Champlain Hudson Power Express

Inadvertent Release Contingency
Plan For Horizontal Directional Drilling
in Segment 10 - Package 6

Selkirk to Catskill
Greene & Albany County, New York

KUE Project Number: P-22014TK

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1.0 INTRODUCTION

The Kiewit Team, with the support of Kilduff Underground Engineering (KUE), proposes to design and construct approximately 52 horizontal directional drilling (HDD) crossings for a pair of HVDC electrical transmission cables plus a telecommunications line located in upland areas of the Hudson River Valley of New York for Segments 10 from Selkirk Rail Yard Bypass to Catskill. 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 casings 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 casings spaced a distance dependent on depth and TR values provided by NKT measured center to center. A third, 2-inch-diameter DR 9 casing will be bundled with one of the 10-inch-diameter casings for a telecommunications line. The casings are to be installed in 16-inch to 22-inch final reamed diameter bore holes.

This Inadvertent Release Contingency Plan (IRCP) is for Segment 10 - Package 6 which includes fifty HDD crossings: HDD#91 through HDD #111.A.

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

A primary potential environmental concern associated with HDD involves the inadvertent release of drilling fluids, also referred to as drilling mud, during the drilling process. 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 pipe installation activities to minimize and control erosion and sediment releases to adjoining wetlands or watercourses;
- Have site specific preplanned general response programs in place at the start of construction that is understood and can be implemented immediately by all field crews in the event of an inadvertent release of drilling fluid occurs; and
- Establish a chain of command for reporting and notifying, in a timely manner, the construction management team, the Certificate Holders, and the proper authorities in the event of an inadvertent release of drilling fluid and of the preplanned actions that are to be implemented.

It is important to note that the plan in this document serves as the guiding framework for confirming that the HDD 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 Subcontractor specific means and methods plan for each HDD crossing reaffirming and detailing how the 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 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. 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 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 NSF certified additives are required by specification for use on this project and those planned for use by the 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 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 pipe 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. Steps two and three may be combined, with the conduit being pulled back through the bore hole immediately behind the final reaming bit or swabbing pass.

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

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

The drilling fluids are composed primarily of potable water, which will likely be obtained from nearby sources selected and permitted by the 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., inert biodegradable) additives are required by specification for this project and before the start of work at a specific HDD, the HDD Subcontractor is required to submit crossing, environmental, and toxicity data regarding any additives for review and acceptance by the design team.

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

3.0 ORGANIZATION AND STAFFING RESPONSIBILITIES

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

Organizational Chart

Entity	Contact Information
Certificate Holders	Name, Title Phone Email
Construction Manager	TBD
HDD 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	Mathew Smith Department of Public Service Empire State Plz 3 Albany, NY 12223 (518) 402-5141 Mathew.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 Design Engineer for the HDD Design is KUE and Kiewit. During construction, the Design Engineer will be responsible for reviewing and approving required Subcontractor submittals, shop drawings, and material certificates. Kiewit Power Constructors 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 is KUE and Kiewit. During construction, KUE/Kiewit will be assisting Kiewit Power Constructors with the review of the Subcontractors Inadvertent Release Plan and providing technical assistance as needed with the HDD installation.

3.6 CONSTRUCTION MANAGER

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

3.7 HDD CONSTRUCTION SUBCONTRACTOR

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

The HDD Drill Operator (Drill Operator) will be responsible for operating the HDD drill rig and observing and managing changes in annular fluid pressure or loss of circulation. The Drill Operator will communicate with other members of the drill crew as needed when issues arise. The Subcontractor will be responsible for developing the specific lines of communication within their organization and shall dedicate a responsible person for 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 counties, state and federal resource agencies, compliance with and changes to any environmental permits.

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

3.9 LINES OF COMMUNICATION AND AUTHORITY

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

3.10 TRAINING

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

4.0 FLUID RELEASE MINIMIZATION MEASURES

4.1 GEOTECHNICAL INVESTIGATION

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

4.2 HDD DESIGN

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

- Depth of cover during profile design (based on soil borings) to limit the potential inadvertent break through to the water body, road, wetlands, or ground surface.
- Typically, potential exists for releases near the entry and exit pits of a bore. The distance where there is a potential for releases at the ends depends on the soil conditions, the slope of the ground surface and the length of the bore. Generally, the longer and deeper the bore the greater the slurry pressures required to hold the borehole open and to carry the cuttings back to the entry or exit pit.
- Specific provisions regarding exit pit design for underwater cable installation (i.e., via the use of temporary dredged cofferdams or steel casing riser pipes).
- Generally, for the formation of inadvertent releases, the more critical stage of the HDD process tends to be during the initial pilot hole drilling when the annular space between the bore sidewall and the drill string is the smallest and therefore requires large slurry pressures to overcome flow resistance to carry cuttings back to the entry pit.

- Adjusting the drill alignment to miss existing infrastructure including existing utilities, and other obstacles,
- Establishing a drill alignment line that allows for gradual angular changes to minimize pressure build-up and limit pull back stresses and bending stresses in the conduit, as well as being compatible with the bending capacity of the drill steel.
- Requiring drilling fluid composition and drilling procedures that minimize drilling fluid pressures,
- Requiring drilling fluids that adequately address site-specific drilling concerns while posing the least threat to the environment, and
- Requiring that, during the performance of any HDD waterbody crossing, contractors monitor the use of inert biodegradable drilling solution and, in the event of a detected release of fluid, implement the procedures specified in the approved EM&CP. For any release occurring in a waterbody, the Certificate Holders shall immediately notify DPS Staff and NYSDEC of details of the release and the course of action they recommend taking.
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

4.3 CONTINGENCY PLAN

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

- Work plan and detailed description of the drilling program (details for executing pilot hole, reaming, pull-back operations, and schedule), this plan shall include necessary procedures for addressing problems that are typically encountered during HDD installations through the anticipated subsurface for each drill location;

- Drilling fluid composition design and on-hand amendments to alter fluid properties to reduce pressures, potential for plugging, and seepage losses;
- Description of the planned drilling equipment and drill site layout;
- Safety Data Sheet (SDS) information for all drilling fluid products proposed for use;
- Procedures for drilling fluid pressure control, and fluid and pressure loss monitoring and management to aid in the detection of an inadvertent release (i.e., metering of makeup water, recording of drilling fluid product quantities utilized, fluid return volumes, fluid and cuttings disposal quantities, turbidity of river water, etc.);
- Contingency plans for addressing inadvertent releases into wetlands, or other sensitive areas, which includes the specific procedures used to halt the release and then contain, clean-up, and remove materials from the release site;
- Notification procedures and chain-of-command in the event of a release;
- Criteria for evaluating the need for a drill hole abandonment and the associated plan for sealing the drill hole if abandoned;
- Drilling fluid management and disposal procedures;
- The work plan and detailed drilling program description should include documentation regarding site restoration, vegetation management, sedimentation and erosion control, and hazardous material usage (if applicable). Intended approach shall be in compliance with those measures presented in the Project EM & CP.
- Notice shall be provided to residents, businesses, and building, structure, and facility (including underground, aboveground and underwater facilities) 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. Example configurations are shown in Figures 1a and 1b, final dimensions to be adjusted based on actual space available and shown on the drawings for each HDD crossing.

4.4 DRILLING FLUIDS MANAGEMENT

As described in the Project EM&CP document, drilling fluid (typically bentonite and water based with selected inert biodegradable additives) will be National Sanitation Foundation (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 HDD subcontractor. However, the drilling fluid management system and subsequent disposal will adhere to the following requirements:

- Drilling fluid will be processed through an initial clearing that separates the solid materials from the fluid;
- Solids will be sifted out by a screening apparatus/system and the solids deposited into a 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;

- Drilling fluid accidentally spilled during construction and operation of drilling rigs 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;
- 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,
- An overview of the drilling fluid system will be submitted to the Environmental Inspector for approval once determi ned 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); and,
- Disturbed soil, such unconsolidated fill.
- Soft soils with low overburden capacity
- Presence of archeological resources.

Our opinions regarding 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 detect drilling fluid seepage prior to a surface release and promptly stop the drilling and they can modify the drilling fluid composition, 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 substantial reduction in the volume of return fluid (loss of circulation)
- 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. Per Article VII Condition 114(n), monitoring of 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 adequate staff and equipment available 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 conditions and observe and monitor the drill path for evidence of an inadvertent release, if there is evidence (typically visual) of a release, the Subcontractor will be required to stop the drilling immediately;
- The Subcontractor shall notify the lead Environmental Inspector of any significant loss of drilling fluid returns at the drill rig; and, in the event of a detected release of drilling fluid during the performance of any HDD waterbody crossing, implement the procedures specified in the approved EM&CP. The Certificate Holders shall immediately notify New York State Department of Public Service (NYSDPS) Staff and New York State Department of Environmental Conservation of details of the release and the course of action they recommend taking.
- The subcontractor will take steps to modify the drill fluid properties and pressures to reduce the potential of drill fluid loss or release; and
- The Drill Operator will take steps to restore drilling fluid circulation in accordance with the requirements of the HDD technical specifications.

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

6.0 INADVERTENT RELEASE RESPONSE (UPLAND AND ROAD AREAS)

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

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

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

Upon containment of the release, the Subcontractor will be required to evaluate the cause of the seepage and develop mitigation strategies to limit the likelihood of recurrence. The location of the seepage and the area around the seep will be monitored upon the re-start of the HDD operations for changes in conditions. The segments of borehole nearest the entry and exit points and other areas of low overburden cover tend to be the most susceptible to surface seepage as they have the least amount of soil confinement. 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 casings 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 inert biodegradable 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 Subcontractor will be required to cease drilling operations and reduce pressures in borehole immediately, and notify the Environmental Inspector, 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. The Subcontractor is required to develop general in-stream or in-rail response methods and pre-place necessary materials and equipment at the site prior to construction. Specific response actions will be determined in consultation with the Environmental Inspector and 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 hay bales, vacuum trucks, silt curtains, containment cells, turbidity curtains, or if suitable,

sand bags and confinement/filter beds. These activities will require that qualified construction personnel and other support equipment, and supplies be prepositioned and readily available at or near the site. Use of a relief well installed at the location of the release.

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

8.0 DRILL HOLE ABANDONMENT PLAN

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

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

9.0 CROSSING SPECIFIC DISCUSSION

9.1 HDD CROSSING #91

HDD #91 consists of two, straight (in plan view) HDD bores, each approximately 551 feet long. The HDD bores will pass approximately 37.1 to 40.0 feet below US Route 9W. The ground surface elevations along the path of HDD #91 ranges between El. 172 to El. 193 with the HDD entry and exit points both approximately at El. 172 (reference datum NAVD 1988).

The bores will have no horizontal curves. The vertical curves of the bore path are designed so that the bore will pass beneath US Route 9W. The proposed work at this location must be constructed in accordance with the Article VII Certificate and associated EM&CP.

Ground conditions at HDD #91 - Borings B-198.9-1 and SC-1A are located along the proposed HDD alignments at approximately Sta. 60010+51 and Sta. 60013+20, respectfully. The borings were completed to depths of approximately 25 and 40 feet, refer to plan and profile drawing package. Based on the borings, the soil profile for the HDD #91 analyses was divided into three [3] layers: silt sand (SM) and poorly graded sand (SP), clayey silt (ML). SC-1A noted trace, less than 10 percent, gravel, and cobbles in the first 3 feet from ground surface. Lean to fat silty Clay (CL/CH) recorded in boring SC-1A is anticipated to be below the HDD borehole.

Specific design considerations for HDD #91 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 40.0 feet below ground surface (bgs). General depth of soil cover under US Route 9W is 40.0 feet near the centers of the bore paths. A maximum allowable pressure for the HDD bores ranges from 0 to 151.9 psi, with a maximum allowable pressure of 151.9 psi under US Route 9W structure. The approximate applied slurry pressure (minimum mud pressure) during drilling ranges from 0 to 12.3 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

- There is a potential of inadvertent release (IR) at the entry and exit locations as cover is lowest at these areas. These should be relatively easy to control through the use of conductive casings, haybales, silt fences, erosion control measures and vacuum trucks.
- C1 and C2 exit may experience gravel within the top 3 feet. KUE recommends 15 to 20-feet of conductive casing to avoid probable difficult soil and reduce risk of IR.

- Erosion and sediment control measures will be placed between the entry/exit location and any watercourses, waterbodies, and environmentally sensitive areas as an additional precaution.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Highly permeable soil such as the water bearing sand stratum has potential for inadvertent returns. Based on the lab data the fines content, less than No. 200 sieve, is between 25 and 37. In our opinion, there is sufficient stratum thickness to reduce the risk of a release due to this condition.

9.2 HDD CROSSING #91.A

HDD #91.A consists of two, straight (in plan view) HDD bores located under the Old Ravena Road. The bores are approximately 1610 feet long. The HDD bores will pass approximately 22.9 to 23.6 feet below Old Ravena Road centerline. The ground surface elevations along the path of HDD #91.A ranges from approximately El. 158 at the northeast end of the bore alignment, to approximately El. 163 at the centerline of Old Ravena Road. The The HDD entry will be at El. 162 and the exit point will be El. 154. (reference datum NAVD 1988).

Ground conditions at HDD #91.A – Borings K-199.6, A199.7-1, and K-199.7 are located along the proposed HDD alignments at approximately Sta. 60048+50, 60051+75, and 60052+25 respectfully. The geotechnical borings were completed to a depth of approximately 37 and 10 feet, refer to plan and profile drawing package. Based on the borings, the soil profile was divided into three [3] layers: Fill, Poorly graded Sand and Silty Sand, and lean Clay.

Specific design considerations for HDD #91.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 25.2 feet bgs. A maximum allowable pressure for the bores ranges from 0 to 25.2 psi, with a maximum allowable pressure of 23.7 psi under Old Ravena Road structure. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 16.8 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

- A potential for releases exists at the exit (south) side for the first 100 to 150 feet of the HDD bore for Conduit 1 and Conduit 2. The entry side has potential for release at the end 20 to 30 feet for the HDD bores. KUE recommends utilizing conductive casing to reduce potential for IR.
- 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.
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Soft soils with low overburden capacity encountered in the borings K-199.6 and K-199.7. Specifically boring K-199.6 indicates the HDD borehole will be advanced through 0 blow count clays, which extends approximately 8 feet above the borehole.

9.3 HDD CROSSING #92 & 92.A

HDD #92 and 92.A consists of two, straight, HDD bores, approximately 2092 feet long, located under Coyemans Creek and Old Ravena Road. From the topography data available, the ground surface elevations along the path of HDD #92 and 92.A ranges from approximately El. 70 to El. 177 (reference datum NAVD 1988).

The bores will have no horizontal curves. The vertical curves of the bore paths are designed so the bores will maintain approximately 20-feet from top of borehole to bottom of estimated mudline of Coyemans Creek. There will be approximately 124.2 feet of clearance between the borehole and Old Ravena Road.

Ground conditions at HDD #92 and 92.A – Borings B200.6-1, B200.7-1, K-200.7, K-200.8, K-200.9,KB-200.6, and KB-200.8A are located at various offsets from HDD alignments. The geotechnical borings were completed to a depth ranging from 40 to 137 feet, refer to plan and profile drawing package. Based on the borings, the soil profile was divided into two [2] layers: coarse grained alluvium consisting of silty sand and fine-grained alluvium consisting of lean to fat

Clay, and Silt. Should existing HDD plan and profile be used for design additional borings that extend to HDD elevations may be required.

Design considerations for HDD 92 and 92.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 128.9 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 128.9 psi, with a maximum allowable pressure of 16.3. psi under Coyemans Creek. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 73.0 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- A potential for releases exists at most of the HDD alignment. This crossing will be redesigned to address and reduce inadvertent return potential.
- 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.
- Requiring monitoring and controlling drilling fluid pressures with down-the-hole sensors during pilot hole drilling.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- KUE anticipates soft soils will extend into alignment based on the borings available. Soft soils with zero blow count clays encountered in the borings K-200.7, K-200.8, K-200.8A, and K-200.9.

9.4 HDD CROSSING #93

HDD #93 consists of two HDD bores located under wetlands and a private road and aggregate structure on Lafarge property. The bores are approximately 1666 feet long as shown in Appendix B. The HDD bores will pass approximately 16.3 feet below the wetlands and 24.0 feet beneath the private road. The ground surface elevations along the path of HDD #93 gently undulates from approximately El. 162 at the north end of the bore alignment, to approximately El. 161 at the centerline of HDD bore, to El. 171 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD *#93* – Borings B201.7-1, K-201.8,K-201.9, and B201.9-1are located at various offsets from HDD alignments. The geotechnical borings were completed to a depth of approximately 25 to 40 feet, refer to plan and profile drawing package. Borings consisted of Fill, silty Sand (SM), Silty fat Clay (CH-MH), Silt (ML), and lean Clay (CL).

Specific design considerations for HDD #93 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 27.3 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 26.4 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 15.2 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet conductor casing and exit should utilize 50 to 75 feet.

9.5 HDD CROSSING #93.A

HDD #93.A consists of two HDD bores located under an unnamed stream. The bores are approximately 744 feet long as shown in Appendix B. The HDD bores will pass approximately 9.1 and 28.3 feet beneath the assumed mudline. The ground surface elevations along the path of HDD #93.A ranges from approximately El. 166 at the north end of the bore alignment, to approximately El. 152 at the centerline of HDD bore, to El. 173 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD *#93.A* –

Boring B202.1-1 is located at an offset from HDD #93.A alignments. The geotechnical boring was completed to a depth of approximately 25 feet and is shown in Appendix B. Based on the borings, subsurface condition at this crossing location will consist of Fill, silty Sand (SM), Silty fat Clay (CH-MH), and lean Clay (CL). Note that boring does not extend to the bottom tangent of HDD crossing.

Specific design considerations for HDD #93.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 46.0 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 40.7 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 25.7 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet of conductor casing and 40 to 50 at the exit.

9.6 HDD CROSSING #94

HDD #94 consists of two HDD bores located under Main Street and CSX Railroad tracks. HDD #94 consists of two HDD bores located under Main Street and CSX Railroad tracks. The bores are approximately 1176 feet. The ground surface elevations along the bore ranges from approximately El. 178 at the west end to approximately El. 186 at the centerline of the Main Street, to El. 172 at the east end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD#*94* – Borings SC-2A, B203.45-1, K-203.5, B203.5-1, and K-203.6 are located, at various offsets from HDD alignments, at approximately Sta. 60247+35, 60249+50, 60252+62, 60254+75, and 60256+55. Borings consisted of Fill, lean Clay (CL), fat Clay (CH), Silt (ML), Silty Clay (ML-CL), Silty Sand (SM), silty Gravel (GM), weathered bedrock, subgraywake bedrock.

Specific design considerations for HDD #94 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 43.4 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 129.9 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 24.8 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- Geologic conditions will vary for both drives. Bedrock is anticipated on the northwest side and will transition to dense silty sand.
- Bedrock, in general, is expected to have higher maximum allowable pressures than soil. Geologic stratification may vary and any delineation on the Graph in Appendix is for reference only.

- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet conductor casing. Based on the inadvertent release analysis and low cover, the exit side, south, shall utilize 50 to 60 feet of conductor casing.

9.7 HDD CROSSING #95

HDD #95 consists of two HDD bores located under an unmapped stream S-19. An approximately 3.8 feet wide by 3.2 feet high box culvert with an invert El. Of 168.0 will be 90 feet offset west of the HDD bores. The HDD bores are approximately 1258 feet long. The HDD bores will pass approximately 18.9 feet and 17.0 feet below the stream. The ground surface elevations along the path of HDD #95 ranges from approximately El. 192 at the north end of the bore alignment, to approximately El. 166 at the stream, to El. 200 at the south end of the bores alignment (reference datum NAVD 1988).

Ground conditions at HDD #*95* – Borings K-204.2, and B204.2-1 are located at various offsets from HDD alignments. The geotechnical borings were completed to a depth of approximately 40 and 25 feet, refer to plan and profile drawing package. Borings consisted of Fill, silty Clay (CL), glacial till (GM), silt (ML), and Graywacke bedrock. Graywacke bedrock was noted to have the following properties: fair RQD (rock quality designation), an average CAI (Cerchar Abrasivity Index) value of 2.8 at sample 30-35 feet bgs, a UCS (unconfined compressive strength) of 11.6 ksi at sample 30-35 feet bgs.

Specific design considerations for HDD #95 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 53.4 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 319.5 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 25.8 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- An elevation difference of 21.7 feet exists between the entry and the exit points. A bulkhead may be utilized at the entry point to keep the borehole pressurized and achieve estimated circulating pressures.

In our opinion the conditions conducive to inadvertent releases that may exist at this site based on the ground conditions described in the borings at the site include:

- In KUE's experience bedrock has been historically classified as a low-risk category for IR occurrence.
- Potential for IR is still present at entry and exit, where overburden is low and assumed to have unconsolidated soils. The exit, south, side may encounter silty gravel, which in general can be a risk for loss of slurry into formation and or circulation pressure. Based on the inadvertent release analysis, the exit side, south, shall utilize 50 to 75 feet of conductor casing and 10 to 20 feet at the entry.

9.8 HDD CROSSING #96.XX

HDD #96.XX consists of two HDD bores with horizontal curves approximately 2111 and 2124 feet long. The bores cross underneath stream S-21, S-22 and New Baltimore Road. The HDD entry will be at El. 179 and the exit point will be El. 202 with New Baltimore Road at El. 242. (reference datum NAVD 1988).

Ground conditions at HDD #96.XX – Borings A205.2-1, and K-205.2 are located, at various offsets from HDD alignments, at approximately Sta. 60319+75 and 60323+80. The geotechnical borings were completed to a depth of approximately 25 and 48 feet bgs, refer to plan and profile drawing package. Borings consisted of Fill, Silt (ML), silty Sand (SM), and Silty Clay (CL-ML).

Design considerations for HDD 96.XX include:

- Soil cover from ground surface to top of borehole ranges from 0 to 75.5 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 55.6 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 20.2 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet of conductor casing and 40 to 50 at the exit.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Boring K-205.2 denotes soft clays with N-values of weight of hammer (who) to 2 from El. 165 to 185. While these conditions can lead to IR, KUE believes risk for IR underneath New Baltimore Road is low, due to significant cover. Conductive casing shall still be considered, especially at entry and exit points of both crossings where

cover is low.

9.9 HDD CROSSING #96.A & 96.B

HDD #96.A & 96.B consists of two HDD bores located underneath Hannacrois Creek and CSX Railroad tracks. The bores are approximately 1499 feet long. The HDD bores will pass approximately 30.8 feet underneath the estimated mudline of Hannacrois Creek, 65.0 feet underneath CSX right (west) tracks, and 44.6 feet underneath the CSX (east) left tracks. The ground surface elevations along the path of HDD #96.A and 96.B ranges from approximately El. 146 at the north end of the bore alignment, to approximately El. 180 at the center, to El. 190 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD #96.A & 96–B - Borings K-205.8, K-205.9, B205.9-2, K-206.0, and KB-205.8 are located, at various offsets from HDD alignments, at approximately stationing to be determined for the first three borings and Sta. 60380+30. The geotechnical borings were completed to a depths ranging from 35 to 65feet, refer to plan and profile drawing package. Borings consisted of Fill, Silt and Silty Clay (CL-ML), lean Clay (CL), and Graywacke bedrock. Graywacke bedrock was noted to have the following properties: poor to excellent RQD (rock quality designation), an average CAI value of 1.1 and, a UCS of 5.9 ksi at sample depth 40 to 44.5 feet bgs (El. 128.5 to 133).

Design considerations for HDD 96.A & 96.B include:

- Soil cover from ground surface to top of borehole ranges from 0 to 79.4 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 400.0 psi, with a maximum allowable pressure of 71.8 psi under CSX rails. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 20.6 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- HDD will likely have a mixed drive between bedrock and medium dense glacial till. Based on the recorded CAI value, the bedrock is anticipated to be very abrasive (Cerchar, 1986).
- Delft equation was utilized to obtain maximum allowable pressures. KUE recognizes that this equation was developed for unconsolidated sediments and does not precisely

predict allowable pressures. Allowable pressures will likely be higher within bedrock, however, KUE still recommends stated pressures as a conservative measure.

- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 25 feet conductor casing.

9.10 HDD CROSSING #97

HDD #97 consists of two HDD bores located underneath Route 44 and CSX Railroad tracks. The bores are both approximately 445 feet long. The HDD bores will pass approximately 22 feet below the road and railroad tracks. The ground surface elevations along the path of HDD #97 ranges from approximately El. 186 at the north end of the bore alignment, to approximately El. 190 at the centerline, to El. 183 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD #–7 - Borings K-206.5, K-206.6, and A202.62-1 are located, at various offsets from HDD alignments. The geotechnical borings were completed to a depth of approximately 40 and 23.8 feet, refer to plan and profile drawing package. Borings consisted of Fill, Silt and Silty Clay (CL-ML), and lean Clay (CL).

Design considerations for HDD 97 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 23.4 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 19.4 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 13.3psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.

9.11 HDD CROSSING #97.A

HDD #97.A consists of two HDD bores located underneath Stream S-25 and a ravine. The bores are both approximately 1700 feet long. The ground surface elevations along the path of HDD

#97.A ranges from approximately El. 178 at the north end of the bore alignment, to El. 133 at the ravine, El. 150 at Stream S-*25*, to El. 169 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD #*97.A* - Borings A207.0-1, KB-206.8, KB-207.0, and KB 207.1 are located at various offsets from HDD alignments. The geotechnical borings were completed to a depth of approximately 23 to 85 feet. Borings consisted of Fill, Silt and Silty Clay (CL-ML), lean Clay (CL), and sandstone and shale bedrock.

Design considerations for HDD 97.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 60.5 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 377.3 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 47.5 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- HDD will likely have a mixed drive between bedrock and medium dense glacial till. Based on the recorded CAI value, the bedrock is anticipated to be very abrasive (Cerchar, 1986).
- Delft equation was utilized to obtain maximum allowable pressures. KUE recognizes that this equation was developed for unconsolidated sediments and does not precisely predict allowable pressures. Allowable pressures will likely be higher within bedrock, however, KUE still recommends stated pressures as a conservative measure.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.

9.12 HDD CROSSING #98

HDD #98 consists of two HDD bores located underneath Stream S-28 and a culvert. The bores are approximately 883 and 923 feet long. The ground surface elevations along the path of HDD #98

ranges from approximately El. 160 at the north end of the bore alignment, to El. 124 at Stream S-28, to El. 161 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD #*98* - Borings K-207.6, SC-2C, and K-207.1are located, at various offsets from HDD alignments. The geotechnical borings were completed to a depth of approximately 40 and 23.8 feet, refer to plan and profile drawing package. Borings consisted of Fill, Silt and Silty Clay (CL-ML), and lean Clay (CL), glacial till consisting of SC-SM, SM, and GW-GM. All samples within glacial till indicated cobbles and boulders.

Design considerations for HDD 98 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 48.8 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 163.5psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 39.6 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- Gravel and cobbles may be present during HDD advancement. Drill bits tooling, equipment, and drilling techniques should be able to handle anticipated ground conditions. Conductor casings can be used at the entry and exit tangents that will mitigate inadvertent return risks. If gravel seams are encountered in the bottom tangent, the depth of bottom tangent should be increased to avoid the gravel.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.
- While gravel and cobbles are present, formation is dense and has fines of 20 to 40-percent and generally substantial cover. Therefore, KUE believes this will limit risk associated with loss of slurry into formation and limit risk of IR.

9.13 HDD CROSSING #99

HDD #99 consists of two HDD bores located underneath CSX Railroad tracks. The bores are both approximately 1609 feet long. The HDD bores will pass approximately 63 feet below the railroad

tracks. The ground surface elevations along the path of HDD #99 ranges from approximately El. 155 at the north underneath two ravines at EL.118 and 141, to El. 161 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD#*99* - Borings Borings B207.9-1, and K-208.1are located, at various offsets from HDD #99. The geotechnical borings were completed to a depth of 25 to 40 feet. Borings consisted of Fill, silty Clay (CL-ML), and lean Clay (CL).

Design considerations for HDD 99 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 66.8 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 106.3 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 43.7 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 10 to 20 feet conductor casing and exit should utilize 30 to 50 feet conductor casing.

9.14 HDD CROSSING #99.A

HDD #99.A consists of two HDD bores with horizontal curves located underneath the New York Thruway. The bores are both approximately 2725 feet long. The HDD bores will pass approximately 63 feet below the railroad tracks. The ground surface elevations along the path of HDD #99.A ranges from approximately El. 155 at the north underneath two ravines at EL.118 and 141, to El. 161 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD#*99.A* -

Borings K-208.2, B208.2-1, B208.3-1,B208.5-1, and K-208.7 are located at various offsets from HDD #99.A. The geotechnical borings were completed to a depth of 25 to 50 feet. Borings consisted of Fill, Silt (ML), silty Clay (CL-ML), lean Clay (CL), and graywacke bedrock. Based

on Boring B208.5-1 the HDD bottom tangents straddle interface between silt and well graded gravel, which is was described as decomposed rock in the boring log. Should gravel conditions be present pressures should be monitored to ensure no loss of fluids to formation.

Design considerations for HDD 99.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 87.4 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 411 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 42.4 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- HDD will likely have a mixed drive between bedrock and medium dense glacial till. Based on the recorded CAI value, the bedrock is anticipated to be very abrasive (Cerchar, 1986).
- Delft equation was utilized to obtain maximum allowable pressures. KUE recognizes that this equation was developed for unconsolidated sediments and does not precisely predict allowable pressures. Allowable pressures will likely be higher within bedrock, however, KUE still recommends stated pressures as a conservative measure.
- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 25 feet conductor casing and exit should utilize 75 to 100 feet.

9.15 HDD CROSSING #101

HDD #101 consists of two HDD bores located underneath a culvert and wetlands. The bores are both approximately 1125 feet long. The HDD entry will be at El. 146 and the exit point will be El. 148 with the ravine at El. 123 (reference datum NAVD 1988).

Ground conditions at HDD#*101* -

Borings A209.05-1, KB-208.8, and KB-208.9 are located at various offsets from the HDD alignments. Borings consisted of fill, elastic silt, lean to fat clay, and silty sand.

Design considerations for HDD 101 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 45.7 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 34.9 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 25.3 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- Gravel and cobbles may be present during HDD advancement. Drill bits tooling, equipment, and drilling techniques should be able to handle anticipated ground conditions. Conductor casings can be used at the entry and exit tangents that will mitigate inadvertent return risks. If gravel seams are encountered in the bottom tangent, the depth of bottom tangent should be increased to avoid the gravel.

9.16 HDD CROSSING #101.A

HDD #101.A consists of two HDD bores located underneath a ravine and unmapped stream S-33. The bores are both approximately 695 feet long. The HDD entry will be at El. 125 and the exit point will be El. 148 with the stream at El. 102 (reference datum NAVD 1988).

Ground conditions at HDD #101.A –

Borings B-209.5, and KB-209.7 are located at various offsets from the HDD alignments. Borings consisted of fill, elastic silt, lean to fat clay, and silty sand.

Design considerations for HDD 101.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 33.1 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 30.8 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 25.8 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- Calculations will need to be verified once final geotechnical data is available.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.
- Additional release may occur near station 4+00. KUE will revise to addresses potential for the IFC submittal.

9.17 HDD CROSSING #102

HDD #102 consists of two HDD bores located underneath unmapped stream S-34 and Coxsackie Creek, and CSX rails. The bores are both approximately 2428 feet long. The HDD bores will pass approximately 22 feet below the stream S-34 and 20.7 feet below Coxsackie Creek. The ground surface elevations along the path of HDD #102 ranges from approximately El. 111 at the north end of the bore alignment, to approximately El. 100 and 98 at the stream crossings to El. 104 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD *#102* – Borings B210.0-1, K-210.1, K-210.2, and B210.4-1are located, at various offsets from HDD alignments, at approximately Sta. 60594+10, 60599+00, 60605+00, and 60612+50. The geotechnical borings were completed to a depth of approximately 25 to 42 feet refer to plan and profile drawing package. Borings consisted of Fill, silt and elastic silt (ML, MH), silty Clay (CL-ML), and lean to fat Clay (CL, CH).

Design considerations for HDD 102 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 41.6 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 32.0 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 23.4 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet conductor casing and the exit 75 to 100 feet. Additional potential for release exists from approximate HDD Station 11+50 to 19+60. KUE will redesign crossing to address potential for release for IFC submittal.

9.18 HDD CROSSING #103&104

HDD #103&104

HDD #103&104 consists of two HDD bores located underneath Mansion Street and CSX tracks. The bores are approximately 1994 feet long. The HDD entry will be at El. 131 and the exit point will be El. 141 (reference datum NAVD 1988).

Ground conditions at HDD *#103&104* –

Borings B211.2-1, B211.5-1, K-211.2, K-211.3, K-211.4, and KB-211.4are located, at various offsets from HDD alignment #103&104. The geotechnical borings were completed to a depth of 20 to 37 feet and are shown in Appendix B. Borings consisted of Fill, Silt (ML), silty Clay (CL-ML), and lean to fat Clay (CL, CH).

K-211.4 indicate very soft clays with N-values of weight of hammer and weight of rod along the bottom tangent of the HDD. Drilling bits, techniques and slurry shall account for soil conditions. HDD shall be able to adjust for steering within soft clays.

Design considerations for HDD 103&104 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 36.3 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 28.3 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 16.8 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet conductor casing. and the exit 100 to 150 feet. Additional potential for release exists from approximate HDD Station 12+00.

9.19 HDD CROSSING #105

HDD #105 consists of two HDD bores located underneath CSX Railroad tracks. The bores are approximately 502 and 532 feet long. The HDD bores will pass approximately 21 to 23 feet below the CSX tracks. The HDD entry will be at El. 131 and the exit point will be El. 141 (reference datum NAVD 1988).

Ground conditions at HDD #*105* – Borings K-211.6, K-211.7, B211.7-1 and K-211.8, are located, at various offsets from HDD alignments=. The geotechnical borings were completed to a depth of approximately 40 to 42 feet, refer to plan and profile drawing package. Borings consisted of Fill (SM), Silt (ML), elastic Silt (MH), silty Clay (CL-ML), and lean Clay (CL). Graywacke bedrock was noted to have the following properties: poor to excellent RQD (rock quality designation), an average CAI value of 1.1 and, a UCS of 5.9 ksi at sample depth 40 to 44.5 feet bgs (El. 128.5 to 133).

Design considerations for HDD 105 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 21.7 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 18.2 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 11.4 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.

9.20 HDD CROSSING #107.A

HDD #107.A consists of two HDD bores located underneath CSX Railroad tracks and Flint Mine Rd. The bores are approximately 819 feet long. The HDD bores will pass approximately 29 feet below the CSX tracks. The ground surface elevations along the path of HDD #107.A ranges from approximately El. 130 at the north end of the bore alignment, to approximately El. 134 at the centerline, to El. 136 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD #*107* – Boring A212.8-1 is located at an offset of 55 feet from the HDD alignments. The geotechnical boring was completed to a depth of approximately 10 feet, refer to plan and profile drawing package. Borings consisted of Well Graded Gravel (GW), Lean Clay (CL), and Shale.

Design considerations for HDD 107.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 32 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 200 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 14.4 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.
- KUE recommends verification of utility depths to avoid conflict of HDD alignment.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry utilize 15 to 20 feet conductor casing and exit 100 to 125.
- Gravel layers present may prevent annular mud cake formation, causing inadvertent releases of drilling mud.

9.21 HDD CROSSING #108

HDD #108 consists of two HDD bores located underneath Murderers Creek in Greene County, New York. The bores are both approximately 2554 feet long. The HDD bores will pass approximately 25 feet below the creek. The ground surface elevations along the path of HDD #108 ranges from approximately El. 120 at the south end of the bore alignment, to approximately El. 114 at the centerline, to El. 118 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD #*108* – Borings B214.1-1, B214.6-1, K-214.5, KB-214.4, and KB-214.4Aare located, at various offsets from HDD alignments, at approximately Sta. 60829+00, and 60835+00. The geotechnical borings were completed to a depth of approximately 25 to 42 feet refer to plan and profile drawing package. Borings consisted of Fill (SM), Silt (ML), elastic Silt (MH), silty Clay (CL-ML), and lean Clay (CL).

Design considerations for HDD 108 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 47.6 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 36.2 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 25.1 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.

9.22 HDD CROSSING #109

HDD #109 consists of two HDD bores located underneath a culvert. The bores are both approximately 556 feet long. The HDD entry will be at El. 123 and the exit point will be El. 123 (reference datum NAVD 1988).

Ground conditions at HDD *#109* - Borings B216.1-1 and K-216.2 are located at various offsets from HDD alignment #109. The geotechnical borings were completed to a depth of 25 to 37 feet and are shown in Appendix B. Borings consisted of Fill (SM), Silt (ML), elastic Silt (MH), silty Clay (CL-ML), and lean to fat Clay (CL,CH). Artesian conditions were noted for boring KB-214.4.

Design considerations for HDD 109 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 23.8 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 19.6 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 13.1 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

- If artesian conditions induce pressure above typical hydrostatic values, conductor casings can be used on the entry and exit tangents to bypass these conditions. Our current assessment indicates that this will not be encountered.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet conductor casing and exit should utilize 60 to 80 feet.

9.23 HDD CROSSING #110

HDD #110 consists of two HDD bores located underneath wetlands. The bores are both approximately 1156 feet long. The HDD entry will be at El. 123 and the exit point will be El. 123 (reference datum NAVD 1988).

Ground conditions at HDD *#110* - Borings B216.4-1, K-216.6-1, and K-216.6 are locate, at various offsets from HDD alignment #110. The geotechnical borings were completed to a depth of 30 to 37 feet and are shown in Appendix B. Borings consisted of Fill (SM), Silt (ML), elastic Silt (MH), silty Clay (CL-ML), and lean to fat Clay (CL,CH).

K-216.6 indicates soft clays with blow counts of weight of 3 to 4 along the bottom tangent of the HDD. Drilling bits, techniques and slurry shall account for soil conditions. HDD shall be able to adjust for steering within soft clays.

Design considerations for HDD 110 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 30.9 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 29.2 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 15.2 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.

9.24 HDD CROSSING #111

HDD #111 consists of two HDD bores located underneath Schoharie Turnpike and a railroad spur line. The bores are both approximately 1126 feet long. The HDD bores will pass approximately 33 feet beneath Schoharie Turnpike and 40 feet below the spur line. The ground surface elevations along the path of HDD #111 ranges from approximately El. 125 at the north end of the bore alignment, to approximately El. 132 at the centerline, to El. 132 at the south end of the bore alignment (reference datum NAVD 1988).

Ground conditions at HDD *#111* – Borings B216.4-1, K-216.6, and B216.6-1 are located at various offsets from HDD alignments. The geotechnical borings were completed to a depth of approximately 30 to 37 feet, *refer to plan and profile drawing package*. Borings consisted of Fill (SM), elastic Silt (MH), silty Clay (CL-ML), and lean to fat Clay (CL,CH).

Design considerations for HDD 111 include:

- Soil cover from ground surface to top of borehole ranges from 0 to 30.5 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 24.3 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 18.3 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry and exit should utilize 15 to 20 feet conductor casing.

9.25 HDD CROSSING #111.A

HDD #111.A consists of two HDD bores located underneath Corlaer Kill. The bores are both approximately 2181 feet long. The HDD entry will be at El. 117 and the exit point will be El. 120 (reference datum NAVD 1988).

Ground conditions at HDD #111.A – Borings A219.05-1, B219.5-1, KB-219.2, KB-219.3, and KB-219.4 are located, at various offsets from HDD alignment #111.A. The geotechnical borings were completed to a depth of 20 to 80 feet and are shown in Appendix B. Borings consisted of Fill (sandy silt), clayey sand with gravel (SC), weathered bedrock, and bedrock consisting of shale and greywacke.

Design considerations for HDD 111.A include:

- Soil cover from ground surface to top of borehole ranges from 0 to 41.5 feet bgs. The maximum allowable pressure for the bores ranges from 0 to 32.0 psi. The approximate applied slurry pressure (circulating) during drilling ranges from 0 to 21.1 psi. A graph showing the maximum allowable pressure and the applied pressure is provided in the attached Appendix A.

In our opinion the conditions conducive to inadvertent releases that may exist this at this site based on the ground conditions described in the borings at the site include:

- Low cover exists near entry and exit locations. C1 and C2 entry should utilize 15 to 20 feet conductor casing and exit should utilize 100 to 150 feet.
- Additional potential for relasease exists at approximate HDD Station 19+50, based on conservative soil properties. Alignment and calculations will need to be updated once geotechnical borings are finalized for IFC.

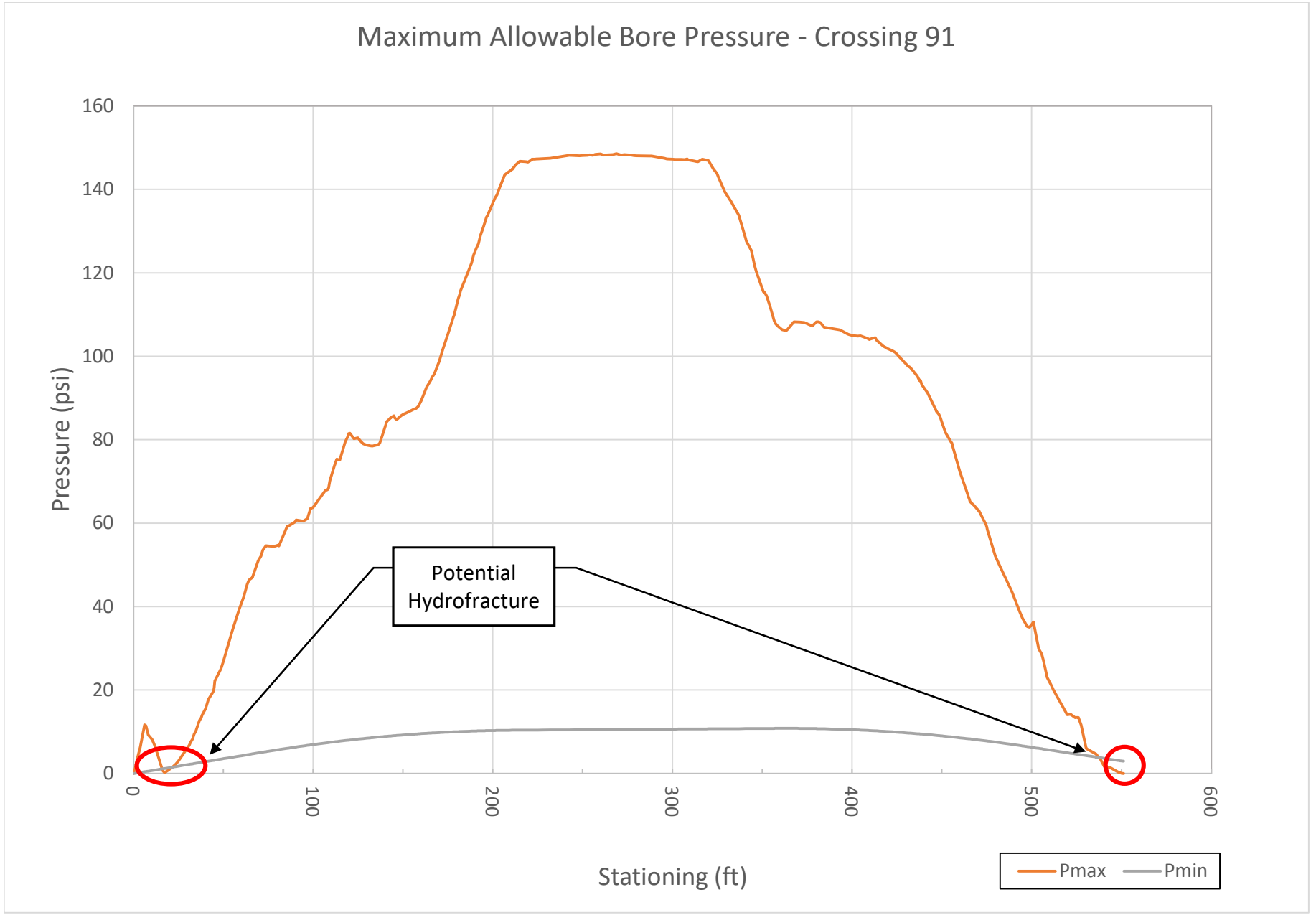
Appendix A

Calculation Package

KILDUFF
UNDERGROUND ENGINEERING, INC.

HDD 91 Hydrofracture Graph

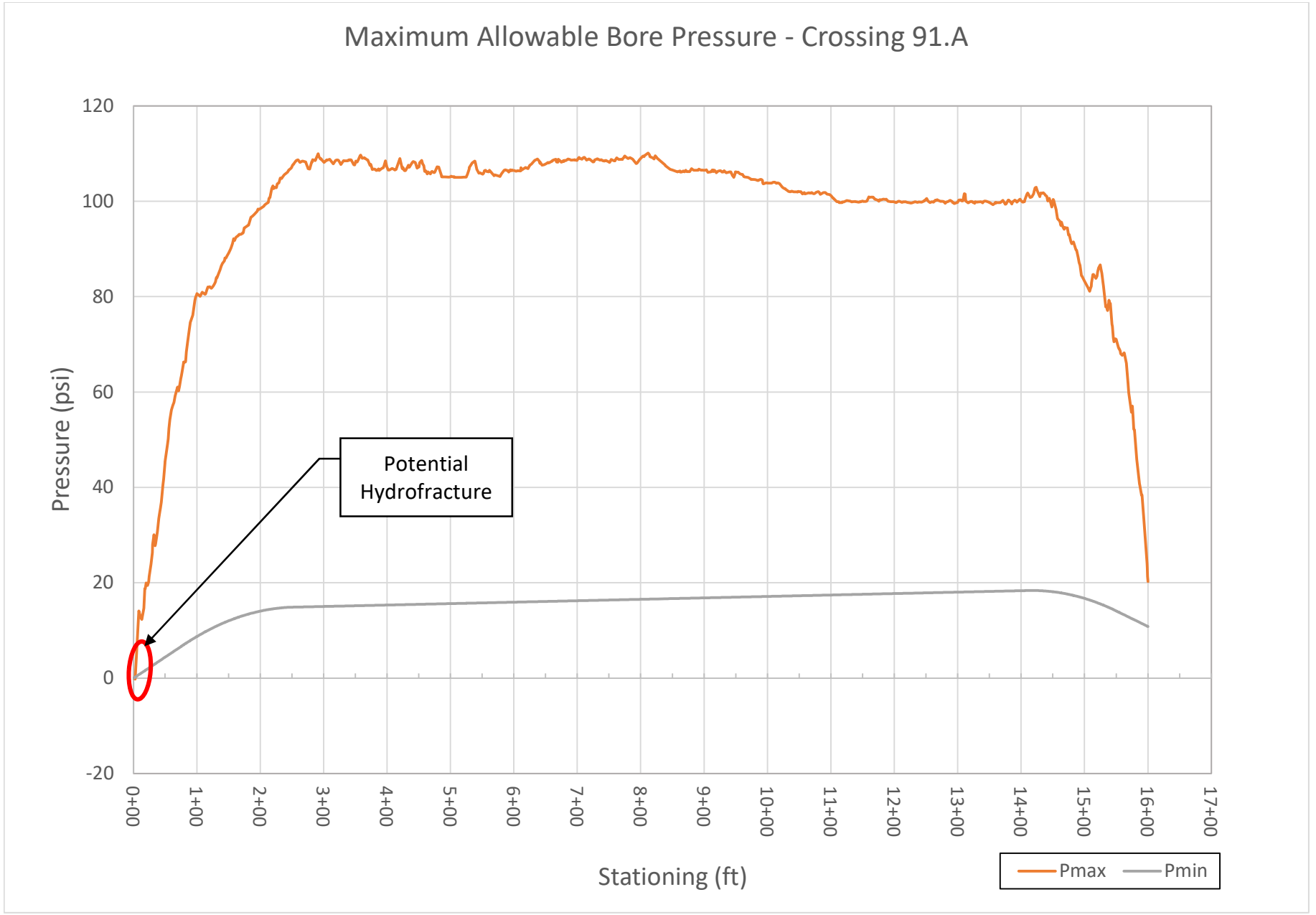
Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 91.A Hydrofracture Graph

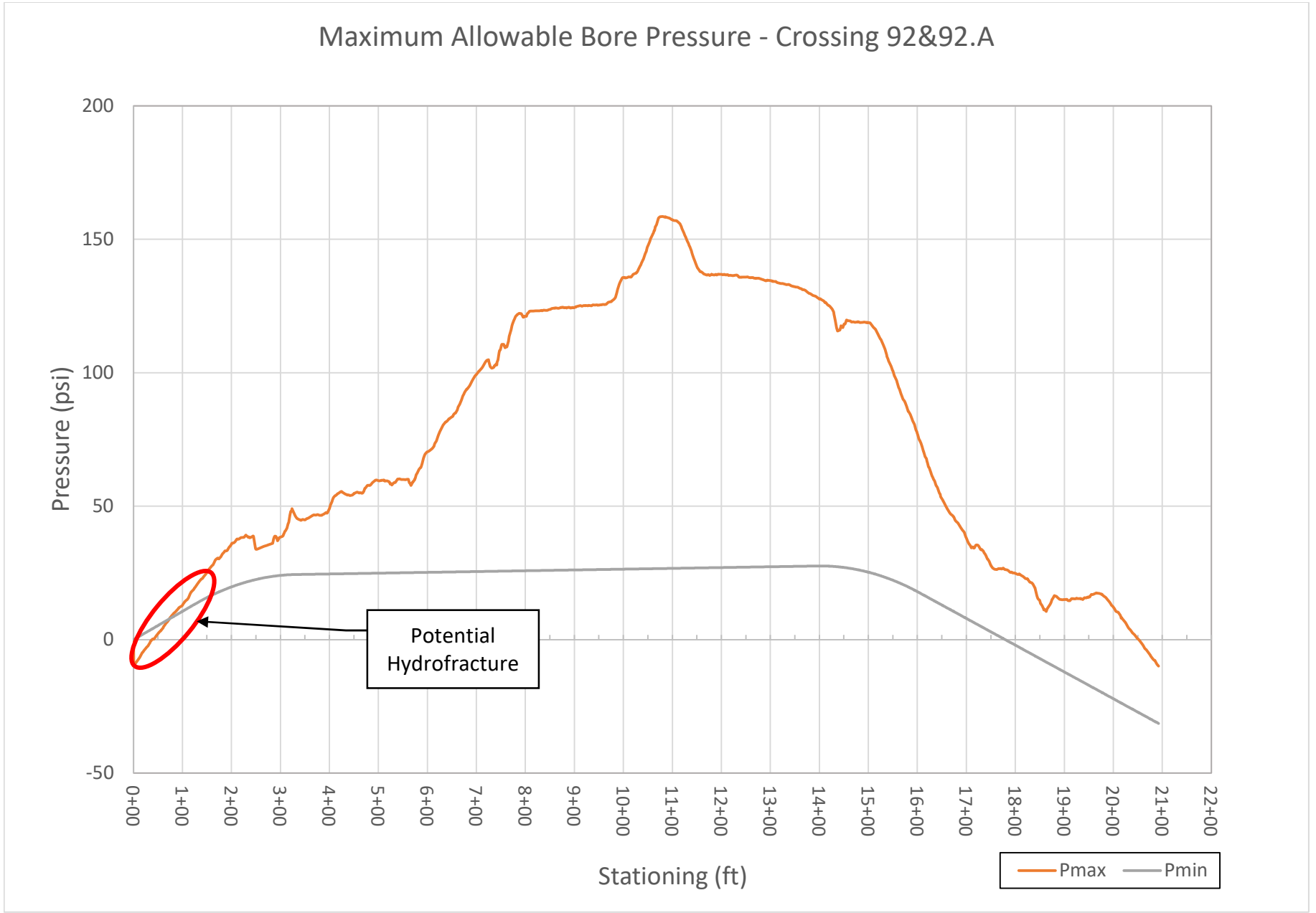
Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 92&92.A Hydrofracture Graph

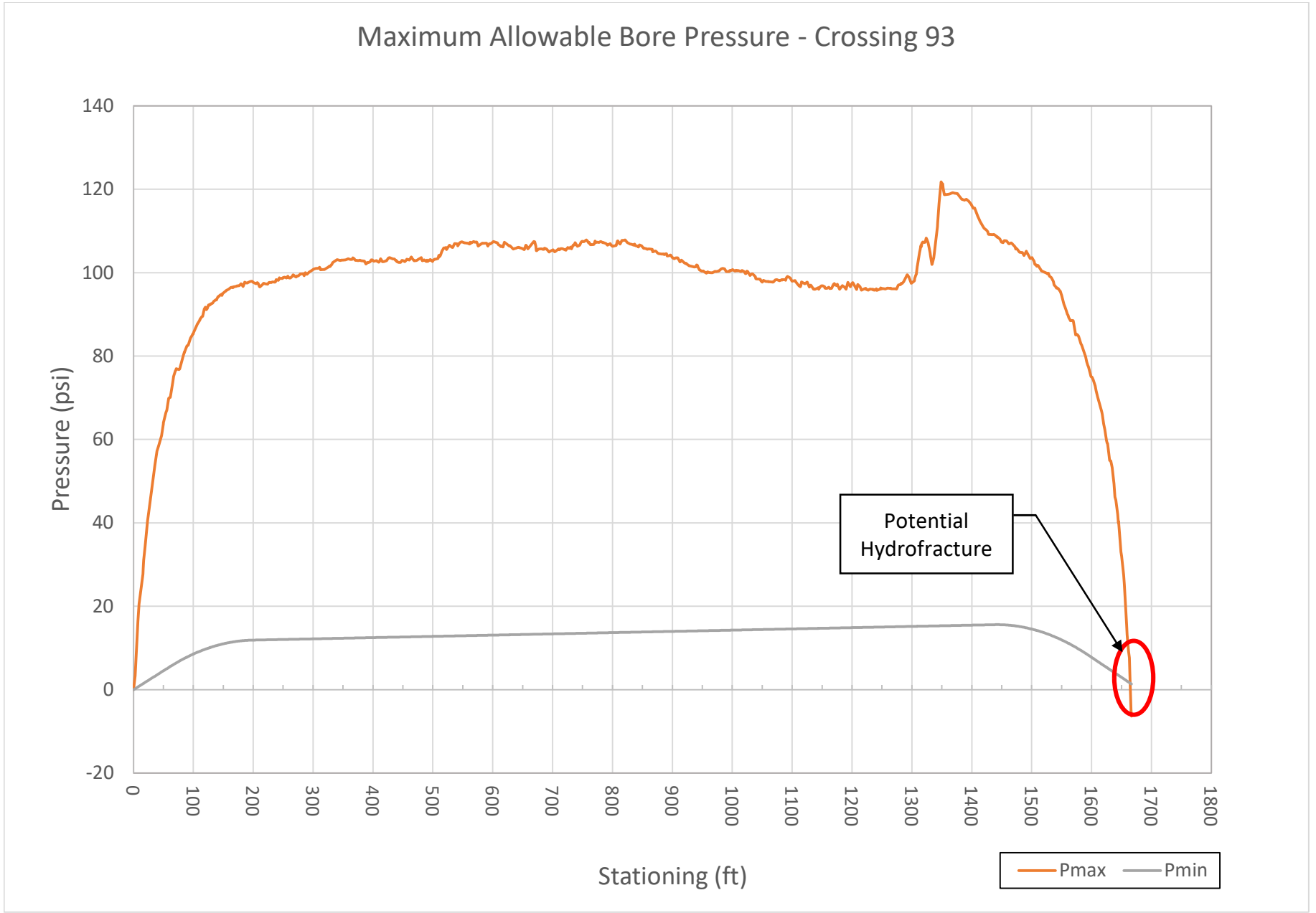
Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 93 Hydrofracture Graph

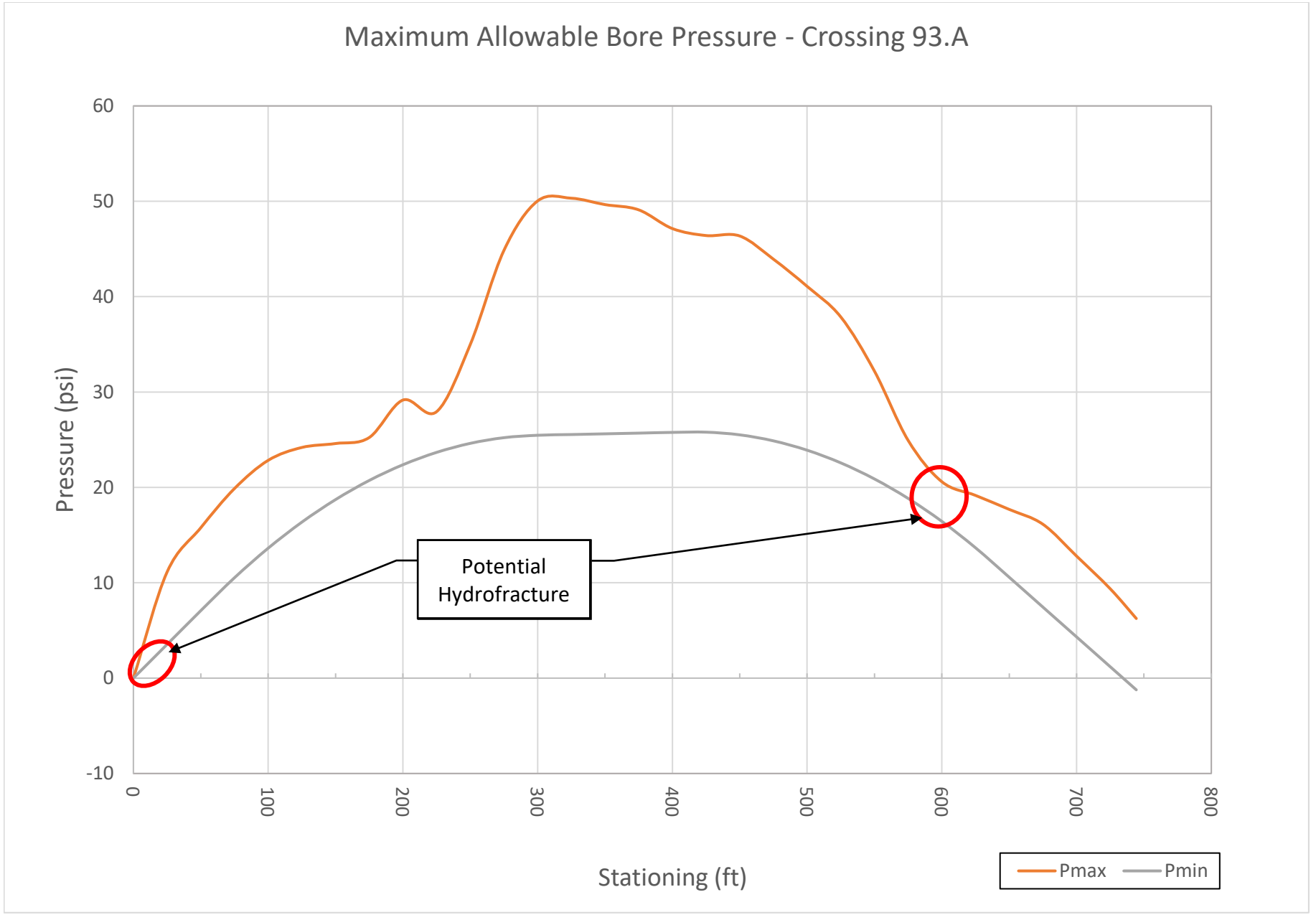
Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 93.A Hydrofracture Graph

Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 94 Hydrofracture Graph

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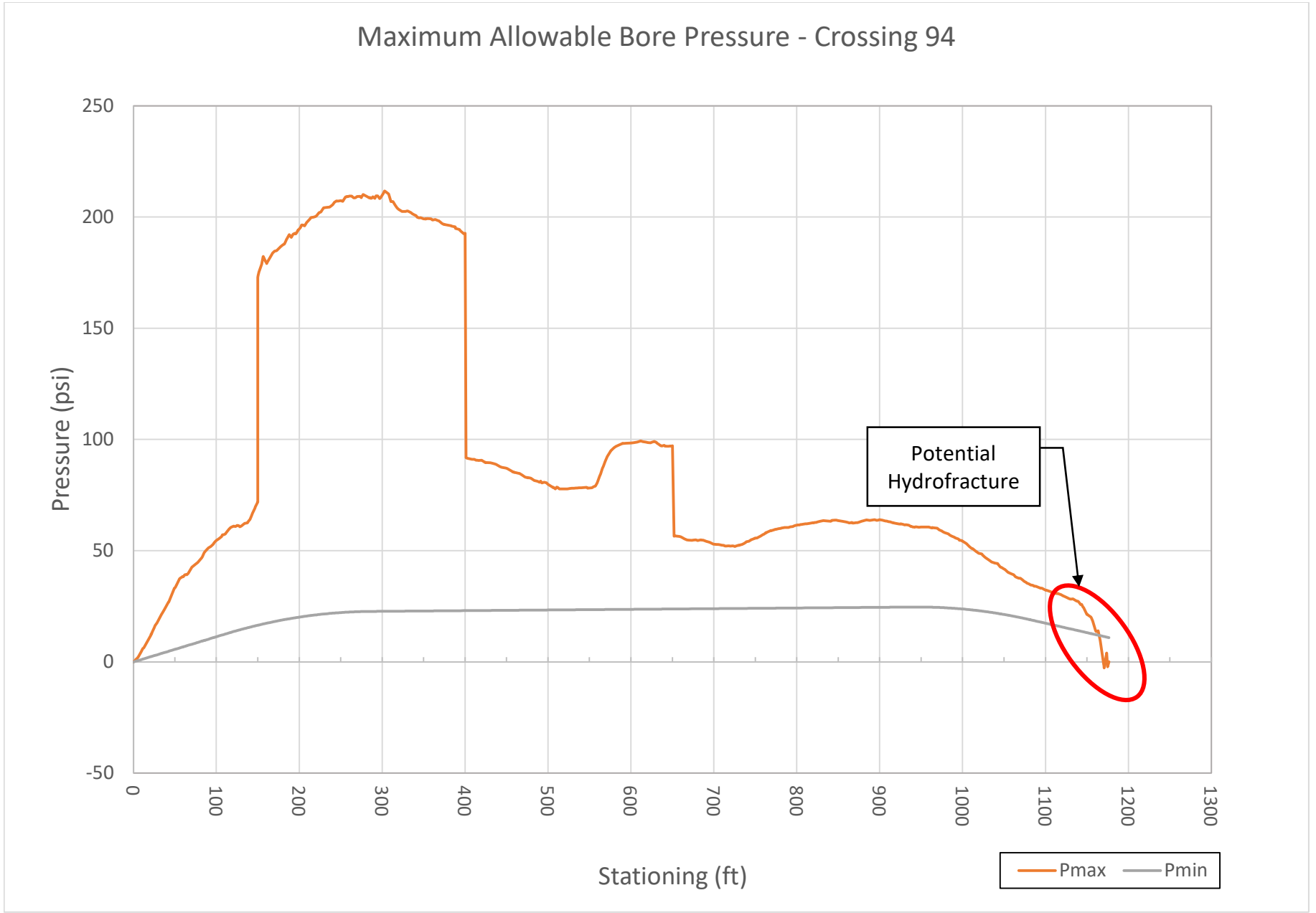
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 95 Hydrofracture Graph

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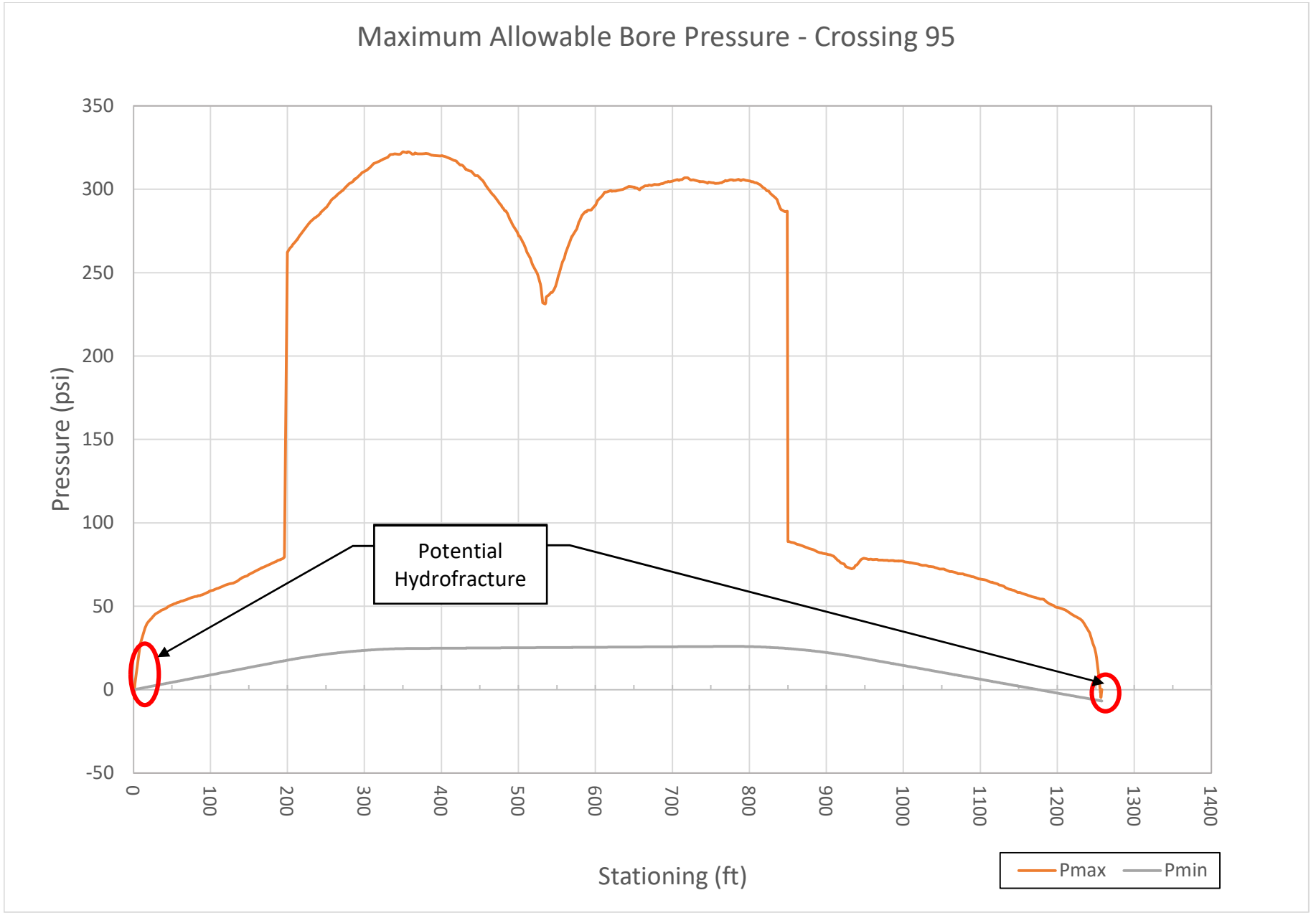
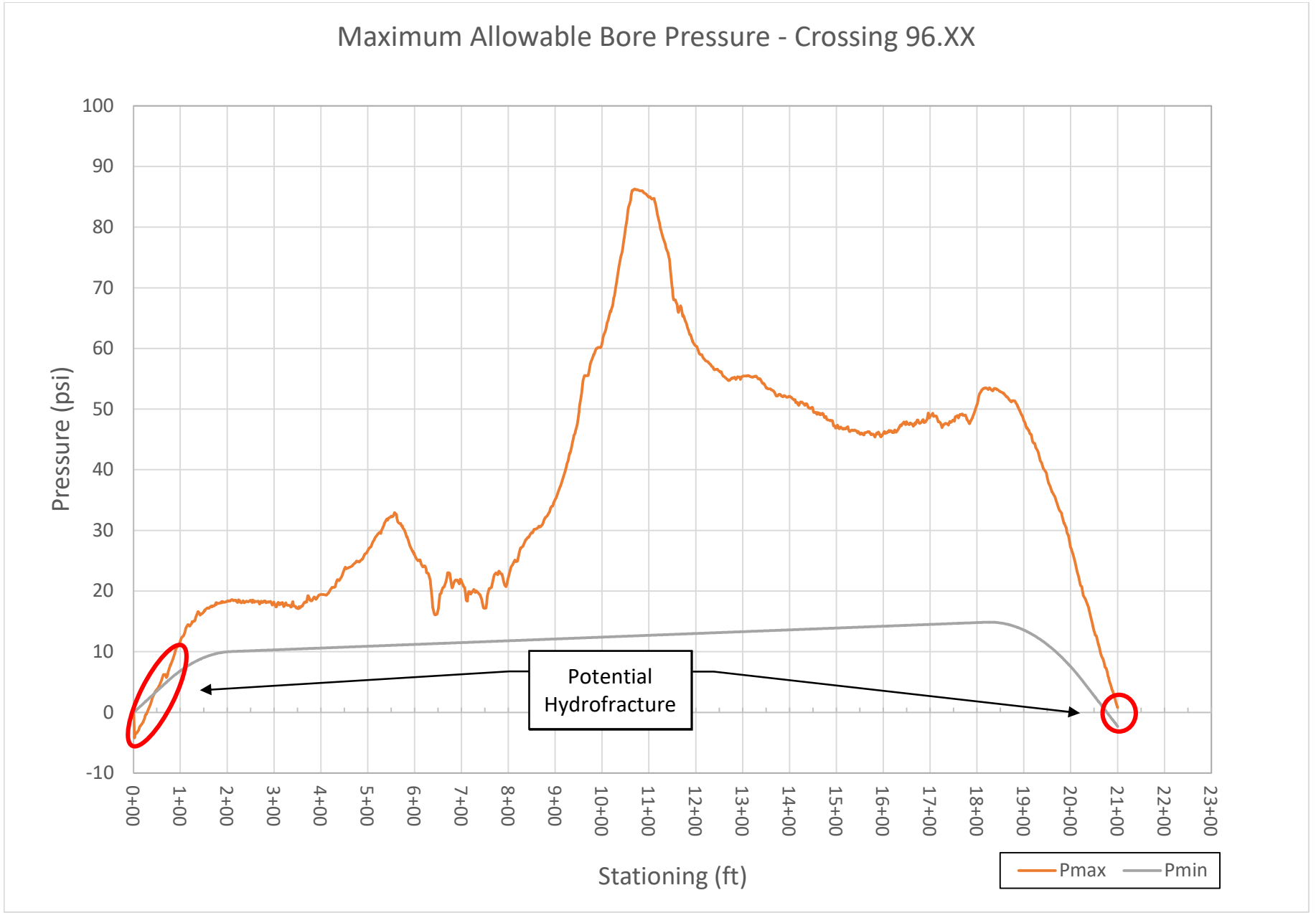
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 96.XX Hydrofracture Graph

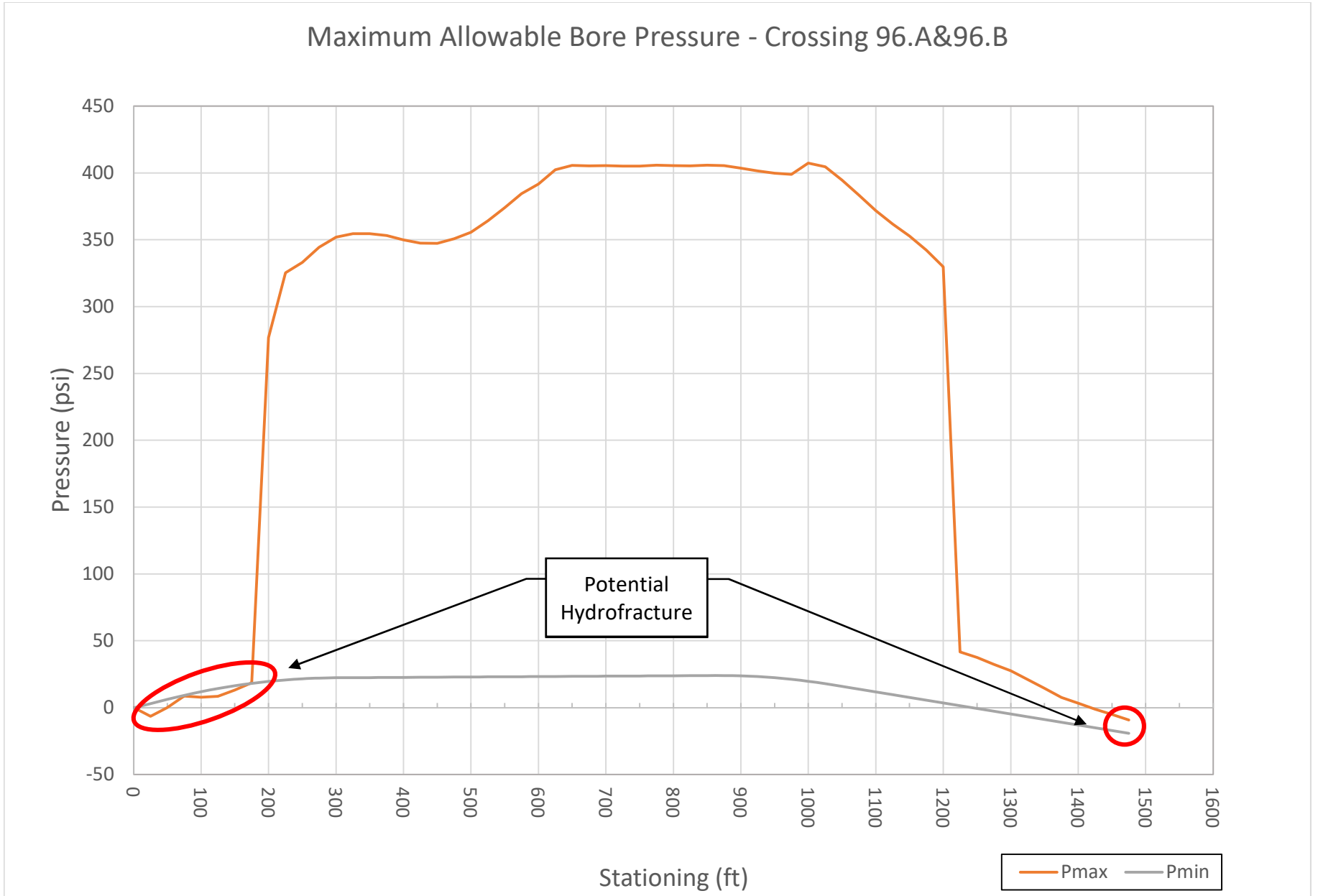
Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 96.A&96.B Hydrofracture Graph

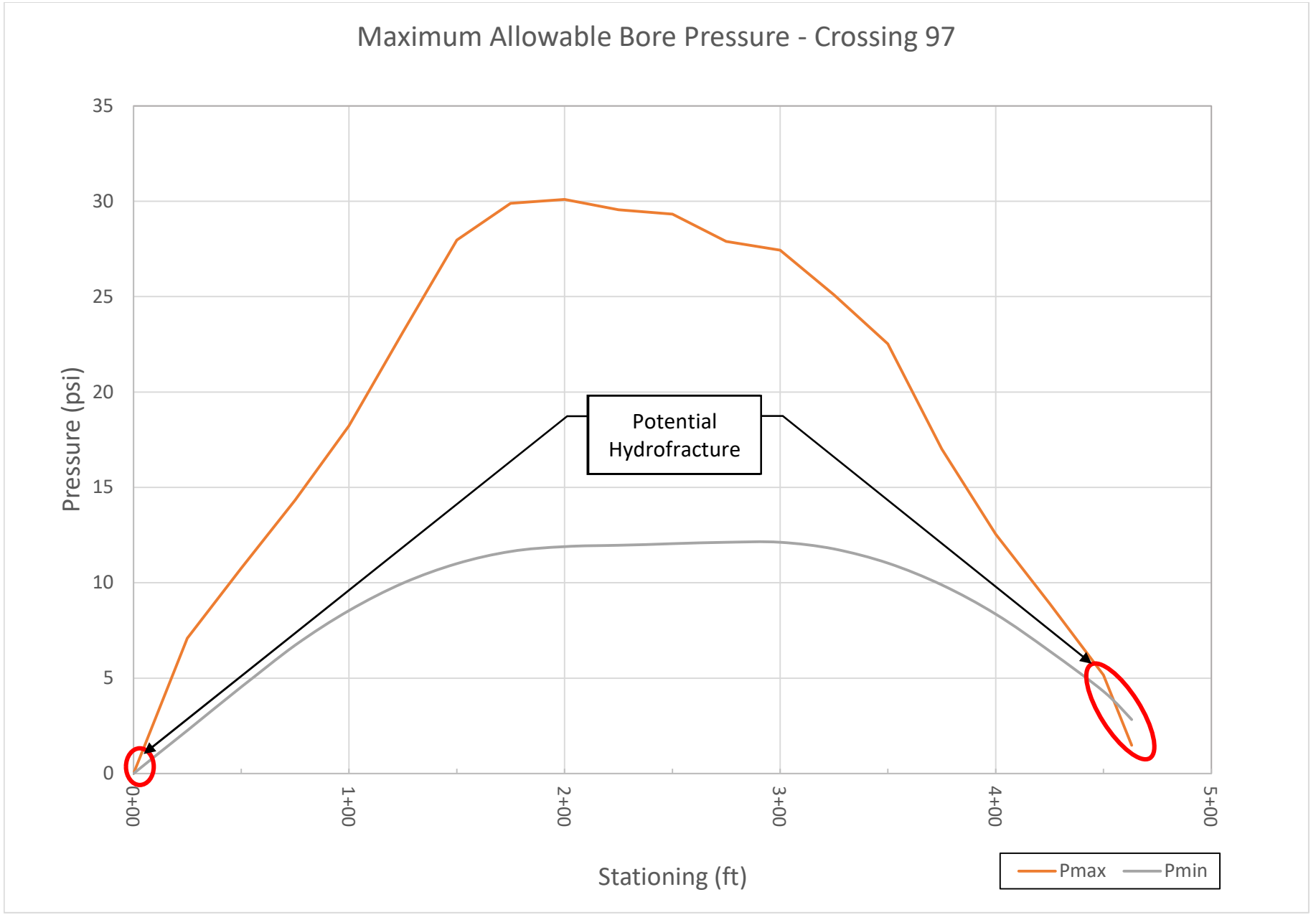
Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 97 Hydrofracture Graph

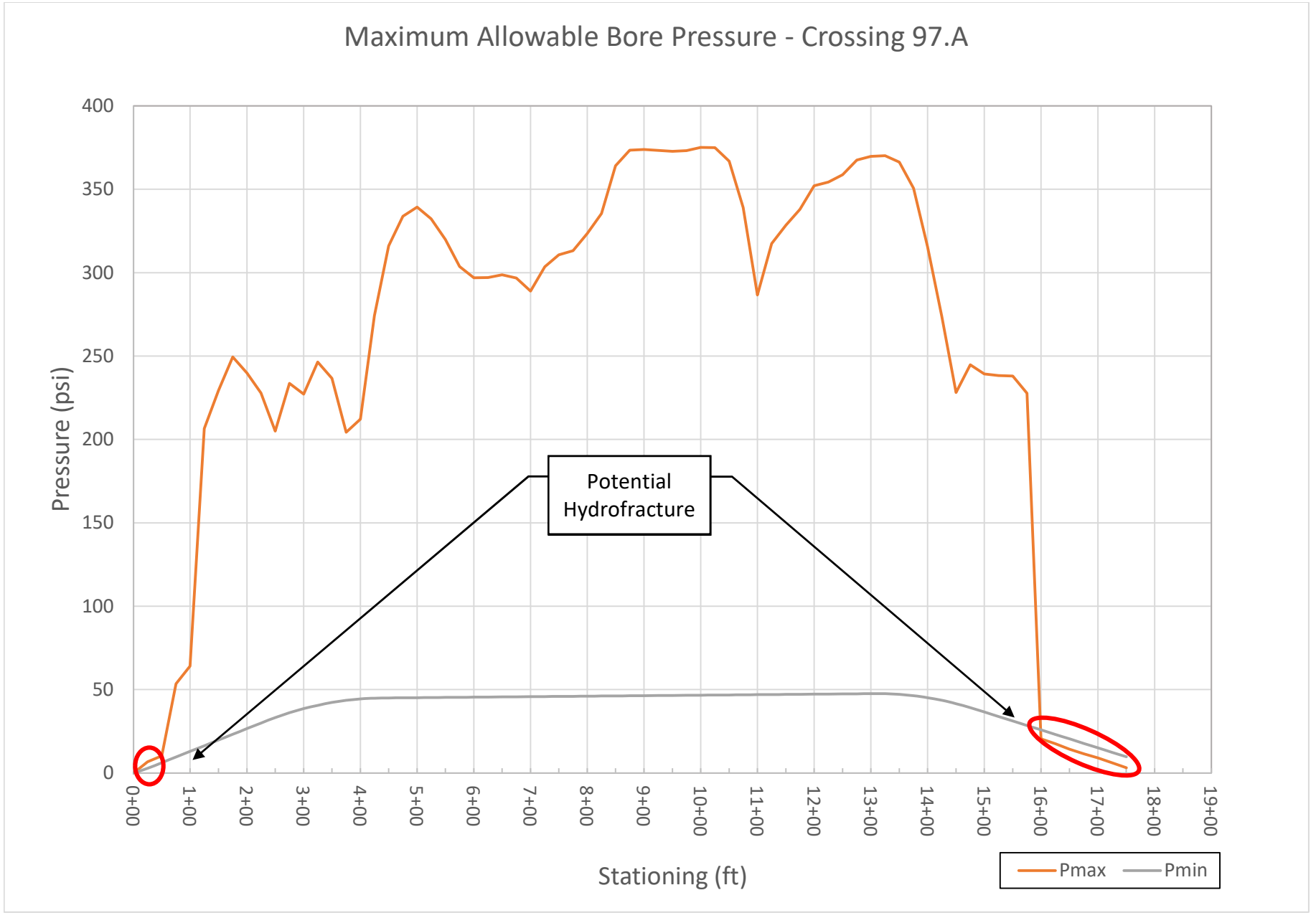
Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 97.A Hydrofracture Graph

Date: 9/27/23
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 98 Hydrofracture Graph

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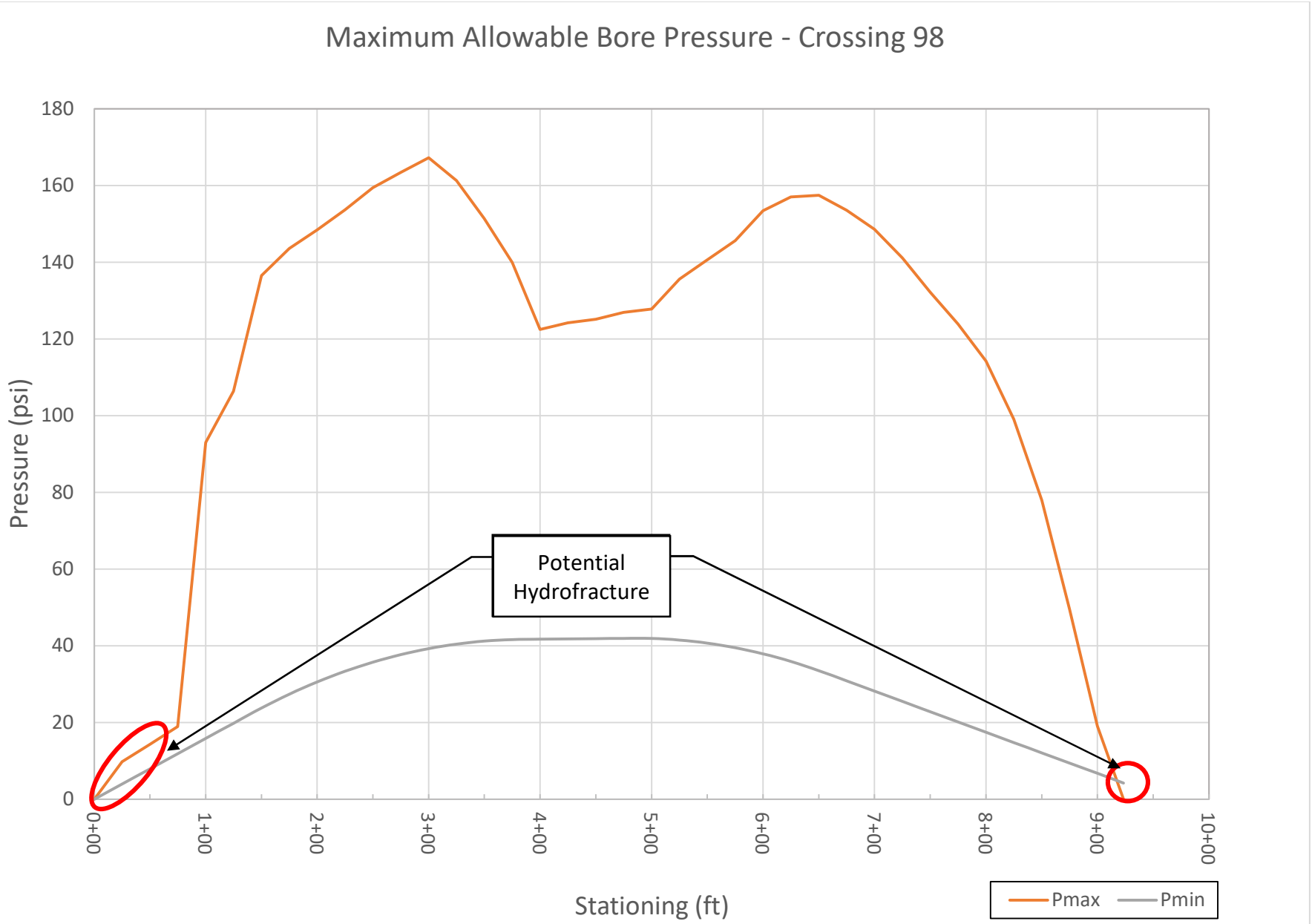

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 99 Hydrofracture Graph

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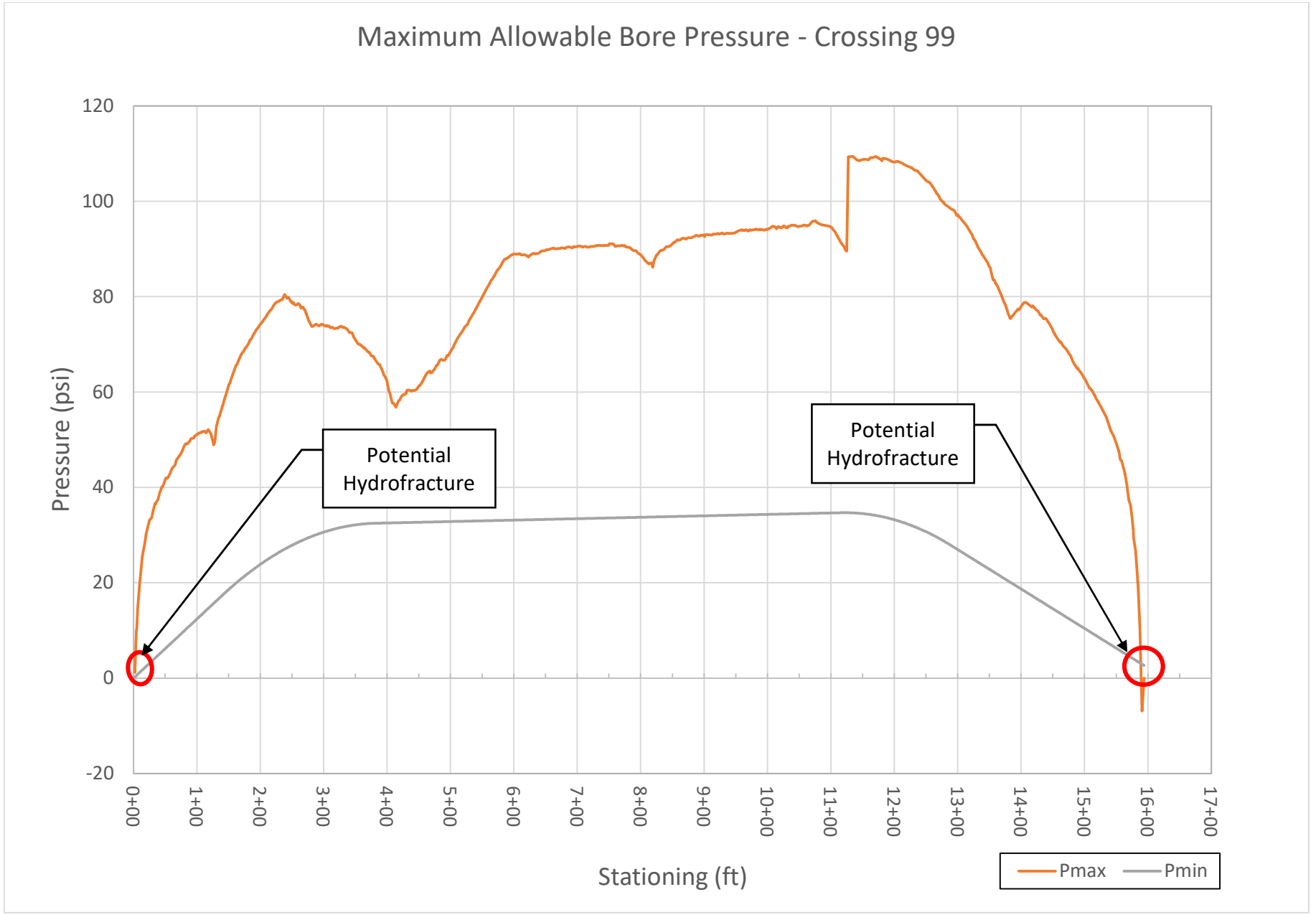
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 99.A Hydrofracture Graph

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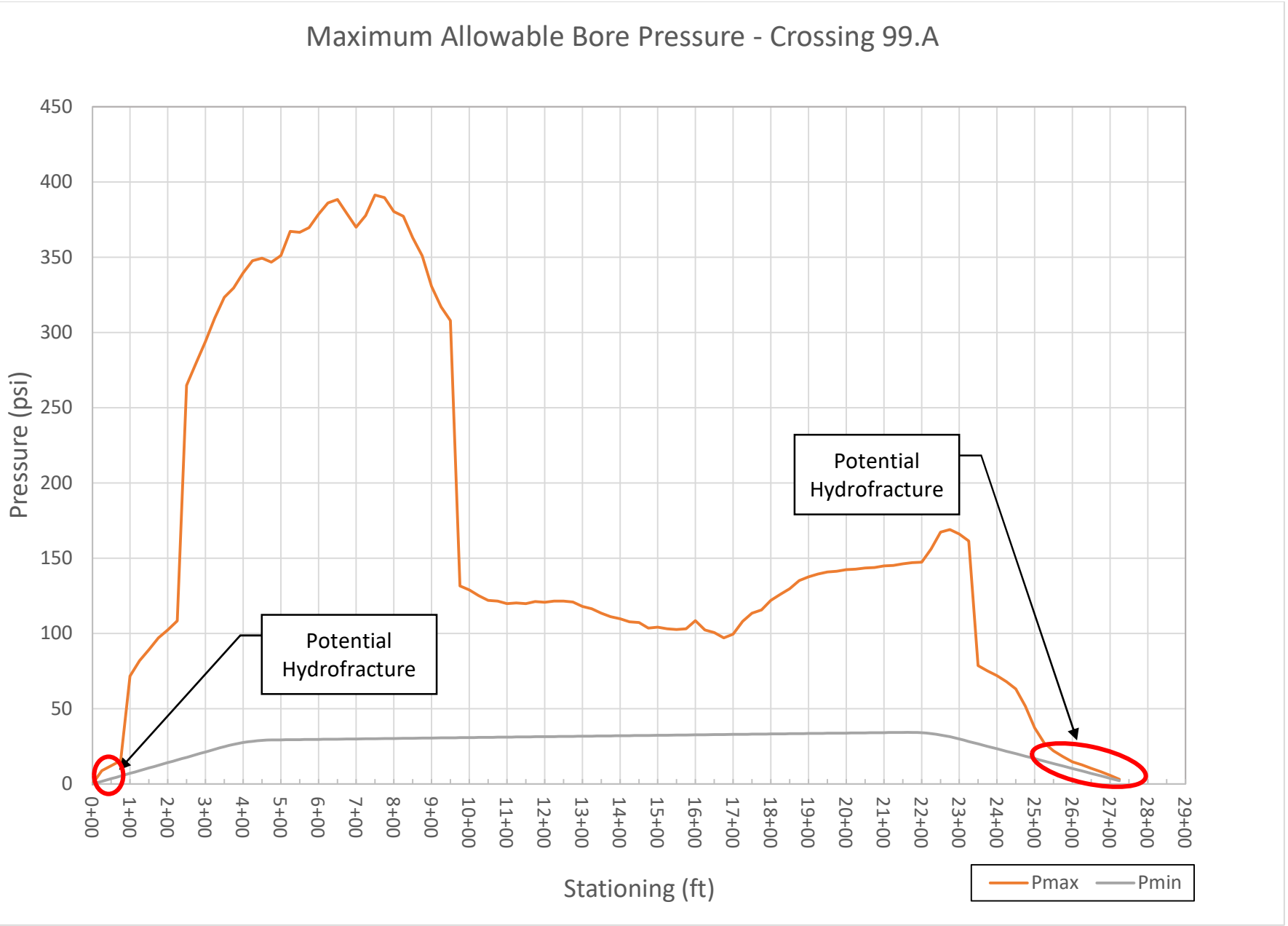
Calculated by: NW
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 101 Hydrofracture Graph

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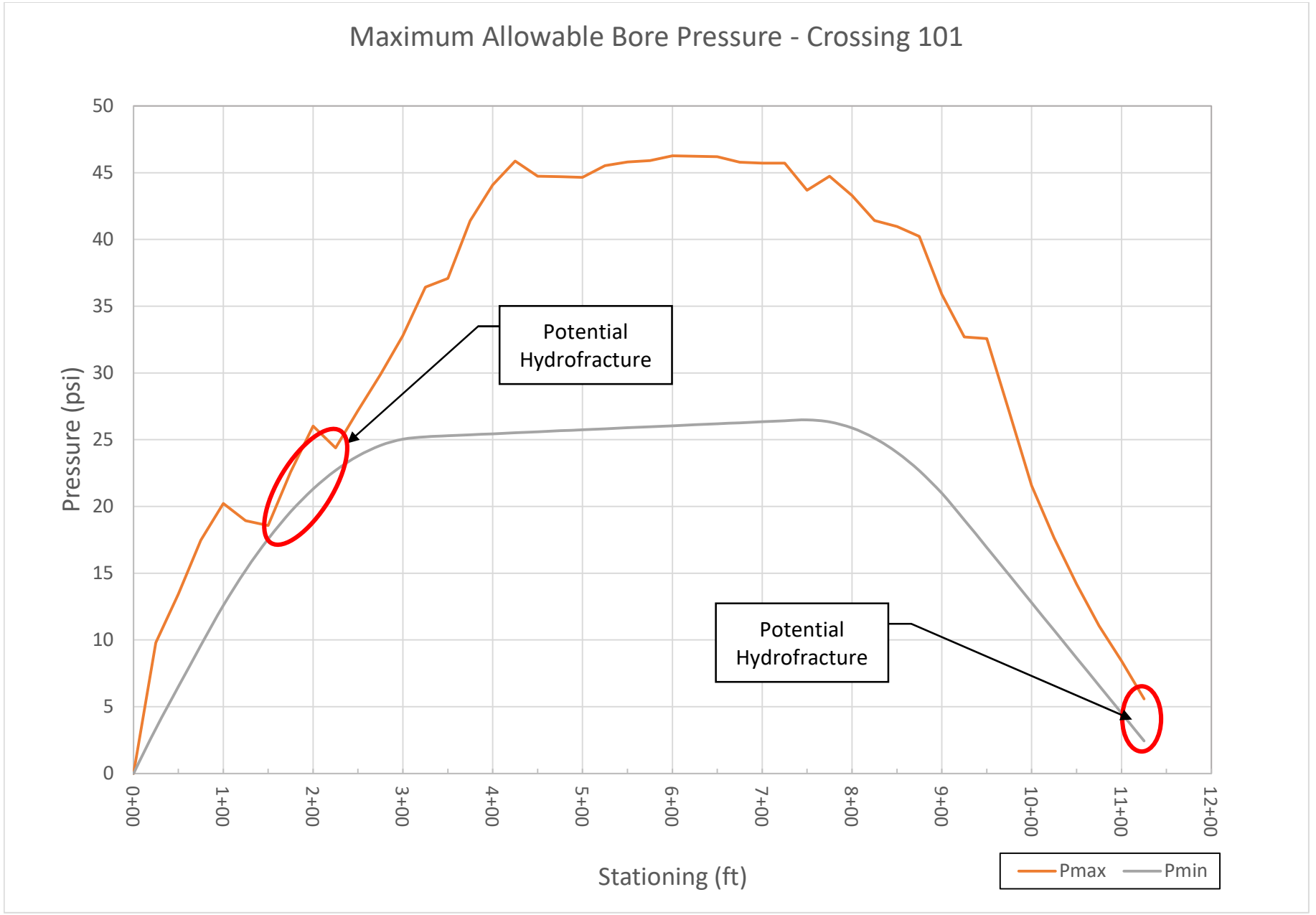

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 101.A Hydrofracture Graph

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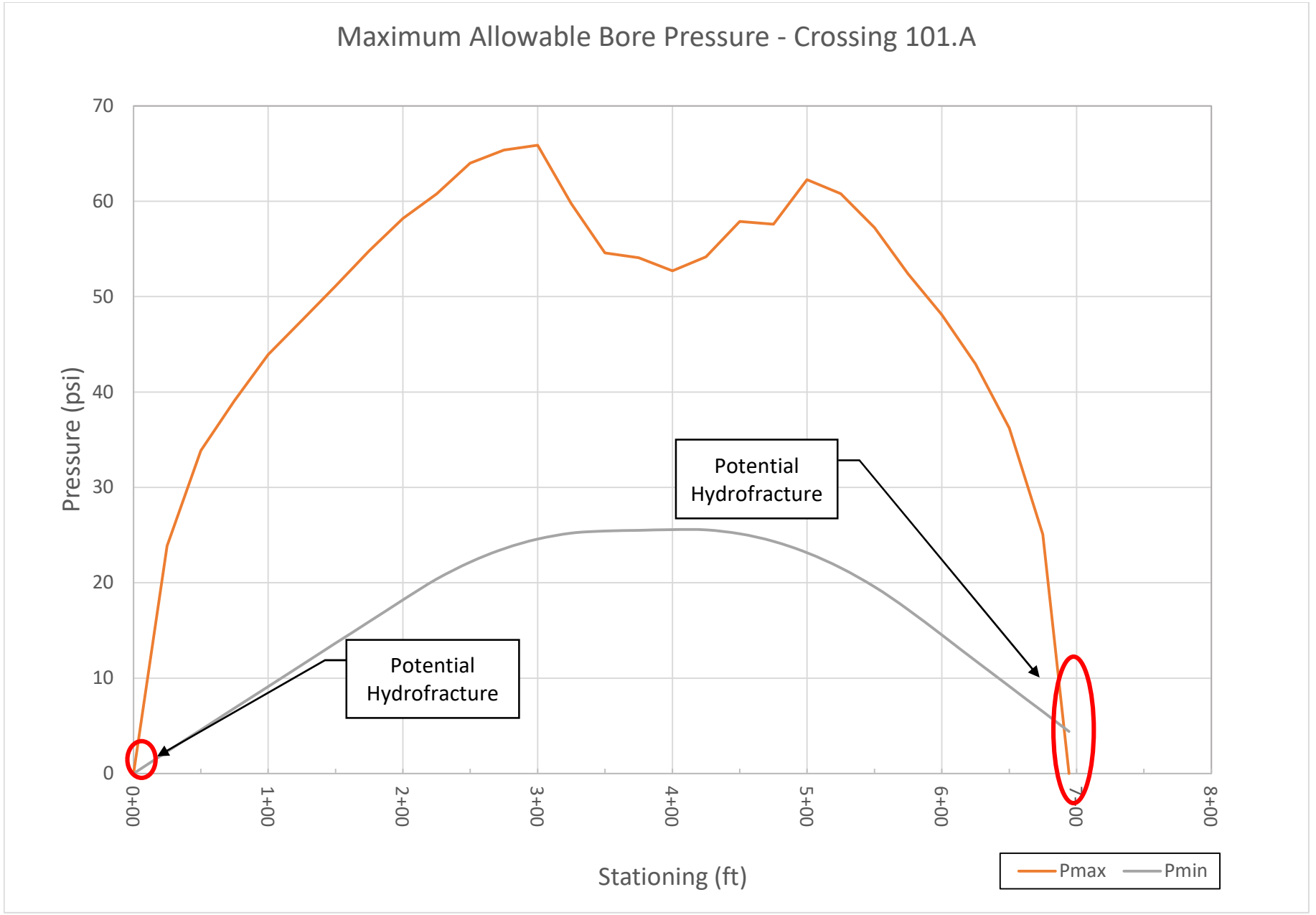

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 102 Hydrofracture Graph

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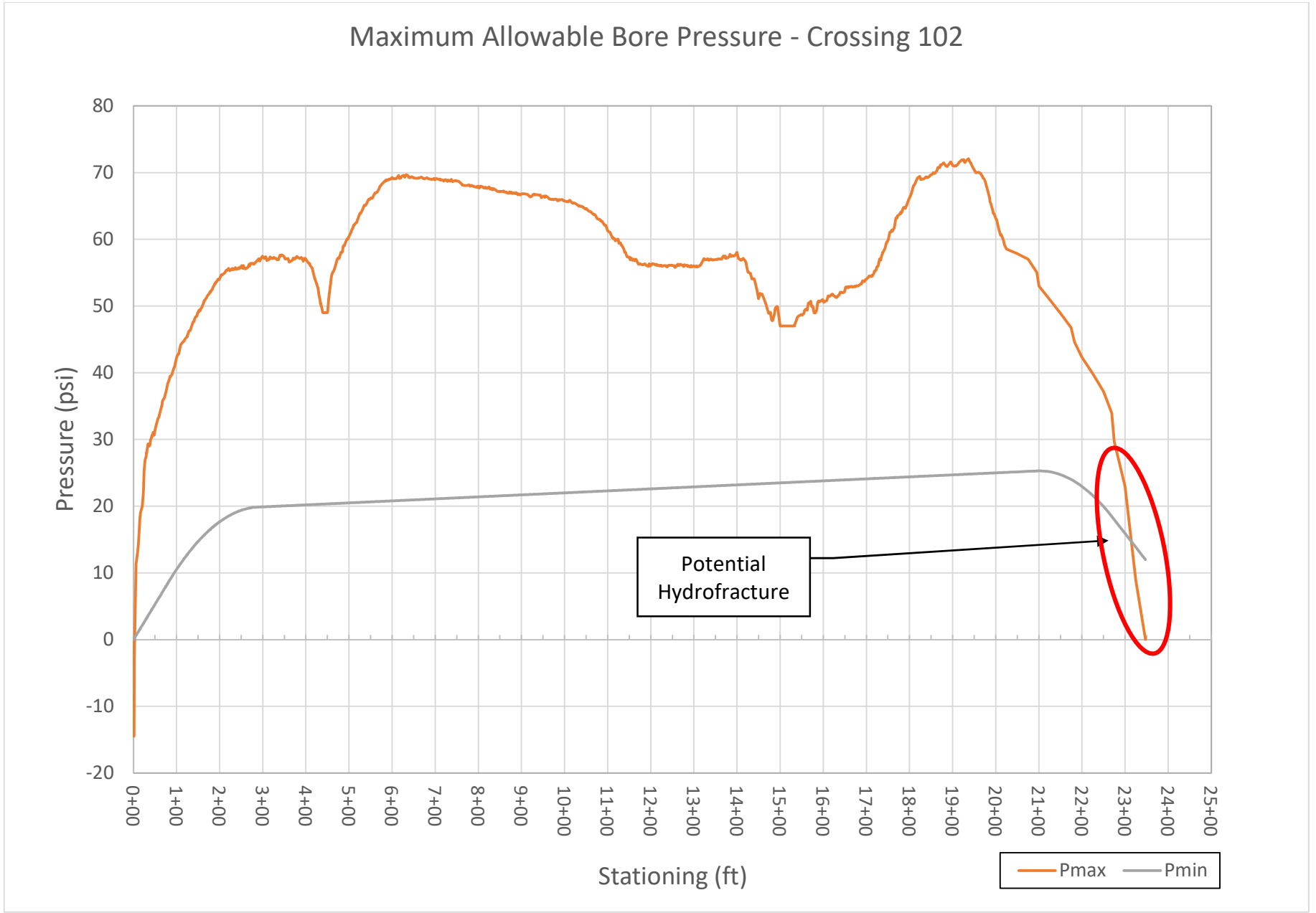

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 103&104 Hydrofracture Graph

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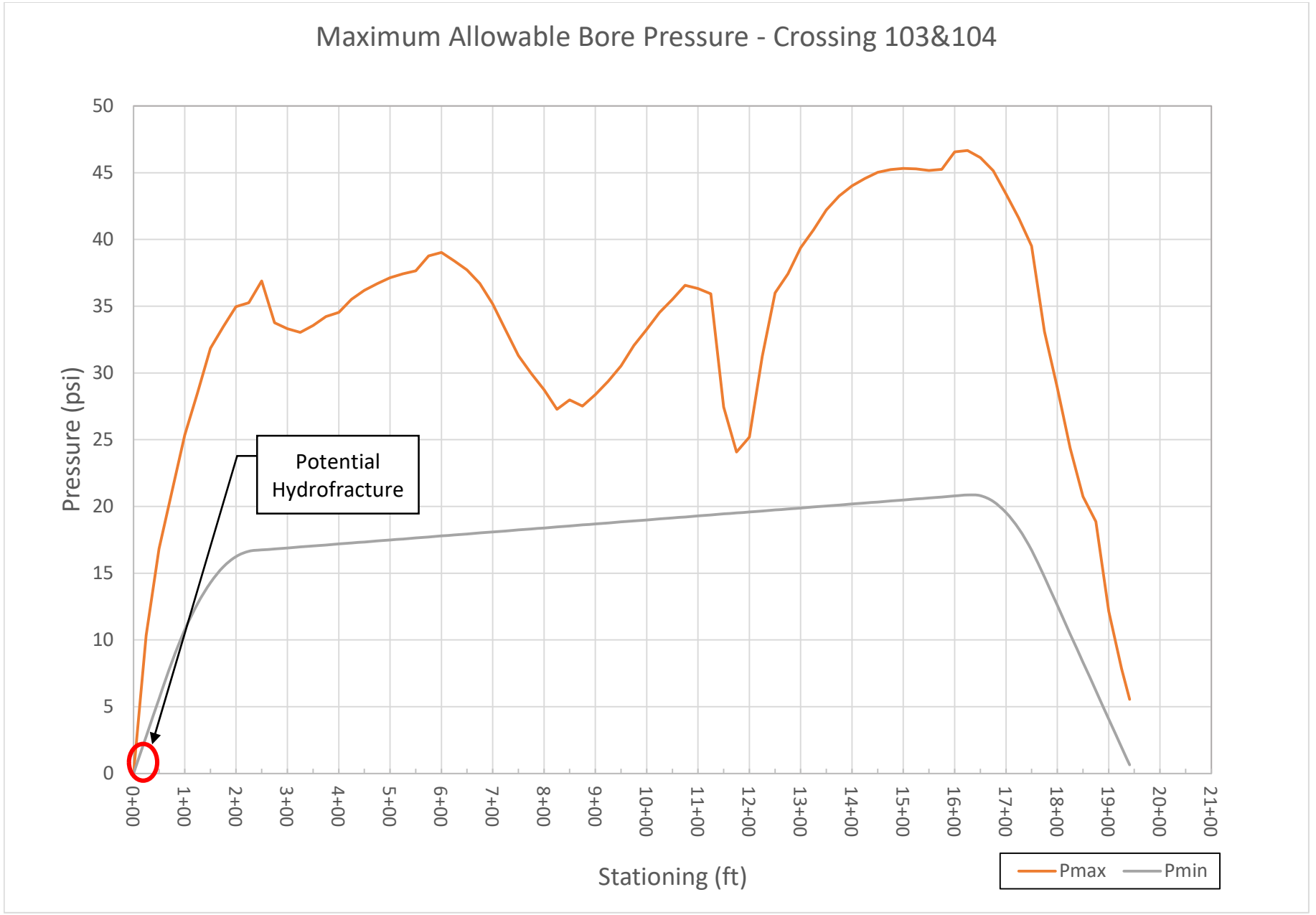
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 105 Hydrofracture Graph

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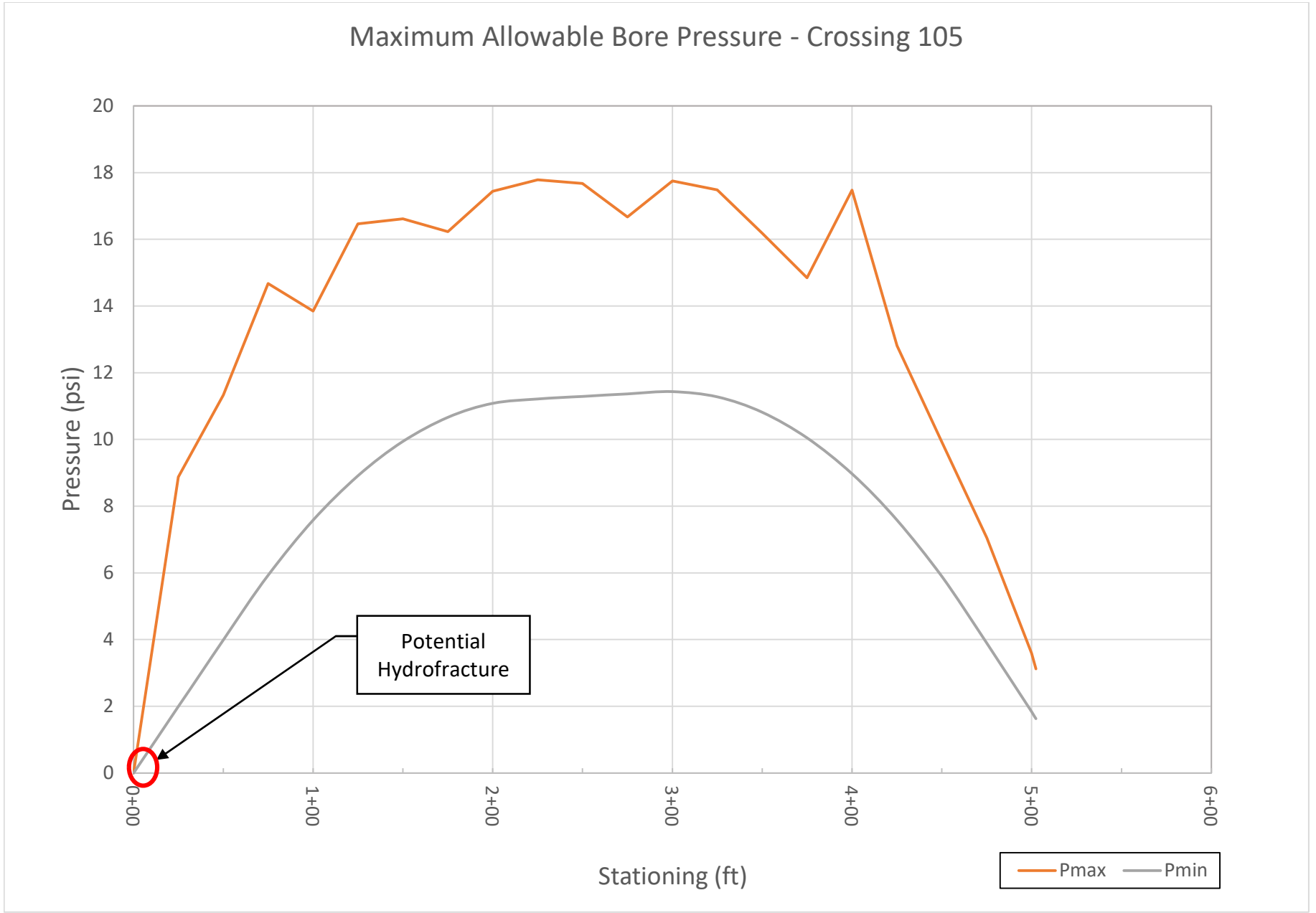

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 107.A Hydrofracture Graph

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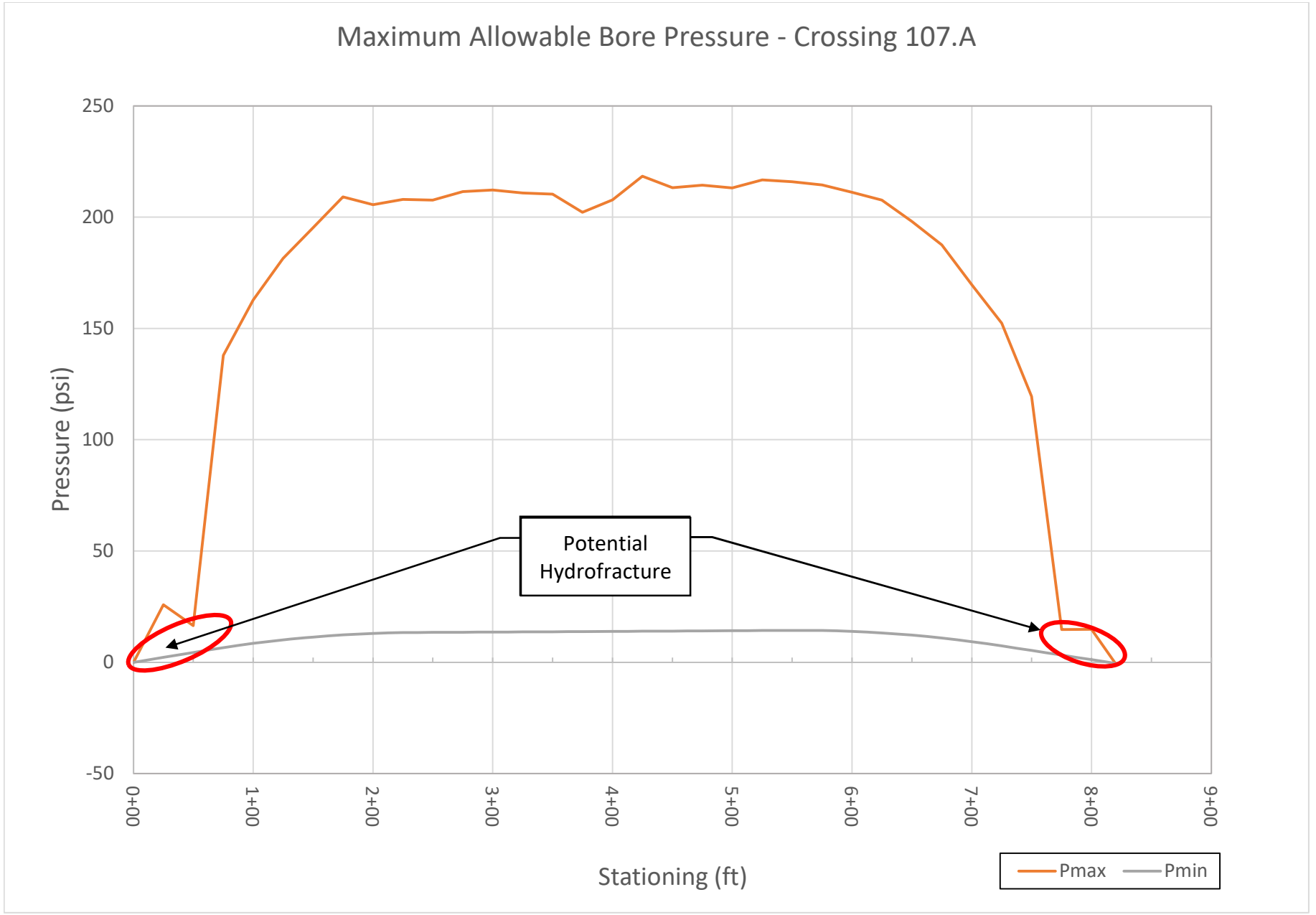

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 108 Hydrofracture Graph

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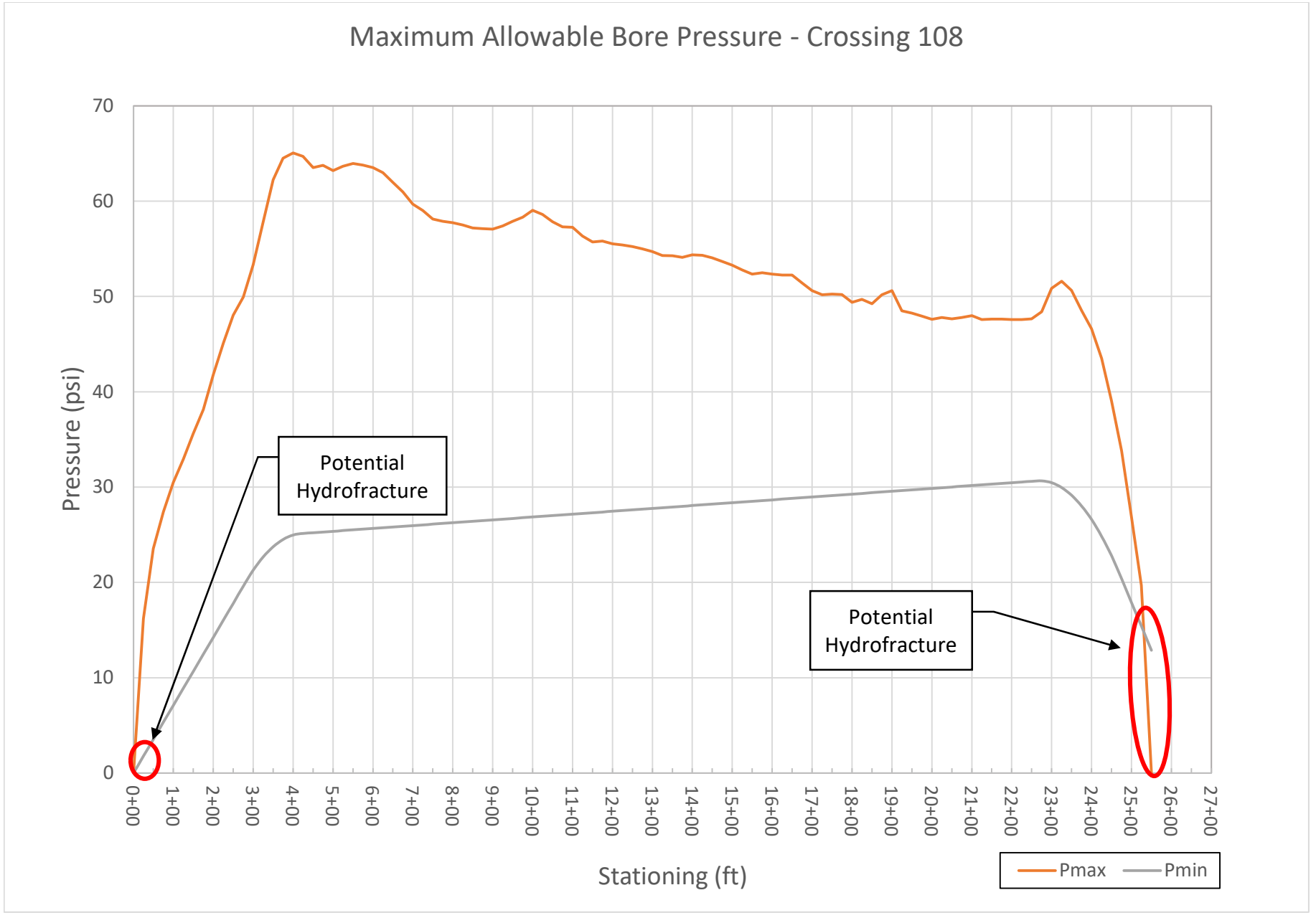
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 109 Hydrofracture Graph

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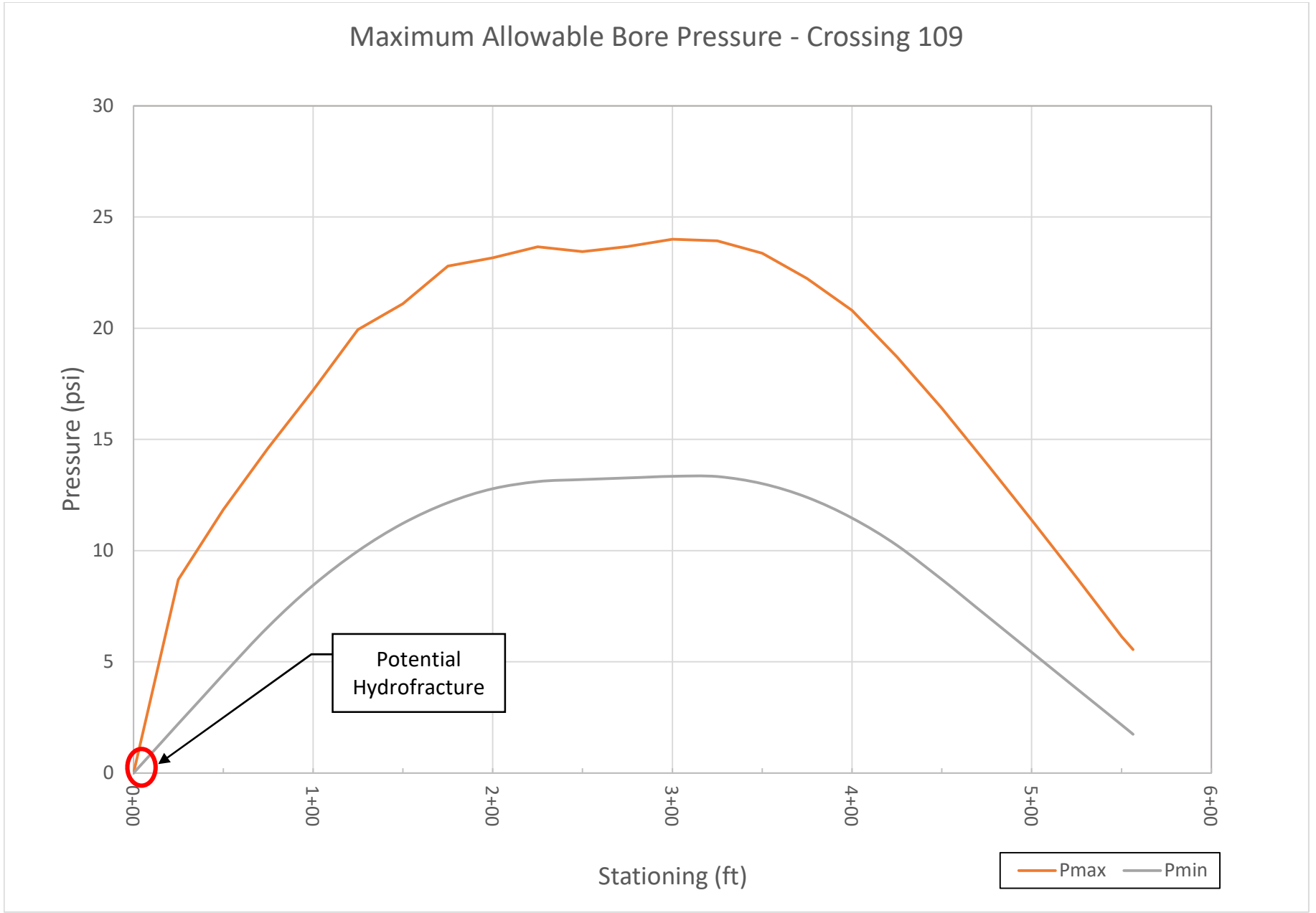

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 110 Hydrofracture Graph

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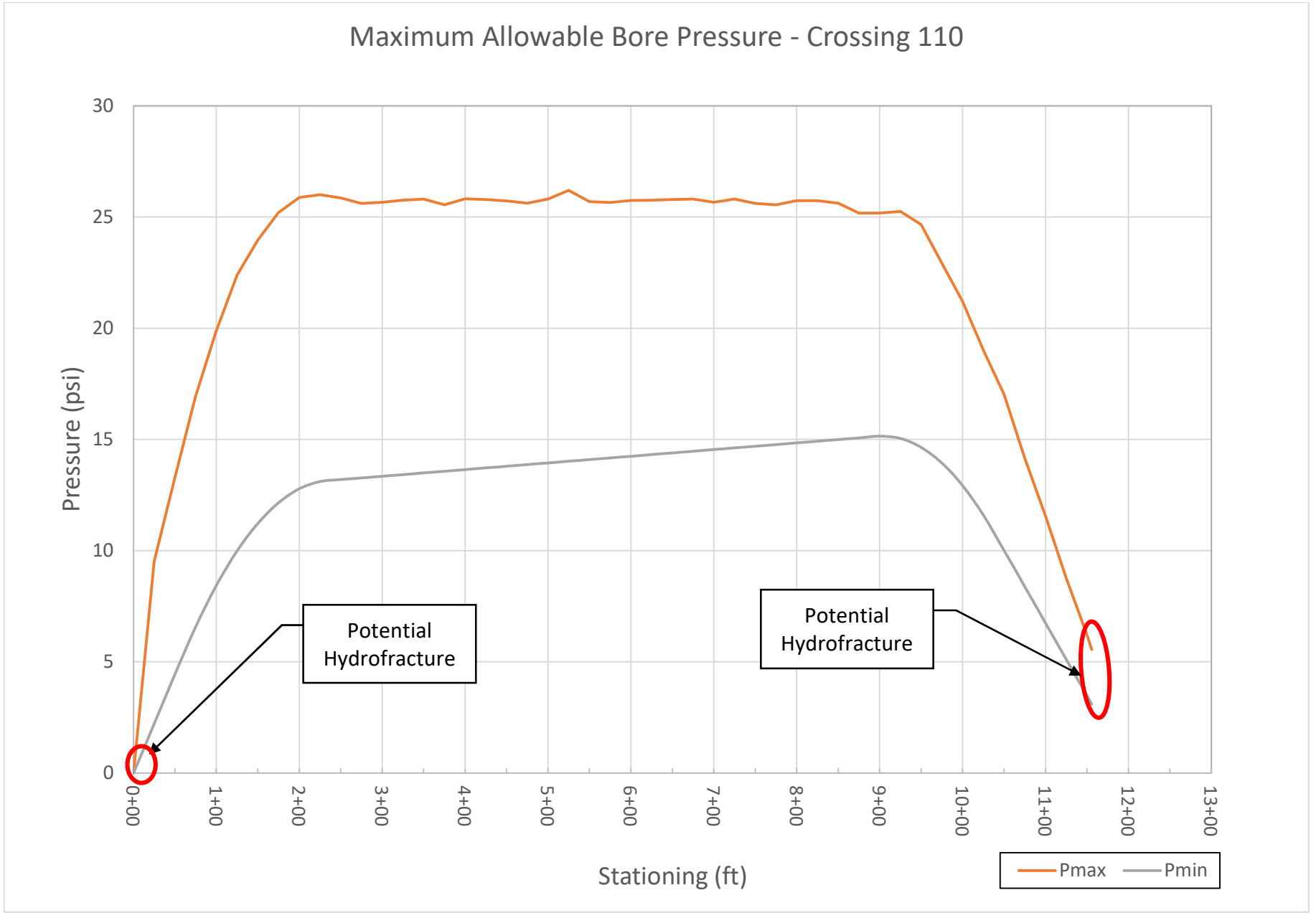

KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 111 Hydrofracture Graph

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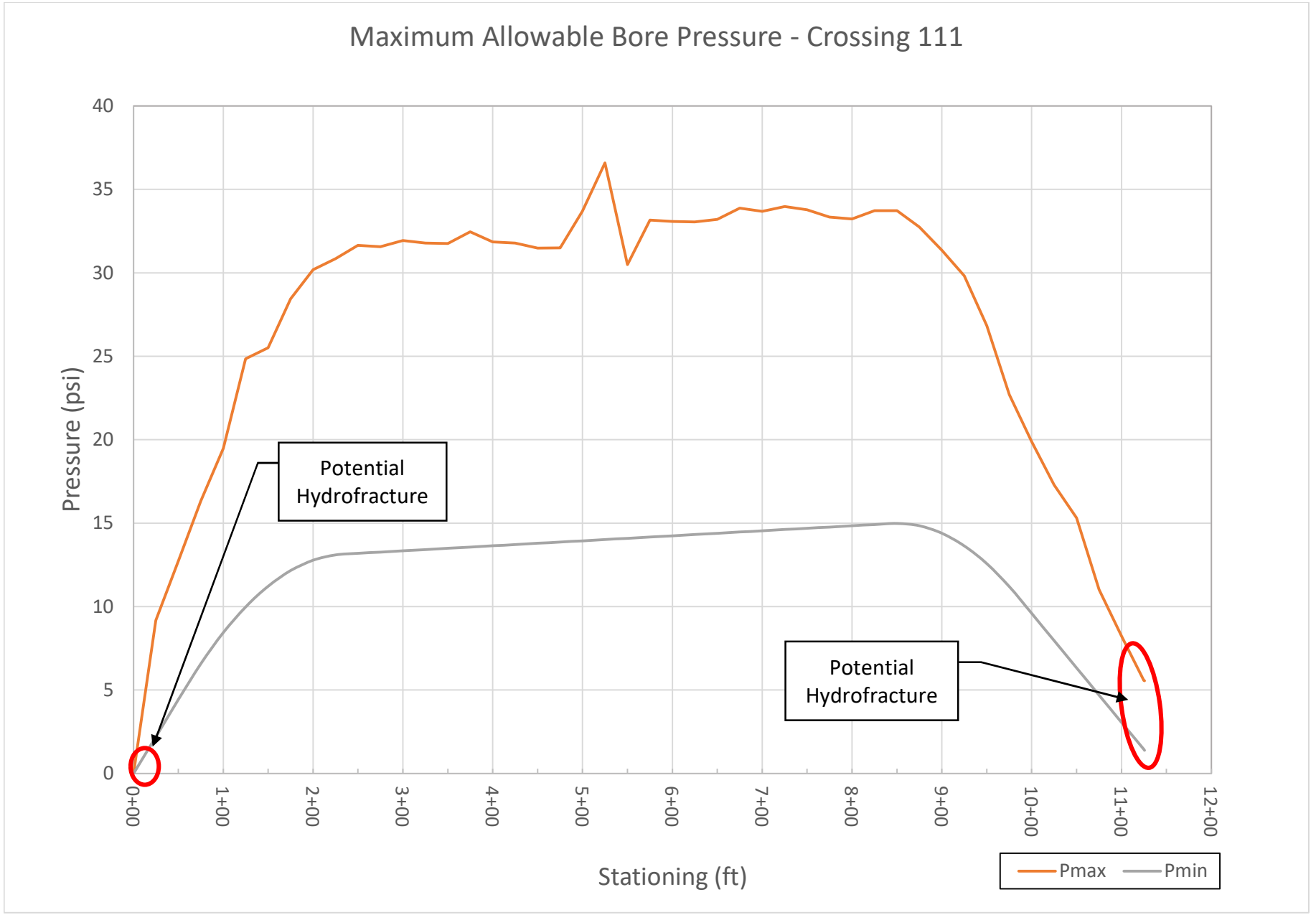
Checked by: SA



KILDUFF UNDERGROUND ENGINEERING, INC.

HDD 111.A Hydrofracture Graph

Date: 9/27/23
Calculated by: NW
Checked by: SA