TENDER DOCUMENTS

SUBSECTION 6.88
DIRECTIONAL DRILLING

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SUBSECTION 6.88 DIRECTIONAL DRILLING

6.88.1 GENERAL

6.88.1.1 This subsection describes the requirements relating to the installation of pipes, made of high-density polyethylene (HDPE), by the directional drilling technique covered by this Contract.

6.88.1.2 Any specific requirements, where necessary, pertaining to the installation of HDPE pipes by the directional drilling technique covered by this Contract indicated on the drawings and in Section 4 *Special Technical Conditions*.

6.88.1.3 The requirements relating to excavation work are set out in subsection 6.87 *Earthworks*.

6.88.2 MEASUREMENT UNITS

6.88.2.1 The measurement units and respective symbols thereof used in this subsection are described as follows:

Measurement Unit	**Designation**	**Symbol**
length	meter	m
length	millimeter	mm
temperature	degree Celsius	°C

6.88.3 REFERENCE STANDARDS

6.88.3.1 The **Contractor** shall carry out all directional drilling work in accordance with the requirements of the following standards and documents, to which the provisions of this Contract are added:

6.88.3.1.1 (ASTM) ASTM International:

- ASTM D2657 *Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings*;
- ASTM F1962 *Standard Guide for Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings*.

6.88.3.1.2 (BNQ) Bureau de normalisation du Québec:

- BNQ 1809-300 *Construction work – General technical clauses – Drinking water and sewer pipes*.

6.88.3.1.3 (CERUI) Center of Expertise and Research in Urban Infrastructure:

- CERUI *Conduit Installation Using the Directional Drilling Technique – Technical Specifications.*

6.88.4 DEFINITIONS

6.88.4.1 The following definitions apply to this Contract:

6.88.4.1.1 Reaming: an operation consisting in the enlargement of a borehole.

6.88.4.1.2 Drilling mud: the mixture of excavated materials and drilling fluid.

6.88.4.1.3 Flexible restrained joint: the joint that allows the resistance to slight angular displacements of the pipe and to the axial stresses inside the pipe.

6.88.4.1.4 Drilling fluid: the mixture of water and additives, such as bentonite or polymers, designed to seal the walls, reduce the friction of the equipment in the ground, keep in suspension and allow the extraction of excavated materials. In the case of dry drilling, the fluid is essentially composed of a large volume of low-pressure air in which a flow of a few liters of water per minute and polymers are added.

6.88.4.1.5 Exit pit: the local excavation allowing the receipt and recovery of the devices used by the drilling technique.

6.88.4.1.6 Entry pit or initial shaft: the local excavation from where the drilling is carried out.

6.88.4.1.7 Localization or exploratory well: the excavation pit allowing the localization of the other pipes or infrastructure.

6.88.4.1.8 Resurgence: the phenomenon that occurs when the pressure in the drilling hole exceeds the vertical earth pressure, which causes the soil to separate and the drilling fluids to be brought back to the surface.

6.88.4.1.9 Pulling: the part of the drilling process that consists in pulling the pipe towards the entry pit.

6.88.4.1.10 Pilot drilling: the first step in any drilling that consists in drilling a hole that will subsequently be reamed.

6.88.5 MATERIAL

6.88.5.1 PIPE

6.88.5.1.1 The pipe shall be made of HDPE. Its diameter and wall thickness shall be as indicated on the drawings.

6.88.6 EQUIPMENT AND TOOLS

6.88.6.1 DRILL

6.88.6.1.1 The drill used by the **Contractor** shall have sufficient capacity to carry out the pipe drilling and pulling operations.

6.88.6.1.2 The drill shall comprise a drilling fluid mixing and circulation system having sufficient capacity to complete the installation of the pipe without exceeding the tensile capacity thereof.

6.88.6.1.3 The drill shall be fitted with a drill head locating and guidance system.

6.88.6.1.4 The drill shall comprise a hydraulic system allowing the rotation, thrust and pulling of the steel rods into the ground, at a variable angle. During these operations, the pressurized drilling fluids shall be injected into the ground on a continuous basis through the drilling head.

6.88.6.1.5 All hydraulic systems shall be watertight and the drill shall have grounding throughout all operations.

6.88.6.1.6 If the drill is equipped with a lightning warning device, the latter shall be maintained in operation at all times.

6.88.6.2 DRILL HEAD

6.88.6.2.1 The drill head used by the **Contractor** shall be steerable and shall be chosen so as to be adapted to the soil conditions encountered.

6.88.6.3 REAMER

6.88.6.3.1 The reamer used by the **Contractor** shall have a diameter equivalent to 1.5 times the pipe's outer diameter or to 300 mm more than the pipe's diameter, whichever is the smaller of the two (2) measurements. In the event that soil swelling is apprehended, the reamer diameter shall be 25% larger than the value obtained.

6.88.6.3.2 All selected equipment shall be chosen so as to be adapted to the soil conditions encountered.

6.88.6.3.3 Unless otherwise indicated on the drawings, the **Contractor** is sole responsible for the choice of the reamer and of the reamer diameters needed to perform the work, as well as for the number of passes that must be performed to install the pipe. These choices shall be consistent with the soil conditions encountered.

6.88.6.4 THE LOCATING SYSTEM

6.88.6.4.1 The locating system used by the **Contractor** shall be calibrated, installed and operated by a qualified and experienced personnel. The operators shall be familiar with the magnetic and electromagnetic sources that may cause a failure of the locating system and impact thereof on the operations.

6.88.6.4.2 The probe placed in the drill head shall be autonomous. It shall transmit the information such as the position, depth with respect to the ground, inclination and clock position by electromagnetic waves to a receiver located on the surface. An operator shall be permanently assigned to this task.

6.88.6.4.3 The location system shall have a margin of error of less than 0.6% with respect to the angle of attack and of 5% with respect to the depth.

6.88.6.5 MIXER

6.88.6.5.1 The system used to mix the drilling fluid shall make it possible to mix the latter completely and uniformly so that it is homogeneous. In addition, it shall have a capability that allows a sufficient flow of fluid.

6.88.6.5.2 The drilling mud flow and pressure shall be controlled so as not to exceed the capacity of the installed pipe, limit the excavation and limit the possibilities of resurgence of drilling mud to the surface.

6.88.6.5.3 The circulation system shall be consistent with the soil conditions encountered. The capacity of the system shall allow, at the very least, the transportation of a volume of drilling mud equivalent to that of the soil drilled.

6.88.6.6 TECHNICAL DATA SHEETS

6.88.6.6.1 At least fourteen (14) days prior to the scheduled drilling date, the **Contractor** shall provide the Engineer with the technical data sheets of the equipment and tools that he plans to use.

6.88.7 EXECUTION OF WORK

6.88.7.1 SPILL MANAGEMENT

6.88.7.1.1 At least fourteen (14) days before the start of work, the **Contractor** shall submit to the Engineer, for review, a copy of its spill management plan. This plan shall comply with subsection 6.13 *Environmental Protection* and describe the measures used to contain spills, clean resurgences and clean contaminated surfaces, including the disposal of contaminated soil.

6.88.7.1.2 The following specific information shall be provided in the spill management plan with respect to the drilling fluid:

6.88.7.1.2.1 list of additives used and Material Safety Data Sheets thereof;

6.88.7.1.2.2 identification of the source of water used to mix the drilling fluid;

6.88.7.1.2.3 method used to contain the drilling mud;

6.88.7.1.2.4 method used to recycle the drilling fluid and excavated materials (where applicable);

6.88.7.1.2.5 method used to remove the excavated materials from the site;

6.88.7.1.2.6 drilling mud disposal site.

6.88.7.2 WORKING METHOD

6.88.7.2.1 The **Contractor** shall submit to the Engineer for review, at least fourteen (14) days before the start of work, a report that clearly describes its working method. The report shall include, without however being limited to, the following:

6.88.7.2.1.1 a plan, prepared from a precise survey, indicating the pipeline route. The maximum distance between each survey point shall be 10 m. The plan shall also include, without however being limited to, the following information:

6.88.7.2.1.1.1 the pipe profile in relation to the existing natural ground;

6.88.7.2.1.1.2 the cover above the pipe;

6.88.7.2.1.1.3 the pipe slope;

6.88.7.2.1.1.4 the radius of curvature of the pipe;

6.88.7.2.1.1.5 the localization of the entry and exit pits;

6.88.7.2.1.2 a work schedule;

6.88.7.2.1.3 a detailed description of the work method used;

6.88.7.2.1.4 a list of the materials and equipment used;

6.88.7.2.1.5 a description of the drill head guidance method (magnetic or other);

6.88.7.2.1.6 a letter from the pipe manufacturer stating that the conformity of the class of pipe used meets the requirements, particularly in regard to the constraints on the pipe;

6.88.7.2.1.7 the shop drawings and technical data sheets of the materials used;

6.88.7.2.1.8 the description of the planned tests;

6.88.7.2.1.9 the drilling fluid management.

6.88.7.3 EXCAVATION OF THE ENTRY AND EXIT PITS

6.88.7.3.1 Following the review of the working method by the Engineer and the localization of public utilities, the **Contractor** shall proceed with the excavation of the entry and exit pits.

6.88.7.3.2 The entry and exit pits shall be executed in the locations indicated in the work plan.

6.88.7.3.3 The depth of the entry and exit pits shall allow the drilling of the pipe to the elevation indicated on the drawings.

6.88.7.3.4 The entry pit shall be of sufficient size to contain all anticipated volumes of drilling mud and excavated materials.

6.88.7.4 DRILLING

6.88.7.4.1 Directional drilling shall be carried out to the depth indicated on the drawings.

6.88.7.4.2 Directional drilling shall be carried out using a rotating drill head pushed mechanically by steel rods. The directional head emits a signal which is detected at the surface by a portable receiver. The rotation of the head, determined by the operator, flexes the steel rods and, therefore, the direction taken by the directional head.

6.88.7.4.3 Once the directional head has reached its target, it shall be replaced by a rotating mandrel to which the **Contractor** shall attach the pipe indicated on the drawing. The mandrel and pipe are then pulled by the steel rods in the opposite direction of the initial course.

6.88.7.4.4 Directional drilling shall be carried out as horizontal as possible.

6.88.7.4.5 During the execution of the pilot drilling and during all stages of the reaming, the **Contractor** shall notify the Engineer when the drilling muds no longer return to the pits or when there is a return of parasitic fluids.

6.88.7.5 PROCEDURE OF INSTALLATION AND CONTROL OF THE PLACEMENT OF THE PIPE

6.88.7.5.1 The **Contractor** is required to select the adequate pipe fusion, welding or assembly mode and to follow all the manufacturer's recommendations regarding these tasks.

6.88.7.5.2 The **Contractor** is also responsible for carrying out the following controls, without however being limited thereto:

6.88.7.5.2.1 observe of the minimum radius of curvature of the pipe according to the manufacturer's recommendations;

6.88.7.5.2.2 ensure that the maximum tensile force on the pipe is never exceeded, in order to avoid any plastic stretching of the pipe;

6.88.7.5.2.3 ensure that the pipe does not undergo any ovalisation exceeding the manufacturer's recommendations following installation thereof;

6.88.7.5.2.4 when specified by the manufacturer, the **Contractor** shall remove all ice or snow deposits from inside the ends of the pipes and make sure that the surface to fusion or assemble does not show any impurities or defects that might prevent adequate joining. For HDPE pipes, the surface shall be properly cleaned with the GENESOLV 200 degreaser or equivalent approved by the Engineer;

6.88.7.5.2.5 for all HDPE type pipes, the **Contractor** shall perform a 10% rejection criterion verification. After the HDPE type pipe has been installed inside the opening, the Engineer must check, over a minimum length of 1.5 m, if the pipe has been damaged. Moreover, when possible, a visual check shall be carried out by the **Contractor** during the pulling in the excavations of localization wells and foreign structure trenches. If the HDPE type pipe has a groove or any other damage of a depth greater than 10% of the minimum thickness of the wall thereof, this pipe section shall be removed from the network and replaced by another pipe section;

6.88.7.5.2.6 the **Contractor** shall submit to the Engineer, at least fourteen (14) days before the start of directional drilling work, with proof that the operator is trained with the equipment in question and is qualified by the pipe manufacturer.

6.88.7.6 PIPE FUSION

6.88.7.6.1 The **Contractor** shall notify the Engineer, at least forty-eight (48) hours before carrying out any fusions between the HDPE type pipes, in order for him to be present during all fusion operations. In addition, a copy of the fusion procedures shall be submitted to the Engineer, for review, at least fourteen (14) days before the start of this work.

6.88.7.6.2 All fusion operations shall be carried out by a team of at least two (2) people.

6.88.7.6.3 The fusion of HDPE type pipes shall be carried out by the butt fusion method or by electrofusion.

6.88.7.6.4 Where necessary, the **Contractor** shall carry out the fusion under a shelter, in order not to contaminate the fusion by dust from the road or the environment.

6.88.7.6.5 No fusion shall be carried out at ambient temperatures below -15ºC, unless a shelter is built. The shelter shall be heated to maintain the ambient temperature beyond the prescribed temperature.

6.88.7.6.5.1 Butt fusion

6.88.7.6.5.1.1 This technique consists in heating two (2) ends of HDPE pipes which are retained against a heating plate until they reach the temperature needed for the fusion. The two (2) heated ends shall subsequently be joined one against the other and held in place according to the manufacturer's recommendations until the pipes have cooled down.

6.88.7.6.5.1.2 When the butt fusion method is used to assemble the HDPE pipes, the **Contractor** shall perform such work in accordance with the ASTM D2657 standard.

6.88.7.6.5.1.3 The control joint executed at the beginning of the day serves as quality indicator for all butt fusions executed during that working day.

6.88.7.6.5.1.4 A control joint shall be tested and accepted by the Engineer at the beginning of each day during which fusions will be carried out.

6.88.7.6.5.1.5 The control joint shall be about 150 mm long on each side of the fused joint by 25 mm, up to 1.5 times the pipe wall thickness in width.

6.88.7.6.5.1.6 A fusion for which a visual inspection does not indicate the presence of defects exceeding the manufacturer's recommendations may be used as a control joint. The control joint may be rejected by the Engineer if, following the endurance test, there are cracks or separation at the fusion.

6.88.7.6.5.1.7 For reference purposes, for pipes with a diameter smaller than or equal to 200 mm, a quality test on the butt joints shall be conducted according to the manufacturer's recommendations and in the presence of the Engineer.

6.88.7.6.5.1.8 All rejected butt joints shall be properly disposed of, in accordance to subsection 6.13 *Environmental Protection*.

6.88.7.6.5.2 Electrofusion

6.88.7.6.5.2.1 Electrofusion is an operation to connect two (2) HDPE parts out of which one is a fitting that can be electrofusioned using an electronic sequencer.

6.88.7.6.5.2.2 The fusion procedures shall be submitted to the Engineer for review.

6.88.7.6.5.2.3 For the electrofusion method, the **Contractor** shall specially take into account the constraints relating to alignment and tangential forces applied to the joints.

6.88.7.6.5.2.4 Electrofusion is allowed only for connections and shall never be used when pulling the pipe.

6.88.7.7 ABANDONMENT OF MATERIALS IN DRILLINGS AND DRILLING SHAFT CLOSURE

6.88.7.7.1 The **Contractor** is responsible for replacing, at its own expense, the equipment parts such as directional heads, steel rods, etc. that are stuck and abandoned in drillings.

6.88.7.7.2 When abandoning parts of equipment, the **Contractor** shall take the necessary measures to prevent any land subsidence. If necessary, he shall fill the space with unshrinkable fill in accordance with subsection 6.33 *Cast-in-Place Concrete*. If a second drilling must be carried out near an existing drilling, a minimum distance, based on the soil conditions, shall be agreed to between the Engineer and the **Contractor**.

END OF SUBSECTION