GOLDER

TECHNICAL MEMORANDUM

DATE January 16, 2020 **Project No.** 18104216-Rev0

TO Vlad Manalastas, P.Eng.
Parsons Corporation

FROM André Bom, P.Eng. **EMAIL abom@golder.com**

REPLACEMENT/REHABILITATION OF 3 STRUCTURAL CULVERTS AND REPLACEMENT/REHABILITATION OF 6 CENTERLINE CULVERTS ASSESSMENT OF CULVERT INSTALLATION BY TRENCHLESS METHOD AND OPEN CUT EXCAVATION CENTRELINE CULVERT AT STATION 14+457, TOWNSHIP OF REANEY HIGHWAY 129, GWP 5071-18-00 CHAPLEAU, ONTARIO
Geocres # 41O-040

Golder Associates Ltd. (Golder) has been retained by Parsons Corporation (Parsons) on behalf of the Ministry of Transportation, Ontario (MTO), to provide Foundation Engineering/Design Liaison Services for the replacement of the following six (6) culverts on Highway 129 near Chapleau, Ontario: Five Mile Creek, Vincent Creek, Trap Creek, and three centreline culverts. Parsons was originally considering the replacement of the centreline culvert at Station 14+457 in Reaney Township by pipe swallowing or pipe ramming. Due to property constraints for the entry and exit pits, we understand Parsons has selected to replace the culvert using open cut in temporary stages with grade lowering and single lane traffic in a 48-hour construction schedule. Based on the foundation investigation completed previously by others, this technical memorandum presents a summary of the subsurface conditions encountered at the culvert site and provides design recommendations for pipe replacement by both trenchless and staged grade lowering with open cut methods. Assuming Golder can rely that the boreholes advanced previously by others at this site were completed in accordance with MTO guidelines and scope expectations, no new additional boreholes were advanced at the site by Golder. Further, embankment stability analyses and design recommendations for the permanent conditions at this highway have been provided by exp Services Inc. (exp) and Golder has not been retained to become the geotechnical engineer of record for such aspects of the work. Golder's scope and responsibility are therefore limited to consideration only of geotechnical engineering aspects of the culvert replacement through use of either trenchless methods and some limited topics for the temporary works necessary to address cut and cover replacement of the culvert. The complexity of subsurface conditions and their attendant risks has resulted in consideration of both trenchless and cut and cover alternatives, both of which must be understood in the context of their various advantages and disadvantages.

1.0 BACKGROUND/SUBSURFACE CONDITIONS

The existing culvert is a 900 mm diameter and 32 m long Corrugated Steel Pipe (CSP) culvert. The embankment is about 6 m high, relative to the culvert invert at about Elevation 456.6 m. The west and east embankment side slopes are reportedly inclined at 2.2 Horizontal to 1 Vertical (2.2H:1V) and 1.9H:1V, respectively.

A Foundation Investigation and Design Report (FIDR) was prepared by exp for the replacement of the culvert by open cut methods (GEOCRES 41O-32, dated December 4, 2017). A total of three boreholes (BH-1 to BH-3) were advanced in December 2016 and January 2017. One borehole each was advanced at the culvert inlet and outlet to refusal at 5.2 m and 6.2 m depths, respectively. One borehole was advanced through the roadway on the south side of the culvert to refusal at 9.5 m depth. Appendix A includes the following from exp's foundation investigation: 1) Drawing 1 showing approximate locations of the boreholes and inferred soil strata, 2) photographs at the site, and 3) Record of Borehole sheets.

Borehole BH-1 advanced through the embankment near the culvert midpoint encountered 6.3 m of fill consisting of compact to very dense gravelly sand, sand, sandy silt, and silt. Cobbles and boulders were reportedly encountered within the fill below 3.5 m depth. The existing culvert is reportedly near the bottom of the fill and the surface of the 1.6 m of very loose to loose peat/wood. About 1.2 m of compact silt and sand was encountered below the peat and about 0.4 m of gravel (assumed till) was encountered below the silt and sand. The borehole was terminated at 9.5 m depth due to refusal on suspected very dense till or bedrock.

Borehole BH-2 was advanced near the culvert outlet and encountered 2.6 m of very loose peat underlain by 3.5 m of very loose silt and sand underlain by 0.1 m of gravel (assumed till). The borehole was terminated at 6.2 m depth due to refusal on suspected very dense till or bedrock.

Borehole BH-3 was advanced near the culvert inlet and encountered 2.3 m of very loose to loose silt and sand to organic silt and sand with peat, underlain by 2.3 m of loose peat, underlain by 0.6 m of silty gravelly sand till. The borehole was terminated at 5.2 m depth due to refusal on suspected very dense till or bedrock.

In January 2017, the top of ice in the creek at the inlet and outlet was at approximately Elevation 457.0 m and 455.8 m, respectively. The groundwater level in the boreholes was inferred to be between Elevation 456.2 m and 457.8 m. Groundwater and creek water levels are subject to seasonal fluctuations and variations due to precipitation events.

2.0 TRENCHLESS INSTALLATION

The following sections provide foundation design recommendations related to replacement of the culvert by trenchless installation. The discussion and recommendations presented in this memorandum are based on our understanding of the project and our interpretation of the factual data obtained from the subsurface investigations completed by others. Design drawings by Parsons indicate the existing culvert will be replaced with a minimum 1.5 m diameter pipe. The pipe might be replaced, if appropriate and if risks are adequately managed, by pipe ramming/swallowing along the existing culvert or by pipe ramming on the south side of the existing culvert (in the vicinity of Borehole BH-1); however, certain subsurface risks and other project constraints (e.g., property availability) may render this option undesirable.

2.1 General Description of Trenchless Technologies

The Contractor should be responsible for choosing the method and equipment for the crossing installations, unless specific methods are otherwise prohibited based on ground conditions or other project criteria. Ground behaviour will be, in part, dependent on the installation method adopted, and this memorandum provides guidance on the influence of ground behaviour. It should not be construed that the Contractor is restricted to the methods considered in this memorandum, and in the event alternative methods are chosen, the Contractor will need to make their own interpretation of the anticipated ground behaviour, based on the factual information from the investigations. MTO's Non-Standard Special Provision (NSSP) for Pipe Installation by Trenchless Method is attached.

Several construction methods were considered during preparation of this memorandum for completeness, though the practicality of some of these techniques for this project may be doubtful if not entirely unsuitable. The techniques considered from a general perspective include, pipe jacking and horizontal auger boring, pipe ramming (including "pipe swallowing"), micro-tunneling "pilot tube" micro-tunneling, and hand mining. Due to the relatively small size of the replacement culvert, at about 1.5 m diameter, tunnel boring machine (TBM) and tunnel digging machine (TDM - i.e., open face shield tunnelling) were not considered for this culvert replacement. Due to the corrugations of the existing steel pipe, we understand from Parsons that replacement by pipe bursting is not an option. Various trenchless installation methods are briefly described below.

- **Horizontal Auger Boring – "Jack and Bore":** In Ontario, a traditional "jack and bore" operation involves pushing a steel pipe (casing) horizontally into the ground by jacking, while simultaneously cutting the ground with an auger head operating near the leading end of the steel pipe. The spoil is generally removed from within the casing using an auger boring machine. The cutting head is driven by, and is positioned at, the leading end of an auger string that is established within the casing pipe. Jacking and receiving pits are required. Typically, there is limited ability to steer the casing during jacking. This method is only applicable to construction in soils and may not be feasible in bouldery soils (e.g., glacial till). In some cases, contractors will run the auger cutting head in front of the lead end of the casing to advance the pipe in difficult ground; however, this approach can lead to high risks for ground losses (settlement, sinkholes). This method is also not feasible in running or flowing ground (dry or saturated sand and silt).

  In some cases, traditional "jack and bore" equipment is supplemented with a specialized rotating cutting head, sometimes referred to as a "small boring unit". These cutting heads are welded to the lead end of steel casings, can sometimes include limited alignment adjustment capabilities, and can be fitted with rock disc cutters. In the right ground conditions (e.g., hard glacial till, weathered rock), the small boring heads can be advantageous. However, these systems are not well suited to and should not be used in saturated and potentially flowing ground conditions. Further, these systems should not be confused with microtunnelling systems that operate using very different principles of ground support.

- **Pipe Ramming:** Pipe ramming uses a pneumatic tool to hammer a steel pipe or casing into the ground. The pipe is almost always driven "open" to thereby direct the soil into the pipe interior instead of compacting it outside the pipe. The leading edge of the pipe typically has a small overcut to reduce friction between the carrier pipe and soil and to improve the load conditions on the pipe. Soil/pipe friction reduction can also be achieved with lubrication, and different types of bentonite and/or polymers can be used for this purpose. Depending on the length of the installation, the soils inside the pipe can be removed either during or after the installation by augering, compressed air, or water jetting. Pipe ramming methods are also better suited for penetrating through/displacing potential obstructions, such as cobbles and boulders in comparison to jack and bore installation method, though this method can still be obstructed by cobbles and boulders depending on their size, number, and their positions relative to the pipe leading edge. Pipe ramming has also been used to accomplish culvert replacement in which a larger diameter pipe is rammed through the ground immediately around an existing pipe and both the existing pipe and ground are removed from within the rammed pipe by manual methods. This technique is sometimes called “pipe eating” or “pipe swallowing.” Partial or full removal of materials from within the pipe, to facilitate driving, should not be carried out if the ground through which the pipe is being driven consists of saturated granular soils (silt, sand, gravel). As with traditional jack and bore methods, flowing ground conditions and/or operating the cleanout augers beyond, at or near the leading edge of the casing can result in significant ground losses, excessive surface settlement and, in some cases, sinkholes that propagate to the surface.

- **Micro-tunnelling Boring Machine (MTBM)**: MTBM is a method of installing pipes in bores ranging from 0.6 to 3 metres in diameter behind a steerable remote-controlled shield that is pressurized with a bentonitic slurry at the cutting face to minimize ground losses. The process is essentially remote-controlled pipe jacking, where all operations are controlled from the surface, cuttings are removed by the circulating slurry, and the necessity for personnel to enter the bore is eliminated. Micro-tunnelling equipment is generally more suited to tunnelling through overburden. Availability of this equipment in the project area is limited. Some MTBMs are promoted as being able to “crush” cobbles with internal cone crushing systems. Others have been promoted as capable of passing boulders of as much as 1/3 of the bore diameter. However, both approaches to managing larger stones can be highly problematic and incapable of completing construction in boulder ground. Large numbers of cobbles can also “choke” these machines and result in failure of the bore. In bouldery ground, where the boulders can be firmly held in place by the surrounding soil matrix, equipping MTBMs with rock-disc cutters can be successful. In all cases, detailed review of the conditions and equipment configuration are needed prior to construction to achieve a reasonable probability of success.

- **Pilot Tube Micro-tunnelling (PTMT):** PTMT employs augers for excavation and soil removal and a jacking system for advancing the drill pipes, casings, and final pipes. The guidance system comprises a target with LEDs mounted in the steering head of the equipment that is monitored through a TV monitor. The PTMT operation includes pilot boring and reaming; and since this technique is used for smaller size pipes, the equipment and space required for this operation is smaller than what is normally required for pipe jacking or microtunnelling. PTMT can obtain an accuracy of 10 mm per 100 m of pipe length; however, the accuracy depends on the ground conditions, the accuracy of the guidance system, and the operator’s skill. The “pilot tube” is advanced in a similar fashion to horizontal directional drilling, with a guidance system used to control alignment and grade.

  In this method, a bore hole is drilled with a steering head connected to pilot tubes whose size is smaller than the required casing size. A steering head is used for pilot boring and adjustment of alignment and grade, and the bore hole is subsequently enlarged by a reamer with an auger string inside the casing used to remove cuttings. Temporary casings, if applicable, or the final pipe follows the reamer into the ground. Configurations of “reamer” tools varies widely within the industry, with some including rotating cutting tools, while others are a simplified cage-like head that allows soils to be forced into the openings as the larger diameter pipe is pulled and pushed into the ground. These reamer systems can have a significant influence on both the feasibility and risks of using this method and should be evaluated with caution.

- **Manual Tunnelling:** Manual excavation within an open-face shield involves excavating the soils using pneumatic or hand tools working within a full-circumference tunnelling shield or at the lead end of the pipe. Typically, the temporary tunnel liner (i.e., steel casing, steel ribs and lagging, steel liner plates, etc.) will be constructed from within a shield or final pipe would be jacked in sections from the launching shaft. This method includes personnel within the tunnel to allow control over the operations and removal of obstructions. Groundwater lowering is necessary to control cohesionless soils below the groundwater level. Manual excavation generally requires a tunnel diameter of about 1.2 m or more, though in some circumstances smaller diameters and small square tunnels can be constructed depending on groundwater conditions. In some instances, vacuum well points installed from within the tunnel at an angle through the face (sometimes called “lances”) can be used to control groundwater levels as the tunnel progresses.

2.2 Assessment of Trenchless Construction Methods

The ground conditions along all the culvert alignment within the tunnel vertical limits (i.e., invert and obvert of the casing) are likely to generally consist of silty/sandy fill or peat near or below the groundwater levels. In Borehole BH-1 advanced through the existing roadway, cobbles and boulders were reportedly encountered within the fill below 3.5 m depth and wood was encountered within the peat. Based on the ground conditions, expected diameter and the anticipated relatively short tunnel distances of about 35 to 40 m, microtunnelling and PTMT methods are likely not suitable or cost-effective. Cobbles and boulders combined with loose ground and wood will likely preclude the use of traditional “jack and bore” systems.

Considering the ground conditions, groundwater levels, tunnel lengths, and local capabilities, the use of pipe ramming and manual tunnelling are likely to be the most feasible and suitable for the culvert installation, provided groundwater can be adequately managed. Based on the available information, interventions to remove obstructions may also be necessary. Geotechnical issues/risks associated with the trenchless construction that should be considered and evaluated are:

- Ground or Road Heave – Shallow culverts with diameters that are relatively large, as compared to the depth of burial, are particularly susceptible to heaving the roadway if the pipe is rammed into place – particularly if cobbles, boulders, or other debris can and are displaced during ramming.
- Obstructions – Cobbles, boulders, wood, etc., can obstruct or foul trenchless construction equipment if they are encountered while boring. Culverts installed close to the interface between the former ground surface and an overlying roadway embankment are at a significant risk of encountering such objects, depending on how the ground was cleared, stripped, and grubbed prior to embankment placement. In some instances, low and wet areas have historically been filled with larger rock materials in attempts to stabilize the ground. Use of “corduroy” timbers (logs placed side-by-side) was also a common road construction technique in low, wet area. If corduroy methods were used or there are logs and brush buried at the interface with the peat, these materials will foul and block any rotating trenchless equipment. In such cases, pipe ramming is the least susceptible to equipment fouling and damage if wood debris are encountered; however, depending on the size of the wood/timber materials, pipe ramming may not be able to penetrate timbers. If such conditions are encountered and a large enough pipe is used, it may be possible to enter the pipe and remove the obstructions manually if groundwater and flowing sand conditions can be adequately controlled as well. To

reduce risks for project completion, it may be beneficial to select a suitably large pipe size, on the order of 1.2 m or more and consider securing enough space to allow pipe ramming from both ends of the culvert.

- Ground or Road Settlement – With water levels being at or above the culvert inverts, there is the potential for uncontrolled flow of saturated granular soils (sand and silt) and groundwater back through the spoils within the casing, shield or tunnelling equipment, and towards the entrance pit. Such flow could cause significant loss of ground at and above the face of excavation. Without proactive dewatering along the entire alignment, these conditions are particularly problematic for traditional "jack and bore," pilot tube, micro-tunnelling systems, or manual tunnelling that do not provide direct and continuous support to the excavation face. In some cases, consideration should be given to specifically prohibiting the use of some of these systems, particularly, if proposed without proactive dewatering, since they can commonly be less costly and can be attractive for achieving low bids, except the risk of ground losses and roadway settlement would likely be unacceptable. Where manual tunnelling methods coupled with proactive dewatering are most appropriate, these should be carried out using "hooded" shields, where the front edge of the shield is angled to permit some sloping of the excavation face to reduce the likelihood of uncontrolled ravelling of the ground. For any method that requires groundwater control for managing risks of ground losses, gravity flow to sumps and pumps or into, permeable linings should not be relied upon except as a supplement to a fully designed vacuum well point or eductor system.

As a general guideline, the depth of cover above the crown of the new pipe installation should be greater than the cut diameter of whatever trenchless system is used to excavate the ground or the largest pipe outside diameter that will be installed, whichever is greater. Similarly, the separation between newly installed pipes should be at least equal to one tunnel diameter, and preferably two tunnel diameters, in both the vertical and horizontal directions. Oversize casings (where separate casings and pipes will be used) or oversize final pipes should be installed to permit fine adjustments of the invert channel elevations for final flow control given the challenges associated with maintaining alignment. Selection of casing size should consider the potential for misalignment over the tunnel length due to ground conditions (e.g., boulders, wood), access to the tunnel face (if necessary, for obstruction removal), proposed tunneling methodology, and the length of the tunnel drive. A two-pass lining, using temporary support constructed by hand mining followed by a permanent pipe lining, may be advantageous to facilitate some methods of tunnelling and for achieving final alignment control, depending on the final hydraulic opening and lining design requirements.

Table 1, following the text of this memorandum, provides a commentary regarding advantages and disadvantages of various trenchless methods and risk issues for planning consideration. As discussed below, under Obstructions, there is a potential that the road may be constructed on buried timbers (i.e., corduroy) or have other wood (stumps, branches, etc.) buried within the peat or embankment fill (near the interface of these materials). The degree to which these conditions could influence the feasibility of trenchless installations cannot be judged given the available data. Additional boreholes or test pits, while they may be helpful, may still not be sufficient to define the site appropriately for construction. Given the embankment height, it is certainly understandable why trenchless construction in these conditions is desirable; however, serious consideration should also be given to the potential risk or need that the culvert be replaced using open cut methods. Consideration should also be given to raising the alignment, if possible, to try and avoid the interface between the peat and embankment fill to reduce the risk of encountering corduroy timbers.

Once the culvert construction options have been narrowed and a design is selected, a settlement monitoring program should be implemented that is consistent with Ontario Provincial Standard Specification OPSS.PROV 539, for shoring systems at the pits if these are near the roadway, as discussed further in Section 2.6. Settlement monitoring should also be carried out over the entire centreline length of the new culvert alignment at the edge of all pavements, in landscape areas leading to the pavement from the entry pit, and at perpendicular off-sets of about 2 m from the centre line at all pavement shoulder edges, for a distance equal to the depth from road surface to invert. Given the elevated risk of settlement or heave for this project, contingency plans for traffic management and road repair should be in-place to rapidly mitigate or limit any distress to the overlying highway embankment, if needed.

Trenchless installation, where and when it is undertaken, can be completed in most seasons but winter conditions in this area of the province could cause difficulty for dewatering, settlement monitoring, excavations, etc., due to snow fall/removal, extreme cold, and application of salt/de-icers on roadway.

2.3 Temporary Excavations, Shoring, and Groundwater Control for Entrance and Exit Pits

A shaft/pit will be required on each side of the embankment to facilitate the construction of jacking structures required for trenchless installation of pipes. The excavation depths for the entrance and exit pits for the culverts is anticipated to be about 0.5 m below the pipe invert. Entrance pits about 4 m wide and 12 m long and exit pits about 4 m in width and length are typically required for trenchless. Excavations for the construction shaft will likely be made through the fill and peat. Property and utility conflicts will need to be reviewed for each pit location.

Excavation works must be carried out in accordance with the guidelines outlined in the Occupational Health and Safety Act and Regulations for Construction Projects (OHSA). The soils at this site would be generally classified as Type 3 soils (compact to loose above groundwater level) and the existing fill and peat below the groundwater level are classified as Type 4 soil, in accordance with the OHSA. Open excavation in the soil below the groundwater level are not recommended at this site.

For the pits, it is envisioned that temporary protection systems may be required adjacent to the highway embankment and along the MTO right-of-way, where limited excavation space is available. The excavation support may also need to be designed to act as a backstop for the jacking forces and tunnelling operations. This support system should be designed and constructed by the contractor in accordance with the Ontario Provincial Standard Specification OPSS.PROV 539. The lateral movement of the temporary shoring system should meet Performance Level 2, as specified in OPSS.PROV 539.

In many cases, the culverts will likely have invert elevations that are close to the ground surface, and the existing bed of the water course and deep excavations may not be required. Depending on the methods of construction and other site constraints, a three-sided excavation support system may be needed to support a cut into the existing highway embankment to achieve a vertical face for the trenchless work. A conventional shoring system for these conditions might consist of soldier piling and lagging or interlocking steel sheet piling supported against lateral movement using wales and internal struts/braces. Tiebacks or ground anchors may not be appropriate for the anticipated depth and size of these excavations. Interlocking steel sheet piling would aid in groundwater control but could be difficult or impossible to install if the ground includes cobbles and boulders or significant amounts of timber (e.g., corduroy). The design of excavation support systems should be the responsibility of the contractor.

It is anticipated that groundwater will be encountered above the base of the excavations at the entrance and exit pits. In some cases, sheet piles might be driven to sufficient depth to minimize groundwater seepage into entrance and exit pits, with the remaining water managed by pumping from sumps in the excavations. However, additional evaluation of the subsurface hydrogeologic conditions, sheet pile driveability, and depths of the pits will be required to ascertain the need for and extent of dewatering systems that may be necessary to control ground stability at the entrance and exit pits.

Groundwater and surface water control will be required for excavation and construction of the culvert replacement and for any trenchless lining option being considered. Dewatering operations must be in accordance with OPSS.PROV 517 (*Dewatering*) and MTO's Special Provision 517F01 (*Temporary Flow Passage System*) recommending that a design engineer be required.

2.4 Obstructions

Cobbles and boulders were reportedly encountered within the embankment fill in Borehole BH-1. Wood was also noted in the samples attempted within the peat. Cobbles, boulders, and wood would all affect installation of the pipe by trenchless methods and temporary protection systems. A Notice to Contractor to specifically identify the presence of cobbles, boulders, wood, and deleterious material within the fill and native soils and wood/trees at the fill and native soil interface, should be included in the Contract Documents; a copy of which is included in Appendix B. We note that even if a Notice to Contractor is included within the Contract Documents, the quantity of cobbles, boulders, and wood will be critical to judging whether any one particular technology will work and quantities of these materials cannot be judged based on the existing subsurface information. A program of test pits into the existing embankment, if at all reasonable or possible, or multiple additional boreholes, may assist with defining the excavation conditions and help judge the probability that significant volumes of wood might be encountered. Clearly, test pits might not be practical given the embankment heights considerations of excavation support during such exploration.

2.5 Instrumentation and Monitoring Program

As discussed above, if trenchless replacement is considered, an instrumentation and monitoring program is recommended at the culvert location to:

- Document the effects of the culvert installation on the overlying highway and adjacent underground utilities/services, if applicable.
- Potentially identify adverse ground movement trends that could occur due to the construction methods and equipment or unforeseen ground conditions.
- Evaluate the contractor's compliance with the settlement limits specified in the Contract Documents.
- Allow adjustments to be made to the culvert installation methods, such that the settlement limits established are not exceeded.

The SP for "Pipe Installation by Trenchless Method" (Appendix B) contains the details of the settlement monitoring program to be implemented to measure ground settlement at the existing roadway prior to, during, and following the proposed installation. A site-specific Settlement Monitoring Plan is attached (see Drawing 1), for inclusion in the Contract Documents.

It is also recommended that, to the extent practicable and possible, the weight or volume of ground removed from beneath the highway be measured and compared to the theoretical cut hole volume on a frequency of at least once per 3 m section of tunnel/pipe installed. On-site observations of construction operations and measurements of grout and/or lubricant volumes should assist in identifying atypical conditions that could be indicative of unacceptable ground losses.

Further, the location (depth/alignment), type, and tolerances to movement and vibrations of any existing buried utilities (functioning or decommissioned) would have to be clearly established prior to any trenchless installation operation, and the Review Level and Alert Level tolerances for settlement confirmed in the SP for "Pipe Installation by Trenchless Method".

2.6 Grouting

Post installation grouting to fill the annular space between the carrier pipe (culvert) and the casing, or the existing pipe if the pipe is replaced on a new alignment, may need to be carried out after the permanent culvert pipe is installed within the casing, as noted in the SP for "*Pipe Installation by Trenchless Method*", included in Appendix B. For any installations at which the settlement monitoring or excavation volume monitoring indicates that pavement settlement or ground loss might have occurred, or where signs of ground loss have been noted, provision should also be made for a program of compensation grouting above the casing pipe and/or repair of the pavements.

3.0 OPEN CUT REPLACEMENT IN STAGES USING GRADE LOWERING

The report by exp provides foundation design recommendations for replacing the existing culvert using open cut, including the recommendation to keep existing peat below the proposed culvert in place and have a 500 mm thick Granular B Type II bedding, as discussed in their Section 2.9. In exp's Section 2.12.2, the Granular B Type II bedding beyond the existing toe of slope, should be increased to 1.5 m, due to the proposed embankment widening (further discussed in our Section 4 below), to mitigate settlement of the proposed culvert replacement.

Parsons has requested Golder to provide foundation design recommendations for a modified culvert replacement strategy, using open cut in temporary stages with grade lowering and single lane traffic. The intent is to complete the entirety of the work within a 48-hour construction schedule. Figure 1, attached, presents the results of stability analysis for temporary grade lowering when the embankment crest elevation has been reduced to about 2 m above the existing pipe (Elevation 459.6 m), and sub-excavation to 0.5 m below the proposed replacement culvert for bedding (Elevation 455.9 m) based on proposed cross-sections provided by Parsons on January 7, 2020. While the peat soils have been consolidated under the existing embankment loads to some degree (depending on their spatial relationship to the existing embankment loads), we recommend that all cut slopes not be steeper than 3H:1V. Slopes that are cut or newly built to be steeper than about 2H to 1V will likely result in a stability factor of safety of less than 1.1, that would not be acceptable for temporary or permanent conditions. If detailed shear strength testing is carried out on the peat soils, the temporary slopes might be safely designed to be steeper, though detailed review of such slope designs should be completed by or for MTO. The cut or new slopes (perpendicular or parallel to the centreline) should be in place for as little time as possible and should be protected from erosion (i.e., tarps, coarse granular cover with geotextiles, or other MTO-approved alternative) during rain events.

Sub-excavation and backfilling during open cut culvert replacement should be completed in strips of limited width, under the review of the Foundation Engineering Specialist, and as outlined in the Notice to Contractor in Appendix B, which should be included in the Contract Specifications. Backfill adjacent to the proposed culvert should be placed in stages along the length of the culvert, as soon as practical, balanced in elevation on both sides of the culvert, and as the culvert sections are installed.

Where new temporary fill is placed for the detour widening beyond the slope of the existing embankment, the new fill should consist of compacted Granular B Type II and should be keyed into the existing slope in accordance with OPSD 208.010 (Benching of Earth Slopes).

The existing embankment fill consisting of sand to gravelly sand may be used for embankment reconstruction. The embankment backfill should be free of organic soil and should be placed and compacted in accordance with OPSS.PROV 501 (Compacting) and OPSS.PROV 206 (Grading). Any excavated organic soil will need to be removed/wasted and is not considered suitable for re-use as embankment backfill; a Notice to Contractor is included in Appendix B.

A geotextile consisting of OPSS 1860 Class II non-woven, with a filtration opening size not greater than 150 µm, should be placed as a separation layer between the granular material and the native subgrade.

4.0 FINAL EMBANKMENT STABILITY AND SETTLEMENT

As referenced in exp's report Section 2.12.1 and summarized in this memorandum for general context, exp has recommended that the final embankment side slopes (beyond the existing embankment crest) at this culvert site should be inclined no steeper than 2.5H:1V for the full final height of embankment. Further, as discussed in Section 3 above, exp recommended that at least 1.5 m of peat be sub-excavated at/beyond the toe of the existing embankment below the proposed culvert extension and replaced with new Granular B Type II. Their design further indicates that such sub-excavation and backfilling should be completed in strips of limited width, under the review of the Foundation Engineering Specialist, and as outlined in the Notice to Contractor in Appendix B, which should be included in the Contract Specifications. New fill should be benched into existing fill in accordance with OPSD208.010. We understand from Parsons, by email on November 14, 2019, that the proposed embankment side slopes to be inclined at 2.5H:1V is only required at the immediate culvert area.

The exp report should be read in its entirety and implemented in design as agreed by others and exp remains the geotechnical engineer of record for all aspects of embankment design for the permanent condition. This memo does not constitute an endorsement or second opinion regarding the work of exp for the final embankment design.

5.0 CLOSURE

We trust that this letter contains sufficient information for your present requirements. If you have any questions concerning this memo, please call us.

GOLDER ASSOCIATES LTD.

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Storer Boone, P.Eng.
Senior Geotechnical Engineer, Principal

AB/SB/ca/sm

Attachment: Table 1 – Trenchless Alternatives
Figure 1 – Stability Analysis – Culvert Replacement by Open Cut in Temporary Stages using Grade Lowering
Drawings 1 and 2 – Settlement Monitoring Plan and Instrument Details
Appendix A – Previous Investigation by exp (Borehole Location Plan and Soil Strata, Photographs, Record of Boreholes)
Appendix B – NSSP and Notice to Contractor (Pipe Installation by Trenchless Method, Obstructions, Swamp Excavation, Embankment Backfill)

https://golderassociates.sharepoint.com/sites/29404g/deliverables/foundations/hwy 129 memo for culvert at stn 14-457/2-final/18104216-tm-rev0-hwy 129 foundations memo 16jan_2020.docx

Table 1: Trenchless Installation Alternatives

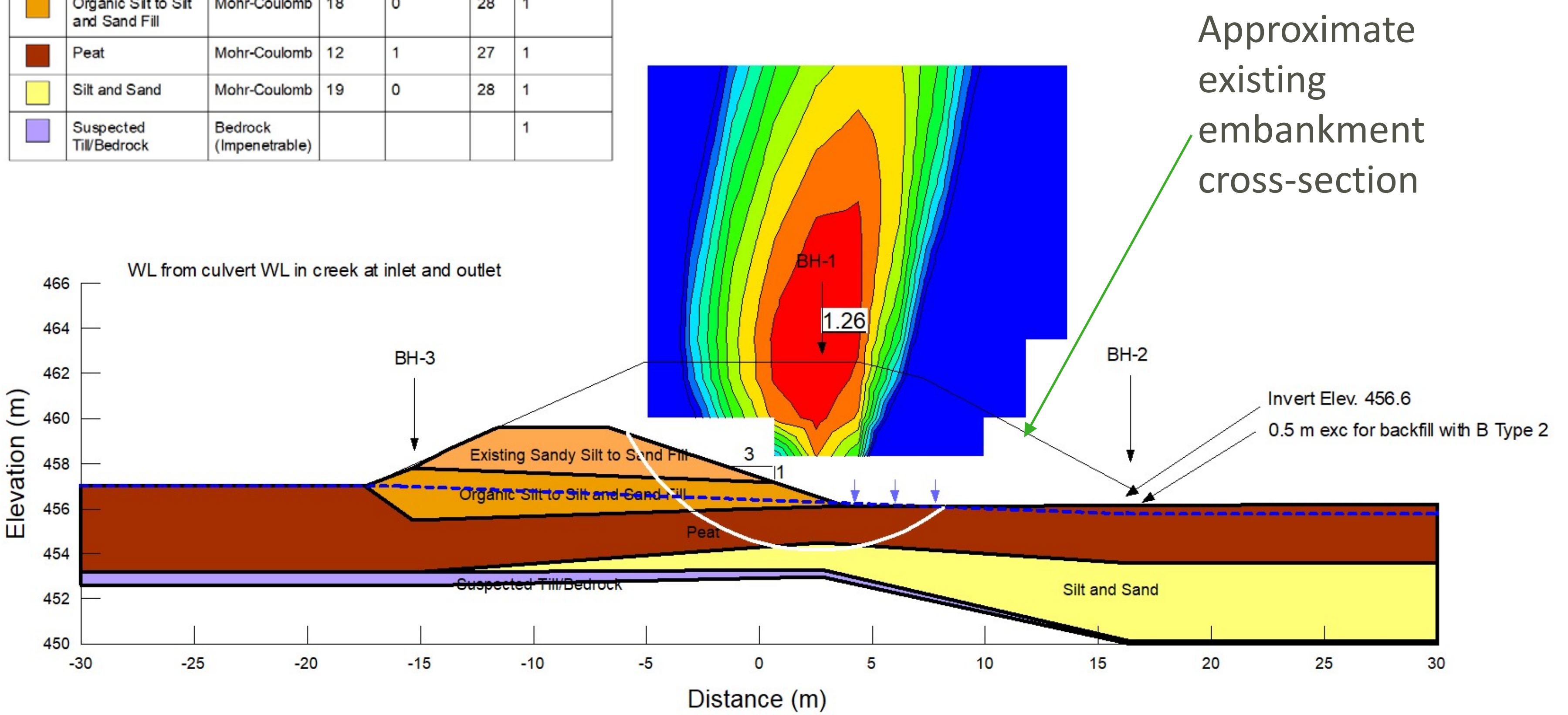
Trenchless Technology	Advantage	Disadvantage	Risks
Pipe Ramming	■ Installed without significant removal of soils prior to full casing penetration through embankment. ■ Relatively low cost. ■ Relatively small site operations footprint. ■ Within size range typical in Ontario. ■ Better than other low-cost technologies for penetrating ground that includes limited numbers of cobbles and small boulders.	■ Combination of ground density, final pipe diameter and length of installation may be near the upper limit of feasibility for a single pipe installation – telescoping casing sizes or use of dual smaller diameter pipes may assist with feasibility. ■ Density of ground in some areas may encourage premature removal of soils from within the casing. ■ Concentrations of cobbles and boulders, large boulders or large pieces of wood (structural timbers, stumps, logs) could obstruct operations. ■ Obstructions may require shaft excavation from the surface. ■ Vibrations from pipe driving can lead to densification and settlement of loose granular materials surrounding and overlying pipe and result in settlement of roadway surface. ■ Alignment control can be difficult when penetrating soils of differing densities or when encountering cobbles and boulders.	■ Telescoping casing would likely require partial removal of soils from within the pipe, to reduce potential for jamming and obstruction and, therefore, flowing ground risks may require additional mitigation (localized dewatering). ■ Need for removal of soil from within casings because of driving resistance (binding of casings, weight of spoil, obstructions) could lead to excess ground losses and surface settlement.
Manual Tunnelling with Hooded Shield and Dewatering	■ Relatively low cost. ■ Relatively small site operations footprint. ■ Within size range typical in Ontario. ■ Best for penetrating ground that includes cobbles and boulders of all sizes. ■ Driving plates or bars ahead of excavation into the crown of the tunnel (spiling, forepoling) can be used to help control loose or ravelling ground.	■ An oversize tunnel diameter (compared to desired pipe size) may be necessary to better facilitate tunnelling. ■ Full alignment length must be dewatered in advance of excavation using proactive methods from surface and/or within tunnel. ■ Inadequate groundwater control can lead to excess ground losses and surface settlement. ■ Spiling or forepoling may be required to control ravelling ground, increasing cost, and schedule. ■ "Two-pass" lining system may be required (e.g., steel liner plates followed by pre-cast or cast in place concrete).	■ Dewatering planning as part of bid may not be adequate and result in real or strategic claims. ■ Inadequate dewatering could lead to ground losses and excess surface settlement.

Stability Analysis

Figure 1

Culvert Replacement by Open Cut in Temporary Stages using Grade Lowering

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Piezometric Line
	Existing Sandy Silt to Sand Fill	Mohr-Coulomb	21	0	32	1
	Organic Silt to Silt and Sand Fill	Mohr-Coulomb	18	0	28	1
	Peat	Mohr-Coulomb	12	1	27	1
	Silt and Sand	Mohr-Coulomb	19	0	28	1
	Suspected Till/Bedrock	Bedrock (Impenetrable)				1



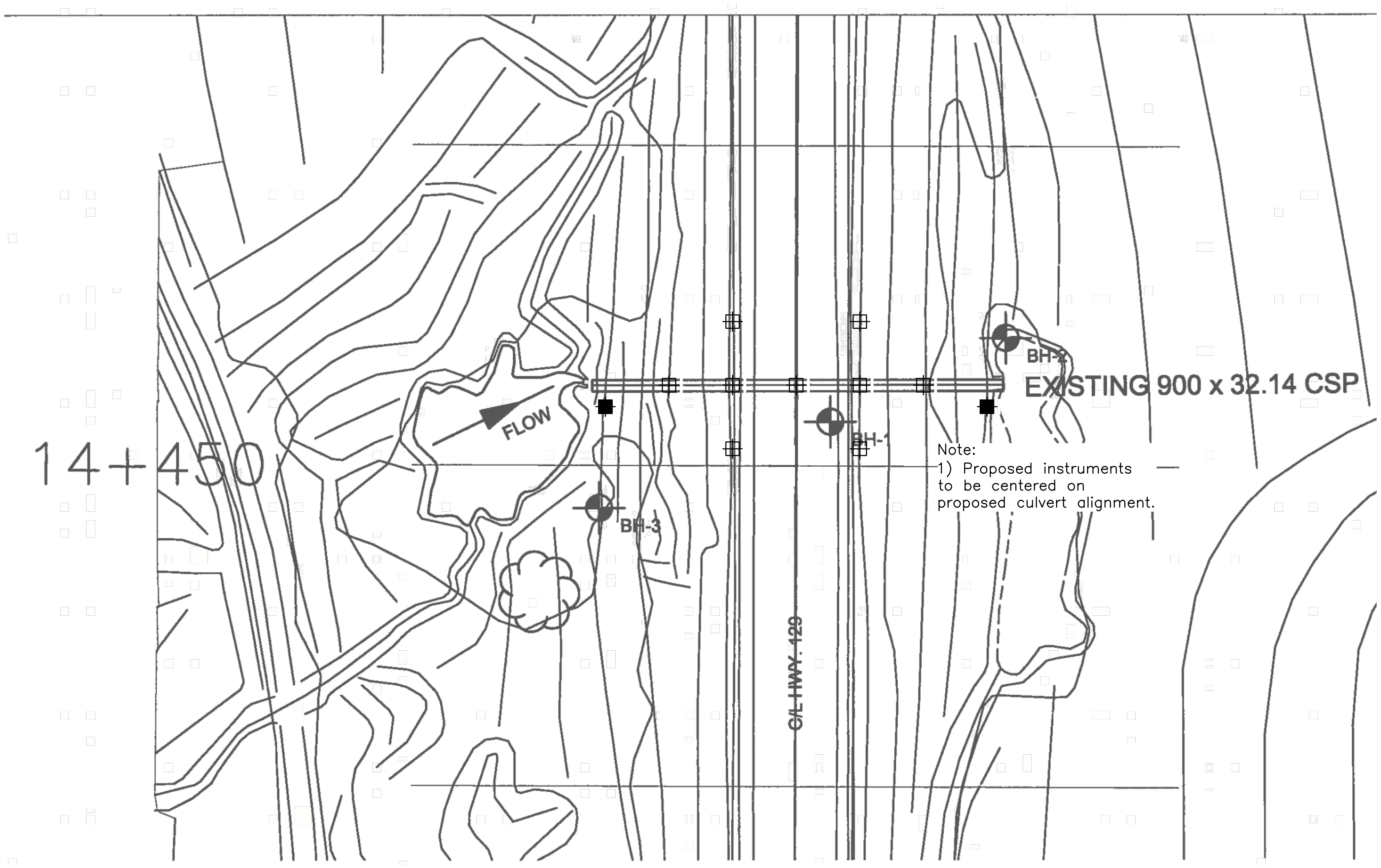
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5071-18-00

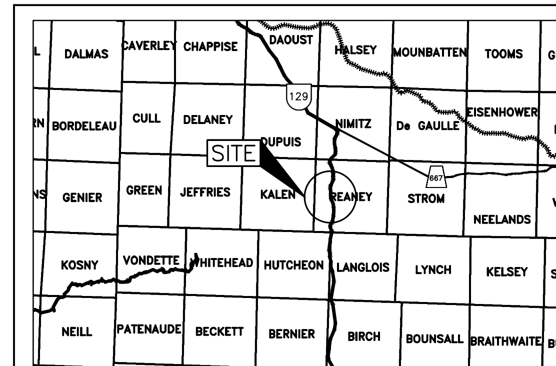
SHEET

HIGHWAY 129
CULVERT AT STATION 14+457 (REANEY TWP)
SETTLEMENT MONITORING INSTRUMENT LOCATION PLAN

GOLDER



PLAN
SCALE
4 0 4 8 m



KEY PLAN
SCALE
10 0 10 20 km

LEGEND

- Borehole – Previous Investigation (Dec/16 to Jan/17)
- In–Ground Settlement Monitoring Point
- Surface Settlement Marker

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence.

REFERENCE

Base plans from exp. report dated Dec/17.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No.

HWY. 129	PROJECT NO. 18104216		DIST.
SUBM'D.	CHKD.	DATE: 11/15/2019	SITE:
DRAWN: TR	CHKD. TB	APPD. AB	DWG. 1

DRAFT

MINISTRY OF TRANSPORTATION, ONTARIO

PLOT DATE: November 15, 2019
FILENAME: S:\Clients\MTO\Hwy129\...\18104216-0002-BG-0001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

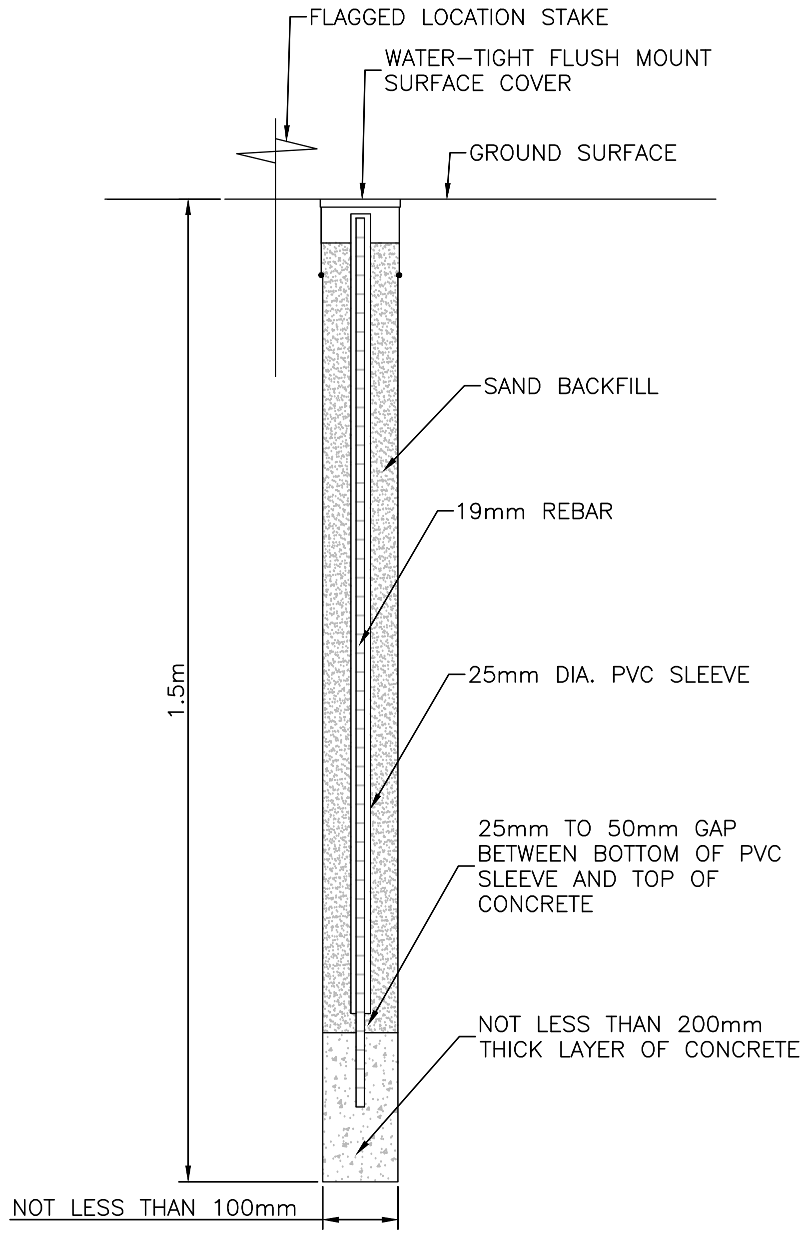
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
WP No. 5071-18-00

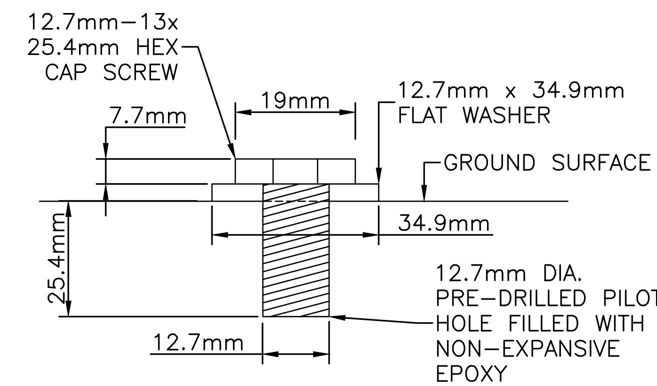
HIGHWAY 129
CULVERT AT STATION 14+457 (REANEY TWP)
SETTLEMENT MONITORING INSTRUMENTATION DETAILS

SHEET

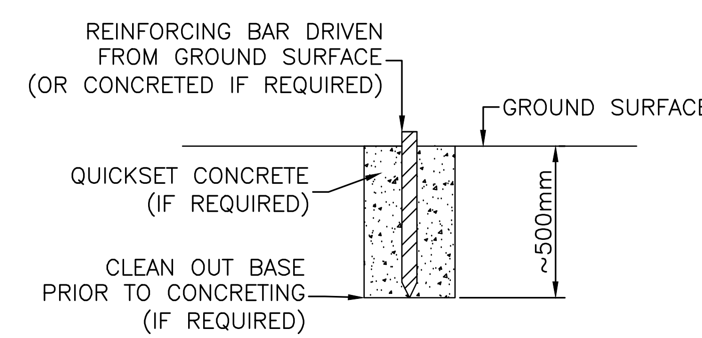
GOLDER



IN-GROUND MONITORING POINT (N.T.S)



ASPHALT SURFACE SETTLEMENT MARKER (N.T.S)



SOIL SURFACE SETTLEMENT MARKER (N.T.S)

DRAFT

NO.	DATE	BY	REVISION
.	.	.	.

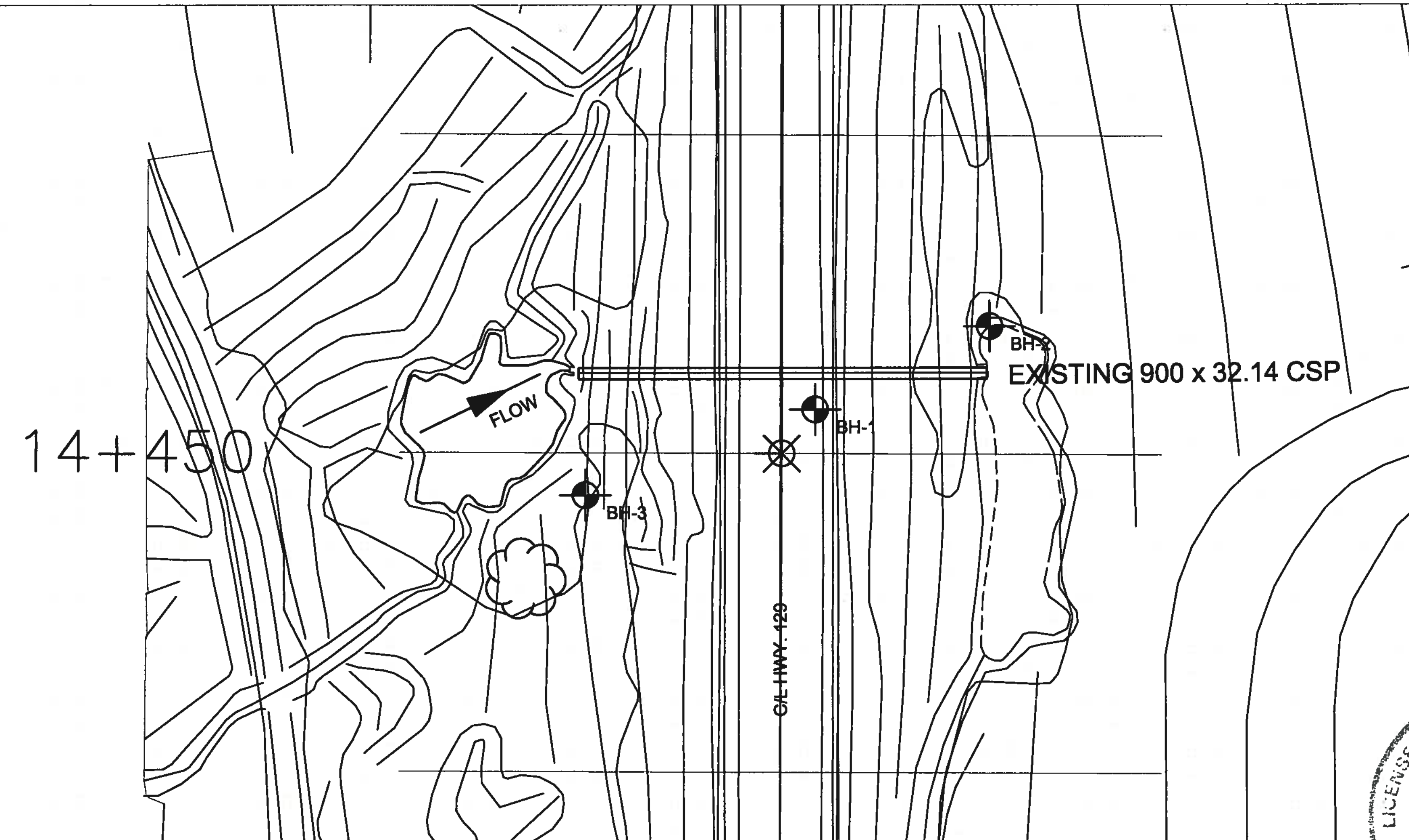
Geocres No.

HWY. 129		PROJECT NO. 18104216	DIST.
SUBM'D.	CHKD.	DATE: 11/15/2019	SITE:
DRAWN: TR	CHKD. TB	APPD. AB	DWG. 2

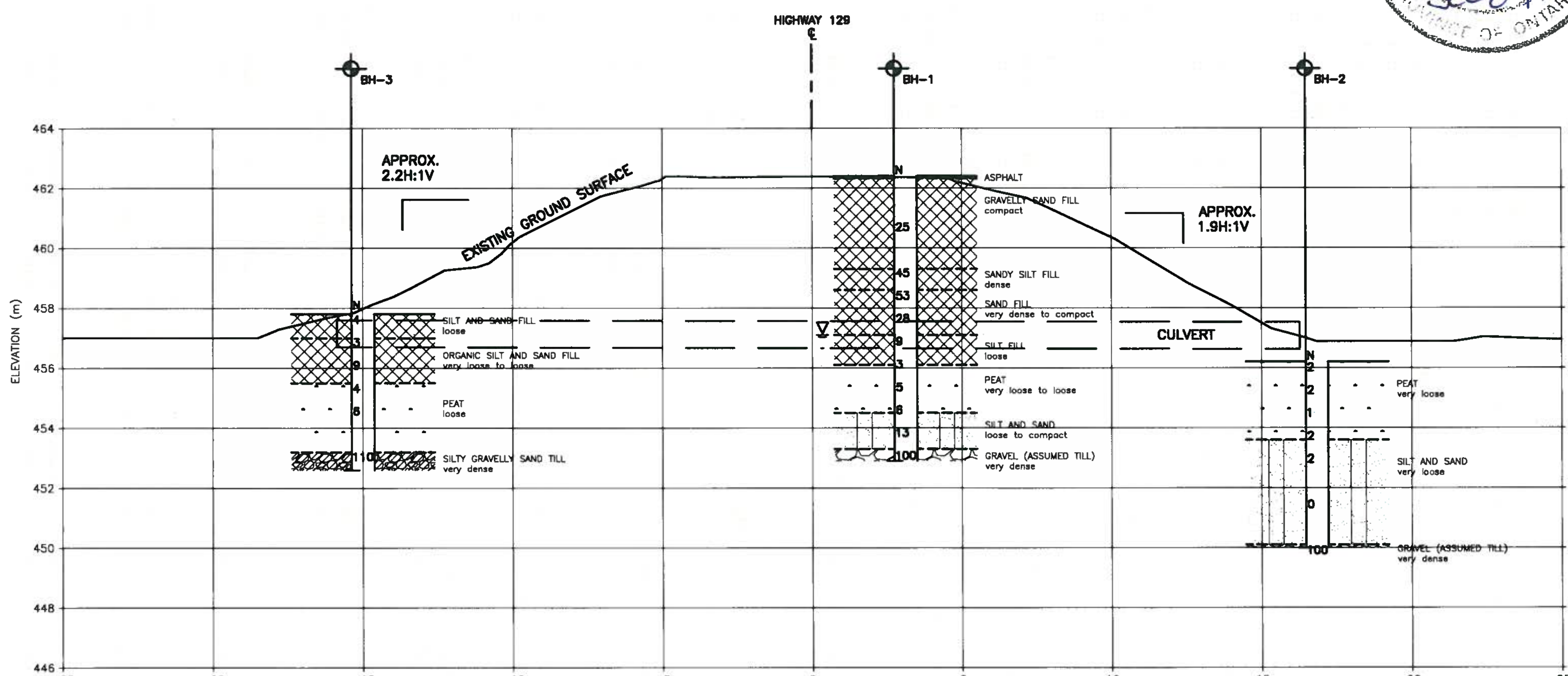
PLOT DATE: November 15, 2019
FILENAME: S:\Clients\MTO\Hwy129\99_PROJ\18104216_Parsons\40_PROD\0002\18104216-0002-BG-0002.dwg

APPENDIX A

Previous Investigation by exp



PLAN



CROSS SECTION AT CULVERT CENTRELINE

METRIC

DIMENSIONS ARE IN METERS AND/OR MILLIMETERS UNLESS OTHERWISE SHOWN. STATIONS ARE IN KILOMETERS +METERS

LICENSED PROFESSIONAL ENGINEER
I.B. MACMILLAN
100157509
Dec 18/17
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
S.E.M. GONSALVES
Dec 8/17
PROVINCE OF ONTARIO

1:500
2 0 2 4 6 8 10m
PLAN

Agreement No. 5016-E-0016
GWP 411-00-00
GEOCRES No. 41O-32

CULVERT REPLACEMENT, STN. 14+457
HIGHWAY 129, REANEY TOWNSHIP
DISTRICT OF SUDBURY

BOREHOLE LOCATION PLAN AND SOIL STRATA

SHEET 1

exp. exp Services Inc.

KEY PLAN - NTS

LEGEND

- BOREHOLE LOCATION
- N — STANDARD PENETRATION TEST (BLOWS/300mm)
- TEMPORARY BENCHMARK (EL. 462.4 m)
- ESTIMATED WATER LEVEL IN BOREHOLE

BOREHOLE COORDINATES

BOREHOLE NO.	APPROX. ELEV. (m)	MTM COORDINATES	
		NORTHING	EASTING
BH-1	462.4	5266613.6	364209.1
BH-2	456.2	5266626.0	364218.0
BH-3	457.8	5266599.0	364196.5

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contract Documents.

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in the report and related documents are specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen. Cond.

SOIL STRATA SYMBOLS

- ASPHALT
- SILT AND SAND
- FILL
- GRAVEL (ASSUMED TILL)
- PEAT
- SILTY GRAVELLY SAND TILL

REVISIONS

DATE	BY	DESCRIPTION
2017.6.26	IM	SUBMISSION FOR MTO REVIEW
2017.11.28	IM	FINAL REPORT SUBMISSION

SCALE: AS NOTED		PROJECT NO.: SUD-00014543-AG	
SUBM'D: IM	CHECKED: AS	DATE: 2017.6.26	
DRAWN: IM	CHECKED: SG	APPROVED: SG	DWG. 1

Photograph No. 1 – Highway 129 at Culvert, Stn. 14+457 (Facing North)

Photograph No. 2 – Pavement Condition at Culvert (Facing North-East)

Photograph No. 3 – Eastern Embankment at Culvert Outlet (Facing North)

Photograph No. 4 – Culvert Outlet (Facing North-East)

Photograph No. 5 – Western Embankment at Culvert Inlet (Facing South)

Photograph No. 6 – Culvert Inlet (Facing West)

Ministry of Transportation Ontario

Foundation Design

RECORD OF BOREHOLE No BH-1

METRIC

W.P.	411-00-00,5016-E-0016
LOCATION	Stn. 14+455, MTM-13, 5266613.63N, 364209.1E, Non-Structural Culvert at Stn. 14+457
ORIGINATED BY	NW
DIST	Sudbury
HWY	129
BOREHOLE TYPE	Continuous Flight HSA and Washboring with NW Casing
COMPILED BY	IM
DATUM	Geodetic
DATE	2016.12.06 - 2016.12.06
LATITUDE	47.53601
LONGITUDE	-83.21087
CHECKED BY	IM

ELEV / DEPTH	SOIL PROFILE – DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
462.4	Pavement Surface				
462.3 / 0.1	**ASPHALT** (~ 76 mm thick)				
	FILL, gravelly sand, trace silt, brown, moist, compact.	1	AS		28 64 (7)
		2	AS		
	No sample returned at ~ 1.5 m depth due to lodged stone in split spoon sampler. Auger sample obtained.	3	SS	25	
459.4 / 3.1	**FILL,** sandy silt, trace organics, trace gravel, trace clay, brown, moist, dense. some cobbles and boulders below ~ 3.5 m depth.	4	SS	45	5 30 63 3
458.6 / 3.8	**FILL,** sand, trace silt, trace to some gravel, some cobbles and boulders, brown, moist, very dense to compact. some silt, trace roots, grey below ~ 4.6 m depth.	5	SS	53	
		6	SS	28	
457.1 / 5.3	**FILL,** silt, some organics, some sand, trace clay, brown to dark brown, wet, loose.	7	SS	9	7 16 74 3
456.1 / 6.3	**PEAT,** with wood, black, moist to wet, very loose to loose.	8	SS	3	
	No soil sample returned at ~ 6.9 m depth due to lodged wood in split spoon sampler.	9	SS	5	
454.5 / 7.9	**SILT AND SAND,** trace clay, trace gravel, grey, moist, loose to compact.	10	SS	6	
		11	SS	13	1 40 56 3
453.3 / 9.1	**GRAVEL,** grey, moist. (Assumed Till)	12	SS	100	
453.0 / 9.5	**END OF BOREHOLE** Borehole terminated at ~ 9.5 m depth due to refusal on suspected very dense till or bedrock				

Column headers: SOIL PROFILE (ELEV DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (462, 461, 460, 459, 458, 457, 456, 455, 454, 453); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (20, 40, 60); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL.

Groundwater level symbol shown at approx. elev. 459.5. Water content value noted: 282.4 (sample 9).

NOTES:
1. This drawing to be read with the subject report and project numbers as presented above.
2. Multiple attempts made to advance borehole beyond refusal depth.
3. Groundwater condition noted may not be accurate as water was pumped into hole due to washboring techniques utilized.

$+^3, \times^3$: Numbers refer to Sensitivity   ○ 3% STRAIN AT FAILURE

ONTARIO MTO SUD-00014543-AG - HWY. 129 - CL CULVERT 14+457.GPJ ONTARIO MTO.GDT 8/22/17

Ministry of Transportation
Ontario

Foundation Design

RECORD OF BOREHOLE No BH-2

METRIC

W.P. 411-00-00,5016-E-0016 LOCATION Stn. 14+460, MTM-13, 5266625.95N, 364218.01E, Non-Structural Culvert at Stn. 14+457 ORIGINATED BY ST

DIST Sudbury HWY 129 BOREHOLE TYPE Portable Tripod With Cathead and Hilti D200 Drill COMPILED BY IM

DATUM Geodetic DATE 2017.01.29 - 2017.01.29 LATITUDE 47.53612 LONGITUDE -83.21075 CHECKED BY IM

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
456.2	Ground Surface					
0.0	**PEAT,** some to with silty sand, some gravel, grey to black, wet, very loose.	1	SS	2		
	no gravel below ~ 0.8 m depth.	2	SS	2		
		3	SS	1	94.4	
		4	SS	2	134.7	
453.6 2.6	**SILT AND SAND,** some organics, trace gravel, trace clay, grey, wet, very loose.	5	SS	2		
		6	SS	0		7 41 45 6
450.1 6.1	**GRAVEL,** grey, wet. (Assumed Till)	7	SS	100		
450.0 6.2	**END OF BOREHOLE**					

Column headings: SOIL PROFILE; SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE (456, 455, 454, 453, 452, 451); DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L, WATER CONTENT (%) (20 40 60); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL.

END OF BOREHOLE
Borehole terminated at ~ 6.2 m depth due to refusal on suspected very dense till or bedrock

NOTES:
1. This drawing to be read with the subject report and project numbers as presented above.
2. Multiple attempts made to advance borehole beyond refusal depth.
3. Groundwater level not measured within borehole as water was pumped into hole due to washboring technique utilized.

$+^3, \times^3$: Numbers refer to Sensitivity ○ $^{3\%}$ STRAIN AT FAILURE

Ministry of Transportation
Ontario

Foundation Design

RECORD OF BOREHOLE No BH-3

METRIC

W.P. 411-00-00,5016-E-0016
LOCATION Stn. 14+447, MTM-13, 5266599.04N, 364196.45E, Non-Structural Culvert at Stn. 14+457
ORIGINATED BY ST

DIST Sudbury HWY 129
BOREHOLE TYPE Portable Tripod With Cathead and Hilti D200 Drill
COMPILED BY IM

DATUM Geodetic
DATE 2017.01.28 - 2017.01.28 LATITUDE 47.53588 LONGITUDE -83.21104
CHECKED BY IM

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
457.8	Ground Surface						
0.0	**FILL,** silt and sand, some organics, grey, wet, loose.	1	SS	4			
457.0 / 0.8	**FILL,** organic silt and sand, with peat, grey to black, wet, very loose to loose.	2	SS	3	457		
		3	SS	9	456	128.3	
455.5 / 2.3	**PEAT,** with silty sand, black, wet, loose.	4	SS	4	455	108.8	
		5	SS	6	454		
453.2 / 4.6	**TILL,** silty gravelly sand, trace clay, grey, wet, very dense.	6	SS	110	453		32 35 32 1
452.6 / 5.2	**END OF BOREHOLE** Borehole terminated at ~ 5.2 m depth due to refusal on suspected very dense till or bedrock						

NOTES:
1. This drawing to be read with the subject report and project numbers as presented above.
2. Multiple attempts made to advance borehole beyond refusal depth.
3. Groundwater level not measured within borehole as water was pumped into hole due to washboring technique utilized.

Column headings: SOIL PROFILE; SAMPLES; STRAT PLOT; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 20 40 60; UNIT WEIGHT γ kN/m³.

+3, ×3: Numbers refer to Sensitivity   O 3% STRAIN AT FAILURE

APPENDIX B

NSSP and Notice to Contractor

PIPE INSTALLATION BY TRENCHLESS METHOD – Item No.

Special Provision January 2019

CONSTRUCTION SPECIFICATION FOR THE INSTALLATION OF PIPES BY TRENCHLESS METHODS

TABLE OF CONTENTS

1.0 **SCOPE**

2.0 **REFERENCES**

3.0 **DEFINITIONS**

4.0 **DESIGN AND SUBMISSION REQUIREMENTS**

5.0 **MATERIALS**

6.0 **EQUIPMENT**

7.0 **CONSTRUCTION**

8.0 **QUALITY ASSURANCE- Not Used**

9.0 **MEASUREMENT FOR PAYMENT**

10.0 **BASIS OF PAYMENT**

1.0 SCOPE

This specification covers the requirements for the installation of pipe by a selected trenchless method.

2.0 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, General

OPSS 180 Management of Disposal of Excess Material

Ontario Provincial Standard Specifications, Construction

OPSS 401 Trenching, Backfilling, and Compacting
OPSS 402 Excavating, Backfilling, and Compacting for Maintenance Holes, Catch Basins, Ditch Inlets and Valve Chambers
OPSS 403 Rock Excavation for Pipelines, Utilities, and Associated Structures in Open Cut
OPSS 404 Support Systems
OPSS 409 Closed-Circuit Television (CCTV) Inspection of Pipelines

OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities and Associated Structures
OPSS 517	Dewatering
OPSS 539	Temporary Protection Systems

Ontario Provincial Standard Specifications, Material

OPSS 1004	Aggregates - Miscellaneous
OPSS 1350	Concrete - Materials and Production
OPSS 1440	Steel Reinforcement for Concrete
OPSS 1802	Smooth Walled Steel Pipe
OPSS 1820	Circular and Elliptical Concrete Pipe
OPSS 1840	Non-Pressure Polyethylene (PE) Plastic Pipe Products

CSA Standards

B182.6	Profile polyethylene (PE) sewer pipe and fittings for leak-proof sewer applications
A3000	Cementitious Materials Compendium
W59	Welded Steel Construction (Metal Arc Welding)

American Society for Testing and Materials (ASTM) International Standards

A 252	Standard Specification for Welded and Seamless Steel Pipe Piles
D 2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
D 3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
D6910	Standard Specification for Marsh Funnel Viscosity of Clay Construction Slurries
F 894	Standard Specification for Polyethylene Large Diameter Profile Wall Sewer and Drain Pipe

International Organization for Standardization/International Electrotechnical Commission (ISO/IEC)

17025	General Requirements for the Competence of the Testing and Calibration Laboratories

3.0 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Auger Jack & Bore means a method of forming a horizontal bore in the subsurface by simultaneously or alternately jacking into the ground a casing pipe and rotating a cutter head at the lead end of an auger flight with removal of material from inside the casing by using continuous-flight augers.

Backreamer or Reamer means a cutting head suitably designed for the subsurface conditions that is attached to drilling equipment and used to enlarge the bore

Bore Path means a drilled path according to the grade and alignment tolerances specified in the Contract Documents.

Design Engineer means the Engineer retained by the Contractor who produces the design and working drawings and other engineering documents required of the Contractor. The Design Engineer shall be licensed to practice in the Province of Ontario.

Design Checking Engineer means the Engineer retained by the Contractor who checks the original design and working drawings. The design checking engineer shall be licensed to practice in the Province of Ontario, shall not be an employee of the Contractor and shall be independent from the Design Engineer.

Digger Shield/Hand Mining means a method of forming a horizontal bore in the subsurface by essentially simultaneously jacking a casing pipe, with or without a protective shield at the lead end, into the ground while tunnelling and removal of earth and rock is completed using manually-operated tools (e.g., pneumatic spades, rams, shovels, breaker bars, etc.) or a "digger" type shield with a hydraulic excavator arm or "road-header" rock cutting machine to remove materials from inside the shield and liner pipe.

Horizontal Directional Drilling (HDD) means horizontal directional boring or guided boring.

Drilling Fluids means a mixture of water and additives, such as bentonite, polymers, surfactants, and soda ash, designed to block the pore space on a bore wall, reduce friction in the bore, and to suspend and carry cuttings to the surface.

Drilling Fluid Hydraulic Fracture or "Frac Out" means a condition where the drilling fluid's pressure in the bore is sufficient to fracture the soil and/or rock materials and allow the drilling fluids to migrate to the surface at an unplanned location.

Earth Pressure Balance (EPB) means a tunnelling system that provides support to the excavated face of the ground and resistance to groundwater inflow through the pressure of mixed earth, rock and any drilling fluids or additives (spoil) as maintained by and in a chamber behind the cutting face of a tunnel boring machine through which spoil can pass only by manner of controlled-load relieving gates or an internal screw-conveyor that is separate from subsequent spoil conveyance systems (e.g., flight augers, belt conveyor, spoil bucket rail cars, etc.). Trenchless systems that apply pressure to the excavated face of the ground only through mechanical and jacking forces on metal parts of the machinery (e.g., steel parts of cutting tools, adjustable gates or doors at cutting face, etc.) will not be considered equivalent to EPB systems.

Excavation means all materials encountered regardless of type and extent and shall include removal of natural soil, boulders, cobbles, wood and fill regardless of means necessary to break consolidated materials for removal.

Environmentally Sensitive Area (ESA) means areas specified in the Contract Documents that are prohibited from entry or use.

Fill means man-made mixture of previously placed or handled materials such as sand, clay, silt, gravel, broken rock, sometimes containing organic and/or deleterious materials, placed in an excavation or other area to raise the surface elevation.

Guidance System means an electronic system capable of indicating the position, depth and orientation of the drill head during the directional drilling process.

Hand Mining means a method of forming a horizontal bore in the subsurface by simultaneously jacking ahead while tunnelling advances using hand–mining (man-entry operation or "Jack and Mine") or a "digger" type shield with a hydraulic excavator arm to remove materials from inside the liner pipe.

Inadvertent Returns means the unexpected flow of fluids, saturated materials (or flowing soil) towards the drilling rig that typically originated from an artesian aquifer encountered during the drilling process.

Loss of Circulation means the discontinuation of the flow of drilling fluid in the bore back to the entry or exit point or other planned recovery points.

Microtunnelling means an underground method of constructing a passage by using a microtunnel boring machine (MTBM) or hand mining using a shield to support the opening.

Pilot Bore means the initial bore to set directional controlled horizontal and vertical alignment between the connecting points.

Pipe Jacking means a method for installing steel casing, concrete pipe or other acceptable material in the subsurface utilizing hydraulically operated jacks of adequate number and capacity for the smooth and uniform advancement of the casing or pipe.

Pipe means pipe culverts, pipe storm and sanitary sewers, watermain pipe, conduits and ducts.

Pipe Ramming means a method for installing steel casings utilizing the energy from a percussion hammer to advance a steel casing with a cutting shoe attached at the front end of the casing.

Project Superintendent means an individual representing the Contractor that oversees the trenchless or tunnelling operation qualified to provide the services specified in the Contract Documents.

Pullback means that part of the HDD method in which the drilling equipment is pulled back through the bore path to the entry point.

Reaming means a process for enlarging the bore path

Rock means natural beds or massive fragments, or the hard, stable, cemented part of the earth's crust, igneous, metamorphic, or sedimentary in origin, which may or may not be weathered and includes boulders having a volume of 0.5 m^3 or greater.

Shaft means an excavation used as entry and/or exit points, alternatively called entry/exit pits, from which the trenchless method is initiated for the installation of the pipe product.

Slurry Pressure Balance (SPB) means a tunnelling system that provides support to the excavated face of the ground and resistance to groundwater inflow through the pressure of slurry as maintained by and in a chamber behind the cutting face of a TBM or MTBM through which spoil can pass only by manner of controlled-pressure and controlled flow slurry pumping systems.

Strike Alert means a system that is intended to alert and protect the operator in the case of inadvertent drilling into an electrical utility cable. The strike alert system consists of a sensor and an alarm connected to the drill rig and a grounding stake. The alarm may be audio or visual or both.

Slurry means a mixture of soil and/or rock cuttings, and drilling fluid.

Soil means all soils except those defined as rock, and excludes stone masonry, concrete, and other manufactured materials.

Spoil means mix of earth cuttings, rock cuttings, water (groundwater or added water), bentonite, polymers and/or other additives that is discharged from the trenchless construction systems.

Trenchless Installation means an underground method of constructing a passage open at both ends that involves installing a pipe product by auger jack & boring, pipe ramming, horizontal directional drilling, or tunnelling.

Trenchless Contractor means the subcontractor retained by the Prime Contractor qualified to provide the services specified in the Contract Documents.

Tunnelling means an underground method of constructing a passage using a tunnel boring machine (TBM) operated by personnel within the tunnel, a microtunnel boring machine (MTBM) operated by personnel at a remote control station or excavation using a shield to support the opening and protect workers.

Zone of Influence means a zone defined by lines projected outward and upward at 45 degrees from horizontal to the ground surface from the vertical and horizontal alignment of the pipe constructed using trenchless/tunnel methods.

4.0 DESIGN AND SUBMISSION REQUIREMENTS

4.01 Design

4.01.01 General

The Contractor shall determine the most appropriate method of installation for each location within the terms of this specification.

The installation method selected for each pipe crossing shall be designed for the subsurface conditions as reported in the Contract Documents.

The detailed design of the installation method selected to carry out the work as specified in the Contract Documents shall be completed.

Based on the ground conditions at the culvert site crossing Highway 129, Station 14+457, Township of Reany, and the anticipated relatively short tunnel distance of up to about 40 m, HDD, jack and bore, TBM, Tunnel Digging Machine (TDM), Pilot Tube Micro-tunnelling (PTMT) methods are likely not suitable or cost-effective methods for culvert installation.

4.02 Submission Requirements

4.02.01 Qualifications

At least two weeks prior to construction, the names and the demonstrated project experience of the Project Superintendent, Trenchless contractor, Design Engineer, and Design Checking Engineer shall be submitted to the Contract Administrator.

4.02.01.01 Project Superintendent

The Project Superintendent shall have a minimum of five years' demonstrated experience on projects with similar scope and complexity.

During construction, the project superintendent shall not change without written permission from the Contract Administrator. A proposal for a change in the project superintendent shall be submitted at least one week prior to the actual change in project superintendent.

4.02.01.02 Trenchless Contractor

The Trenchless Contractor shall have a minimum of five years' demonstrated experience on projects with similar scope and complexity

4.02.01.03 Design Engineer

The Design Engineer shall have a minimum of five years' demonstrated experience on projects with similar scope and complexity

4.02.01.04 Design Checking Engineer

The Design Checking Engineer shall have a minimum of five years' demonstrated experience on projects with similar scope and complexity

4.02.02 Working Drawings

Three sets of Working Drawings for the trenchless installation method selected shall be submitted to the Contract Administrator (CA) for purposes of documentation and quality assurance at least two week prior to the commencement of the work. All Working Drawings shall bear the seal and signature of the Design Engineer and Design Checking Engineer.

The working drawings shall be submitted to the Contract Administrator under cover with a Request to Proceed.

The Contractor shall not proceed with the work until a Notice to Proceed has been received from the Contract Administrator

A copy of the Working Drawings shall be kept at the site during construction.

Information and details shown on the Working Drawings shall include, but not be limited to:

a) Plans and Details:

   i. Plans and profiles defining all horizontal and vertical alignment positions and positions of all utilities and other infrastructure within the zone of influence of the work;
   ii. A work plan outlining the materials, procedures, methods and schedule to be used to execute the work.
   iii. A list of personnel, including backup personnel, and their qualifications and experience.
   iv. A safety plan including the company safety manual and emergency procedures.
   v. The work area layout.
   vi. An erosion and sediment control plan that includes a contingency plan in the event the erosion and sediment control measures fail.
   vii. A contingency plan with specific details of the manner in which rock or boulders will be broken and removed from the face and the face will be protected to prevent soil loss into the liner.
   viii. A drilling fluid management plan, if applicable, that addresses control of frac-out pressures, any potential environmental impacts and includes a contingency plan detailing emergency procedures in the event that the fluid management plan fails.
   ix. Lighting, ventilation and fire safety details as may be required by applicable occupational health and safety regulations.
   x. Excavated materials disposal plan.
   xi. Locations of protection systems.

b) Designs

i. Primary liner design (e.g., steel liner plates, steel ribs and wood lagging, steel casing pipe, etc.),
ii. Design assumption and material data when materials other than those specified are proposed for use.
iii. Drill path design, details of alignment and alignment control, maximum curvature and reaming stages.

c) Materials:

i. Certification from the manufacturer that the product furnished on the contract meets the specifications cited in the manufacturer's product specification and that the materials supplied are suitable for the application.
ii. Manufacturer data sheets for all drilling fluids and additives for use in Earth Pressure Balance, Slurry Pressure Balance
iii. Manufacturer data sheets for drilling systems.
iv. Mix designs, target rheology criteria (e.g., viscosity, density, shear strength, gel time, pressure-filtration – fluid losses under pressure, etc.) and additive dosage rates for all slurries and EPB TBM and MTBM operations.
v. The proposed grout mix design for grouts to be used for lubricating jacking pipe and for filling of voids and annular spaces.
vi. Compressive strength of concrete pipe products.
vii. Pipe class for all steel pipe products.
viii. Steel for Permanent Casings
    - One copy of a mill test certificate certifying that the steel meets the requirements for the appropriate standards for permanent casings shall be submitted to the Contract Administrator at the time of delivery.
    - Where mill test certificates originate from a mill outside Canada or the United States of America, the information on the mill certificates shall be verified by testing by a Canadian laboratory. The laboratory shall be certified by an organization accredited by the Standards Council of Canada to comply with the requirements of ISO/IEC 17025 for the specific tests or type of tests required by the material standard specified on the mill test certificate.
    - The mill test certificates shall be stamped with the name of the Canadian testing laboratory and appropriate wording stating that the material conforms to the specified material requirements. The stamp shall include the appropriate material specification number, the date (i.e., yyyy-mm-dd), and the signature of an authorized officer of the Canadian testing laboratory

ix. The Contractor shall submit the followings to the Contract Administrator two weeks prior to construction:
    - type, source, and physical and chemical properties of bentonite, polymer or other additives;
    - source of water;
    - method of mixing;
    - the water to solids ratio and the mass and volumes of the constituent parts, including any chemical admixtures or physical treatment employed to achieve required physical properties;

- details of procedure to be used for monitoring physical properties of slurry, drilling fluids and tunnelling fluids or EPB spoil; and method of disposal of the slurry, drilling fluids and associated spoil

d) Upstream/Downstream Portal Installation Procedure:

i. The access shaft or entry/exit pit details, as applicable.
ii. Face support and other temporary support details, if applicable.

e) Primary Liner/Secondary Liner Installation and Grouting Procedure:

i. Excavation and pipe installation procedures, including methods to handle obstructions and prevent soil cave-in.
ii. Details of tunnelling equipment/methods to be used for the works.

f) Excavation and Dewatering:

i. Equipment and methods for control, handling, treatment, and disposal of groundwater and water or fluids introduced by the Contractor;
ii. Equipment and methods for maintaining control of ground inflow at the excavation face during excavation;
iii. Equipment and methods for removal of cobbles and boulders;
iv. Manufacturer data sheets for each TBM, shield, tunnelling system or drilling system noting all intermediate and final cut dimensions, and methods and equipment for controlling and measuring drilling fluid, SPB and EPB pressures;
v. Methods for measuring excavated volumes or weights of earth and rock materials cut from ground on a per meter or per pipe basis up to a maximum of 3 m long intervals per measurement;
vi. Target operating pressures (minimum and maximum) and range of expected pressure variation for slurry or EPB spoil at excavated face or drilling fluids at lead end of drilling equipment and in annular gap between maximum excavated dimensions and outside dimensions of tunnelling equipment, drilling equipment and primary liner systems;
vii. Basis for setting target operating conditions (pressures, flow rates, advance rates) and the relationship of target operating conditions to ground conditions;
viii. Basis for selection of excavation tools (e.g., bits, TBM face tools, MTBM face tools, excavator fittings, etc.) as related to expected ground conditions;
ix. Jacking forces for installation of pipe, for driving of trenchless equipment forward and, in the case of Auger Jack & Bore, for advancing the lead end of the casing ahead of the lead end of the auger cutting tools.

g) Monitoring Method:

Methods, equipment, frequency and repeatability (accuracy and precision) of data collection to be employed for measuring and monitoring shall be submitted for:

i. Maintaining the alignment of the installation;
ii. EPB, SPB and drilling fluid pressures at the leading edge of excavation (face), flow rates and volume or weights of spoil;
iii. Jacking forces on pipes, linings and cutting tools;
iv. Torque, total revolutions and revolution rates on rotating equipment such as TBM or MTBM heads, auger flights, drill bits, etc.
v. Grout injection pressures and volumes;

vi. Longitudinal position of all casings and excavation cutting tools (auger flight heads, TBM face, drill bit position, etc.);
vii. Ground displacements (heave and settlement); and noise and ground vibrations induced by trenchless construction

4.02.03 Quality Control Certificate

The Contractor shall submit a Quality Control Certificate to the Contract Administrator for documentation and quality assurance purposes, prepared and stamped by the Design and Design Checking Engineers, a minimum of two weeks prior to commencement of work under this item. The Certificate shall state that the construction procedures are in conformance with the requirements and specifications of the contract documents.

The Contractor shall submit to the Contract Administrator a Quality Control Certificate sealed and signed by the Design and Design Checking Engineer upon completion of each of the following operations and prior to commencement of each subsequent operation for each pipe installation:

Site Surveying (as noted in Section 4.02)
Excavation for pits including dewatering of excavations
Jacking/Ramming/Directional Drilling of Casing/Liner
Installation of the Product
Grouting Operations

Each Quality Control Certificate shall state that the work has been carried out in general conformance with the contract documents, specifications and/or stamped working drawings.

The Contractor shall submit a Request to Proceed to the Contract Administrator upon completion of each of the milestones.

The Contractor shall not proceed to the subsequent operation until a Notice to Proceed has been received from the Contract Administrator

In addition, upon completion of the installation of the pipe at each location, the Contractor shall submit to the Contract Administrator a final Quality Control Certificate sealed and signed by the Design and Design Checking Engineer. The Certificate shall state that the pipe has been installed in general conformance with the Contractor's Submission and Design Requirements, stamped working drawings and contract documents.

5.0 MATERIALS

5.01 Pipe

5.01.01 General

The product shall be concrete pipe, steel pipe or high density polyethylene pipe as specified.

All joints shall be suitable for jacking operations as specified in the working drawings.

Fittings shall be suitable and compatible with the class and type of pipe with which they will be used.

All fittings shall be designed to be watertight.

5.01.02 Steel Pipe

Steel pipe shall be according to ASTM A252.

All steel casing pipe shall be square cut.

Steel casing pipe shall meet a straightness tolerance of 1.5 mm/m. When placed anywhere on the pipe parallel to the pipe axis, there shall not be a gap more than 1.5 mm between a 1 m long straightedge and the pipe.

5.01.03 HDPE Pipe

High density polyethylene (HDPE) pipe according to OPSS 1840 shall be used in accordance with ASTM D3350.

Fittings shall be according to CAN/CSA-B182.6 or ASTM F894 and suitable for the class and type of pipe with which they will be used.

Jointing of HDPE piping shall be completed according to the manufacturer's recommended procedures and ASTM D2657. Where conflicts exist between the manufacturer's instructions and ASTM D2657, the manufacturer's instructions are to be followed.

Jointing of HDPE piping to other piping materials or appurtenances shall be completed using flanged connections.

5.01.04 Concrete Pipe

Concrete pipe shall be according to OPSS 1820.

5.02 Concrete

Concrete shall be according to OPSS 1350. The concrete strength shall be as specified on the Working Drawings.

5.03 Steel Reinforcement

Steel reinforcement for concrete work shall be according to OPSS 1440.

5.04 Wood

Wood shall be according to OPSS 1601.

5.05 Drilling Fluids

Drilling fluid shall be mixed according to the working drawings.

Selection of drilling fluid type shall be based on the soils encountered in the subsurface investigation.

The drilling fluids shall be mixed according to the manufacturer's recommendations.

Slurry shall be mixed according to the submitted slurry design and be appropriate for the anticipated subsurface conditions. The viscosity of slurry used for SPB tunnelling shall be no less than 40 seconds Marsh Funnel viscosity, as defined by ASTM D6910, measured prior to introduction of groundwater and spoil and as required to ensure:

a) development of appropriate filter cake at excavation face to provide slurry support pressures exceeding ground and groundwater pressures at excavation face;
b) lubricate installation of primary liners as required;
c) transport spoil through pipe systems;

5.06 Grout

Purging grout shall conform to the requirements of OPSS 1004 wetted with only sufficient water to make the mixture plastic

6.0 EQUIPMENT

6.01 Auger Jack & Bore

Except in the case of dewatering to at least 1 m below the tunnel/bore invert for the full length of the pipe alignment, Auger Jack & Bore shall not be used and will not be permitted where subsurface conditions indicate that saturated gravel, sand and silt soils may be encountered at pipe level or within one pipe diameter above or below outside pipe dimensions.

Pipe auger jack & bore equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

Specific details of the equipment with which rock or boulders will be broken and removed from the face and the face will be protected to prevent soil loss into the liner shall be submitted to the Contract Administrator for information purposes prior to proceeding with the works.

The lead end of the auger shall be maintained at least one pipe diameter inside the lead end of the casing. The auger cutting tools shall not extend to or beyond the lead end of the casing at any time unless specific exception is provided by the Ministry prior to construction. Submittals shall identify anticipated jacking forces for advancing casing ahead of leading edge of auger cutting tools in addition to friction forces that are to be overcome by jacking systems

6.02 Pipe Ramming

Pipe ramming equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein.

The pipe ramming hammer(s) shall be capable of driving the pipe casing from the entry pit to the exit pit through the existing subsurface conditions at the site without removal of soil from within the casing until the lead end of the pipe is outside the zone of influence for any overlying infrastructure.

Specific details of the equipment with which rock or boulders will be broken and removed from the face and the face will be protected to prevent soil loss into the pipe shall be submitted to the Contract Administrator for information purposes prior to proceeding with the works.

6.03 Horizontal Directional Drilling

6.03.01 General

The Horizontal Directional Drilling equipment shall consist of a directional drilling rig and a drilling fluid mixing and delivery system to successfully complete the product installation without exceeding the maximum tensile strength of the product being installed.

6.03.02 Drilling Rig

The horizontal directional drilling rig shall:

a) Consist of a leak free hydraulically powered boring system to rotate, push, and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill head.

b) Have drill rod that is suitable for both the drill and the product pipe installation.

c) Contain a drill head that is steerable, equipped with the necessary cutting surfaces and fluid jets, and be suitable for the anticipated ground conditions.

d) Have adequate reamers and down-bore tooling equipped with the necessary cutting surfaces and fluid jets to facilitate the product installation and be suitable for the anticipated ground conditions.

e) Contain a guidance system to accurately guide boring operations.

f) Be anchored to the ground to withstand the rotating, pushing, and pulling forces required to complete the product installation.

g) Be grounded during all operations unless otherwise specified by the drilling rig manufacturer.

6.03.03 Drill Head

The drill head shall be steerable by changing its rotation, be equipped with the necessary cutting surfaces and drilling fluid jets, and be of the type for the anticipated subsurface conditions,

6.03.04 Guidance System

The guidance system shall be setup, installed, and operated by trained and experienced personnel. The operator shall be aware of any magnetic or electromagnetic anomalies and shall consider such influences in the operation of the guidance system when a magnetic or electromagnetic system is used.

6.03.05 Drilling Fluid Mixing System

The drilling fluid mixing system shall be of sufficient size to thoroughly and uniformly mix the required drilling fluid.

6.03.06 Drilling Fluid Delivery System

The delivery system shall have a means of measuring and controlling fluid pressures and be of sufficient flow capacity to ensure that all slurry volumes are adequate for the length and diameter of the final bore and the anticipated subsurface conditions. Connections between the delivery pump and drill pipe shall be leak-free.

6.04 Tunnelling

Tunnelling equipment shall be determined by the Contractor and shall be identified in the submission requirements specified herein. Specific details of tunnelling equipment included in the submission shall be provided for:

a) rock or boulder breaking and removal;

b) equipment used within shields for spilling, fore-poling, face drainage, breasting boards/plates and for otherwise maintaining support of the tunnel crown and face under all anticipated conditions;

c) jacking systems;

d) alignment control systems;

Use of rock fracturing chemicals shall only be considered subject to a field demonstration satisfactory to the Ministry prior to its use. Use of explosives is prohibited without specific application and acceptance by the Ministry prior to construction.

6.05 Microtunnelling Equipment

The Contractor shall be responsible for selecting microtunnelling equipment which, based on past experience, has proven to be satisfactory for excavation of the soils that will be encountered.

The Contractor shall employ microtunnelling equipment that will be capable of handling the various anticipated ground conditions.

The MTBM shall also be capable of controlling loss of soil ahead of and around the machine and shall provide continuous pressurized support of the excavated face.

a) Remote Control System – The Contractor shall provide a MTBM that includes a remote control system with the following features:
   i. Allows for operation of the system without the need for personnel to enter the microtunnel. Has a display available to the operator, at a remote operation console, showing the position of the shield in relation to a design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force cutter head torque, rate of advance and installed length.
   ii. Integrates the system of excavation and removal of spoil and its simultaneous replacement by Product Pipe. As each pipe section is jacked forward, the control system shall synchronize all of the operational functions of the system.
   iii. The system shall be capable of adjusting the face pressure to maintain face stability for the particular soil condition encountered.
   iv. The system shall monitor and continuously balance the soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.
   v. The pressure at the excavation face shall be managed by controlling the volume of spoil removal with respect to the advance rate.

vi. The system shall include a separation process designed to provide adequate separation of the spoil from the slurry so that slurry with a sediment content within the limits required for successful microtunnelling, can be returned to the cutting face for reuse. Appropriately contain spoil at the site prior to disposal.
vii. The type of separation process shall be suited to the size of microtunnel being constructed, the soil type being excavated, and the work space available at each work area.
viii. The system shall allow the composition of the slurry to be monitored to maintain the slurry weight and viscosity limits required.

b) Active Direction Control - Provide an MTBM that includes an active direction control system with the following features:
   i. Controls line and grade by a guidance system that relates the actual position of the MTBM to a design reference Provides active steering information that shall be monitored and transmitted to the operating console and recorded.
   ii. Provides positioning and operation information to the operator on the control console.

6.05.01 Pipe Jacking Equipment

Provide a pipe jacking system with the following features:

a) Has the main jacks mounted in a jacking frame located in the launch shaft.
b) Has a jacking frame that successively pushes towards a receiving shaft, a string of Product Pipe that follows the microtunnelling excavation equipment.
c) Has sufficient jacking capacity to push the microtunnelling excavation equipment and the string of pipe through the ground.
d) The main jack station may be complemented with the use of intermediate jacking stations as required.
e) Has a capacity at least 20 percent greater than the calculated maximum jacking load.
f) Develops a uniform distribution of jacking forces on the end of the casing pipe.
g) Provides and maintains a pipe lubrication system at all times to lower the friction developed on the surface of the pipe during jacking.
h) Jack Thrust Blocking shall adequately support the jacking pressure developed by the main jacking system.
i) Special care shall be taken when setting the pipe guide rails in the jacking shaft to ensure correctness of the alignment, grade, and stability.

6.05.02 Spoil Separation System

The Contractor shall determine the type of spoil separation equipment needed for each drive based on the geotechnical information available and other project constraints.

6.05.03 Electrical Equipment, Fixtures and Systems

Electrical equipment shall be suitably insulated for noise reduction. Noise produced by electrical equipment must comply with local municipal noise by-laws.
Electrical systems shall conform to requirements of the Canadian Electrical Code – CSA C22.1.

7.0 CONSTRUCTION

7.01 General

The Contractor shall notify the Contract Administrator at least 48 hours in advance of starting work. The proposed method of pipe installation to be used by the Contractor shall be subject to the limitations presented in the following subsections.

The Project Superintendent shall supervise the work at all times.

7.01.01 Layout, Alignment and Depth Control

The location of the installation shall be established from the lines, elevations and tolerances specified in the Contract Documents. The pipe installation shall be to the horizontal and vertical alignments specified in the Contract Drawings. Deviations from location, alignment, grades and/or invert levels shall be corrected by the Contractor at no cost to the Ministry.

All reference points necessary to construct the pipe installation and appurtenances shall be laid out.

The Contractor shall calibrate tracking and locating equipment at the beginning of each work day, and shall monitor and record the alignment and depth readings provided by the tracking system every 2 m.

The Contract Administrator shall be provided with the assistance and access necessary to check the layout of the pipe installation and associated appurtenances.

The Contractor shall submit records of the alignment and depth of the installation to the Contract Administrator at the completion of the installation.

7.01.02 Construction Shafts

Construction shafts shall be specified in the Contractor's submission. The boundaries and protection of these shall be as required to contain all disturbances to areas outside of the ESA limits.

Shafts shall be maintained in a drained condition.

A minimum 2.4 m high secure fence shall be installed around the perimeter of the construction shaft area with gates and truck entrances. The fence shall be removed on completion of the work.

7.01.03 Protection Systems

The construction of all protection systems shall be according to OPSS539. Where the stability, safety, or function of an existing roadway, watercourse, other works, proposed works or ESA's may be impaired due to the method of operation, protection shall be provided. Protection may include sheathing, shoring, and piles where necessary to prevent damage to such works or proposed works.

7.01.04 Settlement or Heave

Any disturbance to the ground surface (settlement or heave) as a result of the pipe installation shall be immediately corrected by the Contractor, at no additional cost to the Ministry.

7.01.05 Stability of Excavation

The construction methods, plant, procedures, and precautions employed shall ensure that excavations are stable, free from disturbance, and maintained in a drained condition.

The construction methods, plant, procedures, and materials employed shall prevent the migration of soil and/or rock material into the excavation from adjacent ground.

7.01.06 Preservation and Protection of Existing Facilities

Preservation and protection of existing facilities shall be according to OPSS 491.

Minimum horizontal and vertical clearances to existing facilities as specified in the Contract Documents shall be maintained. Clearances shall be measured from the nearest edge of the largest cut diameter required to the nearest edge of the facility being paralleled or crossed.

Existing underground facilities shall be exposed to verify its horizontal and vertical locations when the outlet pipe path comes within 1.0 m horizontally or vertically of the existing facility. Existing facilities shall be exposed by non-destructive methods. The number of exposures required to monitor work progress shall be as specified in the Contract Documents.

7.01.07 Transporting, Unloading, Storing and Handling Materials

Manufacturer’s handling and storage recommendations shall be followed.

7.01.08 Trenching, Backfilling and Compacting

Trenching, backfilling, and compacting for entry and exit points or other locations along the pipe path shall be according to OPSS 401.

7.01.09 Support Systems

Support systems shall be according to OPSS 404.

If any open excavation will encroach into the highway embankment the protection system shall satisfy the requirements for Performance Level 2 as specified in OPSS 539.

7.01.10 Dewatering

The work of this Section includes control, handling, treatment, and disposal of groundwater. The Contractor shall review the foundation investigation report for reference to soil and groundwater conditions on the project site and plan a dewatering scheme accordingly.

The Contractor shall control groundwater inflows to excavations to maintain stability of surrounding ground, to prevent erosion of soil, to prevent softening of ground exposed in the excavation, and to avoid interfering with execution of the work.

The Contractor shall maintain excavations free of standing water at all times during excavation, including while concrete is curing.

Should water enter the excavation in amounts that could adversely affect the performance of the work or could cause loss of ground, the Contractor shall take immediate steps to control the inflow.

The Contractor is alerted that seepage zones of perched water within the fill materials should be expected, particularly where granular materials are excavated.

Dewatering shall be according to OPSS 517.

7.01.11 Removal of Cobbles and Boulders

The Contractor is alerted that cobbles and boulders are expected within the soil deposits at the site. Accordingly, the Contractor shall address the removal of cobbles and boulders in the proposed method of construction. Removal of cobbles shall be expected to be routine and will not be considered cause for delay or additional compensation and the Contractor's trenchless equipment shall be appropriately equipped and operated for these conditions. The Contractor shall immediately inform the Contract Administrator of any obstruction encountered.

7.01.12 Removal of Obstructions

The Contractor is alerted that obstructions such as, but not limited to wood debris, roots, and stumps, and construction debris consisting of (broken asphalt, concrete etc.) are expected within the trenchless alignment as identified in the Contract Documents. Accordingly, the Contractor shall address methods for the removal of obstructions in the proposed method of construction. The Contractor shall immediately inform the Contract Administrator of any obstruction encountered and the Contractor's expected method of and schedule for removal.

7.01.13 Management of Excess Material

Management of excess material shall be according to OPSS 180. Satisfactory re-usable excavated material required for backfill shall be separated from unsuitable excavated material.

7.01.14 Site Restoration

Site restoration shall be according to OPSS 492.

7.02 Auger Jack & Bore Installation

7.02.01 Method of Installation Procedure

The installation procedure to be used shall be subject to the following limitations:

a) Hydraulically operated jacks of adequate number and capacity shall be provided to ensure smooth and uniform advancement without over-stressing of the pipe.
b) A suitably padded jacking head or collar shall be provided to transfer and distribute jacking pressure uniformly over the entire end bearing area of the pipe.
c) The jacking pipe shall be fully supported in the jacking pit at the specified line and grade.
d) Selection of the excavation method and jacking equipment shall take into consideration the conditions at each pipe crossing.

7.02.02 Pipe Installation

Concrete pipe joints shall be water tight and according to OPSS 1820 and must withstand jacking forces, determined by the Contractor.

During the jacking of the liner the space between the liner and the wall of the excavated volume (e.g., maximum cut diameter) shall be kept filled with bentonite slurry. Upon completion of jacking, the space between the liner and the wall of the excavated volume shall be filled with grout or slurry with gel strength properties demonstrated to be sufficient to form a semi-solid or solid gap filling material, prevent ground convergence around the pipe and subsequent ground surface subsidence and prevent long-term water flow at the outside boundary of any pipe and ground.

The annular space between the liner and the product shall be fully grouted with a water tight, expandable and stable grout.

7.03 Pipe Ramming Installation

For pipe ramming installation the following requirements apply:

Only smooth walled steel pipe shall be used. Butt welding of pipe joints shall conform to CAS W59.

Ramming equipment of adequate capacity shall be provided to ensure smooth and uniform advancement between the shafts/pits without overstressing of the pipe. Delays shall be avoided between ramming operations.

A ramming head shall be provided to transfer and distribute jacking pressure uniformly over the entire end bearing area of the pipe.

Two or more lubricated guide rails or sills shall be provided of sufficient length to fully support the pipe at the specified line and grade in the ramming pit. Pipe shall be installed to the line and grade specified.

Removal of materials from within the pipe shall not be undertaken until the lead end of the pipe has passed fully through and beyond the zone of influence of any overlying infrastructure.

Following installation of the liner pipe, all material shall be removed from the pipe to the satisfaction of the Contract Administrator. Any voids remaining between the pipe and the excavation wall shall be grouted as soon as the pipe is rammed. The annular space between the liner pipe and the product shall be fully grouted with a water tight, expandable and stable grout.

7.04 Horizontal Directional Drilling Installation

7.04.01 General

When strike alerts are provided on a drilling rig, they shall be activated during drilling and maintained at all times.

For horizontal directional drilling, the contractor shall ensure that during pilot hole drilling the maximum degree of deviation or “dog-leg” shall be 2.5 degrees per 9 m drill pipe length. Any deviation exceeding 2.5 degrees will necessitate a pull-back and straightening of the alignment at the Contractor’s sole expense. The pilot hole exit location shall be within 0.5m of the target location.

7.04.02 Site Preparation

The work site shall be graded or filled to provide a level working area for the drilling rig. No alterations beyond what is required for HDD operations are to be made. All activities shall be confined to designated work areas.

7.04.03 Pilot Bore

The pilot bore shall be drilled along the bore path in accordance with the grade, alignment, and tolerances as indicated on the Contractor's submitted drilling plan to ensure that the product is installed to the line and grade shown on the Contract Drawings. The Contractor's methods shall take into consideration the conditions at each crossing within the pipe alignment and shall be suitable to advance through such obstructions such as cobbles and boulders and address the potential for deflection off these obstruction and/or soil conditions.

In the event the pilot bore deviates from the submitted path, the Contract Administrator shall be notified. The Contract Administrator may require the Contractor to pullback, fill and abandon the hole and re-drill from the location along the bore path before the deviation.

If a drill hole beneath highways, roads, watercourses or other infrastructure must be abandoned, the hole shall be backfilled with grout or bentonite to prevent future subsidence and subsurface water conveyance.

The Contractor shall maintain drilling fluid pressure and circulation throughout the HDD process, including during the initial pilot bore and during the reaming process.

The Contractor shall at all times and for the entire length of the installation alignment be able to demonstrate the horizontal and vertical position of the alignment, the fluid volume used, return rates and pressures.

7.04.04 Drilling Fluid Losses to Surface ("Frac-Out")

To reduce the potential for hydraulic fracturing of the hole during horizontal directional drilling, a minimum depth of cover of 5 m shall be maintained between the top of pipe and the surface of any pavements or beds of water courses. Sections of the pipe close to the entry and exit pit with less than 5 m cover shall be cased. The Contractor shall ensure that drilling fluid pressures are properly set and controlled for the full length of the bore to prevent frac-out for the depth of cover available between the bottom of the pavement structure (bottom of the subbase material) and the top of the bore.

Once a fluid loss or frac-out event is detected, the Contractor shall halt operations immediately and conduct a detailed examination of the drill path and implement measures to collect all fluids discharged to surface, mitigate and prevent additional fluid loss.

7.04.05 Reaming

The bore shall be reamed using the appropriate tools to a diameter at least 50% greater than the outside diameter of the product.

7.04.06 Product Installation

7.04.06.0 General

The product shall be jointed according to manufacturer's recommendations. The length of the product to be pulled shall be jointed as one length before commencement of the continuous pulling operation.

The product shall be protected from damage during the pullback operation.

The minimum allowable bending radius for the product shall not be contravened.

Product shall be allowed to recover to static conditions from thermal and installation stresses before connections to new or existing facility are made. Product recovery time shall be according to manufacturers recommendations.

7.04.06.02 Pullback and Grouting

After successfully reaming the bore to the required diameter, the product pipe shall be pulled through the bore path. Once the pullback operation has commenced, it shall continue without interruption until the product pipe is completely pulled into bore unless otherwise approved by the Contract Administrator.

A swivel shall be used between the reamer and the product being installed to prevent rotational forces from being transferred to the product. A weak link or breakaway connector shall be used to prevent excess pulling force from damaging the product.

The product pipe shall be inspected for damage where visible at excavation pits and where it exits the bore. Any damage noted shall be rectified to the satisfaction of the Contract Administrator.

The pull back and reaming operations shall not exceed the fluid circulation rate capabilities. Reaming and back pulling operations shall be planned to insure that, once started, all reaming and back pulling operations are completed without stopping and within the permitted work hours.

The space between the pipe and the walls of the excavated volume shall be filled with grout or slurry with gel strength properties demonstrated to be sufficient to form a semi-solid or solid gap filling material, prevent ground convergence around the pipe and subsequent ground surface subsidence and prevent long-term water flow at the outside boundary of any pipe and ground.

7.05 Tunnelling Installation

7.05.01 General

Excavation of native soil and fill shall be done in a manner to control groundwater inflow to the excavation and to prevent loss of ground into the excavation.

Methods of excavating the tunnel shall be capable of fully supporting the face and shall accommodate the removal of boulders and other oversize objects from the face. Continuous ground support shall be maintained during excavation.

As the excavation progresses, the Contractor shall continuously monitor (every 2 m) indications of support distress, such as cracking, deflection or failure of support system and subsidence of ground near the excavation.

The Contractor shall provide ventilation and lighting in accordance with OHSA requirements for the entire length of the tunnel installed as tunneling progresses.

The tunnel is to be kept sufficiently dry at all times to permit work to be performed in a safe and satisfactory manner.

The Contractor shall maintain clean working conditions at all times in tunnels.

If excavation threatens to endanger personnel, the Work, or adjacent property, the Contractor shall cease excavation and make the excavation face secure. The Contractor shall then evaluate methods of construction and revise as necessary to ensure the safe continuation of the work.

The Contractor shall maintain tunnel excavation line and grade to provide for construction of final lining within specified tolerances.

7.05.01 Tunnelling Method

The tunnelling method shall be suitable to provide face support in changing ground conditions that may be encountered during the progress of the work. The selection of the tunnelling method should consider the soil conditions at each pipe crossing and the presence of obstructions, such as cobbles and boulders, with respect to the tunnel alignment.

7.05.02 Primary Liner (Support System)

Primary support systems shall prevent deterioration, loosening, or unravelling of ground surfaces exposed by excavation.

The primary liner support system shall be designed and installed to achieve the intended performance requirements.

Primary liner support system shall maintain the safety of personnel, minimize ground movement into the excavation, ensure stability and maintain strength of ground surrounding the excavation.

The primary liner shall be designed to support all subsurface conditions and hydrostatic pressures and to withstand any additional loads caused by installation and grouting, and shall ensure that no ground loading or other loading will be placed on the new work until after design strength has been reached.

The primary liner shall be installed so that the exterior is as tight as possible to the excavated surface of the tunnel and allows the placement of the full design thickness of the secondary lining.

Primary support systems shall be compatible with the encountered ground conditions, with the method of excavation, with methods for control of water, and with placement of the permanent lining.

All voids between the primary lining and the wall of the excavated volume shall be filled with cement grout or slurry with gel strength properties demonstrated to be sufficient to form a semi-solid or solid gap filling material, prevent ground convergence around the pipe and subsequent ground surface subsidence and prevent long-term water flow at the outside boundary of any pipe and ground. If an unexpanded liner is used, the space outside the liner plates shall be filled at least daily.

7.05.03 Secondary Liner

7.05.03.01 Placing of Grout

The void outside the finished secondary liner shall be filled with cement grout according to the Contractor's submission.

Grout shall not be placed until the lining has achieved 85% of its specified strength or 30 MPa. Grouting shall be limited to such sequences and programs as are necessary to avoid damaging any part of the works or any other structure or property. Grout mix design shall be chemically and thermally compatible with all pipe systems.

7.06 Microtunnelling

7.06.01 General

Excavation of soil, rock and fill shall be done in a manner to control and prevent groundwater inflow to the tunnel.

The MTBM shall be capable of fully supporting the face and shall accommodate the removal of boulders and other obstructions from the face. Continuous ground support shall be maintained during excavation.

The tunnel is to be kept well drained at all times to permit work to be performed in a safe and satisfactory manner.

The Contractor shall maintain clean working conditions at all times.

In the event that excavation threatens to endanger personnel, the Work, adjacent property, roadways, railways, waterways, or the public in any way, the Contractor shall cease excavation. The Contractor shall then evaluate the methods of construction and revise as necessary to ensure the safe continuation of the Work.

The Contractor shall maintain the tunnel excavation line and grade to provide for construction of the product within the specified tolerances.

7.06.02 Method of Installation

The installation procedure to be used shall be subject to the following limitations:

- The jacking pipe shall be fully supported in the jacking pit at the specified line and grade.
- Selection of the excavation method and jacking equipment shall take into consideration the subsurface conditions within the tunnel alignment.
- Perform microtunnelling operations in a manner that will minimize the movement of the ground in front of and surrounding the tunnel in conformance with the limits listed in the Contract Documents.
- Prevent damage to structures and utilities above and in the vicinity of the microtunnelling operations.

- Excavated diameter should be the minimum size required to permit pipe installation by jacking.
- Whenever there is a condition encountered which could endanger the microtunnel excavation or adjacent structures if tunnelling operations cease, continue to operate without intermission including 24-hour working days, weekends and holidays, until the condition no longer exists.
- Maintain an envelope of lubricant around the exterior of the pipe during the jacking and excavation operation to reduce the exterior soil/pipe friction and possibility of the pipe seizing in place.
- In the event a section of pipe is damaged during the jacking operation or a joint failure occurs, as evidenced by inspection, visible ground water inflow or other observations, the Contractor shall submit for approval his methods for repair or replacement of the pipe.

7.06.03 Casing Installation

Casing must withstand the jacking forces determined by the Contractor.

The space between the Casing and the wall of the excavation shall be kept filled with lubricant during the pipe jacking operation. Upon completion of pipe jacking, the space between the Casing and the wall of the excavation shall be filled with grout that is compatible with the Casing.

The Casing shall act as a support system to maintain the safety of personnel, minimize ground movement into the excavation, ensure stability and maintain strength of ground surrounding the Casing.

The Casing shall be designed to support all subsurface conditions and hydrostatic pressures and to withstand any additional loads caused by installation and grouting.

7.07 Instrumentation and Monitoring

The work specified in this Section includes furnishing and installing instruments for monitoring of settlement (and heave) and ground stability.

7.07.01 Surface Monitoring Points

Surface settlement points for monitoring ground stability shall be installed at the pavement/ground surface level on the shoulder, side slope and pavement at intervals of 5 m or less along the tunnel alignment centreline and as arrays of three points in each shoulder of the highway crossing and centred on the tunnel alignment. The equipment and procedures used for settlement monitoring during construction must be capable of surveying the settlement point elevations to within a repeatability (combined accuracy and precision of equipment and methods) ± 2 mm of the actual elevation.

Surface settlement markers shall be hardened steel markers treated or coated to resist corrosion, with an exposed convex head having a minimum diameter of 12 mm and similar to surveyor's PK nails. Markers shall be rigidly affixed so as not to move relative to the surface to which it is attached. Traffic shall be managed by the contractor using short-term lane closures in accordance with the Ontario Traffic Manual (OTM). Surface markers shall be recessed or otherwise designed for safe passage of vehicles at highway speeds and protected from snow removal equipment in the event that work occurs during snow removal seasons.

7.07.02 In-Ground Monitoring Points

In-ground settlement monitoring points shall be 12-18 mm rebar encased in a 50-70 mm, SCH40 PVC pipe, set to a depth of 1.5 m below ground surface or below frost penetration depth whichever is greater. The assembly shall be placed in a drill hole, backfilled with uniform sand and provided with protective covers suitable for high vehicular traffic areas.

7.07.03 Installation, Replacement and Abandonment

The Contractor shall install all settlement monitoring points a minimum of two weeks prior to the start of works to permit baseline surveying to be completed. The settlement monitoring points shall be clearly labelled for easy field identification. The Contractor shall submit to the Contract Administrator a site plan showing the locations of the monitoring points, a geodetic survey of the settlement monitoring points including station, offset and elevation. Instruments damaged by the Contractor’s operations or other causes shall be replaced and surveyed at the time of installation within 24 hours at no additional cost. At the completion of the job, the Contractor shall abandon all instrumentations installed during the course of the Work and restore the surface at instrument locations.

7.07.03 Monitoring and Reporting Frequency

The Contractor shall survey and otherwise obtain elevations of all settlement monitoring points at the following time intervals:

a) Three consecutive readings at least one week prior to commencement of the work (Baseline Reading);
b) Once per shift or once daily during tunnelling operations period whichever results in the more frequent reading intervals; and
c) Weekly after completion of the work for one month, or until such time at which all parties agree that further movement has stopped.

All readings shall be submitted to the Contract Administrator for information purposes on a weekly basis.

Each report shall include all survey data collected in tabular and graphical format as plots of time versus settlement in comparison to survey data collected prior to commencement of the work.

7.07.03 Benchmarks

Two independent benchmarks shall be used for all settlement monitoring surveying and shall be located sufficiently outside the zone of influence such that the benchmarks are not influenced by any trenchless or other construction activity or weather conditions (e.g., frost heave). All surveying shall be reported using the geodetic datum and coordinate system as defined in the Contract Documents.

7.08 Criteria for Assessment of Roadway Subsidence/Heave

Based on the monitoring of ground movement as specified in Subsections 4.02 and 7.07, the following represents trigger levels that define magnitude of movement and corresponding action:

a) Review Level: If a maximum value of 10 mm relative to the baseline readings is reached, the Contractor shall review or modify the method, rate or sequence of construction or ground stabilization measures to mitigate further ground displacement. If this Review Level is exceeded, the Contractor shall immediately notify the CA and review and discuss response actions. The Contractor shall submit a plan of action to prevent Alert Levels from being reached. All construction work shall be continued such that the Alert Level is not reached.

b) Alert Level: If a maximum value of 15 mm relative to the baseline readings is reached, the Contractor shall cease construction operations, inform the Contract Administrator and execute pre-planned measures to secure the site, to mitigate further movements and to assure safety of public and maintain traffic. No construction shall take place until all of the following conditions are satisfied:

   i. The cause of the settlement has been identified.
   ii. The Contractor submits a corrective/preventive plan.
   iii. Any corrective and/or preventive measure deemed necessary by the Contractor is implemented.
   iv. The CA deems it is safe to proceed.

9. MEASUREMENT FOR PAYMENT

Measurement shall be by Plan Quantity Payment as may be revised by Adjusted Plan Quantity Payment in metres, following along the centre line of the pipes from centre to centre of maintenance holes or chambers (catch basins) or from/to the end of the pipe where no maintenance hole or chamber is installed, of the actual length of pipe installed by trenchless methods.

10. BASIS OF PAYMENT

Payment at the contract price shall be full compensation for all labour, equipment and materials required for excavation (regardless of material encountered), dewatering, sheathing and shoring, settlement instrumentation and monitoring, site restoration, and all other work necessary to complete the installation as specified.

Where a protection system is made necessary because of the Contractor's operations (e.g., choice of trenchless installation method), the cost shall be included in this item and shall be full compensation for all labour, equipment and materials required to carry out the work including subsequently removing the temporary protection system and performing any necessary restoration work.

Payment for connecting intercepted drains and service connections shall be made on the following basis:

(a) Where such drains and service connections are shown on the contract drawings the cost of connections shall be included in the contract price for pipe installation.

(b) Where such drains and service connections are not shown on the contract drawings, the cost of connections will be considered an allowable extra to the contract.

OBSTRUCTIONS

Non-Standard Special Provision

The Contactor is hereby notified that at the Culvert at Station 14+457 (Township of Reaney), Borehole BH-1 advanced through the existing roadway encountered cobbles and boulders below 3.5 m depth. This borehole also encountered wood at and just below the interface between the embankment fill and native peat soils. Wood may be indicative of buried timbers for corduroy road construction or branches/trees buried during embankment construction. Technologies utilizing rotating cutter heads may become fouled by wood obstructions. Consideration of the presence of these obstructions must be made in the selection of appropriate equipment and procedures for installation of temporary protection systems and installation of the culvert by trenchless methods.

END OF SECTION

SWAMP EXCAVATION – Item No.

Non-Standard Special Provision

This Non-Standard Special Provision outlines the procedure for sub-excavation of the peat for the embankment widening for the Highway 129 culvert crossing at Station 14+457 in the Township of Rainey.

Staged excavation of limited extent shall be employed to maintain the stability of and to protect the existing Highway 129 embankment and buried utilities (if any) during sub-excavation and replacement operations for the widening. The staged excavation procedures to be followed are:

- Removal of existing peat to the depth specified in the Contract Drawings shall be completed with simultaneous backfilling of the excavation in accordance with OPSS 209 Section 209.07.03.
- Excavation of the peat shall be in accordance with OPSD 203.030.
- Excavation shall be carried out in sections of no greater than 3 m wide along the embankment slope and no greater than 5 m long perpendicular to the embankment slope.
- Provisions for traffic control measures shall be available on site to maintain the safe operation and traffic flow of Highway 129.

BACKFILLING EMBANKMENT – Item No.

Notice to Contractor

The existing sandy silt and silt portions of the fill containing trace to some organics that will be excavated from the embankment and all native peat subgrade soils that may be sub-excavated from the culvert area at this site are to be stockpiled separately from the excavated existing embankment fill comprised of gravelly sand and sand, which may be used for embankment reconstruction. The existing sandy silt and silt fill excavated from the embankment and the native subgrade soils comprised of peat that may be sub-excavated from the culvert area shall not be re-used as backfill to the culvert nor used for embankment reconstruction.