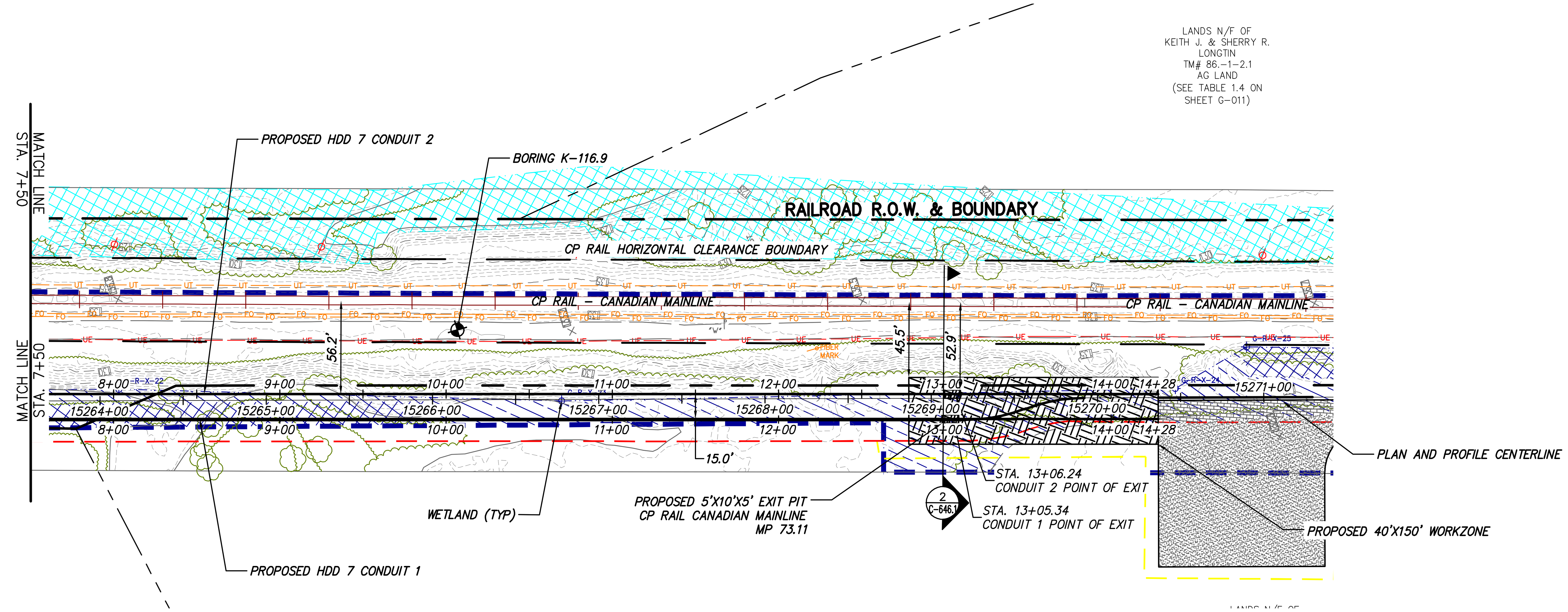
CHAMPLAIN HUDSON POWER EXPRESS
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 7, CONDUIT 2

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. C-306A

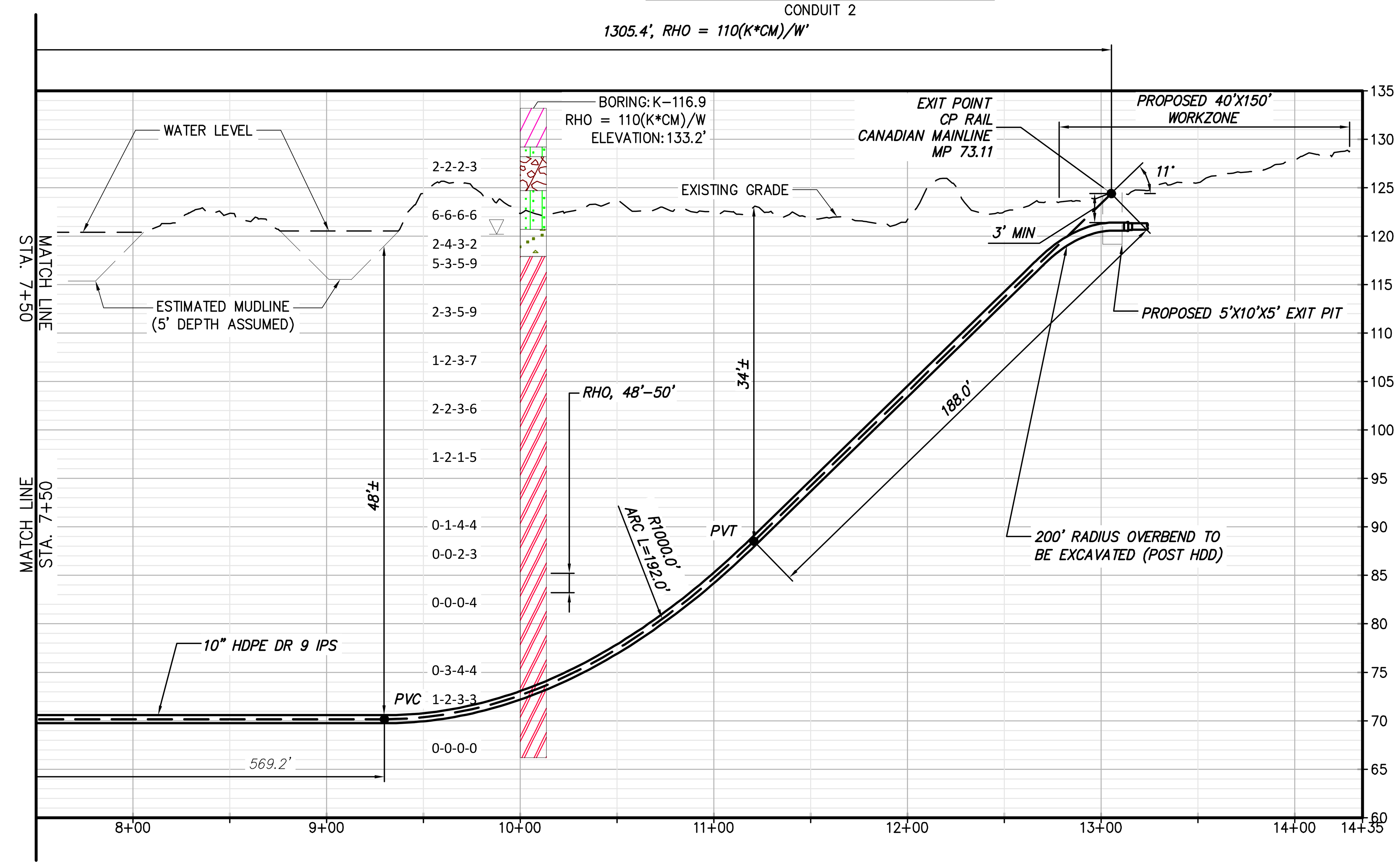
DRAWN BY: MCS DESIGNED BY: MCS APPROVED BY: JEO SCALE AS NOTED DATE 12/16/2022 REV. NO. X



Scale in feet (0, 50, 100)

PROPOSED HDD 7 PLAN VIEW

CONDUIT 2



Scale in feet (0, 50, 100; 0, 10, 20)

PROPOSED HDD 7 PROFILE

CONDUIT 2

BORING LOG STRIP LEGEND

B101

Blow Counts per 6" = 10-10-10

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	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
	USGS 654	Subgraywacke
	USGS 670	Interbedded Sandstone and Shale
	USGS 702	Quartzite
	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
▽	Delayed Water Table	Water Table after drilling

CHPE Champlain Hudson Power Express

Kiewit

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III Winners Circle, PO Box 5269
Albany, NY 12205-0269
518.453.4500 . www.chacompanies.com

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED, THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE, THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

No.	DATE	SUBMITTAL / REVISION DESCRIPTION	DB	APP
0	12/16/2022	FINAL EM&CP SUBMISSION	MCS	JEO

CHAMPLAIN HUDSON POWER EXPRESS

SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN

PLAN AND PROFILE - HDD 7, CONDUIT 2

KIEWIT PROJECT NO. 21162

CHA PROJECT NO. 066076

DRAWING NO. **C-306A.1**

DRAWN BY: MCS DESIGNED BY: MCS APPROVED BY: JEO SCALE AS NOTED REV. NO. X DATE 12/16/2022

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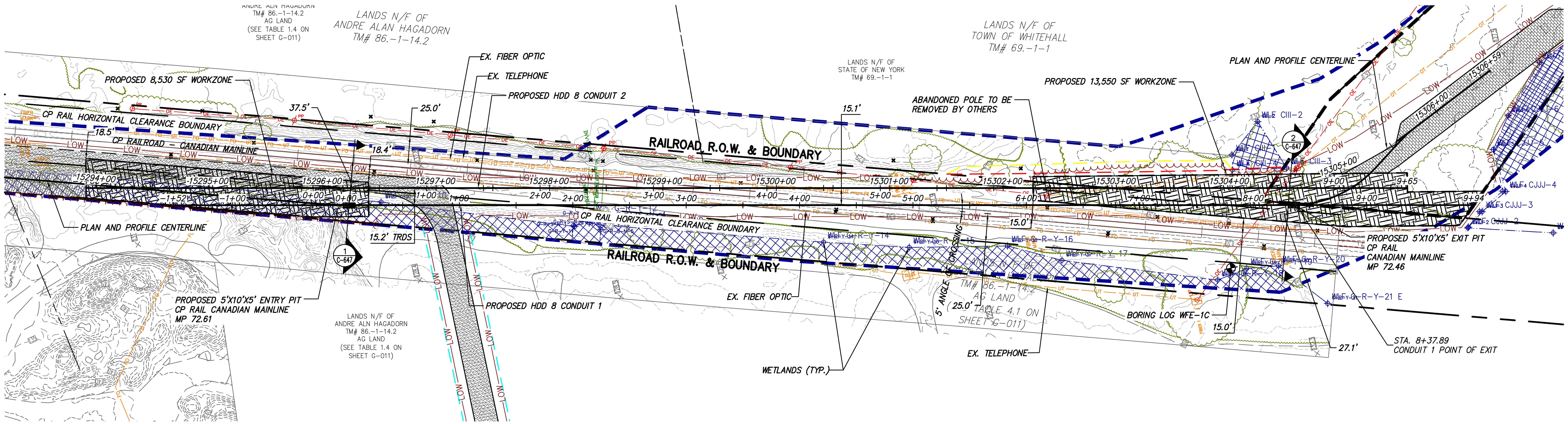
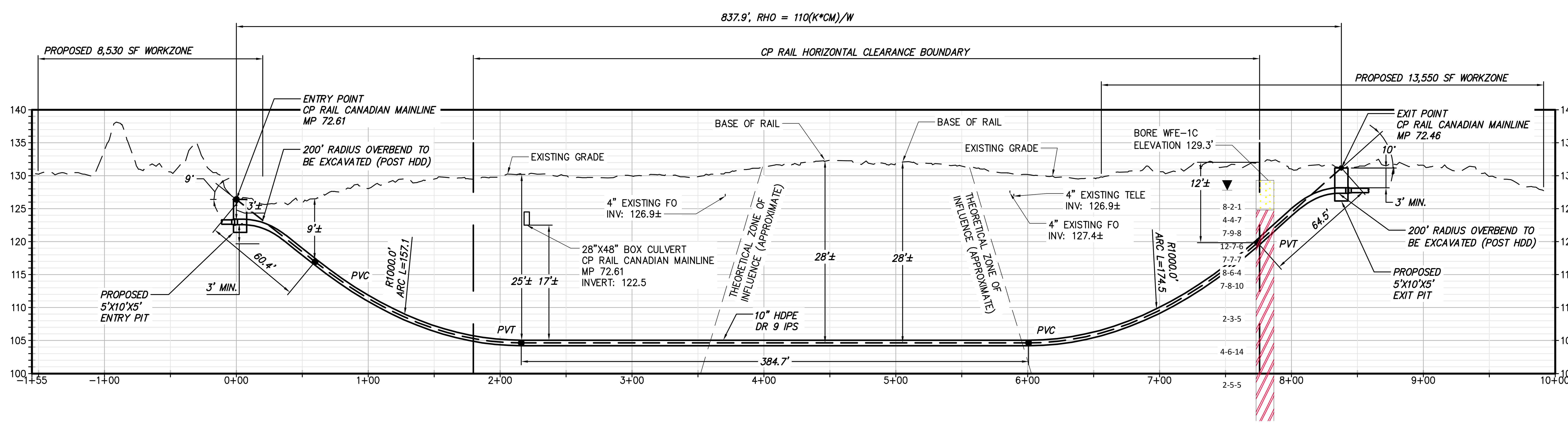


PLAN AND PROFILE CENTERLINE

PROPOSED HDD 8 PLAN VIEW

CONDUIT 1

0 50 100
Scale in feet



PROPOSED HDD 8 PROFILE

CONDUIT 1

0 50 100
Scale in feet

Legend		
	ASPHALT	Asphalt
	Bedrock	Bedrock
	Boulder	Boulder
	CH	Fat CLAY
	CH-MH	SILTY Fat CLAY
	CL	Lean CLAY
	CL-ML	SILTY CLAY
	CONCRETE	Concrete
	Fill	Fill
	GC	CLAYEY GRAVEL
	GC-GM	SILTY CLAYEY GRAVEL
	GM	SILTY GRAVEL
	GP	Poorly Graded GRAVEL
	GP-GC	Poorly Graded Gravel with CLAY
	GP-GM	Poorly Graded GRAVEL with SILT
	GW	Well Graded GRAVEL
	GW-GC	Well Graded GRAVEL with CLAY
	GW-GM	Well Graded GRAVEL with SILT
	Limestone	Limestone
	MH	Elastic SILT
	ML	SILT
	OH	ORGANIC Fat CLAY
	OL	ORGANIC Lean CLAY
	OL/OH	ORGANIC SOIL
	PT	PEAT
	Rock	Rock
	Sandstone	Sandstone
	SC	CLAYEY SAND
	SC-SM	SILT, CLAYEY SAND
	SHALE	Shale
	SILTSTONE	Siltstone
	SM	SILTY SAND
	SP	Poorly Graded SAND
	SP-SC	Poorly Graded SAND with CLAY
	SP-SM	Poorly Graded SAND with SILT
	SW	Well graded SAND
	SW-SC	Well Graded SAND with CLAY
	SW-SM	Well Graded SAND with SILT
	Topsoil	Topsoil
	USGS 601	Gravel or Conglomerate 1
	USGS 654	Subgraywacke
	USGS 670	Interbedded Sandstone and Shale
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	USGS 705	Schist
	USGS 705	Schist
	USGS 708	Gneiss
	USGS 708	Gneiss
	USGS 718	Granite 1
	Void	Void
	Water	Water
	Weathered Rock	Undefined
▼	Water Table	Water Table during drilling
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A

B

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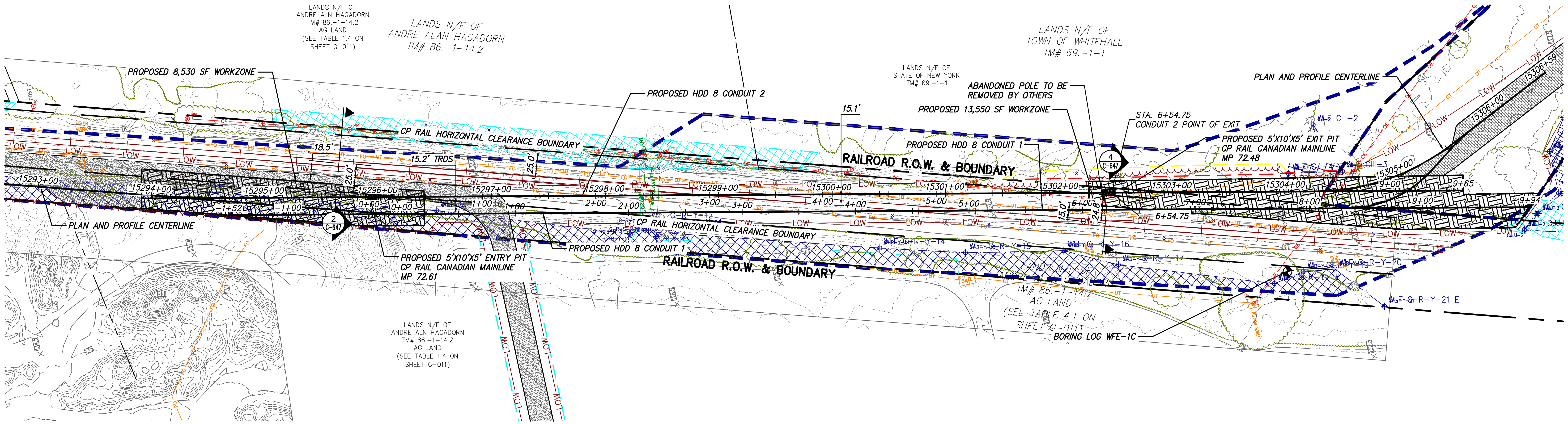
CHAMPLAIN HUDSON POWER EXPRESS
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 8, CONDUIT 1

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. **C-307**

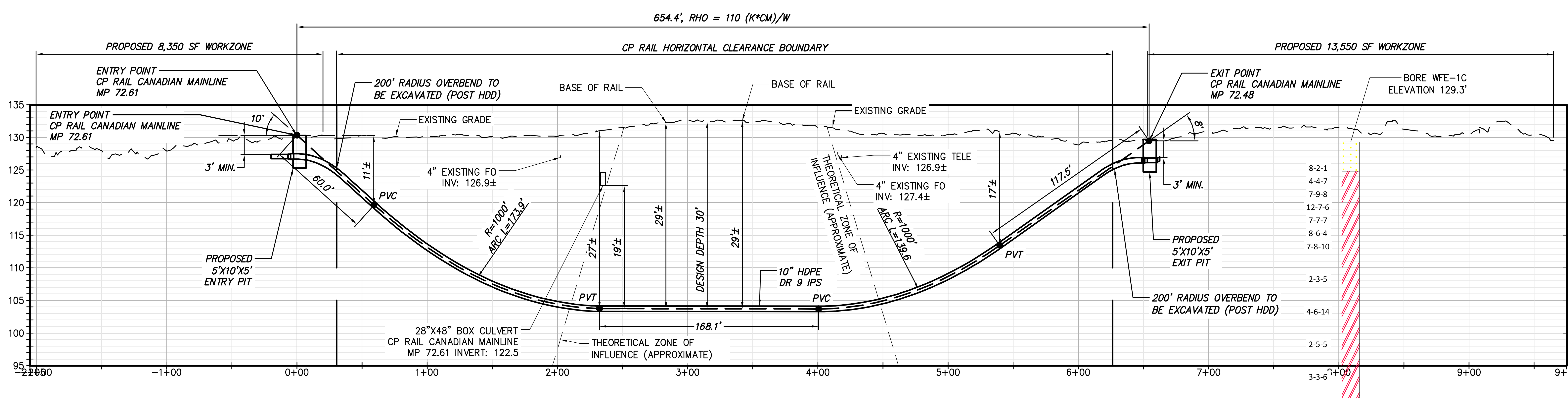
DRAWN BY: CKZ DESIGNED BY: CKZ APPROVED BY: JEO SCALE AS NOTED REV. NO. X DATE 12/16/2022

1 2 3 4



0 50 100
Scale in feet

PROPOSED HDD 8 PLAN VIEW
CONDUIT 2



PROPOSED HDD 8 PROFILE
CONDUIT 2

20 10 0
0 50 100
Scale in feet

BORING LOG STRIP LEGEND
B101
Blow Counts per 6" =10-10-10
Recovery %/RQD % =95%/90%
11000 =UCS

Legend

ASPHALT	Asphalt
Bedrock	Bedrock
Boulder	Boulder
CH	Fat CLAY
CH-MH	SILTY Fat CLAY
CL	Lean CLAY
CL-ML	SILTY CLAY
CONCRETE	Concrete
Fill	Fill
GC	CLAYEY GRAVEL
GC-GM	SILTY CLAYEY GRAVEL
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OL/OH	ORGANIC SOIL
PT	PEAT
Rock	Rock
Sandstone	Sandstone
SC	CLAYEY SAND
SC-SM	SILT, CLAYEY SAND
SHALE	Shale
SILTSTONE	Siltstone
SM	SILTY SAND
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CHAMPLAIN HUDSON POWER EXPRESS
SEGMENT 3 (PACKAGE 1C) WHITEHALL TO FORT ANN
PLAN AND PROFILE - HDD 8, CONDUIT 2

KIEWIT PROJECT NO. 21162
CHA PROJECT NO. 066076
DRAWING NO. C-307A

DRAWN BY: CKZ DESIGNED BY: CKZ APPROVED BY: JEO SCALE AS NOTED DATE 12/16/2022 REV. NO. X

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